

Specification SME141.1

Supply of Voltage Transformers

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Version history

Version	Date	Section(s)	Summary of amendment
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10.0	31/12/2019		SF6 Insulation medium removed. PVT multiple tapping removed. Items H6L, T11L, T12L & D1 added.
11.0	17/07/2020	All	Full content review.

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1. Introduction

1.1 Purpose

This document is the Powerlink Queensland Technical Specification and reference document for voltage transformers. Together with the Commercial Specification, it will form the Tender Specification for voltage transformers and be the technical basis of a supply contract.

1.2 Scope

- This specification document covers the technical and testing requirements of capacitor voltage transformers (CVTs) and Power (high burden) voltage transformers (PVTs).
- It is intended that the plant shall have a service life of at least forty (40) years. The design, selection of materials and manufacture of the plant shall be co-ordinated to achieve the specified service life.
- CVTs and PVTs shall be oil insulated. Main insulators shall be of silicon composite construction.
- The accuracy measurements for the windings shall be certified to national standards of measurement. The testing laboratory in which these accuracy measurements are carried out shall be accredited to **ISO 17025** and this certification shall be included in the routine test report. Alternatively testing laboratory be accredited under a national laboratory accreditation scheme which is recognised under the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (**ILAC Arrangement or MRA**). In Australia, **NATA (National Association of Testing Authorities)** accreditation is required

2. Service Conditions

2.1 Particulars of the System

The plant shall be suitable for operation on a system having the characteristics set out in Table 2-1 Network characteristics.

Table 2-1 Network characteristics

Plant Voltage Rating (kV)	300	145	123	72.5
Nominal Voltage (kV)	275	132	110	66
Highest Voltage (kV)	300	145	123	72.5
Frequency (Hz)	50	50	50	50
Normal Frequency Limits (Hz)	± 0.1	± 0.1	± 0.1	± 0.1
Number of Phases	3	3	3	3
Earthing	⇐ --- Solidly earthed neutral system --- ⇒			

2.2 Environment

The plant shall be capable of operation outdoors in a tropical environment which varies from hot, dry and dusty to hot and very humid, and which is subject to cyclonic wind. Service conditions are as set out in Clause 4 of AS 60044.2 and Clause 5 of AS 60044.5 with the following special service conditions:

- Air Temperatures
 - Extreme maximum = 50°C
 - Extreme minimum = -10°C
- Relative Humidity
 - Average Winter at 1500 hours = 48%
 - Average Summer at 0900 hours = 72%
 - Extreme monthly average at 0900 hours = 80%

(Note that sudden drops in temperature of up to 20°C in a period of 20 minutes may occur which in the presence of the high humidity specified above may give rise to condensation on the surfaces of the equipment.)

(iii) Solar Radiation

Maximum = 1.1 kW/m²

(iv) Wind Loading

The design wind loads shall be as determined in accordance with AS/NZS 1170.2 and the following:
Region C (tropical cyclone area)

Terrain Category 2

1000 years average recurrence interval (V1000) = 60.5 m/s

F_C factor = 1.0

Uniform pressure based on height of 5m

Topographic Multiplier = 1.0

Shielding Multiplier = 1.0

Direction Multiplier = 0.95

(v) Earthquake Load

Components and their attachments shall be designed to resist horizontal earthquake forces equal to 0.3 times the weight of the component. The horizontal earthquake load shall be applied in combination with the gravity load of the element.

3. Drawings/Documentation

The following drawings are included in and form part of this specification.

Drawing No.	Title
H-114167-001	Substation Electrical - Electrical Plant - Standard Terminal Palms - Details
H-115047-001	Substation Electrical - Instrument Transformer - Standard Nameplate - Typical Schematic Diagram

4. Item Descriptions

The following Table 4-1 Item Descriptions provides a basic description of each Item.

Table 4-1 Item Descriptions

SPEC. ITEM NO	DESCRIPTION
H1	300 kV, 50 Hz, single-phase outdoor capacitor voltage transformer
H2	300 kV, 50 Hz, single-phase outdoor capacitor voltage transformer with a harmonic voltage measurement facility
H4L	300 kV, 50 Hz, single-phase outdoor oil insulated 100 kVA power voltage transformer
H6L	300 kV, 50 Hz, single-phase outdoor oil insulated 50 kVA power voltage transformer
H5L	300 kV, 50 Hz, single-phase outdoor oil insulated 25 kVA power voltage transformer
T1	145 kV, 50 Hz, single-phase outdoor capacitor voltage transformer
T2	145 kV, 50 Hz, single-phase outdoor capacitor voltage transformer with a harmonic voltage measurement facility
T3	123 kV, 50 Hz, single-phase outdoor capacitor voltage transformer
T4	123 kV, 50 Hz, single-phase outdoor capacitor voltage transformer with a harmonic voltage measurement facility
T7L	145 kV, 50 Hz, single-phase outdoor oil insulated 100 kVA power voltage transformer
T11L	145 kV, 50 Hz, single-phase outdoor oil insulated 50 kVA power voltage transformer
T8L	145 kV, 50 Hz, single-phase outdoor oil insulated 25 kVA power voltage transformer
T9L	123 kV, 50 Hz, single-phase outdoor oil insulated 100 kVA power voltage transformer
T12L	123 kV, 50 Hz, single-phase outdoor oil insulated 50 kVA power voltage transformer
T10L	123 kV, 50 Hz, single-phase outdoor oil insulated 25 kVA power voltage transformer
D1	72.5 kV, 50 Hz, single-phase outdoor capacitor voltage transformer
SPARE-HM	Kit Harmonic Measurement of 300/145kV Capacitor voltage transformer (Kit required for on-site upgrade of Item H1 to H2, T1 to T2 and T3 to T4).

5. General Requirements

5.1 Interchangeability

All parts similar in design and dimensions shall be made to gauge and shall be interchangeable between the several units of the plant or apparatus. For this purpose, all parts shall be accurately constructed and all machining and setting up shall be done with the aid of jigs.

5.2 Fasteners

- The dimensions of all nuts and bolts shall conform to the ISO standards for coarse pitch metric fasteners. Thin nuts may only be used as lock-nuts.
- Fasteners used in main circuit electrical connections and exposed to atmosphere shall be made from stainless steel and shall have an approved locking device. All other ferrous fasteners shall be hot dip galvanised. (Electro-deposited protective coatings are unacceptable.)
- Where spring washers are provided, they shall be made of stainless steel and shall comprise a single coil. (Hot dip or electro-deposited protective coatings are unacceptable.)

5.3 Earthing

- a) An earthing point shall be provided on each galvanically separate piece of equipment intended to operate at earth potential so that the Purchaser may attach a flat copper earthing conductor.
- b) The earthing point shall comprise a flat surface not less than 40 x 80 mm drilled with two 14 mm diameter holes on 40 mm centres. The surface shall be either tinned or hot dip galvanised or of stainless steel and shall not be covered by a non-conducting paint.

5.4 Handling Provisions

Each piece of equipment which cannot be handled easily by one person shall be fitted with lifting lugs. The lifting lugs shall be positioned such that lifting slings do not foul the sheds of insulators.

