



Armada Health Services High Voltage Electrical Upgrades

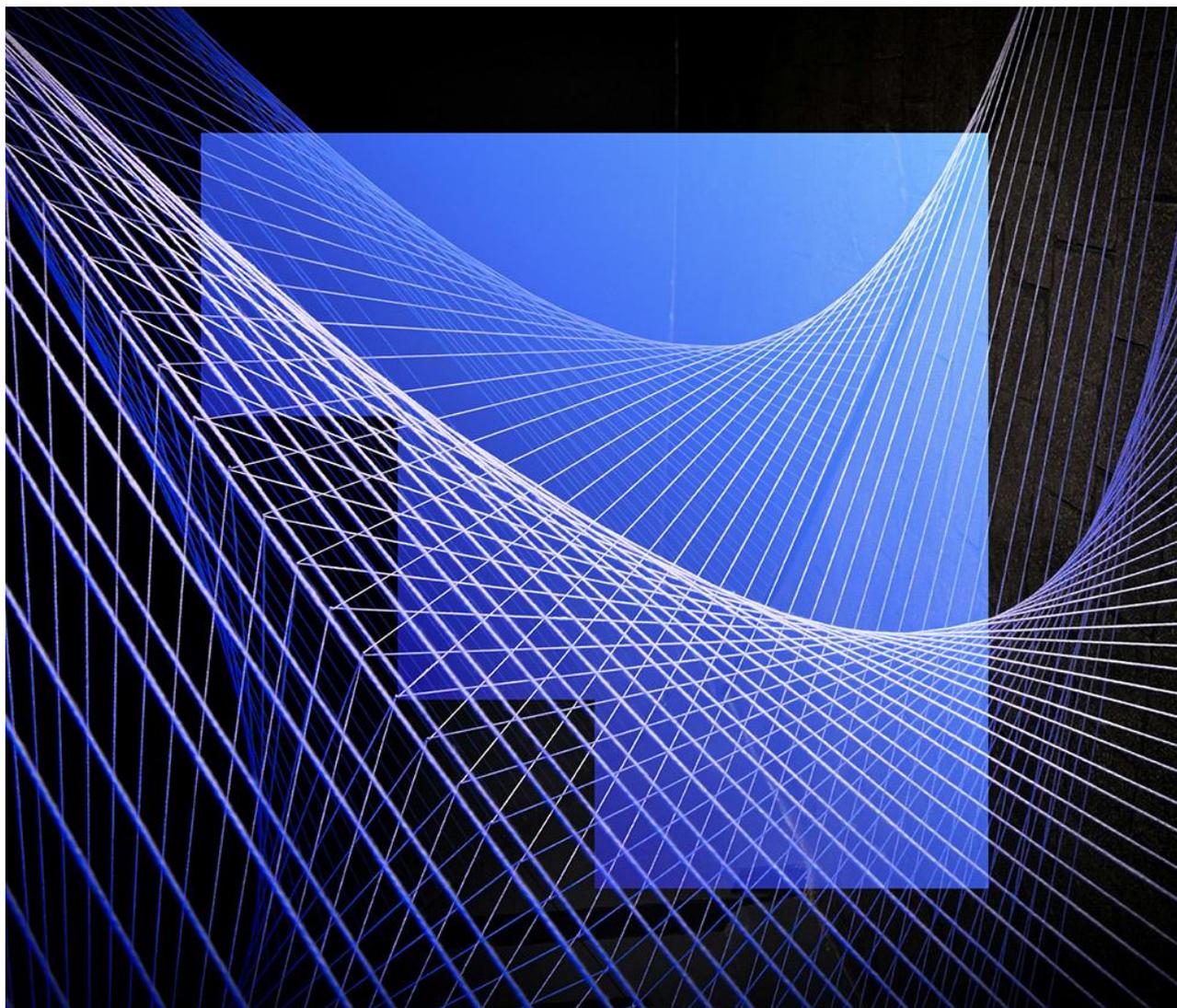
High Voltage / Low Voltage Substation Kiosk Specification

Tender Issue

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East Metropolitan Health Services

CONSULTING ENGINEERING SERVICES

Lucid Consulting Australia

STRUCTURAL AND CIVIL CONSULTING ENGINEERS

Lucid Consulting Australia



CONTENTS

CONTENTS	iii
1. General	1
1.1 Introduction	1
1.2 Cross References	1
1.3 Project Details	1
1.4 Definition Of Terms	2
1.5 Scope	4
1.6 Standards	4
2. Contract Submissions / Requirements	8
2.1 Tender Submissions	8
2.2 Hold Points	10
2.3 Workshop Drawings	11
3. Materials & Workmanship	12
3.1 General	12
3.2 Quality Assurance	12
3.3 Site Conditions	12
3.4 Package And Delivery	13
3.5 Warranties	13
4. 22 kV Ring Main Unit	14
4.1 General	14
4.2 Configuration	15
4.3 Minimum Performance Standard	16
4.4 Switchgear Chamber	16
4.5 Internal Arc Classification	17
4.6 Switchgear Requirements	17
4.7 Protection Relay	19
4.8 Current Transformer	20
4.9 Fault Passage Indication	20
4.10 Interlock	21
4.11 Padlock	21
4.12 Voltage Indication And Testing	21
4.13 Name Plate and Labels	22
4.14 Surface Protection	23
4.15 Earthing of Metallic Parts	23
5. 22 kV/ 433 V Oil Immersed Transformer	24
5.1 Performance Characteristics	24



5.2	Transformer Requirements	25
6.	Low Voltage Main Switchboard	33
6.1	General	33
6.2	Performance Characteristics	33
6.3	External Design	34
6.4	Busbars	35
6.5	Neutral And Earth Links	36
6.6	Finishes	36
6.7	Switchgear	36
7.	Outdoor Kiosk / Enclosure	40
7.1	Construction	40
7.2	Access And Doorways	40
7.3	Surface And Coating	41
7.4	Labelling	41
8.	Inspection And Testing	42
8.1	General	42
8.2	General Testing	42
8.3	Ring Main Unit Testing	42
8.4	Distribution Transformer Testing	45
8.5	Low Voltage Main Switchboard Testing	48



1. General

1.1 Introduction

This document defines the minimum requirements for the design, materials, manufacture, surface protection, inspection, testing, documentation, packaging and delivery for the supply of High Voltage (HV) / Low Voltage (LV) Substation Kiosks, including all ancillary equipment and appurtenances.

All materials used shall be new and of the best quality and of the class most suitable for working under the conditions specified.

Variations of temperature, pressure, etc. arising under working conditions shall not create any distortion or deterioration, or cause any undue stresses in any part that will affect the strength and suitability of the equipment to continue to perform its required duty.

Where the features of the standard design offered by the Supplier vary from, or exceed, the stated requirements the Supplier shall bring this to the attention of the Project Manager for approval.

This document shall be read in conjunction with the associated scope of work document, data sheet/s and other supporting reference schedules.

The Supplier shall adhere to the following complementary requirements when undertaking Work. Adherence to the following complementary requirements is notwithstanding Supplier satisfaction of all legislative requirements under the Contract.

1.2 Cross References

All work covered within this specification shall be read in conjunction with the following trade packages and contracts. Should any discrepancy occur between the references the larger/greater shall be assumed and referred to the Engineer prior to proceeding with any works.

- Architectural Drawings and Specification
- Civil Drawings and Specification
- Structural Drawings for details of footings, piers, beams, columns or the like
- EMHS CAD Drafting Standards and Procedures Manual.

The above documents shall be made available on request through the Client.

1.3 Project Details

The works described within this specification pertain to the High Voltage (HV) Electrical Services at Armadale Health Services, 3056 Albany Hwy, Mount Nasura, 6112. Specifically, the construction and supply and of new 22/0.433 kV Kiosk Distribution Substations (KDS) inclusive of the following:

- 1 MVA, Kiosk 1 at Substation 1 Leschen.
- 1 MVA, Kiosk 2 at Substation 1 Leschen.
- 1 MVA, Kiosk 1 at Substation 2 Central Plant.
- 1 MVA, Kiosk 2 at Substation 2 Central Plant.



1.4 Definition Of Terms

Client/Principal	- Client or end user of the proposed facility. East Metropolitan Health Services
Consulting Engineer	- Consulting engineering firm or individual, appointed by the client, to act as their representative. Lucid Consulting Australia
Electrical Supply Authority	- Western Power Corporation
Equipment	Means the goods to be supplied or supplied by the Provider or Supplier.
Contractor	The Supplier/Manufacturer undertaking the works. Party/company who supplies or manufactures equipment used in the works.
Works	- As described within this specification
Provide	- Design, Construct and Supply
Equal Approved	- Alternative product/method which is presented to the Consulting Engineer and written approval is received.
To Approval	- The Principal must approve this element of the work prior to proceeding with the construction noting that Principal approval is not considered acceptance of the construction.
K	- Natural Ester Oil
SWMS	- Safe Work Method Statement
JSA	- Job Safety Analysis
PCMS	- Power and Control Management System also known as BMS/SCADA
BMS	- Building Management System
SCADA	- Supervisory Control and Data Acquisition
EMHS	- East Metropolitan Health Services
HV	- High Voltage



LV - Low Voltage

ACB - Air Circuit Breaker



1.5 Scope

The scope includes:

- Design, construct, supply, offloading and handover onsite of 3 (off) 1 MVA, 22/0.433 kV Kiosk Distribution Substation (KDS) which comprises the following:
 - Ring Main Unit (RMU) (4 way, I/B/I/B configuration),
 - 22/0.433 kV, 1000 kVA ester oil immersed (KNAN) Transformer,
 - 1600 A LV Circuit Breaker Panel,
 - Remote Operation Panel.
- Design, construct, supply, offloading and handover onsite of 1 (off) 1 MVA, 22/0.433 kV Kiosk Distribution Substation (KDS) which comprises the following:
 - Ring Main Unit (RMU) (5 way, B/I/B/I/B configuration),
 - 22/0.433 kV, 1000 kVA ester oil immersed (KNAN) Transformer,
 - 1600 A LV Circuit Breaker Panel,
 - Remote Operation Panel.
- Kiosk enclosure.
- Cable termination and connection for HV, LV and control circuits.
- HV remote control and mimic panel.
- Earthing and bonding.
- Testing and commissioning.

