

SME-131.3 Supply of High Voltage Combined Transformers for 362 kV

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Version history

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1. Introduction

1.1 Purpose

This document is the technical specification and reference document for high voltage combined transformers for 362 kV. Together with the commercial specification, it will form the tender specification for 362 kV combined transformers, and be the technical basis of a supply contract.

1.2 Scope

- a) This specification document covers the technical and testing requirements of high voltage post type combined current and voltage transformers intended for tariff metering applications (also referred to as metering units (MUs)).
- b) 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.
- c) All plant shall be SF₆ insulated. Oil insulated designs will not be considered and should not be offered. Main insulators shall be silicon composite for safety reasons.
- d) Tenderers should provide evidence in the form of type test certificates and in-service experience which demonstrates the safety characteristics of the design offered with their tender.

1.3 References

High voltage current transformers and metering units 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. Evidence of compliance with these standards, e.g. type test reports, shall be supplied with tenders.

Document code	Document title
AS 60044.1-2007	Instrument transformers – Part 1: Current transformers
AS 60044.2-2007	Instrument transformers – Part 2: Inductive voltage transformers
AS 60044.3-2007	Instrument transformers – Part 3: Combined transformers
IEC 61462 – 2007	Composite hollow insulators
Axxxxxx	SME-131.4 Schedules for High Voltage Combined Transformers for 362 kV

Other relevant standards are listed below:

AS ISO 1000-1998	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 1170.2-2011	Structural design actions - Wind actions
AS 1349	Bourdon tube pressure and vacuum gauges
AS 2700	Colour standards for general purposes
IEC 60376	Specification of technical grade sulfur hexafluoride (SF ₆) for use in electrical equipment
	Queensland Electrical Safety Regulation 2013

1.4 Definitions and abbreviations

General definitions and abbreviations are as per standard industry practice.

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.

2. Service conditions

2.1 Particular 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)	362
Nominal Voltage (kV)	330
Highest Voltage (kV)	362
Frequency (Hz)	50
Normal Frequency Limits (Hz)	± 0.1
Number of Phases	3
Earthing	Solidly earthed neutral system

2.2 Environment

The plant shall be capable of satisfactory 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 3 of AS 60044.1 with the following special service conditions:

- (i) Air Temperatures
 - Extreme maximum = 50°C
 - Extreme minimum = -10°C
- (ii) 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 Pressure

The design wind pressure shall be as determined in accordance with AS/NZS 1170.2 for terrain category 2 exposure in region C (tropical cyclone areas), and the following:

 - Regional Wind Speed for ultimate limit state V1000 = 73 m/s
 - Maximum overall height of structure and equipment = 10 m
 - 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

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

Drawing No.	Title
H-114167-001/B	Substation Electrical - Electrical Plant - Standard Terminal Palms - Details
H-115047-001/B	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
R1M	362 kV, 2000 A, 50 kA, 50 Hz, 2 core, single phase outdoor combined CT/VT (metering unit) with class 0.2 measurement cores (highest ratio 1600/1A).

5. Combined transformer ratings

Combined transformers shall be in accordance with the requirements of AS 60044.3 except where varied by this Specification, and shall have the rated or performance characteristics as set out in Table 5-1 for the current transformer section and Table 5-2 for the voltage transformer section. Tenderers who offer combined transformers which have been designed and tested at rated values better than those specified, shall guarantee the better values and, in the event of being awarded a contract, show the better values on the rating plates of the combined transformers supplied. Tenderers shall state the guaranteed values in Schedule K2. Combined transformers may be located in a position normally occupied by a line voltage transformer and be required to provide the line VT function. The voltage transformer sections of combined transformers have therefore been specified with a protection performance class as well as a metering performance class.