5.5 Support Structures

The supply of support structures for equipment is not required as part of this contract. The Contractor shall provide sufficient information on the contract drawings to enable the Purchaser to design and construct support structures.

5.6 Finish and Painting

Wherever possible, all internal and external steel surfaces shall be hot dip galvanised after fabrication in accordance with the requirements of AS/NZS 4680. A protective coating shall be applied to all internal hot dip galvanised surfaces in contact with oil. Full details shall be provided of the surface preparation and coating proposed. Where this is not possible, surfaces shall be painted in accordance with the following requirements.

- (i) After each section of equipment is completed and before any paint is applied, the surfaces of those parts to be painted shall be thoroughly cleaned of all rust, oil, grease, dirt or other foreign matter.
- (ii) The total minimum thickness of paint, when dry, shall be not less than 0.13 mm.
- (iii) The colour of the finishing coat of paint shall be light grey, reference No. N35 to AS 2700 or close match (e.g. international equivalent).
- (iv) The colours of the priming coat and undercoat shall be different.
- (v) All paint and varnish shall be non-corrosive, heat and oil resistant and shall be applied in accordance with the paint manufacturer's recommendation for this particular application. Such recommendation shall be in writing, certified by the paint manufacturer and shall be made available to the Purchaser on request.
- (vi) Each coat shall cover completely and evenly the surface to which it is applied.

5.7 Kit Harmonic Measurement of 300/145/123 kV Capacitor Voltage Transformer

'Kit Harmonic Measurement' shall be capable of upgrading normal Capacitor Voltage transformer to Capacitor Voltage Transformer with harmonic measuring facility. This upgrading shall be performed by Principle at site on need basis. This Kit shall be suitable to upgrade 300kV CVT Item H1 to H2, 145kV CVT Item T1 to T2 and 123kV CVT Item T3 to T4. Kit shall include minimum of:

- (i) Measurement Unit (MU)
- (ii) Signal Conditioning module (SCM)
- (iii) Interconnecting cable between MU and SCM with minimum 3m length

6. Voltage Transformer Rating and Requirements

Voltage transformers shall be in accordance with the requirements of AS 60044.2 and AS 60044.5 except where varied by this Specification, and shall have the rated or performance characteristics set out in Table 6-1 Voltage Transformer Ratings and Requirements. Tenderers shall state the guaranteed values in Schedule T1 (300kV) and T3 (145kV/ 123kV/ 72.5kV)

Table 6-1 Voltage Transformer Ratings and Requirements

		SPECIFICATION ITEM NUMBERS						
		Items H1 & H2 (CVT)	Items H4L, H5L & H6L (PVT)	Items T1 & T2 (CVT)	Items T3 & T4 (CVT)	Items T7L T8L & T11L (PVT)	Items T9L, T10L & T12L (PVT)	Items D1 (CVT)
(a)	Highest voltage for equipment (U_m) (kV)	300	300	145	123	145	123	72.5
(b)	Rated primary voltage (U_{PR}) (kV)	275/ $\sqrt{3}$	275/ $\sqrt{3}$	132/ $\sqrt{3}$	110/ $\sqrt{3}$	132/ $\sqrt{3}$	110/ $\sqrt{3}$	66/ $\sqrt{3}$
(c)	Rated secondary voltages:		Cl. 7.10			Cl. 7.10	Cl. 7.10	
	(i) Secondary winding no. 1 or power winding (U_{SR1}) (V)	110/ $\sqrt{3}$	415/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$	415/ $\sqrt{3}$	415/ $\sqrt{3}$	110/ $\sqrt{3}$
	(ii) Secondary winding no. 2 (U_{SR2}) (V)	110/ $\sqrt{3}$	n/a	110/ $\sqrt{3}$	110/ $\sqrt{3}$	n/a	n/a	110/ $\sqrt{3}$
(d)	Rated frequency (f_R) (Hz)	50	50	50	50	50	50	50
(e)	Number of phases	1	1	1	1	1	1	1
(f)	Method of interconnecting 3 x 1 phase CVTs/PVTs:							
	(i) Primary winding / capacitor divider unit	star	star	star	star	star	star	star
	(ii) Secondary winding no. 1	star	star	star	star	star	star	star
	(iii) Secondary winding no. 2	star	star	star	star	star	star	star

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		SPECIFICATION ITEM NUMBERS						
		Items H1 & H2 (CVT)	Items H4L, H5L & H6L (PVT)	Items T1 & T2 (CVT)	Items T3 & T4 (CVT)	Items T7L, T8L & T11L (PVT)	Items T9L, T10L & T12L (PVT)	Items D1 (CVT)
(g)	Rated insulation level (RIL):							
	(i) Rated lightning impulse withstand voltage (LIWV) (kVp)	1050	1050	650	550	650	550	325
	(ii) Rated switching impulse withstand voltage (SIWV) (kVp)	850	850	n/a	n/a	n/a	n/a	n/a
	(iii) Rated one minute power frequency withstand voltage (PFWV) (kV)	460	460	275	230	275	230	140
(h)	Rated voltage factor (F_v) and rated duration	1.5 for 30 s	1.5 for 30 s	1.5 for 30 s	1.5 for 30 s	1.5 for 30 s	1.5 for 30 s	1.5 for 30 s
(i)	Combined accuracy classification for each instrument secondary winding. (The accuracy classification for secondary winding no. 1 and no. 2 is identical.)							
	(i) Accuracy class	0.2/3PT2	n/a	0.2/3PT2	0.2/3PT2	n/a	n/a	0.2/3PT2
	(ii) Rated burden at unity power factor (mS)	12	n/a	12	12	n/a	n/a	12
	(iii) Lower limit of burden for accuracy class (mS)	Zero	n/a	Zero	Zero	n/a	n/a	Zero
	(iv) Rated output at unity power factor (measurement duty) (VA)	50	n/a	50	50	n/a	n/a	50
The plant shall meet the accuracy classification over the full range of compliance required by Clauses 9.8.2 and 9.8.3 of AS 60044.5 and Clauses 12.3 and 13.2 of AS 60044.2, and a range of burden from 0.0 to 1.0 per unit of rated burden without adjustment to tappings of trimming windings.								