1.6 Standards

Referenced documents: The latest version of the Australian and International Standards applicable for the works contained within this document should be adopted for works covered by this Specification. The following standards are referred by and/or form part of this Specification:

Code	Description
AS 1214	Hot-dipped galvanised coatings on threaded fasteners
AS/NZS 1170.4	Structural design actions - Earthquake actions in Australia
AS/NZS 1554	Structural steel welding (including all relevant parts)
AS 1580	Paints and related materials - Methods of test - Introduction and list of methods
AS/NZS 1627 Set	Metal Finishing - Preparation and pre-treatment of surfaces
AS 1767	Insulating liquids
AS 1882	Earth and bonding clamps



Code	Description
AS 1931.1	High-voltage test techniques - Part 1: General definitions and test requirements
AS 1931.2	High-voltage test techniques - Part 2: Measuring systems
AS/NZS 2053 Set	Conduit and fittings for electrical installations set
AS 2067	Substations and high voltage installations exceeding 1 kV a.c.
AS/NZS 2081	Electrical protection devices for mines and quarries
AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion using protective coatings (including all relevant parts)
AS 2629	Separable insulated connectors for power distribution systems above 1 kV
AS 2650	Common specifications for high-voltage switchgear and controlgear standards (IEC 60694, Ed.2.2(2002) MOD)
AS/NZS 2700	Colour standards for general purposes
AS 2791	High-voltage switchgear and controlgear - Use and handling of sulphur hexafluoride (SF6) in high-voltage switchgear and controlgear
AS/NZS 3000	Electrical Installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3008	Electrical installations - Selection of cables Part 1 - Cables for alternating voltages up to and including 0.6/1 kV
AS 3756	Paints for steel structures (including all relevant parts)
AS 4436	Guide for the selection of insulators in respect of polluted condition
AS 4680	Hot-dipped galvanized coatings (zinc) on fabricated ferrous articles
AS 60038	Standard voltages
AS 60044.1	Instrument transformers Part 1: Current transformers (IEC 60044-1 Ed.1.2 (2003) MOD)
AS 60044.2	Instrument transformers – Part 1: Inductive voltage transformers
AS 60044.5	Instrument transformers – Part 5: Capacitor voltage transformers
AS 60060.3	High-voltage test techniques - Definitions and requirements for on-site testing
AS/NZS 60137	Insulated bushings for alternating voltages above 1000 V (IEC 60137, Ed. 5.0 (2003) MOD)
AS/NZS 60265.1	High-voltage switches - Switches for rated voltages above 1 kV and less than 52 kV



Code	Description
AS 60270	High-voltage test techniques - Partial discharge measurements
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS/NZS IEC 60947 (Series)	Low Voltage Switchgear and Control Gear
AS/NZS 61000.3.6	Electromagnetic compatibility (EMC) - Limits - Assessment of emission limits for distorting loads in MV and HV power systems (IEC 61000-3-6:1996)
AS/NZS 61439 (Series)	Low-voltage switchgear and controlgear assemblies
AS 62271	High-voltage switchgear and control-gear
AS 62271.1	High-voltage switchgear and controlgear - Common specifications
AS 62271.100	High-voltage switchgear and controlgear - High-voltage alternating-current circuit-breakers (IEC 62271-100, Ed. 1.2 (2006) MOD)
AS 62271.102	High voltage switchgear and controlgear - Alternating current disconnectors and earthing switches (IEC 62271-102, Ed.1.0(2003) MOD)
AS 62271.200	High-voltage switchgear and controlgear Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV (IEC 62271-200, Ed. 1 (2003) MOD)
AS 62271.201	High-voltage switchgear and controlgear Part 201: AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
AS 62271.202	High-voltage switchgear and controlgear Part 202: High-voltage/low-voltage prefabricated substation
AS 62271.203	High-voltage switchgear and controlgear - Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV
AS 62271.301	High voltage switchgear and controlgear Part 301: Dimensional standardization of terminals
AS 60076.1	Power Transformers Part 1: General (IEC 60076-1, Ed.3.0 (2011) MOD)
IEC 60376	Specification and acceptance of new sulphur hexafluoride
IEC 60480	Guidelines for the checking and treatment of sulfur hexafluoride (SF ₆) taken from electrical equipment and specification for its re-use
IEC 61810-1	Electromechanical elementary relays (Set)
IEC 62271.105	High-voltage switchgear and control gear - Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV



Code	Description
ENA EG1	Substation Earthing Guide
IEC 62975	Natural esters – Guidelines for maintenance and use in electrical equipment

Table 1: Codes and Standards List

The works shall comply with the following statutory requirements: -

- Electricity Corporation Act 2005
- Electricity Act 1945;
- Occupational Safety and Health Act 1984.
- Occupational Safety and Health Regulations 1996.
- Electrical (Licensing) Regulations 1991;
- The local and national Electricity Acts, Rules and Regulations.
- Work Health and Safety Welfare Act and Regulations.
- Electricity Supply Authority Service Rules and Conditions of Supply.
- Federal, State and Local Government Building Acts and Regulations.
- All other relevant statutory requirements;



2. Contract Submissions / Requirements

2.1 Tender Submissions

The submissions required at Tender shall incorporate, as a minimum, all information defined within the Appendices of this Specification. Any appendices not completely filled out will be rejected.

Identical equipment to that approved by the Consulting Engineer must be installed on site. Equipment will only be considered “equal approved” if it has been approved by the Consulting Engineer.

Review and approval of the technical data does not remove from the Supplier the responsibility to comply with the requirements of the tender documentation.

2.1.1 Information To Be Provided

To enable the Consulting Engineer to evaluate the equipment being offered, (in addition to the completed attachments) Tenderers will submit the following information with their tender:

General

- A list showing similar equipment supplied to or on order from other Australian clients.
- Installation and maintenance manuals for all equipment.
- Full details of the protective coatings offered.
- Safety information.
- Disposal at end of service life.
- A list of all departures of tender from this specification.

Ring Main Unit

- General arrangement drawings of the RMU offered including details of the HV cable terminations.
- Type test certificates for the RMU offered, or RMU of similar design and rating.
- Short circuit test details for equipment of similar design and rating.
- Erection, testing and maintenance information - the following information with particular reference to the equipment being supplied to this specification shall be provided:
 - A comprehensive description of the plant, its construction, operation and performance capabilities.
 - A tabulation of the guaranteed electrical and mechanical performance characteristics of the equipment.
 - Detailed procedure for receiving, handling and storage.
 - Pre-energisation checks on components and assemblies.
 - Repair procedures for surface coatings.
 - Special precautions during disassembly and reassembly.
 - Relevant special requirements for reassembly (e.g. nut/bolt tensions, crimp connections, welding, etc.)

Distribution Transformer

- General arrangement drawings of the transformers offered including details of the HV cable elbow connectors and LV terminal palms.



- Type test certificates for the transformers offered, or transformers of similar design and rating.
- Typical loading curves (for loading transformers in accordance with AS 60076.7 for oil-immersed power transformers).
- Typical loading curves (for loading transformers in accordance with AS 3953 for dry-type power transformers).
- Short circuit test details for equipment of similar design and rating.
- A tabulation of the guaranteed electrical and mechanical performance characteristics of the equipment.
- Transformer ancillary equipment model numbers and datasheets.
- Detailed procedure for receiving, handling and storage of transformer.
- Detailed procedure for receiving, handling and storage, and required specification of transformer oil.

Low Voltage Main Switchboard

- General arrangement drawings of the Low Voltage Main Switchboard offered including details of the LV cable terminations
- Type test certificates for the Low Voltage Main Switchboard offered, or one of similar design and rating.
- Short circuit test details for equipment of similar design and rating.
- Erection, testing and maintenance information - the following information with particular reference to the equipment being supplied to this specification shall be provided:
 - A comprehensive description of the plant, its construction, operation and performance capabilities.
 - A tabulation of the guaranteed electrical and mechanical performance characteristics of the equipment.
 - Detailed procedure for receiving, handling and storage.
 - Pre-energisation checks on components and assemblies.
 - Repair procedures for surface coatings.
 - Special precautions during disassembly and reassembly (including bushings).
 - Relevant special requirements for reassembly (e.g. nut/bolt tensions, crimp connections, welding, etc.)

Substation Kiosk Enclosure

- General plans, elevations, sections, and other relevant dimensions.
- Cable entry and exit details.
- Location and swing of panels / doors.
- IP rating of offered kiosk enclosure.



2.2 Hold Points

The Contractor shall not commence works on site prior to receipt of written approval for design from Principal.

The Table 2 outlines key hold points that the Contractor is required to achieve / submit information to / notify the Principal for review. Response times are indicative only.

The Contractor is required to respond to all review comments provided by the Principal, ensuring that each is resolved to the Principal's satisfaction prior to next submission.

Clause Reference	Submission Stage	Hold Point	Response Time
2.3	Pre-Construction	Technical Datasheets	10 Working Days
		Workshop Drawings	5 Working Days
		Calculations	5 Working Days
		Functional Controls Specification	5 Working Days
		Constructions Approvals	2 Working Days
2.4	Kiosk Construction	Inspections	2 Working Days
		User Training	10 Working Days
		Prototype copies of Operation and Maintenance Manuals (including As-Constructed Drawings)	5 Working Days
2.4	Post Construction	Operation Maintenance	10 Working Days

Table 2: Hold Points



2.3 Workshop Drawings

Construction Workshop Drawings for Review

Requirement: Supply construction workshop drawings detailing the following items for each HV/LV substation kiosk:

- A fully dimensioned general arrangement drawing for each substation kiosk with the location of all fittings, enclosure panels showing:
 - General plans, elevations, sections, and other relevant dimensions.
 - Centre-lines and centre of gravity.
 - Electrical clearances.
 - Location of lifting points (with maximum sling angle identified) & any associated lifting equipment required.
 - Jacking, towing and tie down points.
 - Maximum safe slope identified which the kiosk can ascend/descend.
 - Cable gland plate and gland details.
 - Cable entry and exit details.
 - An electrical clearance table.
 - Location and swing of panels / doors.
- A drawing showing the name plate and labelling for each equipment.
- IP rating.
- Comprehensive user guides.
- Special precautions during disassembly and reassembly.
- Repair procedures for surface coatings.
- Equipment and kiosk earthing details including proposed bonding and fixing methodology.



3. Materials & Workmanship

3.1 General

The following clauses set out the general requirements for the works. These requirements are not intended to cover all aspects of the manufacturing and supply of the 22/0.433 kV KDS and must be read in conjunction with all other sections of the Specification.

Workmanship shall be of a high standard and each section of the work shall be properly and neatly executed to the best trade practice.

All materials used for equipment shall be new, unused and free from defects.

3.2 Quality Assurance

Implement a Quality Assurance System for the works in accordance with the following Australian Standards:

- AS/NZS ISO 9000
- AS/NZS ISO 9001

The Quality Assurance System shall cover the following minimum aspects:

- Detailed plan setting out supervision, quality control and checking (witness point) procedures.
- Details of the Electrical Contractor's Quality Assurance Plan shall be submitted to the Superintendent upon request.

3.3 Site Conditions

The RMU shall be suitable for operation at the specified rating under the following service condition:

Item	Condition
Elevation	<1000 m
Air Temperature	40°C maximum 3°C minimum
Relative Humidity	80 % - maximum; 50% - minimum
Pollution	Dusty atmosphere containing fine abrasive particles. Pollution category "Heavy". Condensation may appear.
Isokeraunic Levels:	>20 thunder days per year
Rainfall	Heavy Rain, 600 mm average per year 110 mm (max per 24 hours)
Wind	Region A, Terrain Category 3
Corrosion Class	C3 – Medium



Table 3: Site Conditions

3.4 Package And Delivery

Packaging and delivery shall comply with all requirements for Packaging and Transport of Goods to site or a location nominated by the Principal.

After satisfactory completion of final inspection and tests, the Contractor shall dismantle, suitably pack for ocean, rail or road transport, clearly mark and deliver the Equipment in accordance with this Specification. The Contractor shall be responsible to provide insurance during this period, including unloading.