Table 5-1 Rated Characteristics for Item R1M CT Section

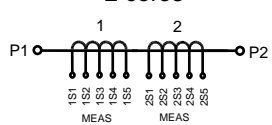
(a)	SYSTEM NOMINAL VOLTAGE	330 kV																																																
(b)	HIGHEST VOLTAGE FOR EQUIPMENT	362 kV																																																
(c)	INSULATION LEVEL																																																	
(i)	Rated lightning impulse withstand voltage	1 175 kVp																																																
(ii)	Rated one minute power frequency withstand voltage	510 kV																																																
(iii)	Rated switching impulse withstand voltage	950 kVp																																																
(d)	RATED FREQUENCY	50 Hz																																																
(e)	DIAGRAM OF ARRANGEMENT OF CORES TO BE SUPPLIED IN EACH SINGLE PHASE POST TYPE COMBINED TRANSFORMER																																																	
(i)	Number of cores	2 cores																																																
(ii)	Core No.:																																																	
(iii)	Prim. term. marking:																																																	
(iv)	Sec. term. marking:																																																	
(v)	Type of CT:																																																	
<div></div> <p>(MEAS = Measurement Core)</p>																																																		
(f)	TAPPINGS TO BE PROVIDED FROM WHICH THE SPECIFIED) TRANSFORMATION RATIOS SHALL BE OBTAINED,) EXPRESSED AS TRANSFORMATION RATIOS (ALL CORES))	1600.800.600.400/1A																																																
(g)	SECONDARY WINDING THERMAL LIMIT CURRENT	2 A																																																
(h)	<u>PERFORMANCE OF MEASUREMENT CORES 1 AND 2</u>																																																	
	<table><tr><th>Rated Transformation Ratio (A)</th><th>Class of Accuracy</th><th>Min/Max Rated Burden (VA)</th><th>Thermal Limit Current (A)</th><th>Rated Short-time Current (kA for 1s)</th><th>Secondary Terminals</th></tr><tr><td>1 600/1</td><td>0.2 ext. 150%</td><td>1/5</td><td>2 000</td><td>50</td><td>xS1-xS5</td></tr><tr><td>1 200/1</td><td>0.2 ext. 150%</td><td>1/5</td><td>2 000</td><td>50</td><td>xS2-xS5</td></tr><tr><td>1 000/1</td><td>0.2 ext. 150%</td><td>1/5</td><td>2 000</td><td>50</td><td>xS3-xS5</td></tr><tr><td>800/1</td><td>0.2 ext. 150%</td><td>1/5</td><td>1 600</td><td>50</td><td>xS1-xS4</td></tr><tr><td>600/1</td><td>0.2 ext. 150%</td><td>1/5</td><td>1 200</td><td>50</td><td>xS1-xS3</td></tr><tr><td>400/1</td><td>0.2 ext. 150%</td><td>1/5</td><td>800</td><td>50</td><td>xS1-xS2</td></tr><tr><td>200/1</td><td>0.5 ext. 150%</td><td>1/5</td><td>400</td><td>50</td><td>xS2-xS3</td></tr></table>	Rated Transformation Ratio (A)	Class of Accuracy	Min/Max Rated Burden (VA)	Thermal Limit Current (A)	Rated Short-time Current (kA for 1s)	Secondary Terminals	1 600/1	0.2 ext. 150%	1/5	2 000	50	xS1-xS5	1 200/1	0.2 ext. 150%	1/5	2 000	50	xS2-xS5	1 000/1	0.2 ext. 150%	1/5	2 000	50	xS3-xS5	800/1	0.2 ext. 150%	1/5	1 600	50	xS1-xS4	600/1	0.2 ext. 150%	1/5	1 200	50	xS1-xS3	400/1	0.2 ext. 150%	1/5	800	50	xS1-xS2	200/1	0.5 ext. 150%	1/5	400	50	xS2-xS3	
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Table 5-2 Rated Characteristics for Item R1M VT Section