Specification SME141.1 Supply of Voltage Transformers

		SPECIFICATION ITEM NUMBERS						
		Items H1 & H2 (CVT)	Items H4L, H5L & H6L (PVT)	Items T1 & T2 (CVT)	Items T3 & T4 (CVT)	Items T7L, T8L & T11L (PVT)	Items T9L, T10L & T12L (PVT)	Items D1 (CVT)
(j)	Maximum output of VT while maintaining accuracy on both instrument secondary windings (VA)	100	n/a	100	100	n/a	n/a	100
(k)	Rated output of power winding (kVA)	n/a	H4L: 100 H6L: 50 H5L: 25	n/a	n/a	T7L: 100 T11L: 50 T8L: 25	T9L: 100 T12L: 50 T10L: 25	n/a
(l)	CVT Base/Base Plate dimension (for mounting CVT to support structure)	<u>Bolt Spacing</u> : 600mm x 600mm <u>Bolt Hole Diameter</u> : 24mm <u>Bolt size</u> : 4 x M20	n/a	<u>Bolt Spacing</u> : 600mm x 600mm <u>Bolt Hole Diameter</u> : 24mm <u>Bolt size</u> : 4 x M20	<u>Bolt Spacing</u> : 600mm x 600mm <u>Bolt Hole Diameter</u> : 24mm <u>Bolt size</u> : 4 x M20	n/a	n/a	<u>Bolt Spacing</u> : 600mm x 600mm <u>Bolt Hole Diameter</u> : 24mm <u>Bolt size</u> : 4 x M20
(m)	High Voltage (Line) terminal (Reference drawing H-114167-001)	Type 1	Type 1	Type 1	Type 1	Type 1	Type 1	Type 1

7. Voltage Transformer Design and Construction

7.1 General

- a) In the case of CVTs, designs which incorporate the capacitor divider and electromagnetic components into a single unit with capacitors enclosed in a single insulator are preferred.
- b) The plant, together with its packaging or crate(s), shall be of robust construction with tanks and internal components braced where necessary and capable of withstanding the forces which occur during transport over rough roads for long distances, erection and service without damage to the plant.
- c) The construction of the exposed portions of the plant shall be such that there are no pockets in which water can accumulate.
- d) The plant shall be capable of withstanding a full vacuum without damage.
- e) Particular attention shall be given to sealing of flanges to prevent corrosion and seal failure from occurring. Equipment drawings and information submitted with tenders should indicate full details of flange treatments intended to prevent ingress of moisture or oxygen together with evidence of the effectiveness of the adopted treatments.
- f) Terminal boxes and similar enclosures shall be supplied with openings to allow ventilation and the draining of condensation. The minimum size of a ventilation hole shall be 30 mm to mitigate blockage by native insect activity. These and any other openings or vents shall be covered by suitable screens or gauze and shall be designed to prevent the ingress of rain water, insects and vermin.
- g) **Use of any materials / components containing asbestos in any proportion, form, size and shape is strictly prohibited and such material shall not be used to manufacture plant offered or supplied to Powerlink.**

7.2 Harmonic Measurement

- a) Items H2, T2 and T4 are essentially identical to Items H1, T1 and T3 respectively except that they provide a harmonic measurement capability.
- b) A harmonic measurement capability is a facility of the design that allows the Purchaser to measure harmonic voltages on the high voltage system over a wide range of frequencies, typically 50 Hz to 5 kHz) by providing a faithful, frequency independent, low voltage replica of the primary voltage (e.g. 63.5 V r.m.s. phase to ground).
- c) Harmonic measurement provisions are non-standard features of CVTs. Full details of systems offered, including frequency range and output voltage, shall be stated in Schedule T1 (300kV) and T3 (145kV/123kV).

7.3 Explosion Resistant

Where a Tenderer offers a voltage transformer described to be of explosion resistant design, the design must be such that in the event of an internal fault involving the primary conductor:

- (i) Insulators and housings shall remain in their mountings with all solid internal components retained therein.
- (ii) Insulators and housings may be cracked, chipped or eroded by arcing, but shall not be fragmented, nor shall any part be ejected.
- (iii) End caps and fittings may be eroded by arcing but shall remain in position except for diaphragms and indicators.
- (iv) Loss of insulating medium shall be in a controlled, non-violent manner. Venting of arcing products, if applicable, shall be directed upwards from the top of the VT or CVT unless otherwise agreed to by the Purchaser.
- (v) The design of vents shall prevent moisture entering the voltage transformer for the whole of its design life under the most arduous weather conditions.
- (vi) An explosion resistant design shall incorporate silicon composite type insulators.

7.4 Main Insulators

- Insulators shall be of the composite type with Grey silicon sheds.
- Insulators shall be manufactured and tested in accordance with the requirements of IEC 61462.
- Each insulator shed shall have an effective drip edge so as to prevent the continuous flow of water down the insulating surface.
- Plant to be supplied under this contract shall be provided with insulation suitable for a Pollution Level of III - Heavy, as set out in Table 8 of AS 60044.2 and Table 6 of AS 60044.5.
- The minimum specific creepage distance of insulators shall be not less than 25 mm/kV and the actual values of creepage calculated in accordance with the specific creepage are set out in Table 7-1 Insulator Creepage Distances.

Table 7-1 Insulator Creepage Distances

Highest Voltage of Equipment (kV)	Minimum Creepage Distance for Heavy Pollution Insulators (mm)
300	7 500
145	3 625
123	3 075
72.5	1815

7.5 Oils

- Insulating oil shall comply with the requirements of AS 1767.
- Oil insulated plant shall be supplied filled with oil to the correct level for service. Oil replacement fillers are not to be used.
- The manufacturer shall specify the type and the required quantity and quality of oils in the plant on delivery and in service and shall provide the Purchaser with the necessary instructions for removing/replacing the oils for checking and maintaining their required quantity and quality, and for their disposal.
- All plant shall be sealed. Oil preservation systems employing dehydrating breathers shall not be considered.
- The plant shall be rendered completely oil tight by the manufacturer.
An oil leak or weep shall be deemed to exist if at any time after cleaning the suspect area with a suitable solvent and applying chalk or whitewash, any discolouration due to oil appears on the white surface.
It has been the Purchaser's experience that even the smallest oil weeps develop into oil leaks with time under service conditions.
Oil tightness where required at a threaded joint shall be provided by a flat gasket or O-ring and shall not depend upon sealing material between mating threads.
All gaskets or O-rings shall be continuous and not contain any joints whether lapped, sealed, welded or otherwise formed.
- Joints in chambers shall be arranged so that shrinkage of gaskets and seals with time causing leakage can be taken up.
- Oils shall be biodegradable. Plant containing polychlorinated biphenyls (commonly known as PCBs) is prohibited.
- In the case of oil filled plant, all seals shall be below the cold oil level with the exception of seals associated with oil level indicators.
- Oil filled plant shall be designed and constructed using a bellows or diaphragm system to enable expansion/contraction of oil insulating media in the main chamber. Plant using a gas cushion oil preservation system for the main chamber shall not be considered.
- Oil filled plant shall have provision for taking a sample of the oil. Such a sample shall be truly representative of the oil in contact with the primary insulation in respect of moisture content, dissolved gases and degradation products.

- k) The sampling point shall consist of a "Swagelok" stainless steel type QC4-B-4PM (or -4PF) valve and SS-QC4-BP plug located near the top of the unit. It shall be sufficiently braced to allow for the forces required for coupling and uncoupling. It shall also be suitably shrouded to protect it from accidental damage during transport and erection.
- l) The quality of the oil used in oil filled plant, and the quality of construction of the plant, shall be such as to guarantee the following characteristics of the oil at the end of the first twelve months of service.
Loss tangent of the oil at 90°C < 20 milliradian
Resistivity of the oil at 90°C > 100 G.ohm.m
- m) It shall be possible to fill and drain all oil chambers of the plant easily. The lowest point of all oil filled chambers (except for high voltage oil filled capacitor stacks) shall be fitted with a drain/sampling valve of the gate type. The preferred valve has a flange on the chamber side and a half inch BSP flanged plug and seal on the outside. The Purchaser will use the drain/sampling valve to draw samples of oil from the bottom of the unit for dissolved gas analysis. A syringe is used to draw off the sample. An identical quantity of new degassed oil is then returned to the plant. Such sampling by the Purchaser would be carried out at commissioning and then approximately every four years, unless problems inside the plant are anticipated in which case more frequent sampling would be undertaken.
- n) Capacitor voltage transformers employing a gas cushion oil preservation system for the electromagnetic unit base box shall be designed such that, when correctly filled with oil and gas, the gas cushion pressure never goes negative over the full range of operating temperatures of the oil and shall be provided with a Swagelok valve and plug as specified in Clause 7.5 (j) above for the maintenance of gas pressure in the field.