Two weeks prior the equipment dispatch the Contractor shall provide details of equipment and material packaging and preservation requirements for any stage of the work or during delivery of equipment or materials for Principal review and approval.

The Equipment shall be packed in such a manner to protect it from any damage and corrosion during handling, transport, storage and offloading. All items shall be crated. The crates shall be suitable for outdoor storage.

Packing Details shall consist of:

- Drawings showing the Equipment packed for shipment and shipping arrangement required for handling the Equipment during the transport and/or erection.
- Packing list and shipping documents in accordance with this Specification.
- Notice of consignment number and contract details of the transport/shipping company.
- At least 7 working days' notice shall be given to Principal prior to unloading.

Immediately upon dispatch of the item(s) of the Equipment from the Manufacturer's works, a copy of the complete packing list shall be sent to the Principal electronically. This should list the contents of each case, procedures describing the controls to prevent loss, damage or deterioration of equipment and material.

In addition, details of proposed means of disposal of all material used for storage, preservation and packaging shall be provided by Contractor.

The Contractor shall allow for storage of the kiosk should delivery and transport to site of the kiosks are delayed. Storage shall be charged on a per day basis under Schedule of Rates with prior approval from the Principal.

The Contractor to provide methodology for unloading/lifting plan and, SWMS/JSA for review at least 7 days prior to unloading.

The Contractor shall provide a list of all people attending site to the Principal and registered on Sitepass at least 7 days prior to site attendance.

3.5 Warranties

All equipment and workmanship are required to be provided with a warranty. Warranty periods shall be for the manufacturer's standard period only, unless extension offers become available at no cost in the purchase of the equipment.

Warranties must commence at date of supply, not the date of construction. Ensure due allowance for this is made within tender price.

All warranties however must have a minimum period of 12 months from the date of Practical Completion.

Details for all products with extended manufacturers warranties shall be provided with the tender.



4. 22 kV Ring Main Unit

4.1 General

The Switchgears supplied shall consist of freestanding, dead front, metal clad, panel types equipped with main contacts in vacuum or gas switchgear and protection relays as a single assembly. The switchgear shall be SF6 free.

Unless otherwise stated, Switchgears shall have the following characteristics:

- Mechanical indicators shall provide visual indication of switch status at all times.
- Provision shall be made for locking of the RMU in the 'ON', 'OFF' and 'Earthed' positions.
- Provide auxiliary switches that indicate the Open/Closed/Tripped status of each item of switchgear. Connect these switches to a separate terminal strip for extension to a future PCMS.
- Provide one set of equipment required for the safe and satisfactory operation of the switchgear, such as operating handles, fuse extractors, etc. for each RMU. Mount equipment within a mounting frame suitable for wall mounting within a kiosk substation.
- Provision of fault passage indicators connected to terminal strips for connection to a future PCMS. Refer Table 4.
- Provide capacitive test points for voltage indication and phasing purposes; and
- The RMU should be operated without the need to be standing directly in front of it / clear of any potential blast from a switchgear fault. Preference is for operation of the Switchgear and RMU from a control panel at the LV end of the kiosk substation. Operation of the mimic panel shall require the insertion of a HV key. Motor units and auxiliary equipment as required to be provided.

For emergency and maintenance purposes the following controls and indicators shall be provided on each switchgear panel:

- Local Open/Close electrical controls.
- Local/Remote switch – the Open pushbutton shall be active irrespective of the position of the Local/Remote switch.
- Illuminated indicators for: (1) Open (or not racked in) – Green (The Open indicator shall light even if the CB truck is not in the panel.) (2) Closed (In the Service position and racked in) - Red (3) Tripped (due to the action of any protection relay) - Yellow (4) CB in Local Mode – Yellow.

RMU specification is based on Schneider RM Airset switchgear. If the Contractor provides a proposal based on other preferred switchgear, the Contractor shall provide the proposal as an alternative.

Preferred switchgear:

- Schneider.
- ABB.



4.2 Configuration

The system shall not contain any pressurised gas for breaking, disconnection or insulation medium, and shall be totally SF6-free. The RMU shall be extendable to allow the installation of an additional breaker/switch disconnector of equal rating in the future. The kiosk shall also be large enough for the future configuration. The kiosk shall also be high enough to fit future breaker/switch disconnector/fuse switch disconnector/ protection relays.

Refer to section 1.5 for RMU configurations.

Technical Parameter	Unit	Circuit Breaker	Isolator	Earth Switch
System Highest Voltage	kV (rms)	24	24	24
Normal System Voltage	kV (rms)	22	22	22
Frequency	Hz	50	50	50
Lightning Impulse Withstand Voltage	kV (peak)	125	125	125
Power Frequency Withstand Voltage (1 Minute) (rms)	kV-min (rms)	60	60	50
Fault Making Capacity	kA (peak)	50	50	50
Short Circuit Withstand Current	kA	20	20	20
Short Circuit Withstand Duration	Sec	3	3	3
Load breaking capacity / Rated Current	A	630	630	
Busbar current rating	A	630	630	
Minimum number of mechanical switching operations at no load	No	10,000	1,000	1,000
Minimum number of mechanical switching operations at rated normal current	No	1,000	1,000	
Minimum number of mechanical switching operations at rated short circuit current	No	5	5	5
Auxiliary Equipment				
Remote Motorized Operation		Yes	Yes	No
Auxiliary Contacts		2 NO – 2NC	2 NO – 2NC	2 NO – 2NC
Voltage / Cable Live Indicator		Yes	Yes	
Test Box		Yes	Yes	



Current Transformers	Protection	Yes, including core balance type for earth fault protection	No	No
	Other	No	Yes – Fault Passage Indication	No
Protection Relay		Yes.	No	No
Fault Passage Indication		No	FLAIR 23DM	No

Table 4: RMU Characteristics

4.3 Minimum Performance Standard

The minimum operational lifetime of the equipment shall not be less than 30 years.

The switchgear must comply with category LSC2A as defined in AS 62271.200.

4.4 Switchgear Chamber

The RMUs shall be totally enclosed, protected against dust, humidity and rain and shall be designed to prevent the entry of vermin and insects.

The HV and LV windings shall be made from copper or aluminium conductors. Windings shall be designed to reduce to a minimum any unbalanced magnetic forces due to short circuit conditions.

The design shall ensure that components and welded connections are subjected to low peak and alternating stresses in all areas to eliminate the chance of fatigue failure. The support frame shall incorporate suitable lifting lugs.

The design shall be such that all electrically active parts and inter-bay busbars are housed in a sealed enclosure. This tight housing together with the fuse chamber shall constitute a fully insulated design so as to render the switchgear functions completely insensitive to the outside environment.

The switchgear chamber shall be designed to withstand the pressure due to an internal arc supplied by a current equal to the rated short circuit current listed in *Section 4.2* of the equipment for one second. For any abnormal pressure rises above this, the switchgear chamber shall be provided with a pressure relief vent in accordance with *Section 4.2* without causing any danger to the operating personnel.



The IP rating of the equipment shall be of the following:

Function	IP rating
Main HV Compartments	IP 54
Low Voltage Control Compartment	IP 3X minimum
HV Cable Compartment	IP 2X minimum

4.5 Internal Arc Classification

The RMU shall comply with the requirements of *AS 62271.200 Annex A, Accessibility Type AFL*. Operators of the Equipment shall be protected against the effects of an arcing fault in any of the HV compartment at all times, including while carrying out maintenance work on other compartments. Full arc containment shall be possible under these conditions.

The prefabricated kiosk, along with the equipment housed in it, must be compliant with *AS 62271-202 Annex A, Classification IAC-AB*. Irrespective of the operational mode of the RMU the enclosure must provide protection to the general public and the operator from an internal arc with the doors closed.

Arc containment in both the cases shall be achieved for the short circuit fault current in accordance with *Section 5.2* for duration of one (1) second.

The heat and overpressure resulting from internal arc inside the sealed chamber shall be limited by the opening of pressure limiting devices in the lower part of the enclosure.

The internal arc energy and gas shall be vented out of the switchgear through the bottom or rear of the switchgear ensuring compliance with the requirements above.

The Supplier/Contractor shall provide type test reports to prove compliance with *AS 62271-200, Annexure A*, and with internal arc protection classification as stated on the data sheets for the enclosure of the RMU.

4.6 Switchgear Requirements

4.6.1 Operating Mechanism

The RMU shall be of ergonomic design. The operating mechanism shall be manually initiated, but the speed of closing and opening shall be determined by a spring and not the action of the operator. Switch operation shall be controlled externally from the front by a removable handle. The handle shall be of such a length that it complies with the relevant internal arc protection requirements and extends beyond the enclosure to enable ease of operation. The effort exerted on the handle by the operator should not be more than 250 N. One set of operating handles shall be provided for each RMU unit. Facilities for storing the handles shall be provided.

The direction in which the handle must be moved in order to attain a particular position shall be clearly marked on the front of the units. All 3 phases are to be switched at the same time.

An incomplete movement of the handle shall not leave any energy in the spring.

It shall not be possible, without the use of tools, to gain access to the tripping toggle or any part of the mechanism which would allow defeat of the mechanical tripping feature.



4.6.2 Switch Disconnecter

Switch disconnectors shall be load breaking and fault-making type and comply with AS 60265.1, AS 62271.102 and AS 62271.100. Switches shall be designed for interrupting full rated current in accordance with as stated in *Section 4.2* as well as small inductive or capacitive currents involved in disconnecting cables.

The switch-disconnectors shall be three-phase, spring assisted and manually gang operated.

Each switch-disconnector shall be provided with an interlocked earthing switch for earthing the isolated feeder cable. The option of having two independent manual operating mechanisms for switch disconnector and earth switch is also acceptable. However, the Contractor or Supplier shall ensure that the safety of operators is not compromised, and the interlock systems are provided as required in *Section 4.2*. The design shall prevent simultaneous closing of the main switch contacts and the earth switch contacts.

Switch-disconnectors shall be provided with the following indication clearly visible from the front panel: -

- "SERVICE" by indicating "ON" or "OFF"

4.6.3 Earth Switch

Earth switches shall be fault-making type and shall comply with AS 60265.1, AS 62271.102 and AS 62271.100.

Earth switches shall be three-phase, spring assisted and manually gang operated.

It shall not be possible to switch, in one operation, directly from the "on" to the "earth" position.

Double Bolt Earthing bars shall be supplied for earthing of all metal structures to the general earth mass at both ends of the ring Main Unit.

Earth switch shall be provided with the following indication clearly visible from the front panel: -

- "CIRCUIT EARTH" by indicating "OFF" or "EARTH".

Facilities for padlocking shall be provided for the purpose of preventing inadvertent earthing.

4.6.4 Circuit Breaker

Circuit breaker (CB) units, shall comply with the requirements of AS 2650 and AS 62271.100. CB units shall comprise a fixed circuit breaker, switch-disconnector and interlocked earth switch.

CB units shall have electronic relay operation and shall be a self-powered protection unit in accordance with *Section 4.2*. The CB shall be designed for interrupting full rated fault current, and for making full fault current as stated in *Section 4.2*. The interrupting medium can be either gas.