(a)	Highest voltage for equipment (U_m) (kV)	362
(b)	Rated primary voltage (U_{PR}) (kV)	330/ $\sqrt{3}$
(c)	Rated secondary voltages:	
	(i) Secondary winding no. 1 (U_{SR1}) (V)	110/ $\sqrt{3}$
	(ii) Secondary winding no. 2 (U_{SR2}) (V)	110/ $\sqrt{3}$
(d)	Rated frequency (f_R) (Hz)	50
(e)	Number of phases	1
(f)	Method of interconnecting 3 x 1 phase VTs	
	(i) Primary winding / capacitor divider unit	star
	(ii) Secondary winding no. 1	star
	(iii) Secondary winding no. 2	star
(g)	Rated insulation level (RIL):	
	(i) Rated lightning impulse withstand voltage (LIWV) (kVp)	1175
	(ii) Rated switching impulse withstand voltage (SIWV) (kVp)	950
	(iii) Rated one minute power frequency withstand voltage (PFWV) (kV)	510
(h)	Rated voltage factor (F_v) and rated duration	1.5 for 30 s
(i)	Combined accuracy classification for each secondary winding. (The accuracy classification for secondary winding no. 1 and no. 2 is identical.):	
	(i) Accuracy class	0.2 / 3P
	(ii) Rated burden at unity power factor (mS)	12
	(iii) Lower limit of burden for accuracy class (p.u.)	Zero
	(iv) Rated output at unity power factor (measurement duty) (VA)	50
	The plant shall meet the accuracy classification over the full range of compliance required by 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 tapings of trimming windings.	
(j)	Maximum output of VT while maintaining accuracy on both secondary windings (VA)	100

6. Design and construction

6.1 General

- a) Each core of each single phase current transformer section shall be magnetically independent.
- b) Only those tapplings nominated in the appropriate section of Table 5-1 shall be brought out of each secondary winding of each core. All of the available rated transformation ratios shall be obtained by connection between the appropriate secondary winding tapplings.
- c) Each post-type transformer shall be capable of withstanding a full internal vacuum without damage.
- d) The plant 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.
- e) The construction of the exposed portions of the plant shall be such that there are no pockets in which water can accumulate.
- f) Terminal boxes and similar enclosures shall be supplied with openings to allow ventilation and the draining of condensation. These and any other openings or vents shall be covered by suitable screens and shall be designed to prevent the ingress of rainwater, insects and vermin.
- g) Rupture discs with suitable weather protection housings shall be fitted to prevent the build-up of dangerously high pressures within all SF₆ insulated units. Exhaust of gases shall be directed in a manner that is not hazardous to adjacent personnel.

6.2 Explosion resistant design

Combined transformers shall preferably be of explosion resistant design. Where a Tenderer offers a current transformer 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 current transformer, unless otherwise agreed to by the Purchaser.
- (v) The design of vents shall be such that moisture is prevented from entering the current transformer for the whole of its design life under the most arduous weather conditions.

6.3 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.

6.4 Fasteners

- a) The dimensions of all nuts and bolts shall conform to the ISO standards for coarse pitch metric fasteners. Thin nuts shall not be used.

- b) 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).
- c) 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.)

6.5 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.

6.6 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.

6.7 Bushings and insulators

- a) Bushings or insulators shall be of the composite type with grey silicon sheds.
- b) Bushings and insulators shall be manufactured and tested in accordance with the requirements of IEC 60137 and IEC 61462.
- c) Each insulator shed shall have an effective drip edge so as to prevent the continuous flow of water down the insulating surface.
- d) 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 7 of AS 60044.1.
- e) The minimum specific creepage distance of insulators shall be not less than 25 mm/kV and the actual value of minimum creepage calculated in accordance with the specific creepage is set out in Table 6-1 Insulator Creepage Distances.

Table 6-1 Insulator Creepage Distances

Highest Voltage of Equipment (kV)	Minimum Creepage Distance for Heavy Pollution Insulators (mm)
362	9 050

6.8 SF₆ Gas

- a) Combined transformers shall be supplied with sealed compartments filled with a transport charge of SF₆ gas. The Contractor shall separately supply sufficient additional SF₆ gas to fill the units to the correct operating density or pressure. The Contractor shall also supply a take-out price for the gas. The Purchaser intends to use his existing stocks of IEC 60376 compliant recycled SF₆ gas for new plant where possible, and this gas shall be deemed acceptable by the manufacturer. The Purchaser will advise in the purchase order if the take-out price is to be applied.
- b) The manufacturer shall specify the required mass of gas in the plant (including the transport pressure and the mass of SF₆ gas supplied at that pressure within the equipment) in service and shall provide the Purchaser with the necessary instructions for adding or removing the gas.

