Specification – SF_6 Ring Main Units (RMU)

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** Must be the Process Owner and is the person assigned authority and responsibility for managing the whole process, end-to-end, which may extend across more than one division and/or functions, in order to deliver agreed business results.*

*** This person will have the power to grant the process owner the authority and responsibility to manage the process from end to end.*

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Revision Control		
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0	20/11/2013	Original Issue
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STAKEHOLDERS *The following positions must be consulted if an update or review is required:*	
Strategic Asset Management Consultant	Asset Managers
Manager Capacity Management Services	

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1 SCOPE

This specification covers Horizon Power's requirements for new factory-assembled metal-enclosed Medium Voltage (MV) ring main switchgear, energy metering equipment, associated kiosks and support stands. It applies to SF_6-insulated switchgear rated for voltages from 6.6 kV up to 33 kV.

Tests prescribed will evaluate the performance of the switchgear, and must comply with this specification.

Approval in terms of this specification may be obtained by one or a combination of the following:

a) successful completion of the appropriate tests required by this specification by an independent and accredited test authority.

b) provision of test certificates from an independent and accredited test authority based upon an alternative specification, with test requirements at least equivalent to this specification. Details of approval in this regard are provided in Section 10.

NOTE: Verification of accreditation of the test authority must be provided by NATA (National Association of Testing Authorities) accredited test house or by a test house possessing accreditation from a NATA MRA (Mutual Recognition Agreement) partner.

2 NORMATIVE REFERENCES

2.1 Standards

The following documents contain provisions that, through reference in the text, constitute requirements of this specification. At the time of publication, the editions indicated were valid. Information on currently valid national and international standards and specifications can be obtained from SAI Global's – Standards On-Line data base or equivalent standards database.

Table 1: List of Applicable Standards

STANDARD	DESCRIPTION
AS 1580.0	Paints and related materials – Methods of test Part 0 : Introduction and list of methods
AS 2024	High voltage ac switchgear and controlgear – Switch-fuse combinations.
AS 2067	Switchgear assemblies and ancillary equipment for alternating voltages above 1 kV.
AS/NZS 2312-2002 (incl. Amdt 1:2004)	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
AS/NZS 4680	Hot-Dip Galvanised (Zinc) Coatings on Fabricated Ferrous Articles

STANDARD	DESCRIPTION
AS 60044.1	Instrument Transformers – Part 1: Current transformers
AS 60044.2	Instrument Transformers – Part 2: Inductive voltage transformers
AS 60137	Insulated bushings for alternating voltages above 1000 V
AS 60265.1	High-voltage switches – Part 1: Switches for rated voltages above 1 kV and less than 52 kV
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS 62271.1 - 2012	High Voltage switchgear and controlgear – Part 1 : Common specifications
AS 62271.100	High voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers
AS 62271.102-2005	High voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches
AS 62271.200	High-voltage ac switchgear and controlgear - Metal-enclosed -Rated voltages above 1 kV up to and including 72.5 kV.
AS 62271.202-2008	High-voltage switchgear and controlgear - High-voltage/low-voltage prefabricated substation
AS 62271-301	High voltage switchgear and control gear – Dimensional standardisation of terminals
IEC 60060-1	High-voltage test techniques – Part 1: General definitions and test requirements
IEC 60071-2	Insulation co-ordination – Part 2: Application guide
IEC 60376	Specification of technical grade sulphur hexafluoride (SF6) for use in electrical equipment
IEC 60480	Guidelines for the checking and treatment of sulphur hexafluoride (SF6) taken from electrical equipment and specification for its re-use
IEC 60282-1	High-voltage fuses - Part 1: Current-limiting fuses
IEC 62271-105	High-voltage switchgear and controlgear - Part 105: Alternating current switch-fuse combinations

Other applicable documents:

Western Australia *Electricity Industry (Metering) Code 2012*

The following standards are available on Horizon Power's website, or may be made available on request:

1) HPC-9EJ-01-0001-2013 - Std - *Horizon Power Environmental Conditions*

2.2 Definitions and Abbreviations

For the purposes of this specification the following definitions apply:

2.2.1 Definitions

1) **Composite RMU:** means comprising of two (2) or more coupled unitised extensible ring main switchgear units assembled by the Vendor on a common mounting base and offered to Horizon Power as a single RMU – typically accepted only for 5-way RMUs.
2) **Equipment:** must collectively refer to ring main switchgear functions (switch-disconnector, fuse-switch, energy metering unit, etc.) that form extensible or non-extensible ring main switchgear units, kiosks and support stands meeting the intent of this Specification.
3) **Extensible ring main switchgear:** means a 3-way or 4-way unitised ring main switchgear unit that is capable of been extended by one switchgear function. The extension transforms the RMU to become a 4-way or a 5-way respectively. The extended unit has a separate tank from the main unit.
4) **Fault Indicators (FIs):** means overcurrent and earth fault indicator devices fitted to switch-disconnector functions, inclusive of associated CTs or current pickup coils, and wiring.
5) **Ring main switchgear or Ring main unit or RMU:** means one or more MV switchgear functions (e.g. switch-disconnector or fuse-switch) contained in one common tank capable of switching underground cable networks in a ring or radial configuration.
6) **Switchgear function:** means a single switch-disconnector or fuse-switch or circuit breaker that is contained within a ring main switchgear unit.