Circuit breakers shall be trip free and be equipped with a stored energy operating mechanism. The operating mechanism shall provide independent manual closing and stored energy tripping. The mechanism shall include: -

- Pushbuttons for opening and closing,
- Mechanical "open/closed" position indicator,
- "Charged/discharged" indicator for the operating mechanism springs,
- Local means for manually discharging the springs, and,
- Auxiliary contacts.



Opening of the circuit breaker is actuated either by the removable operating handle mechanism, local push button, by the protection device or by remote tripping signal. Closing movement charges the opening mechanism of the circuit breaker.

Closing of the circuit breaker is actuated either by the removable operating handle mechanism, local push button or by remote closing signal.

The spring charging lever shall form an integral part of the mechanical operating mechanism. The spring charging lever must not be removable.

Circuit breakers shall be provided with a motor mechanism for electrical charging of the operating mechanism as well as the necessary accessories and operating handle(s).

Circuit breakers requiring an electrical supply for charging operating mechanisms shall be provided with an independent emergency manual operating mechanism. Power for the closing and opening devices shall be derived from the high voltage supply, (i.e. self-powered).

A four digit operational cyclometer shall be fitted to each circuit breaker.

Auxiliary switches on circuit breakers shall be in accordance with AS 62271.

Circuit breaker shall be provided with the following indication clearly visible from the front panel: -

- "SERVICE" by indicating "ON" or "OFF"

4.6.5 Identification and Wiring

The functional identification system as per all internal wiring shall comply with Table E1 of AS 2067.

The ends of each cable and control wire shall be identified by suitable markings to show its function, name, input and output.

All HV and LV cables shall be labelled by providing a stainless-steel tag at each end of each HV cable indicating:

- The cable source and destination.
- The cable size and construction.
- The date installed (new cables only).

The labels shall be a proprietary system with the letter size being adequate to be easily read from the required distance (minimum 5 mm high).

General labels shall have black lettering. Coloured labels, e.g. red, shall be used to provide emphasis for warning labels.

Each disconnecter and circuit breaker panel shall be provided with fixed labelling indicating the panel name and supply origin. Labels shall be permanent traffolyte.

Handwritten labels are not acceptable.

4.7 Protection Relay

Protection relays shall be dual-powered i.e. self-powered and provided with an auxiliary Vdc electrical supply. The relay auxiliary 24 V battery supply shall be capable of 4 hours backup duration. Two control operations per device and two protection operations per device. The relay is to detect phase and earth faults and shall have the ability to accommodate the transformer onboard protection devices trip signals.

The relays shall be capable of withstanding the output current of the associated current transformers corresponding to a primary current equal to the applicable network maximum fault current and time of the assembly.



The protection relay shall have as a minimum the following features for phase and earth faults protection: -

- Selectable inverse time characteristics trip curves, including Standard Inverse, Very Inverse, Extremely Inverse and Long Time Inverse.
- Inverse definite minimum time trip curve.
- Instantaneous or High Set Definite time operation.
- All trip settings shall be adjustable in steps from the front of the relay.
- Indicators on the front of the relay to reflect the protection function that caused the CB to trip.

The trip output from the relay shall be matched to the tripping requirement of the circuit breaker.

Three phase sets of current sensors or CT's shall be provided with each circuit breaker and relay unit. Current transformers must be suitable for overcurrent protection and fault current disruption. The relays shall be provided with calibration and testing facilities, manual reset devices and operation indication.

The Protection Relay shall be provided with remote monitoring and control facility via specified control protocols and communication protocols such as Modbus or Ethernet.

4.8 Current Transformer

The current transformers (CT's) shall have the same short-time withstand current and rated voltage as the switchgear. They shall be in accordance with IEC 61869-2 and be made of cast epoxy resin.

Each CT shall be labelled individually. A second label shall be installed on the front of the switchgear.

The CT's must be provided with conformity assessment certified by an approved laboratory affiliated with international organisations. CT's not satisfying these criteria will not be accepted.

4.9 Fault Passage Indication

The fault passage indicator shall be Schneider Flair 23DM or equal, subject to approval. The device will allow communications on a RS485 link in Modbus protocol with access to states and measurements and remote parameter setting through a future PCMS.

4.9.1 Fault Indication

Fault indication will be as follows:

- Display of settings and faulty phases as soon as the fault is confirmed.
- Indication via red LED on front panel.
- Indication of faulty phase on LCD display.

4.9.2 Fault Detection

- Detection of phase/phase short circuits and earth faults.
- Capability to perform special override settings.
- Inrush function to prevent unwanted detection in the event of inrush on load switching on.



4.10 Interlock

An adequate mechanical interlock system shall be provided on the Equipment to prevent mal-operation and to ensure operator safety.

The interlock system shall prevent operational access to parts of the switchgear functional unit that contain live components so that access to such parts is not possible unless all live parts have been rendered safe, either by an applied earth connection or by being positively disconnected and screened from the remaining live parts.

The design of the interlock system shall be in compliance with *Section 5.1.1* of AS 62271.200.

The interlock system must be such that it shall not be possible for the operator to physically override the interlock controls. The following interlock system must be achieved in the Equipment: -

- It shall not be possible to operate the earth switch to ON/OFF unless the switch disconnecter or circuit breaker is in the OFF position.
- It shall not be possible to operate the switch disconnecter or circuit breaker to ON unless the earth switch is in the OFF position.
- It shall not be possible to remove partially or completely the cable compartment covers unless the main switch has first been turned OFF and then the earth switch turned ON.
- Once the compartment cover has been removed, it shall be possible to take the earth switch OFF (for testing purposes).
- It shall not be possible to turn the main switch to the ON position while the cable compartment cover is removed at any time.
- It shall not be possible to open the testing access when the equipment is in any other than the “EARTH” position.
- It shall not be possible to insert or withdraw testing devices when the equipment is in any other than the “EARTH” position.
- It shall not be possible to move the switch from the “EARTH” to the “OFF” position with the testing access open and the testing device inserted.

4.11 Padlock

The Equipment shall have robust padlocking facilities for locking each switch operating handle entries in the “ON”, “OFF” or “EARTH” position. This provision includes switch disconnectors, circuit breakers, fuse switches and earth switches. These locking facilities shall prevent inadvertent operator switching as well as unauthorised switching.

The minimum diameter hole for padlocks shall be 10 mm and it shall be positioned to attach the padlock at the lips of the operating handle entries and such that the shank of the padlock can be easily inserted onto the hole.

The padlocking facility material shall be robust and compatible with the life of the RMU. The Supplier or Contractor shall ensure that the padlocking facilities are properly secured so that they are not susceptible to damage during transportation.

4.12 Voltage Indication And Testing

All Equipment shall provide a means of permanent voltage indication with ultra bright indicators on all phases to indicate whether the cable associated with the equipment is energised or not. Provision shall also be made for the use of test lamps as an additional means of voltage indication.

Voltage indication systems that require an external power supply will not be accepted.



Provision shall be made for individually testing of all high voltage power cables connected to the switchgear while the busbars are in service preferably through a built-in facility without the necessity to have access to cable compartment

A capacitive voltage testing device shall be provided on all equipment. The cable testing device shall be suitable for use with a standard voltage indicator (Multimeter) and shall be capable of being used for phase sequence and identification testing.

4.13 Name Plate and Labels

4.13.1 Name Plate

Stainless steel main nameplate, installed in the front of the RMU containing the relevant information as stated in AS62271.200 clause 5.10 including but not limited to: -

- Switchboard name designation;
- Switchboard identifying number;
- Manufacturer's name, address and contact details;
- Year of manufacture;
- Order number and/or serial number;
- Ratings of the RMU
- Applicable standard (AS 62271 or IEC 62271)
- Owner: Armadale Health Services
- The electrical single line diagram drawing number.

4.13.2 Labelling

Black or red and white laminated traffolyte or plastic to provide black or red lettering on a white background labelling shall be used to identify assemblies as follows: -

- complete assembly;
- functional unit such as a circuit breaker sub assembly;
- protection, control and metering devices;
- dangerous situation.

Red lettering is for identifying high risk areas and black lettering for all other cases. All nameplates shall be fastened with stainless steel escutcheon screws and not adhesives.

Indicating lights, and devices including components inside compartments to be clearly and uniquely identified with screw affixed, engraved traffolyte labels.

Titles shall be as detailed on the equipment drawings or schematics.

All equipment with rear access shall be appropriately labelled at all points of access on a fixed portion of the switchgear.

Cable terminations and components shall be identified including relevant details making identification possible in accordance with a wiring list or diagram.

Small wiring shall be identified according to function by suitable marking on both ends of each wire as per AS 2067 Appendix E



4.14 Surface Protection

The supplier standard surface preparation and finishing system shall be acceptable, subject to the Client / Consulting engineer approval and provided that the paint is applied in a minimum of three coats to an overall dried film thickness of 60 microns and is applied over a blast cleaned surface or, in the case of components where blast cleaning is impractical, a power tool cleaned surface.

The supplier shall provide details of the paint and finishing system in the Tender response.

4.15 Earthing of Metallic Parts

The earthing circuits of each of the panels / cubicles of the switchboard shall be interconnected and shall be connectable outside the switchboard.

The earthing bar shall be designed for connection to the main earthing bar of the substation without dismantling any of the bars.



5. 22 kV/ 433 V Oil Immersed Transformer

5.1 Performance Characteristics

The requirements apply to the new oil immersed distribution transformers at below locations:

- 1 MVA, Kiosk 1 at Substation 1 Leschen.
- 1 MVA, Kiosk 2 at Substation 1 Leschen.
- 1 MVA, Kiosk 1 at Substation 2 Central Plant.
- 1 MVA, Kiosk 2 at Substation 2 Central Plant.

Technical Parameter		
Applicable standards		AS/NZS 60076, AS2374
Transformer type		Outdoor, oil filled (installed within KDS enclosure)
No. of windings		Two windings
No. of phases		3 phase
Rated voltage	HV winding	22,000 Volts (phase - phase)
	LV winding	433 V (phase – phase)
Frequency		50 Hz
Neutral terminal		Star point
System earthing		Effectively earthed
Vector Group		Dyn11
Impedance		1000 kVA: Approximately 5 % Refer AS 60076.5
Winding temperature limit after short circuit.		Maximum 250 °C Refer AS 60076.5
HV Taps		± 2.5 %, 0 % and ± 5 %
Tap Changer		OCTC
Maximum sound levels		Refer to AS/NZS 60076.10 Standard or Reduced
Efficiency		Minimum Energy Performance Standard (MEPS) compliant
Max Dimensions		To be advised for site conditions as required



Technical Parameter	
Max Weight	To be advised for site conditions as required
Manufacture	Contractor to select
Cooling	KNAN
Rated Insulation Level and External Clearance	
Rated Voltage	22 kV
System Highest Voltage	24 kV (rms)
Rated Insulation Level	125 kV (p) 50 kV (rms)
Minimum Clearance	As specified in AS/NZS 60076.3 Table 4 for detailed lightning and impulse voltage
Minimum power efficiency @ 50% load (MEPS) 1000 kVA	99.27 % As specified in AS 2374.1.1 Table 1
Earth Quake Design	Transformer parts and components shall be designed for horizontal and vertical earthquake forces as defined in AS 1170.4
Protection	
Low level Oil alarm	1 pairs of NO/NC contacts
High level Oil alarm	1 pairs of NO/NC contacts
Oil temperature alarm	2 pairs of NO/NC contacts
Oil temperature trip	2 pairs of NO/NC contacts
Winding temperature alarm	2 pairs of NO/NC contacts
Winding temperature trip	2 pairs of NO/NC contacts
Pressure Relief Device	2 pairs of NO/NC contacts

5.2 Transformer Requirements

Loading of transformer

The transformer shall be suitable for loading in accordance with AS 60076.7. No component of the transformer (for example; bushings, tapping switch) will impose restrictions on the loading capabilities.