- c) Any SF₆ gas supplied by the manufacturer shall comply with the requirements of IEC 60376.
- d) SF₆ gas insulated equipment shall operate satisfactorily with gas having the following properties:
 - (i) Dew Point < - 25°C at 101 kPa
 - (ii) Purity > 98%
 - (iii) Contamination < 1 p.p.m. decomposition products
- e) SF₆ gas insulated equipment shall be processed and dried internally after assembly, and delivered with an internal level of moisture low enough to permit the Purchaser to fill and commission the equipment with gas complying with the requirements of IEC 60376 to achieve a dew point level of the gas within the equipment soon after filling of less than -30°C at 101 kPa.
- f) Before expiration of the first twelve months of service, the Purchaser may test the dew point of the gas of SF₆ insulated plant. The dew point shall not be greater than -30°C at 101 kPa. If the gas moisture level is higher than this value, the Purchaser reserves the right to require remedial action by the Contractor under warranty.
- g) Each SF₆ gas chamber shall be provided with a DILO type DN8 or DN20 (or other equivalent type as approved by the Purchaser) SF₆ valve fitting/coupling for filling/drainage and sampling purposes. The filling valve shall be located in a position where it can be safely accessed while the combined transformer is in service without infringing upon the safety clearances of Table 6-2. The valve fitting shall be securely fixed in position and shall not rely on any gas piping for its support. The valve shall be provided with a suitable protective sealing cap to prevent moisture and dust ingress during the life of the equipment.
- h) The pressure/density of each separate SF₆ gas chamber shall be monitored by means of:
 - (i) a suitable visual indicator i.e. gauge,
 - (ii) two temperature compensated pressure switches. The first switch shall provide indication when the pressure in the chamber is approximately 20 kPa above the minimum value for service (stage 1 alarm pressure), and the second switch shall provide indication when the pressure in the chamber has fallen to the minimum value for service (stage 2 alarm pressure). The switches shall be wired to the secondary terminal box for the Purchaser's connection.
 - (iii) an analogue density transducer as specified in Clause 6.9 g) wired to the secondary terminal box for the Purchaser's connection.
- i) The pressure monitoring instruments specified in the previous clause shall be connected via self-sealing valves to prevent loss of gas on their removal. It shall be possible to safely remove the pressure monitoring equipment for maintenance checks or replacement without removing, or loss of, gas from the combined transformer. Instructions for such removal and checking shall be included in the maintenance manual.
- j) SF₆ insulated plant shall be designed to have a gas leakage rate of not more than 0.2% per year and routine tested using the gas accumulation method to demonstrate an achieved leakage of less than 0.5% per year. Tenderers shall state the guaranteed maximum leakage rate in Schedule L.
- k) The Tenderer shall guarantee in Schedule L the maximum gas loss in percent per year.

6.9 Indicators and gauges

- a) All gauges shall meet the requirements of AS 1349 with respect to industrial gauges. All gauges shall be constructed with a stainless-steel body and a glass front. Gauges shall preferably be liquid filled and resistant to deterioration due to UV (solar) radiation. In addition to a numerical scale, coloured zones shall be provided on gauge scales. A green zone shall indicate the acceptable operating range, a yellow or orange zone shall indicate low pressure, and red zones shall indicate over-pressure and below lockout pressure
- b) All pressure indicators and gauges shall be calibrated in kilo-Pascals (kPa). Other scaling units such as mega-Pascals (MPa) or Bars, and particularly imperial units such as PSI or PSIG, are not acceptable.