7.6 Indicators and Gauges

- a) All gauges shall meet the requirements of AS 1349 with respect to industrial gauges. The scale of the gauges shall preferably be clearly marked with a green band to show the normal working range and red bands to indicate abnormal conditions above and below the limits of the normal working range. All gauges shall be constructed with a stainless steel body and a glass front. Gauges shall preferably be oil filled.
- b) All pressure indicators and gauges shall be calibrated in kilo Pascals (kPa).
- c) Each reservoir or chamber containing oil shall be provided with a level gauge or indicator.
- d) Each chamber of the plant which is totally filled with oil and which employs a diaphragm on top of and in direct contact with the oil, or metal bellows, to accommodate volumetric changes due to variations in temperature and to preserve the oil shall be provided with a diaphragm/bellows displacement or equivalent indicator. Such indicator shall be clearly and indelibly marked to show the normal working range, and provide indication outside the limits of the normal working range that signify abnormal conditions.
- e) Capacitor voltage transformers employing a gas cushion oil preservation system for the electromagnetic unit base box shall be provided with the following fittings:
 - (i) An oil level indicator clearly and indelibly marked to show the correct level and corresponding temperature, the normal working range, and which shall provide indication of oil level above and below the limits of the normal working range.
 - (ii) A pressure gauge monitoring the gas cushion pressure either directly or indirectly through the oil.
For each type of chamber employing a gas cushion oil preservation system, the manufacturer shall provide a graph of gauge pressure versus oil temperature range and shall include such graphs in the installation, operating and maintenance instructions.
- f) All level/pressure/density/displacement indicators or gauges shall be arranged such that they can be easily read by a person standing at ground level with the plant in its normal service position.
- g) Gauges and/or densimeters shall be protected from direct exposure to the rays of the sun by, for instance, placing within a cubicle behind a window or by provision of a sunshade. Experience of local conditions has shown that direct exposure to the sun promotes heating effects leading to inaccuracy, as well as premature aging of face covers and insulation on electrical contacts.
- h) Indicators, gauges and transducers shall be connected to the plant via self-sealing valves to allow for their removal and replacement without loss of oil or gas from the plant.
- i) Records of the calibration of all gauges shall be included as part of the Routine Test record.

7.7 High Voltage (Line) Terminal

- CVTs and PVTs will be voltage-connected by the Purchaser (refer AS 60044.5 Cl. 3.1.35). The high voltage terminal of the plant shall be a Type 1 two hole terminal palm or functional equivalent as shown on Specification Drawing no. H-114167-001.
- If alternative grades of material to those shown on the drawing are used, it shall be the responsibility of the Tenderer to demonstrate equivalence with the specified grades.
- The primary terminal shall have a rated mechanical terminal load in accordance with Table 9 of AS 60044.2 or AS 60044.5 as appropriate.

7.8 Primary Winding/Capacitor Divider Unit Low Voltage Terminal

The low voltage terminal of the primary winding or capacitor divider unit shall be solidly connected to an adjacent earth terminal by means of a removable link on which shall be engraved a suitable statement warning against disconnection whilst in service.

7.9 Second Terminals

- Each end of each secondary winding shall be brought out to a terminal.
- The secondary terminals shall be housed in a weather, vermin and insect proof terminal box with a degree of protection of IP55 or better and shall have a gauze covered breathing vent of not less than 30 mm diameter fitted to its underside. The terminal box, the terminal box cover, and any other cover or plate, shall be galvanically connected to the main tank i.e. earthed. Hinges are not considered to provide a satisfactory earth connection.
- Secondary Terminals shall be Phoenix type UK10N.
V-shape clamps or screws which bear directly on the wire shall not be accepted.
- Fuses or Miniature Circuit Breakers (MCB) shall not be installed in the secondary terminal box.
- The underside of the secondary terminal box shall be fitted with an undrilled detachable gland plate capable of accommodating two GN40 and two GN32 cable glands.

7.10 PVT Secondary Voltage

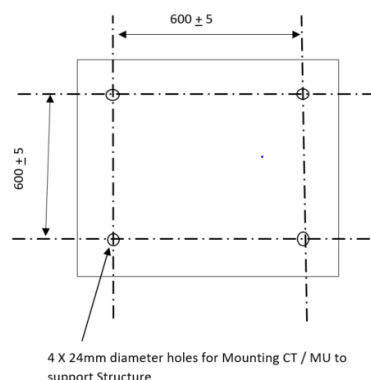
The power voltage transformers (PVTs) shall have a secondary output voltage of 240 V.

7.11 CVT Base/Base Plate Dimension

The base or removable base plate (base plate shall be supplied if CVT base has different bolt spacing to the dimensions shown below) for mounting CVT to support structure shall contain a minimum of 4 holes arranged in a square pattern. The spacing and diameter of the holes shall comply with the pattern shown in the table and diagram below.

Table 7-2 Base /Base Plate dimension

Bolt Spacing	Bolt Hole Diameter	Anchor Bolt Size
600 mm x 600 mm	24 mm	M20



7.12 Safety Clearances

- a) Voltage transformers shall be constructed such that all gauges, transducers, secondary terminals and the boxes housing these terminals shall be accessible to personnel while the voltage transformer is in service, without causing infringement of safety clearances. The safety clearances shall not be less than the values given in Table 7-3 Safety Clearance Distances below, which are based on the Exclusion Zone defined by the Queensland Electrical Safety Regulation 2002, Schedule 2, Part 2, appropriate to the rated voltage of the voltage transformer. The exclusion zone for exposed parts for authorised or instructed persons is the Queensland statutory distance that an authorised or instructed person must maintain between himself or herself and exposed high voltage conducting parts. (Exclusion zones for untrained personnel are much greater.)

Table 7-3 Safety Clearance Distances

Reference Voltage of Equipment (kV)	Exclusion Zone (Minimum Approach Distance) (mm)
275	2 300
132	1 430
110	1 430
66	1000

- b) The preferred means to guarantee that the requirement of Clause 7.11 (a) is met is to employ an insulator with a flashover distance at least equal to the safety clearance distance. This would enable personnel to easily ascertain the safe approach limit. This approach will generally require a longer insulator than strictly necessary to meet electrical insulation performance requirements. If Tenderers are concerned that such an approach would make their offer unduly expensive and/or uncompetitive, then they should offer the longer insulator as an extra-cost option to their standard design instead. The Purchaser will then evaluate the economic merits of both options. The safety clearance distance is to be indicated and dimensioned on general arrangement drawings for the equipment.