Normal temperature rise limits



The temperature rise of each winding of the transformer, designed for operation at normal service conditions, shall not exceed the corresponding limit specified AS 60076.2 Table 1.

Earthing

Two (2) earthing points shall be used for the magnetic circuit. The frame work and clamping arrangements of core and coil shall be securely earthed by copper strip connection to the main frame and enclosure. Earthing terminals shall be provided on the frame to bond the enclosure. A suitable earthing terminal shall be located externally, near the bottom of the transformer enclosure.

The earth terminals shall be a minimum M12 stud to accommodate a 120 mm² copper cable lug.

Windings

The HV and LV windings shall be made from copper or aluminium conductors. The design and arrangement of the windings and their insulation shall provide uniform distribution of the voltage surges among all winding coils.

All transformers shall have electrically separate high voltage and low voltage windings. Winding connections shall be in accordance with AS/NZS 60076.1.

HV connection to the tapping switch shall be by means of bolted or crimped connections. Spade type connectors are not acceptable.

The core and winding assembly shall be supported by the main tank and not by the cover.

Means shall be provided at both the top and bottom of the core and coil assembly for locating the transformer core centrally in the tank and securing it in position to prevent movement particularly during transport.

The core and all metalwork shall be electrically bonded to the tank. The bonding of 3 phase core/cores shall be brought to one point only.

The insulation between the core and the frame will have a resistance no lower than 50 MΩ after assembly, and will withstand 2.5 kV for one minute. The core and frame will then be electrically connected together at one point only.

Tappings

The tappings shall be on the HV side. The transformers shall be capable of delivering its rated output at any tap position without damage.

Transformer tapping arrangements

Each transformer shall be capable of off-circuit tap changing by means of an externally operated switch. The tapping switch shall be located near the top of the transformer for ease of access and to readily facilitate the removal of the transformer from the transformer oil tank.

Each tapping selector switch position shall be identified by a number clearly and indelibly stamped onto either the switch operating handle or the transformer tank.

Tap position No. 1 shall correspond to the full winding in circuit.

The tap position selector switch shall be manufactured in such a way that it may be assembled only in the correct manner, not 180° out of adjustment. This shall be done so no inadvertent open or short circuit can occur due to incorrect assembly following out of tank repair/inspection.

A sealing gland shall be provided on the tapping selector switch operating shaft where it passes through the transformer tank to prevent any breathing or leaking along the shaft.

Finish

All internal and external surfaces shall be treated with a coating that provides protection against corrosion caused by water such as hot dipped galvanising.



All welds shall be made smooth, rough edges rounded and weld splatter removed. The transformer shall remain corrosion free for the life of the transformer. The internal and external surfaces shall be prepared and the paint applied strictly in accordance with the manufacturer's instructions.

When an existing transformer suffers damage to its finish, the repair shall be to the original standard of finish.

Painting

Require all internal and external surfaces to be treated with a coating which provides protection against corrosion induced by water, salt laden atmosphere and low levels of industrial pollutants. In addition, external surfaces must be coated with electrically insulated paint.

As the estimated service life of this installation shall not be less than 30 years, the installation requires a coating system to provide "Very long term" durability as defined in Clause 1.6 of AS 2312 for structural steel. Metallic components other than structural steel shall be provided with a coating system having performance equivalent to or superior to that stated above.

Finished coatings shall be oil resistant, heat resistant and non-corrosive.

All coatings shall be capable of being maintained on-site.

The materials used and method of application shall be suitable for the base metal to be coated, shall be supplied by a reputable manufacturer and shall be applied in accordance with the recommendations for this particular application.

The Contractor shall provide evidence supporting the performance of the offered coating under the conditions defined above including details of all tests performed in accordance with AS 1580.

The Contractor shall provide details on the method of protective coating repair to allow the Client to carry out field maintenance.

Rating and terminal marker plates

The transformer shall be provided with a rating plate of weatherproof material, fitted in a visible position.

The rating/terminal marking plate shall be in accordance with Section 8 of AS/NZS 60076.1 to include: -

- Oil Immersed transformer;
- Number and year of this part of AS/NZS 60076;
- Manufacture's name;
- Manufacturer's serial number;
- Year of manufacture;
- Number of phases;
- Rated power;
- Rated frequency;
- Rated voltages, including tapping voltages, if any;
- Rated currents;
- Connection and phase displacement symbol;
- Short-circuit impedance, measured value in percentage;
- Type of cooling;
- Total mass;
- Mass and type of insulating liquid with reference to the relevant IEC standard;



- Maximum system short-circuit power or current used to determine the transformer withstand capability if not infinite;
- Transportation mass (if different from total mass)
- For transformers equipped with winding indicators (WTI), the settings for each WTI.
- For all current transformers installed inside the transformer, the location, ratio(s), accuracy class and rated output (VA rating) of the current transformer.
- Short notation of insulation levels (withstand voltages) as described in AS 60076.3
- Tapping designations;
- Vacuum withstand capability of the tank, conservator, tap-changers and cooling equipment.

In addition, it shall state:

- Statement that the transformer complies with AS 2374.1.2 (MEPS efficiency compliance); and

All quantities on the rating and terminal marking plates shall be stated in metric units.

The Contract No. and the Client structured plant number (SPN) shall be shown on the plate or on a separate tag permanently attached in close proximity to rating/terminal marking plate. The SPN will be nominated in the Client orders to the successful Tenderer.

The rating and terminal marking plates shall be located on the side of the transformer near the tapping switch in a position that can be easily and safely read when the transformer is in service.

The rating and diagram plates shall be manufactured from either brass, brass alloy or stainless steel with the lettering etched or otherwise formed in relief and coloured black (except for values which vary from nameplate to nameplate) such that the lettering is in sharp contrast with the background.

The terminal marking plate shall show a diagram of windings and internal connections, a legend (where applicable) stating which tappings are connected at each of the five tapping selector switch positions as well as a voltage vector diagram.

The plates shall not be attached to a removable cover. Plates shall be attached with screws or rivets



Lifting and transport facilities

Fully rated lifting and hold down points will be provided on the transformer to facilitate the hoisting and holding down during transport and these shall be clearly marked with a permanent label or stencilled.

Two lifting lugs marked "Transformer Lifting Point" with a minimum hole diameter of 28 mm will be provided, suitable for lifting the transformer. These lugs will be positioned to allow centre lifting and cater for a maximum included angle for slings of 120°. They will be arranged so that any slings attached do not foul any part of the transformer, and when suspended by the slings the transformer will hang without tilting.

Lifting lugs must be capable of supporting the transformer and its filling oil.

All parts of the transformer which must be removed for inspection or repair shall be fitted with lifting facilities suitable for use with slings and shackles. The transformer main tank cover shall have at least two lifting lugs marked "Cover Lifting Points".

Oil level indicator

A clear glass oil level indicator is required on all oil insulation type transformers and shall be of the flush type and fitted to a perfectly flat surface. It shall be of sufficient length to show the oil level over the designed operating temperature range of the transformer. The correct oil level at 15 °C shall be clearly and indelibly marked on the gauge. A rigid metal frame shall surround and adequately support the glass. Gaskets shall be used to seal the oil level indicator so as to prevent oil leaks. Gauges using material other than glass shall not be accepted unless the Tenderer can demonstrate that they will not be cracked, blurred or distorted by aging over a 30 year period. The oil level indicator shall be positioned to allow easy inspection.

Thermometer pocket

A thermometer pocket shall be installed for oil insulation transformers. Thermometer pocket shall be prefilled with oil prior to commissioning of the transformer. Thermometer pocket shall be capable of connection to the building management system to provide external monitoring, alarm and tripping functions. Alarm setting shall be set to 10 °C less than the maximum allowable insulation oil temperature. Trip setting shall be set to 5 °C less than the maximum allowable insulation oil temperature. Thermometer pocket shall be positioned on the transformer such that it is easily and safely read when the transformer is in service.

Oil draining

An oil drain valve is required on all oil insulation transformers. The drain valve shall have a 25 mm BSP internal thread fitted with a flanged plug and shall be of the metallic sealing gate type. The valve shall be positioned so that all sludge and thick oil can be drained from the bottom of the tank and that clear access is provided to operate the valve. The drain valve shall be located in a position easily accessible. The actual valve location shall be to the satisfaction of the Client and Consulting Engineer.

Filler cap

Oil insulation transformers shall be fitted with a filler cap on the transformer within the cubicle LV end/side as near as possible to the edge of the transformer. The oil filler cap shall be positioned such that a pipe for draining oil can be inserted to the bottom of the transformer tank, and if moisture enters it would drop to the bottom of the tank. The oil filler cap shall be sealed using gaskets or thread sealing compound in order to prevent moisture being drawn into the transformer.

Earthing Bracket

A corrosion-resistant bare metal earthing bracket shall be provided near the bottom of the tank, as close as practicable vertically below the LV neutral terminal.

The earth bracket must be welded vertically i.e. there are to be no bolted connections in the electrical path between the bracket and the tank.



Tank marking

The transformer capacity, the Client's identification number and the structured plant number shall be stencilled in black on the tank where it can be easily seen. Each character shall be 75 mm high and have a body width of not less than 12 mm.

DANGER signs must be fixed to the HV and LV panels of all transformers and must display the words "Danger – High Voltage".

Windings

The HV and LV windings shall be made from copper or aluminium conductors. The design and arrangement of the windings and their insulation shall provide uniform distribution of the voltage surges among all winding coils.

All transformers shall have electrically separate high voltage and low voltage windings. Winding connections shall be in accordance with AS/NZS 60076.1 and shall conform to vector group Dyn11.

HV connection to the tapping switch shall be by means of bolted or crimped connections. Spade type connectors are not acceptable.

The core and winding assembly shall be supported by the main tank and not by the cover.

Means shall be provided at both the top and bottom of the core and coil assembly for locating the transformer core centrally in the tank and securing it in position to prevent movement during transport and installation.

The core and all metalwork shall be electrically bonded to the tank. The bonding of 3 phase core/cores shall be brought to one point only.

The insulation between the core and the frame will have a resistance no lower than 50 MΩ after assembly, and will withstand 2.5 kV for one minute. The core and frame will then be electrically connected together at one point only.

Insulation oil

Any and each insulating oil offered will be certified as polychlorinated biphenyl-free (PCB- free)

The fluid shall be new. The Supplier shall follow approved quality procedures to ensure that the oil cannot be contaminated while under their control. The Tenderer shall supply full identification of the oil offered. Details of the insulation oil are to be stated in the tender submission.