- c) Gauges for local indication of pressure on SF₆ gas insulated equipment shall be temperature compensated for the true ambient temperature.
- d) It shall be clear to a person looking at the gauge whether the gauge is calibrated in absolute or relative units, and also to confirm that the indicated pressure is compensated for temperature. Acceptable means of doing this are by including the words, for example, "absolute" and "temperature compensated" on the faceplate or an attached label.
- e) All pressure/density 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.
- f) Gauges, densimeters and transducers shall be protected from direct exposure to the rays of the sun or to rain by, for instance, placing within a cubicle behind a window or by provision of a sun/rain shade. 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. Exposure to rain can lead to moisture ingress and corrosion. External plug-in type electrical connections are not acceptable due to the propensity for moisture ingress and subsequent corrosion. Internal connections with wires exiting through sealed glands oriented beneath the device so that rain water flows away from the gland under the effects of gravity should be used.
- g) Analogue transducers for remote indication of density on SF₆ gas insulated equipment shall be temperature compensated for the true ambient temperature of the gas. Each transducer shall be wired to the secondary terminal box, have an isolated output of 4 to 20 mA corresponding to a density of 0 to 60 g/litre of SF₆ and operate from a 28 V d.c. supply. The Purchaser's required standard model transducer is a WIKA model GD-10L with process connection G ½ B male.
- h) Hybrid gauges combining the functions of a visual gauge, alarm contacts and density transducer in a single unit are permitted.
- i) Records of the calibration of all gauges shall be included as part of the Routine Test record.

6.10 Support structures

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

6.11 Primary terminals

- a) The primary terminals shall be a Type 3, 6-hole terminal in accordance with 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.
- b) Primary terminal marking plates manufactured from non-ferrous metal or stainless steel with characters, in accordance with AS 60044.3 Cl. 10.2, etched or otherwise formed in relief and legible from ground level with the plant in its normal service position, shall be provided adjacent to each primary terminal. For legibility, the height of the characters should be not less than 50 mm.
- c) The conductive head material of post-type current and combined transformers shall be connected to terminal P2. The primary terminal A of the VT section shall be connected to terminal P2.
- d) Each primary terminal shall have a rated mechanical terminal load not less than that for load class I as set out in Table 8 of AS 60044.1. The actual value of rated terminal load shall be shown on the general arrangement drawing.
- e) Terminal palms shall be factory fitted and not supplied loose for assembly on site.

6.12 Primary winding low voltage terminal

- a) The earthy end of the primary winding of electromagnetic voltage transformers shall be brought out through an insulated terminal and shall be capable of withstanding an applied voltage of 3 kVrms at 50 Hz for one minute.
- b) The low voltage terminal of the primary winding 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.

6.13 Secondary terminals

- a) Each end of each secondary winding shall be brought out to a terminal.
- b) The secondary terminals shall be housed in a weather, vermin and insect proof terminal box. The terminal box which houses the secondary terminals shall be of adequate size to allow termination of a minimum of four cables with sufficient space to allow for looping of incoming cable cores. The terminals should be located so as not to interfere with the cable entry.
- c) The diameter of the stems of the secondary bushings comprising the secondary terminals shall not be less than 6 mm. Alternatively, rail mounted clip-on tunnel type terminals fitted with flat pressure plates are acceptable. V-shape clamps or screws which bear directly on the wire will not be accepted. Examples of acceptable terminals are Phoenix type UK6N and UK10N. If there are two rows of terminals, the Purchaser's cables should terminate on the top of the upper row and the bottom of the lower row.
- d) The underside of the secondary terminal box shall be fitted with a gauze covered breathing vent of not less than 30 mm diameter.
- e) The underside of the secondary terminal box shall be fitted with an undrilled detachable metal gland plate capable of accommodating the glands of the Purchaser's cables. The preferred minimum size of the gland plate is 220 mm wide x 130 mm deep.

6.14 Polarity

The polarity shall be arranged so that current flow into terminal P1 induces current flow out of terminal S1.

6.15 Accuracy of metering cores

- a) In addition to the limits of current error and phase displacement for measuring current transformers set out in Table 11 of AS 60044.1, measurement current transformer cores shall meet the accuracy requirements for 100% current at 40% of rated current and be routine tested at these points.
- b) Current transformer cores with an extended current accuracy rating shall comply with the accuracy requirements of Clause 11.3 of AS 60044.1.

6.16 Safety clearances

- a) Each combined transformer shall be constructed such that all gauges, transducers, secondary terminals and the boxes housing these terminals shall be accessible to personnel while the current transformer is in service, without causing infringement of safety clearances. The safety clearances shall not be less than the exclusion zone values given in Table 6-2 Safety Clearance Distances below, which are based on the Exclusion Zone defined by the Queensland Electrical Safety Regulation 2013. 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 6-2 Safety Clearance Distances

Reference Voltage of Equipment (kV)	Exclusion Zone (Minimum Approach Distance) (mm)
330	3 000

- b) The preferred means to guarantee that the requirement of Clause 6.16 (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.
- c) The safety clearance distance is to be indicated and dimensioned on general arrangement drawings for the equipment.