7.13 Windings

- a) Before aluminium may be used in windings, full details on the method of jointing the leads to the winding shall be submitted to and approved by the Purchaser.
- b) Secondary windings and connected equipment shall be protected against damage by electrical contact with the primary/intermediate voltage winding as the result of breakdown of insulation, by an earthed shield between the primary/intermediate voltage winding and the secondary windings.
- c) The winding conductor shall not contain any joints.

7.14 Electrical Joints

- a) No electrical joint shall be made which depends on a gasket material backing for its contact pressure.
- b) Soft solder shall not be relied on to provide mechanical strength in the making of electrical joints.

7.15 Rod Gaps

The Purchaser will install surge control equipment to be supplied by others which will ensure that over-voltages applied to the plant in service are limited to values below the withstand levels specified, and in the case of single phase plant, will install it at phase centres sufficient to ensure flashover from phase to earth rather than phase to phase. The provision of rod gaps with the plant for either of these purposes is therefore not permitted.

7.16 Gaskets

- a) Metal surfaces of oil joints on all manufacturers flanges shall be machined, grooved and fitted with O-rings or other type of seals with proven "in service performance".

Where flat gasket type seals are used, Nitrile or higher grade rubber gasket shall be used. Cork types of gaskets are not permitted.

- b) Gasket materials shall not contain asbestos in any proportion, form, size and shape.

7.17 Rating and Identification Plates

- a) Each CVT or PVT shall be fitted with a rating plate or plates carrying all information required by Clause 11.1 of AS 60044.2 or Clauses 16.1 and 12.2 of AS 60044.5. The plate(s) shall also include sufficient information to uniquely identify the type of oil or gas insulating medium used.
- b) In addition, each rating plate shall show the Purchaser's contract and item number, the purchase order number, and the material code of the item.
- c) The rating plate shall also show a diagram of connections with terminal markings in accordance with AS 60044.2 or AS 60044.5 as appropriate, and Specification drawing no. H-115047-001.
- d) Where a CVT consists of a separate capacitor divider unit and an electromagnetic unit, both units shall be fitted with an identification plate.
- e) Rating plates shall be made of 316 stainless steel with all lettering engraved, etched or formed in relief and be affixed to the transformer by means of stainless steel screws. The minimum depth of characters shall be 0.2 mm.
- f) A rating plate shall not be attached to a removable cover unless the serial number of the unit is separately stamped on to the equipment in a clearly visible location.
- g) Rating plates shall be located in a position where they can be easily read by a person standing at ground level, insofar as this is practical.

8. Voltage Transformer Tests

8.1 General

- a) All type tests and routine tests specified in AS 60044.2 and AS 60044.5 together with the following tests shall be carried out by a recognised testing laboratory before despatch of the plant to the Purchaser and shall verify the compliance of the plant with this Specification.
- b) In lieu of type tests, the Purchaser may accept certified copies of reports of type tests carried out previously on plant of identical design to that being supplied.
- c) The documentation of type and routine tests will not be considered adequate if a statement of compliance with the test requirements is provided without full details of the test equipment used and the actual readings taken during tests.
- d) The Purchaser may repeat the specified routine tests after delivery and before expiration of the Defects Liability Period. The plant shall satisfactorily pass such repeat tests.

8.2 Lighting/Chopped Impulse Voltage Withstand Tests on Primary Insulation (Type Test)

Lightning Impulse and Chopped Impulse withstand test shall be carried out as a type test on the "first unit of each Item" type manufactured against Powerlink's Specification.

- a) Lighting Impulse test on Power Voltage transformers (PVT) in accordance with Clause 8.3.2 of AS 60044.2 with the base earthed through a low-impedance non-reactive shunt and with the test sequence shown in Clause 8.2 (d) below.
- b) Chopped Impulse voltage withstand test on Power Voltage transformers (PVT) in accordance with Clause 6.1.2.4 of AS 60044.2.
- c) Lightning Impulse test on Capacitor Voltage transformer (CVT) in accordance with Clause 9.4.2 of AS 60044.5 with the base earthed through a low-impedance non-reactive shunt and with the test sequence shown in Clause 8.2 (d) below.
- d) The test sequence for lightning impulse routine testing shall be as shown below with a test voltage of the appropriate value given in Table 6-1 Voltage Transformer Ratings and Requirements (g)(i):
One reduced (50% test voltage) full wave negative impulse
Three full (100% test voltage) full wave negative impulses
One reduced (50% test voltage) full wave negative impulse
- e) Chopped impulse voltage withstand test on Capacitor Voltage transformer (CVT) in accordance with Clause 9.4.3 of AS 60044.5.
- f) The requirements of the test shall be complied with if there is no disruptive discharge and if no indication of failure is obtained from the oscillographic record of the impulse and of the voltage appearing across the shunt in the base earth lead.

8.3 Power Frequency Withstand Test (Routine Test)

- a) All items of plant shall be subject to a routine power frequency withstand test. The test voltage shall have the appropriate value given in Table 6-1 Voltage Transformer Ratings and Requirements (g) (iii).
- b) The power frequency withstand test on a CVT shall be carried out on the complete CVT with damping elements disconnected.

8.4 Measurement of Capacitance and Dielectric Dissipation Factor (DDF) (Routine Test)

- a) Measurements of capacitance and DDF shall be made both before and after the power-frequency and lightning impulse voltage withstand tests in accordance with Clause 10.2 of AS 60044.2 and Clause 10.2 of AS 60044.5 and at an ambient temperature of 20 ± 10 C. Measurements shall be taken with test voltages of 0.5, 1.05 and 1.5 $U_m / \sqrt{3}$ applied to the primary terminals of the CVT or PVT, where U_m is the highest voltage for the equipment given in Table 6-1 Voltage Transformer Ratings and Requirements (a).
- b) The value of DDF shall not exceed 0.007 for oil/paper/film insulation or 0.010 for gas-insulated systems.

8.5 Partial Discharge Tests (Routine Test)

- a) Each voltage transformer shall be tested after high voltage impulse and power frequency tests to prove its virtual freedom from partial discharges. The measurement of partial discharge shall be made while reducing the voltage applied during the power frequency test and within ten minutes of commencing the reduction of the test voltage.
- b) The level of internal partial discharge measured shall not exceed 5 pC at a voltage level of U_m where U_m is equal to the rated highest voltage (phase-to-phase) for the voltage transformer or coupling capacitor.
- c) In addition to measuring the discharge level at U_m , records shall be kept, and included in the test report, of the level of partial discharge measured at the full power frequency test voltage together with the discharge inception and extinction voltage levels.