Transformer HV terminals

Transformers shall be provided with bushing wells. The taught string metal to metal clearance of the bushing external terminals shall be as stated in AS 2067.

A cable cleat bar manufactured from P3300x200mm long 'Unistrut' or equivalent shall be fitted to the transformer tank of all items and positioned appropriately to support the incoming cable.

The HV bushings shall comply with the relevant requirements of AS/NZS 60137.

Transformer LV terminals

The transformer LV phase terminals shall be mounted such that Electric and Magnetic Fields (EMF) associated with the equipment are minimised. The terminal palms shall be in a vertical configuration.

Transformer construction

The transformers shall be of robust construction and shall be capable of being transported, installed, removed or dismantled for repair by accepted methods without damage. The capability of being transported must be interpreted in Australian context regarding the distances and state of the roads.



Transformers shall be of the sealed tank construction type. Sealed transformers shall be as described in Clause 9.3 of AS 60076.1, but not pressurised, nor incorporate gases other than air. Diaphragm sealing is not acceptable.

Fasteners

All bolts (fasteners, etc.) and nuts shall be to Australian Metric Standards. Hot dip galvanised bolts and nuts complete with stainless steel washers under the nut and bolt head shall be used to secure the transformer tank lid, where a bolted lid design is used. All other bolts, nuts and washers shall be stainless steel with the bolts and nuts being of different grades (i.e. 304/316) to assist in preventing binding. Bolts shall be hexagon head (unless this is impractical and alternative is approved by the Consulting Engineer). The bearing surface of all bolt heads and nuts shall be parallel to the surface onto which they tighten. Where necessary, angled washers shall be provided to meet this requirement.

Tanks and lids

On the external areas of the tank, welding of horizontal and vertical joints shall be on both sides of the joint. Welding in all cases shall be continuous. All seams shall be electrically welded and they shall be oil tight. All metal work shall be electrically bonded to the tank to permit earthing. If a part cannot be adequately bonded it shall be constructed from a suitable insulating material instead of metal.

Transformer tanks shall be designed so that with a top oil temperature of 105 °C, the oil level in the tank will be below the tank lid flange. The tanks shall be designed to withstand, without permanent distortion, at least the internal pressure due to maximum permissible overload. This pressure may be calculated from temperature/ volume change of expansion space while neglecting flexing of walls, or it may be established experimentally, at Contractor's preference. The tank lids shall, be capable of supporting up to 100 kg of a person's weight without permanent deformation. The cover of each tank shall be bolted or clamped using suitable gaskets and surfaces to achieve a seal which prevents moisture ingress, oil leaks and the exchange of air between the inside of the tank and the external atmosphere. The tank shall incorporate all mounting studs necessary for the fitment of an LV cable enclosure. It will also incorporate two mounting lugs located approximately 450 mm above ground level for attachment of the LV cable support bracket.

Joints and gaskets

All joints shall be oil tight. Holes shall not be punched through dovetail joints in gaskets. Gaskets shall be manufactured from synthetic rubber or a synthetic and cork composition which is resistant to both corona discharge and transformer oil (including additives if applicable). Gaskets exposed to UV radiation shall be UV stabilised, oil resisting synthetic rubber or a synthetic rubber and cork composition. All gasket seals should last the intended life of the transformer.

Transformer oil containment

An oil containment bund is required for oil type transformers. A bund shall be provided to contain any oil loss from the transformer at the installation site. The bund shall be of sufficient size to contain the total transformer oil capacity plus 10 %, shall have a 32 mm nominal size threaded drainage outlet complete with galvanized plug and shall comply with AS 2067. The outlet shall be located so that access to it is not unreasonably obstructed.

On Board Protection

Liquid insulated Transformers for distribution substations shall be fully sealed and have the following ancillaries as a minimum:

- Off-line Taping Switch c/w lockable locating pin.
- Oil level alarm
- Oil Temperature Indicator.
- Over pressure sensor.



- Oil Level Sight Glass.

All onboard protection trips shall be connected to the protection relay installed on the transformer feeder circuit breaker in the RMU.

Oil temperature

This device shall provide local indication of the transformer "top-oil" temperature. A typical overall measurement accuracy of ± 1 °C is expected. The device shall record the maximum oil temperature in a given time period, arranged for manual resetting.

The device shall include the following alarm signalling and tripping contact:

- Two pairs of NO/NC of circuit-closing, potential free, alarm signaling contacts.
- Two pairs of NO/NC of circuit-closing, potential free trip.

The contact shall be manually set to close at predetermined temperatures.

Winding temperature

A winding temperature thermometer, fully compensated for the effects of ambient temperature, shall be provided and shall have a load-temperature characteristic approximately the same as the hottest part of the windings. The current transformer/s for operating the thermometer/s shall be built into the main transformer tank and shall be located so as to reflect the maximum hot-spot temperature of the respective windings.

This device shall provide local indication of transformer winding temperature.

The device shall record the maximum winding temperature in a given time period, arranged for manual resetting.

The device shall include the following alarm signalling and tripping contact:

- Two pairs of NO/NC of circuit-closing, potential free, alarm signaling contacts.
- Two pairs of NO/NC of circuit-closing, potential free trip.

The contact shall be manually set to close at predetermined temperatures.



6. Low Voltage Main Switchboard

6.1 General

This section covers the requirements for the design and manufacturer of the low voltage main switchboard. This specification is not intended to limit the Contractor's design, nor exclude recommendations in the interest of the Project Manager. Any departure from the general requirements must be clearly stated at time of tender with reference to the relevant specification.

The LV compartment of the kiosk shall house the below:

- 1600 A LV Main Circuit Breaker panel
- Lighting and Small Power Distribution Board
- HV Remote Control and Mimic Panel

6.2 Performance Characteristics

The requirements apply to the new 1600 A LV main circuit breaker panel for the below kiosks:

- 1 MVA, Kiosk 1 at Substation 1 Leschen.
- 1 MVA, Kiosk 2 at Substation 1 Leschen.
- 1 MVA, Kiosk 1 at Substation 2 Central Plant.
- 1 MVA, Kiosk 2 at Substation 2 Central Plant.

Technical Parameter	
Applicable standards	AS/NZS 61439
Rated Voltage	415 V
Phases	3phase + Neutral
Rated Current	1600 A
Frequency	50 Hz
Fault Rating	36 kA for 1 second
Form Factor	3b
Degree of Protection	IP54
Earthing	Solidly Earthed
Outgoing Cable Exit	Below via gland plates (seal all exits)
Accessories	ACB
Max Dimensions	Sized to be contained within the substation kiosk LV compartment.



Technical Parameter	
Special Requirements	ACB shall be provided with rotary handles such that ACB's are required to be switched off before the escutcheons be opened. ACB's shall be provided with lockout capability. 1(off) light and 1(off) GPO each to be provided in the LV and RMU compartment. Provide 2 (off) 20 A RCBOs for external perimeter lighting around the kiosk. Kiosk heaters to be provided.

6.3 External Design

REQUIREMENT: Provide an enclosure comprising panels, doors and the like, giving the specified enclosure, segregation and degree of protection as specified.

- Design and Construction to AS/NZS 61439
- Degree of Protection to AS/NZS 1939 & AS/NZS 60529

Supporting Structure: Fabricate supporting frames from rolled, cold formed or extruded metal sections, with joints fully welded and ground smooth. Provide concealed fixing or brackets located to allow the assembly to be mounted and fixed in the specified location without removal of equipment.

Panels: Machine fold sheet metal angles, corners, and edges with a minimum return of 25mm around the edges of front and rear panels, and 13mm minimum return edge around doors. Provide stiffening to panels and doors where necessary to prevent distortion or drumming.

Equipment Fixing: Provide equipment mounting panels fixed to threaded metal inserts located inside the enclosure at the rear of the mounting panels.

Lifting Provisions: Provide fixings in the supporting structure, and removable attachments, for lifting switchboard assemblies where floor mounted. Provide switchboards in sections as required to enable installation in their final location.

Minimum flange width: 32mm

Cable Entries

Provide sufficient clear space within each enclosure, adjacent to the cable entries, to allow the incoming cables and wiring to be neatly run and terminated, without overcrowding.

For cable entry and internal distribution, provide cable entries of not less than 100mm depth by the full width of cubicle space which is unrestricted by equipment or internal wiring.

Provide to each entry a removable gland plate fitted with a gasket to maintain the specified degree of protection.

Cable bushes for all entering and exiting cables (bunches of cables) to provide a close fit around cabling in accordance with the requirements of AS/NZS 3000. Seal cable entries to provide a close fit in all instances and to maintain the switchboard protection rating.

Escutcheon Plates

Requirement: Provide hinged removable escutcheon plates with the front of the circuit breakers protruding through neat cut-outs. Provide cut-outs for all spare space allowances. Fit insulated clip-in infill panels to each spare pole space. This escutcheon plate shall provide a flush surface between the edges of the distribution board case. Fit chromium plated lifting handles to each escutcheon plate.



Rigidity: The escutcheon panel shall be not less than 1.6mm thick and must be rigid. Stiffen or brace the panel as necessary to achieve this rigidity.

Frame: Provide a continuous 12 mm wide support frame for the fixing of each escutcheon plate, including additional support where necessary to prevent panel distortion.

Fixing: Fix each plate to the frame with metal fixings held captive in the plate and spaced uniformly.

Maximum Height: To suit accommodation or as specified.

Hanging: Hang escutcheon plates on hinges which allow opening through a minimum of 120° and permit the removal of the escutcheon when in the open position.

Cable Duct

Requirement: Provide internal cable ducting sufficient to house cables for maximum board capacity without restricting closure to duct cover.

Minimum size: Cable duct to be a minimum of 70mm wide for all boards and minimum of 100mm for boards with a total capacity greater than 60 poles.

6.4 Busbars

Requirement: Provide a three (3) phase busbar assembly with high conductivity electro tinned copper busbars designed for a maximum current density of 1.5 A/sq.mm from the termination of the incoming unit to the line side of the protective equipment for outgoing circuits.

Provide each distribution switchboard segment with a busbar assembly suitable for a minimum 100A take-off at any point.

Future Extensions: Predrill the main busbar assembly for future extension and extend busbar droppers to spare locations. Drill each dropper to suit connection of future equipment of the same type as that specified.

Cross Section: Radius edges and corners to prevent damage to insulation.

Support: Provide support sufficient to withstand without damage the maximum prospective fault currents. Do not support busbars from circuit breaker terminals.

Joining: Make busbar joints with high tensile bolts and nuts, locked in position with lock nuts or locking tabs. Tighten bolts to the manufacturer's recommendation with a tension wrench. Do not use tapped holes and studs or the like for jointing current carrying sections.

Insulation: Insulate busbars as follows:

Active and neutral busbars: Fully insulate the busbars with suitable plastic insulation of appropriate colours to designate phases. Busbar assemblies shall be red, white, blue phases from left to right when viewed from the front of the switchboard. Maintain phase colours (and rotation) throughout the installation.

Joints: Insulate either by taping or plastic coating, as follows:

Taped joints: Apply a non-adhesive stop off type tape, coloured to match the specified colour coding, half lapped to achieve a thickness of not less than that of the solid insulation.