2.2.2 Abbreviations

1) AC: Alternating Current
2) AS: Australian Standard
3) CB: Circuit Breaker
4) CT: Current Transformer
5) LV: Low Voltage < 1000 Volts AC
6) MV: Medium Voltage >1000 Volts AC; <35 000 Volts AC
7) VT: Voltage Transformer

2.3 Drawings

The drawings listed below form part of this specification:

Table 2: List of Drawings

DRAWING No.	DESCRIPTION
M/D/4/08/4/1 (Rev A)	Tariff Metering - HV Indoor Equipment RMU 11/22/33 kV 3 Ph/4 Wire With Customer Cores Connection Diagram
Appendix I of this specification	Typical arrangement of RMU Kiosk, Support Stand and Mounting base for equipment

3 REQUIREMENTS

3.1 Power System Particulars

The Equipment must be suitable for continuous connection to a power system with the characteristics covered by this specification.

3.1.1 Rated Voltages

Two voltage types of Equipment must be offered:

1) 22 kV – which must be suitable for 6.6 kV and 11 kV.
2) 33 kV

The Equipment must be rated for highest system voltage and withstand voltages listed in Table 3.

3.1.2 Design Fault Levels

The Maximum design fault currents are as follows:

1) 13.1 kA rms / 1 second for 33 kV systems
2) 25 kA rms / 1 second for 22 kV, 11 kV and 6.6 kV systems

Equipment that is rated for operation in conditions with three (3) second fault duration will be considered favourably.

Vendors must state the short time rating for 1 second and equivalent 3 seconds for the Equipment offered in the Proposal. Equipment that does not meet these requirements will not be considered.

3.1.3 Nominal System Frequency

The nominal system frequency is 50 Hz.

3.1.4 System Insulation Levels

The system withstand voltages are as follows:

Table 3: System Insulation Levels

Nominal System Voltage (kV rms)	System Highest Voltage (kV peak)	Lightning Impulse Withstand Voltage (kV peak)	Power Frequency withstand Voltage (kV peak)
6.6	7.2	75	20
11.0	12.0	95	28
22.0	24.0	150 (125*1)	50
33.0	36.0	200(170*2)	70

* NOTE:

1) For underground applications with a nominal system voltage of 22 kV, equipment with a rated lightning impulse withstand voltage of 125 kV may also be considered.
2) For underground applications with a nominal system voltage of 33 kV, equipment with a rated lightning impulse withstand voltage of 170 kV may also be considered.

3.2 Standard Operating Conditions

The Equipment must be suitable for continuous operation under the service conditions for outdoor switchgear (irrespective of whether installed indoor or outdoor) as per AS 62271.1 with the following additions:

- environmental conditions listed in HPC-9EJ-01-0001-2013 *Horizon Power Environmental Conditions*, and
- those conditions stated in Table 4

Table 4: Conditions of Service

Condition	Requirement
Pollution:	Wind borne dust deposits may accumulate over a number of months followed by high humidity with heavy dew or light rain.
Salt:	At points along a 4 km wide West Coast strip, salt deposits can reach levels as high as 40 mg/100 cm^2 per month.

Vendors must submit with the Proposal, documentation (evidence, test reports, etc.) to demonstrate the Equipment offered meets the environmental service conditions listed in Table 4. Vendors must clearly state in the Proposal, any Equipment that does not meet the environmental service conditions listed in *Horizon Power Environmental Conditions* and Table 4. Vendors must also provide the maximum environmental service conditions the Equipment is capable of withstanding.

The vendor must comment on the impact to the performance of switchgear when it is subjected to day temperatures over 40° C, and the effect on product lifespan.

3.2.1 Seismic Disturbances

The equipment must be designed to withstand the effects of shock waves and earth movements resulting from earthquakes without failure.

The Vendor must provide calculations which show the forces applied to the Equipment and its fittings under earthquake conditions in accordance with AS 1170.4, including:

1) Overturning and sliding forces.
2) Bending moments at base of bushings.
3) Force on bracing between core and main tank and strength of bracing.
4) Details of fixing main tank to concrete plinth and strength of fixing.

3.2.2 Wind Loads

The Vendor must demonstrate with calculations that the equipment can withstand the pressure associated with the specified maximum wind gust in Table 4. Also see Section 5 for additional requirements for kiosks.