8.6 Accuracy Tests on Windings (Routine Test)

- a) Accuracy tests to prove compliance with measurement and protection accuracy requirements of Clauses 12.2 and 13.2 of AS 60044.2 and Clauses 14.4 and 15.4 of AS 6044.5 shall be made at 5%, 80%, 100%, 120% and 150% of rated voltage, at rated frequency, and at 0% and 100% of rated burden.
- b) The tests shall be made in turn on each secondary winding, first with the rated burden and then with zero burden. Each test shall be made firstly with rated burden on the other winding and secondly with zero burden on the other winding.
- c) The accuracy measurements for class 0.2 measurement windings shall be certified to national standards of measurement. The testing laboratory in which these accuracy measurements are carried out shall be accredited to **ISO 17025** and this certification shall be included in the routine test report. Alternatively testing laboratory be accredited under a national laboratory accreditation scheme which is recognised under the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (**ILAC Arrangement or MRA**). In Australia, **NATA (National Association of Testing Authorities)** accreditation is required.
- d) The routine test report must also state the **uncertainty level** of the accuracy measurements for class 0.2 measurement windings. The maximum allowable level of uncertainty is $\pm 0.05\%$ for ratio and ± 0.05 crad for phase. An "estimate of testing uncertainties" must be calculated in accordance with the ISO "Guide to the Expression of Uncertainty for Measurement". This is a requirement of Schedule 7.3 in Chapter 7 of the Australian National Electricity Rules – refer <https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current> for additional information.

9. Information to be supplied by the Manufacturer

9.1 General

- a) All information shall be provided in the English language or accompanied by a certified faithful translation in the English language.
- b) All drawings shall be dimensioned, and all rating plate information given, in metric (SI) units in accordance with AS 1000.
- c) All graphical symbols used in drawings shall conform to the requirements of AS/NZS 1102.1xx (IEC 60617-x) series of standards.

9.2 Drawings

- a) The drawings and information set out below shall be supplied to the Purchaser. The Purchaser will approve the drawings prior to manufacture. Equipment supplied shall conform to the approved drawings. If the drawings supplied do not conform to the Purchaser's requirements as set out below or elsewhere within this Specification, the Purchaser will indicate the non-conformances and the required corrections to the Manufacturer, and the Manufacturer shall make the corrections to the drawings for the Purchaser's approval prior to manufacture.
- b) Dimensioned outline drawings of the equipment clearly showing:
 - (i) The contract number, the item number, the material code and, where relevant, the Purchaser's order number of the equipment to which the drawing refers
 - (ii) Overall dimensions of equipment
 - (iii) The height of the lowest part of the main insulator, the lowest live metal above the mounting base, and the safety clearance distance defined by Table 7-3 Safety Clearance Distances so that safety clearances can be established
 - (iv) Mounting and installation details for the plant
 - (v) The basic design wind velocity and terrain category for which the plant is designed
 - (vi) The locations of high voltage (primary) terminals and marking plates, rating and diagram plates, secondary terminal box and detachable gland plates, lifting lugs, membrane/bellows level indicators, oil drain/sampling valves, filling/sampling valve type and location, pressure relief devices, and earthing points etc. with references to the manufacturer's drawing numbers for supporting detail drawings
 - (vii) The total mass of the plant in kilograms
 - (viii) The volume of oil contained during transport and also that volume or mass contained in the plant at full operating level or pressure
 - (ix) Details of surface finish
 - (x) Details of earthing points showing surface finish
 - (xi) The rated mechanical terminal load for each primary terminal which can be applied in addition to the specified maximum wind loading
- c) Detail drawings of the main insulators showing material, finish, colour and all dimensions from which the Purchaser can establish the electrical performance of the insulator. These dimensions include flashover distance, creepage distance, protected creepage distance and all shed profile dimensions.
- d) Detail drawings of each primary terminal showing drilling detail, the material from which it is manufactured (including alloy specification), and the surface finish.
- e) Details of gauges, transducers and indicators including make, type, and catalogue number of proprietary items and calibration charts.
- f) Detail drawings of rating and diagram plates setting out all information to be shown thereon as well as the material from which it is manufactured and the method of indelibly marking.
- g) The arrangement of secondary terminals and earth link, breathing vent and detachable gland plate, and make and type of terminals within the secondary terminal box.
- h) A cross-sectional drawing showing the shielding arrangements or stress control, and the method of support for the windings of voltage transformers.

- i) Packing crate drawings showing dimensions, internal arrangement, weight, lifting/slinging arrangement and centre of mass, type of material, cross members etc. Each drawing shall show the Purchaser's contract number, item number and material code.

9.3 Instruction Manual

9.3.1 General

- a) Information and manuals as set out below shall be supplied to the Purchaser prior to the delivery of equipment.
- b) Each manual shall include a cover sheet showing the contract number, the item number and the material code of the equipment to which the manual refers.
- c) Manuals and/or test reports shall be supplied in Adobe Acrobat pdf format by email for the Purchaser to reproduce in hard copy if required.

9.3.2 Goods Receipt

The instruction manual shall describe how the equipment is packed, including weights and dimensions of crates, the checks that should be made on equipment upon arrival, the location and activation values of any shock indicators, and the action to be taken by the Purchaser's representatives if damage or deterioration in the equipment is found.

9.3.3 Storage Requirements

The Manufacturer shall advise the Purchaser of any special storage requirements for the equipment or any special actions for the Purchaser to take in order to ensure the continued good condition of the equipment while it is in the Purchaser's store or at the Purchaser's site awaiting assembly and erection in outdoor storage for a minimum period of one year.

9.3.4 Installation and Test

The Contractor shall supply a detailed installation and testing manual. This manual shall:

- (i) Be suitable for use by the Purchaser's staff or by an independent installation contractor. It shall be assumed that such staff or installation contractor are reasonably experienced in the installation and testing of high voltage equipment but have no special training with the particular equipment being supplied
- (ii) Contain full and detailed instructions, including diagrams and check sheets, describing materials, special tools required and check points and test measurements which will enable the Purchaser or installation contractor to install the equipment
- (iii) Contain safety instructions, warnings or cautionary notes relating to the safe installation of all equipment
- (iv) Detail all checks and functional tests required to be carried out on the equipment to verify its suitability for service at high voltage.

9.3.5 Abridged Installation Manual

The abridged Installation manual shall provide sufficient instruction to allow a reasonably competent installation contractor with no special training to remove an item of equipment from its packing and mount it on its structure, and carry out the installation tasks as deemed suitable by the manufacturer.

9.3.6 Pre-Commissioning

- a) The pre-commissioning manual shall be suitable for use by the Purchaser's staff or by an independent contractor and shall contain details of any additional tests recommended to be performed following erection but prior to commissioning of the equipment on to the high voltage network.
- b) The manual shall also contain a commissioning check sheet listing all items the manufacturer considers need checking and/or verifying prior to the equipment entering service.

9.3.7 Operation, Maintenance and Repair Manual

A general operation, maintenance and repair manual for use by the Purchaser's maintenance staff or maintenance service provider shall be provided. The manual shall include:

- (i) Full and detailed information, with references to contract drawings or other diagrams provided, which explains how the equipment works, how it should be operated, and any special safety features provided
- (ii) Safety instructions, warnings or cautionary notes relating to the safe operation of all equipment
- (iii) Full information about accessory components.

- (iv) Full and detailed instructions for the maintenance of the plant including instructions enabling the repair of any leak, together with a list of the necessary spare parts and special tools
- (v) A detailed specification of oils used in the plant including a minimum specification with which the plant will operate satisfactorily as guaranteed, and a specification which should be achieved when the plant is first commissioned to ensure the oils do not fail to meet the minimum specification over the life of the equipment
- (vi) A parts list including a full description of all parts, their manufacture, type, grade and catalogue number in sufficient detail to enable the Purchaser to replace any part which may become defective in service
- (vii) A full set of approved contract drawings
- (viii) The manual shall not contain routine test reports. These shall be supplied separately to the Purchaser (refer Clause 9.4).