6.17 Secondary windings

- a) Secondary windings shall be wound with copper wire; aluminium wire shall not be used.
- b) The winding conductor shall not contain any joints.
- c) All current transformer core secondary windings shall have a thermal limit current of not less than 2 p.u. (i.e. 2 A).
- d) Spark gaps or varistors shall not be fitted to CT secondary windings/secondary terminals.

6.18 Screens

- a) An earthed shield shall be provided between the primary and secondary current transformer windings. This shield shall protect the secondary circuit from damage by electrical contact with the primary winding as the result of the breakdown of the high voltage insulation. The shield and the shield earthing lead shall be capable of carrying one cycle of 2.5 times the specified fault current and ten cycles of the specified fault current.
- b) Joints between components of the shield and shield earthing lead specified in Clause 6.18(a) above shall, in addition to clamping or pressure, be welded or soldered to ensure electrical continuity for high frequency currents.
- c) Voltage transformer 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.
- d) Where reasonably practicable, the location and earthing of screens shall be shown diagrammatically on the rating or other plate attached externally on the equipment.

6.19 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.

6.20 Finish and painting

- a) The Purchaser requires that, wherever possible, all internal and external steel surfaces be hot dip galvanised after fabrication in accordance with the requirements of AS 1650. 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.
- b) 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.
- c) The total minimum thickness of paint, when dry, shall be not less than 0.13 mm.
- d) The colour of the finishing coat of paint shall be light grey, reference No. N35 to AS 2700 or similar.
- e) The colours of the priming coat and undercoat shall be different.
- f) 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.
- g) Each coat shall cover completely and evenly the surface to which it is applied.

6.21 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 unnecessary.

6.22 Asbestos

Materials containing asbestos are prohibited for use in gaskets and for any other purpose.

6.23 Rating and identification plates

- a) Each combined transformer shall be fitted with a rating plate or plates carrying all information required by Clauses 10.2 and 11.7 of AS 60044.1 and Clause 11.1 of AS 60044.2. The plate(s) shall also show sufficient information to uniquely identify the 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 current transformer rating plate shall show a diagram of connections with terminal markings in accordance with AS 60044.1 and Specification Drawing No. H-115047-001, and a table listing the connections, performance designation, class of accuracy, rated output, rated short-time current, primary thermal limit current and secondary thermal limit current for each transformation ratio of each core.
- d) The voltage transformer rating plate shall show a diagram of connections with terminal markings in accordance with AS 60044.2 and Specification Drawing No. H-115047-001.

- e) Rating plates of SF₆ insulated equipment shall show the maximum allowable gas pressure, the normal filling pressure, the stage 1 alarm pressure and the stage 2 alarm pressure. Any pressure value shown on any rating plate shall be given in the same units previously specified and as used on any pressure gauge supplied with the equipment and intended to be used to indicate the pressure referred to. For example, if the normal SF₆ operating pressure of the equipment is indicated as 600 kPa (relative) on the gauge attached to the equipment by the manufacturer, then the pressure stated on the rating plate shall be "600 kPa relative" and not "700 kPa absolute".
- f) Rating plates shall be manufactured from non-ferrous metal or stainless steel with characters etched or otherwise formed in relief. The minimum depth of characters shall be 0.2 mm. Rating plates made using alternative processes previously approved by the Purchaser are also acceptable.
- g) Rating plates shall not be attached to removable secondary terminal box covers, unless the serial number of the unit is separately stamped on to the base of the unit in a clearly visible location.
- h) 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.

7. Tests

7.1 General

- a) All type tests and routine tests specified in AS 60044.1 and AS 60044.2 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 or representative 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.