Plastic coated joints: Apply, in accordance with the manufacturer's recommendations, and to a minimum thickness equal to that of the solid insulation, an air-drying plastic coating material which achieves a tensile strength in excess of 17MPa, and a minimum elongation of 300%.

Colour Coding: Colour the insulation as follows:

Active busbars: Red, white, or blue.

Neutral busbars: Black where applicable.

Earth busbar: Green and yellow where applicable.



Neutral Busbar: Extend the neutral busbar into each switchboard compartment containing outgoing circuits with neutral connections. Provide terminals or drill the busbar for neutral connections.

Identification: Clearly mark and number terminal connections.

6.5 Neutral And Earth Links

Location: Locate neutral and earth links within 600mm of each cable entry unless written approval of greater spacing is obtained.

Connections: Provide stud connections for cables of cross section 16mm² or larger.

Identification: Clearly mark and number terminals. Numbers on circuit breakers, neutral link and earth link for each circuit shall correspond.

Terminals: Provide a separate dual screw neutral terminal and earth terminal for each circuit breaker pole or fuse on each switchboard section. Provide additional terminals for future circuits.

Clearances: Provide 100mm (minimum) wiring channel between neutral and earth links and switchboard sheetmetal enclosure. Provide adequate clearance or insulating barrier between links and all live conductors.

6.6 Finishes

Surface Preparation: Where metal surfaces are to be painted, prepare them appropriately to avoid corrosion, and to withstand the relevant environmental conditions.

Paint Systems: For indoor locations use system not inferior to FULL GLOSS, SOLVENT-BORNE: INTERIOR - PAINTING. Colours are to be provided to AS 2700, to the approval of the Consulting Engineer.

6.7 Switchgear

Requirement: Provide mains switching, outgoing circuit switching, motor and equipment controls and starters, protection, setting and auxiliary equipment.

6.7.1 Air Circuit Breakers (ACBs)

General

Air circuit breakers to comply with As60947.2.

Circuit breakers shall incorporate 'Service', 'Test', and 'Isolated' positions.

Circuit breakers shall be mounted so that controls are operable and indications (e.g spring charging, closed tripped) are visible from the front of the switchboard.

Racking handles shall be supplied with each circuit breaker.

Air circuit breakers to be "Schneider Electric" manufacture (or equal approved).

Settings

All adjustable circuit breakers are to be set at the values shown on the drawings accompanying this specification. The Electrical contractor is responsible for setting of MCCB on site to specified values as shown on the accompanying drawings.

Cascading and Discrimination

All protection devices shall be selected to enhance discrimination and avoid cascading between upstream and downstream devices. It shall be arranged so that only the protection device immediately upstream of the fault shall operate to clear the fault.



Construction

Operating mechanism shall be of the quick make, quick break type, with the speed of operation independent of the operator, and mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. The operating mechanism shall be constructed to operate all poles in a multi pole breaker simultaneously during opening, closing and tripped conditions.

The breakers shall be operated by a toggle or handle which shall clearly indicate the three fundamental positions ON, OFF and TRIPPED.

If required, rotary handles shall be fitted to the breaker.

Moulded Case Circuit Breakers shall be available in normal, high, and limiting ranges.

Moulded Case Circuit Breakers of the same range shall have a common depth.

The standard operating mechanism shall provide positive break indication i.e.: -

- The operating mechanism shall be designed such that the toggle or handle can only be in OFF position if the power contacts are all separated.
- Isolation shall be provided by a double break on the main circuit.

The breakers shall provide double insulation from the front face allowing field installable auxiliaries without isolating the unit.

It shall be possible to lock the circuit breaker in the “isolated” position only with the use of a locking device and padlocks.

Protection Units

All MCCBs shall be fitted with RMS sensing electronic trip units.

The trip units of MCCBs shall be easily interchanged with standard tools.

All electronic components shall withstand temperatures up to 125°C.

All settings on trip units shall have provision for sealing. Where circuit breakers as nominated to be sealed, the adjustable controls shall be concealed behind an escutcheon sealed with authority tags or otherwise.

Universal electronic trip units shall provide:

- Long-time protection with adjustable time delay
- Short-time protection with adjustable time delay
- Instantaneous protection
- All with adjustable thresholds

All universal trip units will incorporate a load monitoring function.

It shall be possible to install the following options without increasing the circuit breaker volume:

- High threshold earth-fault protection
- load monitoring with adjustable threshold
- LEDs to indicate the cause of tripping
- Data transmission via a BUS

All breakers from 1250A to 3200A shall be fitted with trip units of the solid-state interchangeable type.

Characteristics



The solid-state protection unit shall have as required: -

- Long-time protection adjustable from 0.4 to 1 times sensor rating (In).
- Short-time protection adjustable from 3 to 6 times the setting made on the long-time protection: time delay (when required) adjustable for discrimination with downstream MCCBs.
- Instantaneous threshold set at 35kA.
- Earth fault protection (when required) adjustable from 0.2 to 0.5 times the long-time protection setting; adjustable time delay from instantaneous to 0.3s.

The circuit breaker shall provide positive break indication.

When required, motor operated mechanism with or without fault lockout, shunt trip, undervoltage release, auxiliary switches (up to four changeover contacts) and a tripped signal contact shall be provided. Each of these units shall incorporate a pre-wired terminal strip which is accessible from the front of the breaker without removing the cover.

Operation

All circuit breakers shall be provided with the facility for padlocking or key locking in the open position.

It shall be capable of being used in conjunction with a visible break isolation switch to become one integral unit.

Electronic Trip MCCBs shall be possible to field test the trip units utilizing a secondary injection test kit.

Circuit breakers shall have clearly accessible from the front face:

- Markings of rating
- Marked as suitable for isolation
- "Push to trip" test button to test operation of poles.
- Contact position indication

Auxiliaries and Accessories

All accessories and electrical auxiliaries shall be manufactured in such a way that they can be easily field fitted without adjustment.

The breakers will have a double insulation of the front face allowing field installable auxiliaries without isolating the unit.

All electrical auxiliaries shall be equipped with built-in control terminals. All internal electrical auxiliaries shall be of snap-in type.

It shall be possible to fit the Moulded Case Circuit Breaker with a motor mechanism without affecting the circuit breaker characteristics.

All electrical auxiliaries shall be separated from power circuits and their addition shall not increase the volume of the circuit breaker.

It shall be possible to retrofit a residual current device (RCD) directly to the existing circuit breaker enclosure.

It shall be possible to equip the circuit breakers with devices indicating faults without tripping the circuit breaker.



6.7.2 Miniature Circuit Breakers

Standards: To AS60947 for fault capacities of 10 kA or more. To AS/NZS 3111 for miniature overcurrent circuit breakers up to 1000 A current rating and less than 10 kA fault capacity.

Type: Provide circuit breakers which are true DIN rail mounted of “Schneider Electric” manufacture (or equal approved).

Provide non-standard curve type circuit breakers for all mechanical or refrigeration plant. Alternatively increase the size of circuit breakers and sub-circuit cabling to allow starting currents in accordance with AS/NZS 3000. Provide combined MACB/RCD circuit breakers where nominated, having a tripping current imbalance of 30mA within 300ms complying with AS/NZS 3190. MACB/RCD circuit breakers shall utilise a single pole space (alternatively increase pole spaces within distribution boards to suit).

6.7.3 Control, Test Switches And Equipment

Rated operational current: Not less than 6 A at 230 V a.c. at utilisation category AC-11.

Degree of protection: Not less than the degree of protection specified for the switchboard.



7. Outdoor Kiosk / Enclosure

7.1 Construction

Separate compartments shall be provided for High Voltage RMU, Transformer and Low Voltage switchboard.

The kiosk shall be designed and constructed to ensure it is robust, weather-proof, vermin and bird-proof construction. Exterior surfaces shall have no unnecessary protrusions. It shall be securely bolted down to the hot dipped galvanised steel or concrete base.

All kiosk seams (i.e. door returns, door stay location brackets, etc.) shall be fully seam welded. All surfaces shall be arranged to prevent the accumulation of water. All welded sections must be fully seam welded to prevent the ingress of water and corrosion. Ventilation louvers shall be provided.

The kiosk is to have an ingress protection rating not less than IP65.

All metalwork including panels, doors and lid shall be electrically bonded to permit earthing

Two lifting lugs with 25 mm dia holes shall be fitted to the kiosk. The inside of the lid above the switchgear compartments shall be fitted with thermal insulation to prevent moisture condensation.

If the HV switchgear operating handle cannot be mounted on a suitable location on the switchgear, then a suitable frame complete with noise and vibration prevention cushioning shall be provided on the door to mount and store operating handles.

All penetrations for the reticulation of cabling between compartments of the enclosure shall be via the use of gland plates with protection against abrasive edges.

The base of the kiosk shall be hot dipped galvanised steel construction.

Oil catchment tray capable of retaining all of the transformer oil in the event of an oil leak from the tank or the radiators shall be incorporated into the transformer compartment.

The design of the kiosk shall be sufficiently strong and rigid to allow lifting and transport of the kiosk complete with specified switchgear and transformer.

The kiosk shall be equipped with appropriate document and operating handle storage facilities.

Each compartment shall be provided with an anti-condensation heater supplied from the LV switchboard.

7.2 Access And Doorways

Separate external access doors shall be provided to all compartments.

Access doors shall open outwards at an 180° angle. Operating doorways shall be hinged and fitted with door stay brackets. Doors shall be fully recessed into and sit flush with the kiosk panel mullions. It shall not be possible to pry open the doors by inserting a crowbar or similar object and gain unauthorised access to the switchgear compartments.

All doors shall be fitted with 3-point locking. Where double doors exist, single 3-point locking to secure the 2 leaves is acceptable in conjunction with the necessary additional door hardware and stiffening. A robust door restraint shall be provided to hold each door in the open position

Access door(s) to the transformer compartment shall provide ready access to the transformer tapping switch, oil level indicator, earthing terminal, oil thermometer, transformer pressure relief valve, rating plate, terminal marking plate, transformer primary cable terminations, transformer primary surge diverters, secondary cable terminations,

Each door / lift of panel shall be provided with a release switch to activate the lighting upon opening. Each compartment shall be provided with a weatherproof LED batten.



7.3 Surface And Coating

All internal and external surfaces shall be treated with a coating which provides protection against corrosion induced by water, salt laden atmosphere and low levels of industrial pollutants.

The coating system to provide “Long term” durability as defined in Clause 1.6 of AS 2312 for structural steel. Metallic components other than structural steel shall be provided with a coating system having performance equivalent to or superior to that stated above.

Finished coatings shall be oil resistant, heat resistant and non-corrosive.

The external surface colour of Kiosk/Enclosure shall be to Consulting Engineer approval.

All coatings shall be capable of being maintained on-site. The materials used, and method of application shall be suitable for the base metal to be coated, shall be supplied by a reputable manufacturer and shall be applied in accordance with the recommendations for this particular application.

The Supplier/Contractor shall provide evidence supporting the performance of the offered coating under the conditions defined above including details of all tests performed in accordance with AS 1580.214.3 Details are to be attached to the Tenderers response.