9.4 Routine Test Reports

- a) A certified report shall be prepared of each routine test conducted on each item of equipment and a copy forwarded to the Purchaser by email.
- b) The report shall be received prior to delivery of the equipment. As the test report provides critical evidence of the conformance of the equipment to the Purchaser's specification, non-receipt of the test report shall be sufficient grounds for the Purchaser to indefinitely defer issuing the certificate of acceptance for the equipment.
- c) Each test report shall include a cover sheet showing:
 - (i) The contract number
 - (ii) The contract item number
 - (iii) The Purchaser's purchase order number
 - (iv) The Purchaser's material code
 - (v) The Purchaser's project number (where this information has been provided by the Purchaser)
 - (vi) The type of equipment
 - (vii) The range of serial numbers to which the report refers (if applicable).
- d) Routine Test reports shall:
 - (i) Identify the individual serial number of the equipment to which the report refers
 - (ii) State all values measured or tested
 - (iii) State upper and lower tolerance limits for all measured parameters that are not specified in Standards or in the body of this specification so that the Purchaser can independently assess the acceptability of the recorded values
 - (iv) Certify the calibration of measuring equipment used for VT accuracy measurements to NATA or equivalent local national standards of measurement under a MRA
 - (v) Certify the uncertainty level of the accuracy measurements on class 0.2 voltage transformer secondary windings as calculated in accordance with Clause 8.6 (d)
- e) To ensure routine test results will be acceptable to the Purchaser, particularly the accuracy measurements, the Contractor is advised to submit the test protocol for the Purchaser's approval prior to conducting the tests.

9.5 Type Test Reports

The Tenderer shall supply details of type tests carried out on the offered equipment during the last ten years which verifies its performance according to the relevant standards. This is to be included in the Tender submission in the form of certified copies of type test certificates covering type tests carried out on equipment of identical design. Full copies of type test results shall be supplied to the Purchaser on request either before or after acceptance of the Tender. Lack of acceptable type test evidence of the performance of equipment shall be grounds for rejection of the Tender. The acceptability (or not) of a type test report on equipment of a similar but not identical item of equipment, or of a test report of a test conducted more than five years previously, shall be at the sole discretion of the Purchaser's registered professional engineer.

9.6 Specification on Drawings and Documents

9.6.1 General

- a) Unless specified otherwise, the Contractor shall provide the Purchaser with the required number of copies of all correspondence, including all drawings and technical documentation, which describes or provides details about the equipment supplied, along with one full set of electronic versions for the same documents and drawings in an agreed format.
- b) Some drawings and technical documentation may need to be submitted progressively to the Purchaser for verification and checking purposes. Such documents may be sent electronically and shall be in a format agreed in writing between the Contractor and the Purchaser. Preference will be given to the formats outlined in Clauses 9.6.2.2 and 9.6.3.2 below.
- c) Finally accepted documentation shall be forwarded to the Purchaser in electronic form by email or file transfer.
- d) The cost of the supply of all hard copy and electronic drawings and technical documentation shall be included in the scheduled rate for the equipment.

9.6.2 Drawing Standards

9.6.2.1 General

- a) Drawings shall comply with Australian Standards 1000, 1046, 1100, 1101 and 1102.
- b) All measurements shall be in millimetres.
- c) All graphical symbols used in drawings shall conform with the requirements of AS/NZS 1102.102 and AS/NZS 1102.103 (IEC 60617-2: and IEC 60617-3).
- d) All fonts shall comply with ISO 3098-2.
- e) All notes, instructions and words used on the drawings shall be in the English language.
- f) All drawings shall be to scale and fully detailed.
- g) All drawings are to show key dimensions of all parts, components and equipment, along with complete details of all materials used in manufacture, fabrication and assembly.
- h) Any references to off-drawing information shall require supply of that information as part of contract-supplied documentation, unless it refers to recognisable third party reference material such as international Standards.

9.6.2.2 Electronic Format

- a) All Engineering Documentation (Engineering Drawings) supplied electronically shall be supplied in one of the following formats. The Purchaser's preferred format is MicroStation (Promis.e), although other drawing file formats (AutoCAD .dwg or .dxf) are acceptable.
- b) Only A1, A2, A3 and A4 size sheets shall be used. The Purchaser's preferred size is A1 and drawing frame files will be supplied to the Contractor on request. To facilitate batch plotting, drawing frames shall be left full size and the drawing reduced to fit into the frame.

9.6.2.3 Amendments to Drawings

- a) Means of an approved stamp such as a red triangle or an arrow in red on the revisions provided. Amended drawings submitted shall at all times retain the original drawing number, followed by the revision letter or number, with summary details in a separately sequenced amendment block. If there is a need to supersede one drawing by a new drawing with a different number, then reference to the superseded drawing number shall be made immediately above the title block of the new drawing and referenced in the amendment block under the appropriate revision. Attention shall be drawn to the change of number in the covering correspondence.
- b) The Contractor shall indicate the portions of the drawing which have been amended in a re-issue by

9.6.2.4 Transfer of Ownership

The Contractor shall transfer ownership of all contract-specific drawings to the Purchaser. The Purchaser will be permitted full use of the drawings for any future extensions or for re-use at other sites. In such cases, the Contractor shall be absolved of all responsibility for such future use but shall remain responsible for all matters resulting from their original use.

9.6.3 Document Standards

9.6.3.1 General

- a) All documents shall comply with relevant Australian Standards and be formatted for printing on metric-sized paper, preferably A4.
- b) All manuals, test reports and similar documents will be registered as the Purchaser's documents and require appropriate titles similar to drawings as per Clause 9.6.2.1 above.
- c) For reference the contract number and the Contractor's document reference number may be placed as part of a header information on the front sheet of any document and relevant pages thereafter.

9.6.3.2 Electronic Format

All engineering documentation (engineering manuals, test reports, etc.) supplied electronically shall be supplied in "**searchable .pdf (Acrobat)**" or "**.docx (MS Word)**" format and shall be in accordance with the following:

- (i) Only A3 and A4 size sheets shall be used, with the Purchaser's preferred size being A4.
- (ii) Each electronic file shall contain only one document. References to other documents supplied under the contract can be referenced as hyperlinks where appropriate.
- (iii) Where drawings have been supplied as per Clause 9.6.2 above, and form part of an instruction manual or similar, these drawings may also be supplied in pdf format where sufficient detail can be provided.
- (iv) All fonts shall be TrueType fonts and appropriate character sets supplied to the Purchaser. If approval has been given by the Purchaser to use other fonts, the Contractor shall supply these fonts to the Purchaser in electronic format.
- (v) All notes, instructions and words used on the documents shall be in the English language.