7.2 Chopped impulse voltage withstand test on primary insulation (routine test)

- a) The primary insulation of each transformer shall be subjected to a routine chopped impulse voltage withstand test in accordance with Clause 9.1 of AS 60044.1 and Clause 10.1 of AS 60044.2 with the base earthed through a low-impedance non-reactive shunt and with a test sequence as shown below.
 - (i) one reduced (50% test voltage) full wave negative impulse
 - (ii) one full (100% test voltage) full wave negative impulse
 - (iii) two increased (115% test voltage) chopped wave negative impulses
 - (iv) two full (100% test voltage) full wave negative impulses
- b) 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.

7.3 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 chopped impulse voltage withstands tests in accordance with Clause 9.2 of AS 60044.1 and Clause 10.2 of AS60044.2 and at an ambient temperature of $20 \pm 10^{\circ}\text{C}$. 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 combined transformer, where U_m is the highest voltage for the equipment.
- b) The value of DDF shall not exceed 0.010.

7.4 Secondary inter-turn overvoltage test (routine test)

- a) All current transformer secondary windings shall be tested in accordance with Procedure B of Clause 8.4 of AS 60044.1
- b) The specified voltage for measurement CTs shall be 10 times the rated knee point voltage of the winding.

7.5 Partial discharge tests (routine test)

- a) Each post-type combined 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. Note that for combined transformers, the test frequency may be increased and the test duration reduced in accordance with Clause 9.2.1 of AS 60044.2.
- 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 current transformer. Tenderers may submit alternative offers for equipment with a higher level of partial discharge but such offers should provide a significant price advantage to merit consideration and in no case will a level exceeding 10 pC at 1.5 $U_m / \sqrt{3}$ be considered.
- 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.

7.6 Accuracy tests (routine tests)

- a) The accuracy tests specified under Clause 11.4 of AS 60044.1 shall be carried out on each and every rated transformation ratio of each measurement class core as set out in Table 5-1 of each combined transformer except that the tests shall be carried out, and the required accuracy achieved, *at the extended burden range indicated by the minimum and maximum values of burden shown in the tables.*
- b) In addition to the requirements of Table 11 and Clause 11.3 of AS 60044.1, all measurement core ratios *shall also be tested at 40% of rated current.* The allowable measurement errors at this current shall be the same as those for 100% of rated current. This is to ensure that there is a range of percentage of rated current at which full class accuracy can be demonstrated.
- c) Accuracy tests to prove compliance with VT 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. 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.
- d) The calibration of accuracy measurements for measurement cores, windings or ratios must be traceable to national standards of measurement. For example, in Australia, NATA (National Association of Testing Authorities) accreditation is required. In other countries, the laboratory must be accredited under a national laboratory accreditation scheme which is recognised under the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC Arrangement) and this is to be certified in the routine test report.

- e) The routine test report must also state the **uncertainty level** of the accuracy measurements.
- (i) For CTs, the maximum allowable level of uncertainty for class 0.2 ratios is $\pm 0.05\%$ for ratio and ± 0.07 crad for phase. The maximum allowable level of uncertainty for class 0.5 ratios is $\pm 0.1\%$ for ratio and ± 0.15 crad for phase.
 - (ii) For VTs the maximum allowable level of uncertainty for class 0.2 ratios is $\pm 0.05\%$ for ratio and ± 0.05 crad for phase.
 - (iii) An “estimate of testing uncertainties” must be calculated in accordance with the ISO “Guide to the Expression of Uncertainty for Measurement”.
 - (iv) These are all requirements of Schedule 7.3 in Chapter 7 of the Australian National Electricity Rules – refer <http://www.aemc.gov.au/Electricity/National-Electricity-Rules/Current-Rules.html> for additional information.
- f) The secondary burden used for test purposes shall have a power factor of 1.0. It is noted that Cl. 5.6.201.4 of IEC 61869-2 Edition 1.0 2012-09 provides that an extended burden range may be specified for all measuring classes and that the power factor shall be 1.0 over the full burden range from 1 VA up to a maximum of 15 VA. Cl. 11.2 of AS 60044.1 allows that for a burden less than 5 VA, a power factor of 1.0 may be used and the results converted to equivalent results at 0.8 lagging power factor in accordance with Annex ZA.
- g) The routine accuracy tests shall be conducted on the CT cores after assembly into a fully completed unit at service pressure.