The successful Tenderer shall provide details on the method of protective coating repair to allow the Client to carry out field maintenance.

7.4 Labelling

A warning notice shall be fitted to the doors allowing access to the High Voltage switchgear and to the High Voltage side of the transformer as follows: DANGER HIGH VOLTAGE in accordance with Australian Standards, notably AS 2067 and AS 1319.

The kiosk shall be provided with a stainless steel clearly legible nameplate which shall contain the information specified in section 5.3 ‘Nameplate’ of AS 62271.202.



8. Inspection And Testing

8.1 General

All testing and commissioning shall be undertaken in accordance with regulatory requirements, manufacturers requirements, and the requirements listed in this Specification.

Test and provide Certificates of Compliance for the installation in accordance with the requirements of the Electricity Act.

Notice: Give sufficient notice so that all testing may be witnessed by the Consulting Engineer.

Testing certificates: Provide test certificates and Certificates of Compliance for approval. Include copies within Installation Manuals. Payment of the contract value shall not become due and payable unless and until the certified test results showing that the plant complies with the specification and that the manufacturer's guarantees are within the tolerances specified, have been received by the Client and Consulting Engineer. All test certificates shall state the manufacturer's serial number, the corresponding Client number, the order number, and contact number.

Approval for energising: Obtain approval before energising newly installed or reconnected wiring or equipment.

Faulty installation: During testing, replace all equipment damaged as a result of incorrect installation work.

Provide a schedule of equipment that has been tested and tagged in the Installation Manuals, and confirm whether or not the appliance has passed or failed, date of test, and schedule for next test.

Defects: Rectify all defects upon notification. Provide written notice to the Project Manager of completion of defects. Retention monies will not be released until completion and rectification to the Proprietors approval of all defects.

8.2 General Testing

- Insulation resistance measurements.
- Earth resistance measurement.
- Confirmation of effective earthing of the exposed metal of electrical equipment.
- Confirm that circuit protective devices are sized altered and adjusted, wherever necessary, to protect the installed circuits.
- Test phase sequence prior to commencement of works and ensure the correct phase sequence is maintained throughout the construction.

8.3 Ring Main Unit Testing

8.3.1 Type Testing

The RMU shall be fully type tested as per the relevant standards. If type tests have been carried out previously on identical plant, not earlier than 5 years from this specification date, copies of test certificates may be accepted. These shall be submitted with the tender.

The Following type tests are required on each design:

- Impulse withstand test;
- Temperature-rise type test;
- Short-time withstand current test;



- Mechanical operation test;
- Switch, circuit breaker, earthing switch making capacity;
- Switch, circuit breaker breaking capacity;
- Internal Arc withstand;
- Confirming degree of protection;
- Salt spray withstand test;

8.3.2 Routine Testing

If the equipment or any part thereof, fails to give satisfactory results under these tests, then all costs incurred in making good the equipment and of carrying out further tests shall be borne by the Supplier / Contractor.

Two copies of test certificates, drawings, graphs, etc. giving details and results of all tests carried out shall be submitted by the Supplier / Contractor within 48 hours of the tests.

Routine tests shall be carried out on all RMU's in accordance with AS/NZS 60265 and AS 62271. As a minimum, the following routine tests shall be carried out:

Load Break Switches

- Power frequency voltage test;
- Voltage test on auxiliary equipment;
- Measurement of resistance on main circuit;
- Operation test;
- Operation and mechanical endurance test;
- Measurement of short-circuit impedance and load loss;
- Measurement of no-load loss and current;
- Tightness tests and pressure tests;
- Visual inspection of overall finish, painting, welds, metal works, lifting lugs, terminal fastening, insulation, terminations, fixings, etc;
- Dimensional checks;
- Check auxiliaries and accessories against specification, including function testing;
- Rating plate checks, name plates and any additional markings and labels as per specifications;
- Checking of partial discharge on individual units;

Circuit Breakers

- Power frequency voltage test;
- Voltage withstand test on control and auxiliary equipment;
- Measurement of resistance on main circuit;
- Mechanical Operation test;
- Operation and mechanical endurance test;
- Measurement of short-circuit impedance and load loss;
- Measurement of no-load loss and current;



- Tightness tests and pressure tests;
- Visual inspection of overall finish, painting, welds, metal works, lifting lugs, terminal fastening, insulation, terminations, fixings, etc;
- Dimensional checks;
- Check auxiliaries and accessories against specification, including function testing;
- Rating plate checks, name plates and any additional markings and labels as per specifications;
- Checking of partial discharge on individual units;
- Dielectric testing;
- Check of the ratio and polarity of built-in current transformers;
- Verification of all protection devices including functional and trip test;

Current Transformers (CT)

- Polarity test.
- Winding resistance test.
- Insulation resistance test.
- Turns ratio test.
- Excitation (saturation) test (knee point).
- Burden/impedance check.
- Phase angle error.
- Secondary loop continuity check.
- Secondary loop burden and load test.
- Primary injection test

8.3.3 Protection And Metering Equipment Test

Primary and secondary three phase current injection testing shall be performed by the Contractor or Supplier to check the proper operation of all protection and metering instruments specified on the data sheets.

Functional test shall be performed on all equipment. These shall include complete functionality of all equipment supplied, including the complete assembly of the individual cubicles as a complete unit with all inter-cubicle busbar and wiring connections.

The tests shall include:

- Electrical tests of all operating circuits including indication and remote operating facilities,
- Mechanical tests of all mechanisms, operational controls, shutters, interlocks, withdrawable assemblies and breaker interchangeability.

8.3.4 Final Checks

Prior to dispatch the Supplier / Contractor shall perform standard factory checks, which shall include the following verifications as a minimum:

- Measuring of opening and closing speed/time;
- Measurement of operating torque;



- Checking of filling pressure;
- Checking of partial discharge on individual units;
- Check of the ratio and polarity of built-in current transformers;
- Verification of all protection devices including functional and trip test;
- Transportability, skid, lifting, pulling lugs, jacking pads, etc;
- Layout of Control Cabinet and auxiliary wiring;
- Earthing connections;
- Completeness of rating plate, name plate and warning signs;
- Proper terminal connections, tightness and markings;
- Finished quality of the RMU and components;
- Completion of routine and type test and results recorded accordingly;
- Electrical tests of all operating circuits including indication and remote operating facilities.
- Mechanical tests of all mechanisms, operational controls, shutters, interlocks, withdrawable assemblies and breaker interchangeability.

8.4 Distribution Transformer Testing

8.4.1 Type Testing

The following applicable type tests are required for each transformer.

No.	Required Type Test	Relevant Standard / Clause No.
1	Temperature rise test.	AS/NZS 60076.2
2	Dielectric type tests.	AS/NZS 60076.3
3	Determination of sound level.	AS/NZS 60076.10
4	Measurement of no-load loss and current at 90 % and 110 % of rated voltage.	AS/NZS 60076.1 / Clause 11.5
5	Short circuit tests	AS 60076.5

8.4.2 Routine Testing

The following applicable routine tests shall be carried out for each transformer.

No.	Required Routine Test	Relevant Standard / Clause No.
1	Measurement of winding resistance.	AS/NZS 60067.1 / Clause 11.2
2	Measurement of voltage ratio and check of phase displacement.	AS/NZS 60067.1 / Clause 11.3



No.	Required Routine Test	Relevant Standard / Clause No.
3	Measurement of short-circuit impedance and load loss.	AS/NZS 60067.1 / Clause 11.4
4	Measurement of no-load loss and currents.	AS/NZS 60067.1 / Clause 11.5
5	Dielectric routine tests.	AS/NZS 60067.3 / Clause 7
6	Tests on on-load tap-changers, where appropriate.	AS/NZS 60067.1 / Clause 11.7
7	Functional testing of alarms and on-board protection.	N/A
8	Check of the ratio and polarity of built-in current transformers.	N/A
9	Leak testing with pressure for liquid immersed transformers.	AS/NZS 60067.1 / Clause 11.8
10	Check of core and frame insulation for liquid immersed transformers with core or frame insulation	AS/NZS 60067.1 / Clause 11.12
11	Partial discharge tests	This specification
12	Transformer cable tests	This specification
13	Pressure test on sealed transformers.	This specification
14	Transformer oil analysis, before and after energisation.	This specification
15	Tightness tests and pressure tests for gas-filled transformers.	IEC 60076.15

Partial discharge tests

All insulation composed of synthetic material shall be subject to tests for the measurement of partial discharge in accordance with the provision of AS 60270. Such tests shall demonstrate that the insulation is free of discharges of magnitude greater than 20 pC, when subjected to a test voltage of 15 kV. Reports of these tests shall be supplied with test reports of other routine tests. Where the synthetic material insulation has a long history of proven performance, the Purchaser may consider accepting batch testing providing sufficient data is forwarded to support the claims made about the material.

Transformer cable testing

The following tests shall be completed for each transformer cable: -

- Tan/Delta Test
- IR Test.



Pressure tests

To prove the sealed transformers are adequately sealed, the following routine test shall be required on each fully assembled transformer.

Establish and monitor internal transformer pressure. The test pressure shall equal the maximum pressure stated on the rating plate.

If, after 30 minutes, the pressure has not dropped more than 2 kPa, the transformer will be considered to have passed the test.

Ambient temperature variation shall be within +2°C.

Oil Analysis

Oil sampling and testing shall be done before the transformer is energized and 72 hours after load energisation.

The oil sample shall be analysed by an approved laboratory. The following test shall be included in the analysis

- Dissolved Gas Analysis (DGA)
- Dielectric Strength
- Colour and Visual Inspection
- Neutralisation Number (Acidity)
- Interfacial Tension
- Water Content
- Particle Count

8.4.3 Final Checks

Prior to dispatch the Supplier shall perform standard factory checks, which shall include the following verifications as a minimum:

- Transportability, skid, lifting, pulling lugs, jacking pads, etc.;
- Suitability of termination boxes for ease of cable installation;
- Layout of Control Cabinet and auxiliary wiring;
- Tap changer, where appropriate;
- Earthing connections;
- Completeness of rating plate, name plate and warning signs;
- Proper terminal connections, tightness and markings;
- Finished quality of the transformer and components;
- Completion of routine and type test and results recorded accordingly;
- Correct type and make of oil;
- Oil tightness of tank, conservator, flange joints, cooling system, valves and fittings;
- Facilities for oil sampling, cleaning and filtering;



8.5 Low Voltage Main Switchboard Testing

8.5.1 Type Testing

Type testing shall have been carried out in accordance with AS 61439.1 and internal arcing tests in accordance with Annex ZD of AS 61439.1.1.

8.5.2 Final Checks

Prior to dispatch the Supplier shall perform standard factory and routine checks in accordance to AS 61439, which shall include the following verifications as a minimum:

- Insulation resistance tests;
- Mechanical operating tests;
- Ductor test of each busbar bolted joint;
- Secondary injection testing of all protection current transformers;
- Check of protective circuits;
- Testing of all control and interlock circuits to ensure satisfactory operation;
- Functional tests of equipment.
- Check of wiring and terminations.
- Point to point testing of all wiring;
- Check of nameplates and labels.
- Mechanical testing and checking of all doors, latches and interlocks;
- Functional testing of all components;