9.6.3.3 Amendments to Documents

- a) Amended documents submitted shall at all times retain the original document number, followed by the revision letter or number. If there is a need to supersede a registered document by a new document with a different number, then reference to the superseded document shall be made immediately below the title of the new document. Attention shall be drawn to the change of number in the covering correspondence.
- b) The Contractor shall indicate the portions of the document which have been amended in a re-issue by means of an approved stamp such as a red triangle or an arrow in red on the amended pages, or by 'revision marking' within the text.

9.6.3.4 Transfer of Ownership

The Contractor shall transfer ownership of all contract-specific documents to the Purchaser. The Purchaser will be permitted full use of the documents for any future extensions or for re-use at other sites. In such cases, the Contractor shall be absolved of all responsibility for such future use, but shall remain responsible for all matters resulting from their original use.

9.7 Training

- a) The Tenderer shall provide full details of recommendations for training of the Purchaser's staff or contract workers in the installation, operation, maintenance, monitoring and testing of the equipment to be supplied under the contract. These details shall include information about the duration of the training, the maximum number of participants, and whether or not the training would be provided at the Purchaser's work site.
- b) Training shall be considered at two levels. Basic training shall allow an installer to mount a voltage transformer on its structure, and complete basic wiring tasks. Detailed training shall allow a technician to perform all tasks associated with installation, maintenance and fault-finding.
- c) The Tenderer shall include prices for conducting such training with the tender.

10. Packing and Delivery

10.1 Packing

- a) Care in packing of the equipment at the factory prior to shipment is absolutely critical to the arrival of the equipment in good condition at site. Extreme care and consideration must be exercised to ensure that equipment is adequately protected from environmental and transport damage during its journey from factory to the delivery point and subsequent onward transport to the final work site.
- b) The equipment shall be adequately packed to withstand the rigours of transport and outdoor storage for a period of at least six months at the delivery point and any subsequent onward transport to its final destination. Any parts not intended to be exposed to outdoor environmental conditions in the un-erected state shall be adequately treated and protected to prevent water ingress, corrosion or deterioration.
- c) Any item intended for indoor storage only at the delivery point and/or final destination must be clearly and indelible labelled as such on the exterior of the packaging.
- d) Packaging/crates shall preferably be suitable for safe unloading and handling by means of forklift. Locating points for forklift tines shall be marked on the packaging. If slinging is required, this shall be clearly marked and slinging points identified to prevent incorrect handling. Centres of gravity of packaged/crated items shall be clearly identified in two orthogonal horizontal dimensions on the exterior of the packing.
- e) Equipment which may be particularly vulnerable to hidden damage during transport if handled incorrectly shall be equipped with shock indicators. In addition, the Purchaser would prefer that the equipment be mounted on shock absorbers for transport to mitigate the effects of hard impacts. The shock indicators shall be as located on the packaging as to be readily inspected upon receipt at the delivery point without necessitating interference to the integrity of the packaging materials. If indicators are found to be missing or activated/tripped upon delivery, the equipment shall be deemed to be damaged and may be rejected. It shall be easily possible, where appropriate and subject to the approval of the Manufacturer, for the Purchaser to replace tripped indicators for the purposes of onward travel if required. Indicators should not be stuck-on to painted surfaces such that removal of the indicators at the final delivery point, or the indicators falling off, causes the paint to peel away or be otherwise damaged and exposing the base material to corrosion. Where painted surfaces are damaged by the removal of indicators, this shall be deemed to be a warranty defect and the Contractor shall be required to make good the damage.
- f) All items required to erect a single item of equipment shall be packaged together and not aggregated into a larger batch covering several items. Even small items such as bolts, nuts and washers shall be packaged in individual quantities on a single item of equipment basis.
- g) Equipment ordered on different purchase orders shall be packaged and shipped as separate items, and not be aggregated or packaged together such that the Purchaser has any difficulty separating them for storage or onward transport.
- h) All fasteners, screws, clamps etc. shall be tight prior to shipping. In particular, the screws in all terminal blocks shall be tight. The Purchaser shall be entitled to treat loose fasteners found on delivery as a warranty defect.
- i) All packaging shall become the property of the Purchaser upon delivery except that in the event of erection being performed by the Contractor, all packaging material shall remain the property of the Contractor and be removed from the site by the Contractor upon completion of erection.

10.2 Delivery

- a) Delivery of equipment and its packaging shall be made in good order suitable for onward road transport if necessary within the time for delivery and to the place nominated by the Purchaser and otherwise according to the contractual and commercial terms of the contract. The Purchaser will not provide loading or unloading facilities at the delivery site.
- b) The Contractor shall supply the Purchaser with notification of intended delivery, with the advance notice and addressed to the place, as set out in the contractual and commercial terms of the contract. Such notification shall include a complete inventory of all crates, boxes, pallets and cartons, and their contents, together with weights and dimensions, so that the Purchaser will be able to verify the correctness or otherwise of the consignment received, and also locate all of the items required for assembly of any particular item of equipment.

- c) Delivered equipment shall be accompanied by a readily identifiable comprehensive packaging inventory and delivery note attached in a prominent position identifying the Purchaser's purchase order number and line item, the material code for the equipment as previously advised by the Purchaser to the Contractor, equipment serial number(s), and weights and dimensions of all packages forming the delivery.
- d) If the delivered equipment is not in accordance with the specification, or received in a damaged condition, or otherwise fails to meet the guaranteed performance, the Purchaser reserves the right to reject the plant and insist that the plant be replaced, repaired or modified at no cost to the Purchaser.
- e) The Purchaser reserves the right to conduct on the equipment any test necessary in order to establish that the equipment conforms to the requirements of the contract. Should the Purchaser not perform any such test, or if the equipment passes any such test or inspection, this shall not prejudice any right of the Purchaser to subsequently reject the equipment or require rectification should it be found that the equipment does not meet the requirements of the contract.

11. References

Voltage transformers shall be designed, manufactured and tested to meet the requirements of the relevant Australian and International Standards and normative reference standards. These include the standards listed below. Unless otherwise specified herein, the plant shall be in accordance with the latest edition and amendments of the appropriate Standards. Evidence of compliance with these standards, e.g. type test reports, shall be supplied with tenders.

Document code	Document title
Powerlink references	
AS 60044.2	Instrument transformers Part 2: Inductive voltage transformers
AS 60044.5	Instrument transformers Part 5: Capacitor voltage transformers
IEC 61462	Composite hollow insulators
A279709	SME-141.2 Schedules for Voltage Transformers
Other references	
AS ISO 1000	The international system of units (SI) and its application
AS 1100	Technical drawing - General principles
AS 1101	Graphic symbols for general engineering
AS 1102.1	Graphic symbols for electrotechnical documentation
AS 1170.2	Structural design actions - Wind actions
AS 1349	Bourdon tube pressure and vacuum gauges
AS 1767	Insulating liquids
AS 2700	Colour standards for general purposes
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
	Queensland Electrical Safety Regulation

12. Defined terms

All definitions and abbreviations are as per standard industry practice.

Terms	Definition
Purchase order number	Typically a seven digit number preceded by the letters PO shown on, and identifying, individual sub-orders placed by the Purchaser under the contract.
Material code	Typically a five digit number as advised to the Contractor by the Purchaser that the Purchaser uses to uniquely identify an item of equipment within its material inventory (stores) system.