8. Information to be supplied by the contractor

8.1 General

- a) All information shall be provided 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 with the requirements of AS/NZS 1102.1xx (IEC 60617-x) series of standards.
- d) Any reference to a dew point value shall be referred to atmospheric pressure.
- e) Any reference to pressure shall state whether it is absolute or gauge (relative) pressure. Absolute values are preferred but, more importantly, consistent units shall be used throughout documentation and on the equipment itself.

8.2 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 Contractor, and the Contractor shall make the corrections to the drawings for the Purchaser’s approval prior to manufacture.

- b) Dimensioned outline drawing(s) of the equipment(s) clearly showing:
- (i) The contract number, Item number, 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 and also the lowest live metal above the mounting base, and the safety clearance distance defined by Table 6-2 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, pressure/density gauges and transducers, 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 mass of insulating gas required to fill the plant to operating 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 palm 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, 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 within the secondary terminal box.
- h) A cross-sectional drawing showing the location of the break in each and every shield which would otherwise provide a closed conducting path linking the CT cores, and the method of support for the toroids. This drawing is also to be included in the Tender submission documentation.
- 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.

8.3 Instruction manuals

8.3.1 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 on a USB flash memory drive and/or by email for the Purchaser to reproduce in hard copy as required.
- d) Hard copy instruction manuals stamped "UNCONTROLLED COPY" shall accompany each delivery of equipment.

8.3.2 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.

8.3.3 Storage requirements

The Contractor 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.

8.3.4 Erection and test

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

- (i) Be suitable for use by the Purchaser's staff or by an independent contractor. It shall be assumed that such staff or contractor are reasonably experienced in the erection 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 measurements which will enable the Purchaser's staff or contractor to erect and/or install the equipment
- (iii) Contain safety instructions, warnings or cautionary notes relating to the safe erection 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.

8.3.5 Abridged erection manual

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

8.3.6 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.

8.3.7 Operation, maintenance and repair

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 including densimeters, transducers and gauges
- (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 gas 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 gas does 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 8.4 below).

8.4 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 CT and 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 and 0.5 secondary cores or windings as calculated in accordance with Clause 7.6(e)
 - (vi) State nominal and actual settings of SF₆ densimeter operating values
 - (vii) State fully the method used and the values obtained for leak or pressure testing of sealed SF₆ chambers.
- 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.
- f) Secondary cores and windings of combined transformers are intended to be used for tariff purposes. Routine test reports containing accuracy results of tests on all the secondary cores or windings must meet the requirements of the appropriate regulating authority.

8.5 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 may 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.

8.6 Specification on drawings and documents

8.6.1 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 8.6.2.2 and 8.6.3.2 below.
- c) Finally accepted documentation shall be forwarded to the Purchaser in electronic form by email and/or on USB flash memory drive.
- 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.

8.6.2 Drawing standards

8.6.2.1 General

- a) All drawings shall comply with Australian Standards 1000, 1046, 1100, 1101 and 1102.
- b) All measurements shall be in millimetres.
- c) All fonts shall comply with ISO 3098-2.
- d) All notes, instructions and words used on the drawings shall be in the English language.
- e) All drawings shall be to scale and fully detailed.
- f) 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.
- g) 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.

8.6.2.2 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. Drawings forwarded for initial approval processes should be sent in Adobe Acrobat pdf format.
- 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.

8.6.2.3 Amendments to Drawings

- a) 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 means of an approved stamp such as a red triangle or an arrow in red on the drawings provided.

8.6.2.4 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.

8.6.3 Document standards

8.6.3.1 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 8.6.2.1 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.

8.6.3.2 Electronic Format

All engineering documentation (engineering manuals, test reports, etc.) supplied electronically shall be supplied in Adobe Acrobat pdf or Microsoft Word doc(x) 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.

8.6.3.3 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.

8.6.3.4 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.

8.7 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 current transformer or combined 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.

9. Packing and delivery

9.1 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 indelibly 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 so 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.

9.2 Gas filling contained on delivery

All equipment shall be factory sealed ready for service, not require any assembly on site involving a sealed SF₆ volume, and be shipped and supplied containing SF₆ gas at a suitable transport pressure.

9.3 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 is 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.