3.2.3 Clearances & Insulation

The minimum electrical clearance in air to earth for all high voltage parts of the Equipment must be not less than that specified in AS 2067.

All current carrying MV conductors that are air insulated (not in SF_6 gas tank) must be enclosed with either cold shrink or thermofit insulation. This must include busbars and terminals of CTs and VTs within the energy metering units.

Vendors that offer Equipment with cast resin (or similar material) encapsulated current carrying MV conductors must provide test reports to demonstrate that the cast resin or similar material must not be affected by the operation of the Equipment under the service conditions detailed in this Specification. The test reports must cover in particular, load cycling due to the different coefficient of expansion of the metallic conductor and the insulation material at different temperatures over time.

3.2.4 Dimensions

As the ring main switchgear unit is to be installed in ground-mount kiosks (non-walkable) of low profile and compact construction, the Equipment must have minimum dimensions and be of low mass and vandal-proof. Preference must be given to Equipment having minimum dimensions that do not exceed the following:

1) maximum height:
    a) 1,500 mm for 24 kV Equipment; and
    b) 1,800 mm for 36 kV Equipment
2) maximum depth:
    a) 800 mm for 24 kV Equipment; and
    b) 950 mm for 36 kV Equipment

3) maximum width:

a) 2500 mm for 24 kV and 36 kV Equipment

It is acknowledged that metering units, when used on indoor applications for connection to adjacent switch units, may need to be wider and/or deeper.

4 RING MAIN UNITS (RMU)

4.1 General

The Equipment must comply with the relevant Australian Standards list in Table 1.

4.2 Application

RMUs can either be used for indoor or outdoor applications:

1) Indoor:

- The Equipment must be suitable for installation in a concrete building structure in substations;
- The Equipment must be able to accommodate a transport frame (mounted at the base) for 4-way and 5-way RMU;
- Metering unit (optional) can also be incorporated into the switchgear;
- Interfaces to Horizon Power's SCADA system must be provided.

2) Outdoor:

- The Equipment must be suitable for mounting on a galvanised steel supporting stand and housed inside a naturally ventilated all-weather metal kiosk;
- The Equipment must be able to accommodate a transport frame (mounted at the base) for 4-way and 5-way RMU;SCADA (optional).

4.3 Design and Construction

The Equipment must be of a metal enclosed design in accordance with AS 2067, AS 62271.1-2012, AS 62271.202-2008 and AS 62271.200-2005.

4.3.1 Loss of Service Continuity

The switchgear must comply with category LSC2A as defined by AS 62271.200-2008.

4.3.2 Functions

The Equipment offered by the Vendor must be 1-way, 3-way, 4-way and 5-way extensible ring main switchgear units having various unitised configurations as specified in Appendix G, comprising of the following switchgear functions:

1) Switch-disconnector unit;

2) Fuse-switch unit;

3) Circuit Breaker unit (only in special cases);

4) Energy metering unit (only for indoor applications).

Vendors may offer circuit breakers as an alternative to fuse-switches. The circuit breakers must comply with the requirements of this Specification. Vendors that offer only circuit breakers must indicate this as Non-conformance in their Proposal. Vendors that offer both fuse-switches and circuit breakers are preferred.

In the case of outdoor applications, the Vendor must offer corresponding kiosks and support stands to suit the ring main switchgear outdoor units offered.

For ease of installation, operation and maintenance, preference will be given to 1-way, 3-way, 4-way and 5-way Equipment that is of similar type and design.

4.3.3 Requirements

4.3.3.1 Rated Parameters and Performance

The Equipment must meet the requirements specified in Appendix C included with this document.

4.3.3.2 Equipment Housing

The Equipment design must be such that all electrically active parts of each switchgear function (switch-disconnector, earth switch, and fuse-switch except the HRC fuse compartment) and inter-bay busbars are housed in a sealed enclosure. The enclosure must be SF_6 gas insulated and sealed for the operational lifetime of the equipment. This tight housing together with the HRC fuse chamber must constitute a fully insulated design so as to render the switchgear functions completely insensitive to the outside environment. The IP rating of the equipment must be of the following:

Table 5: IP rating for switchgear functions

Function	IP rating
Switchgear main electric circuits degree of protection (IPxx)	IP64
Switchgear drive mechanism degree of protection (IPxx)	IP3X
Switchgear MV cable compartment (with access cover closed) degree of protection	IP3X

Energy metering units (indoor application only) that do not meet the requirement of sealed housing will be considered, but those showing superior insensitivity to outside environment must be preferred.

4.3.3.3 Operation

The Equipment must be ergonomically designed (in compliance with the dimension requirements in Section 3.2.4). Operating handles of the removable type are preferred. The handle must be of such a length that it complies with the relevant internal arc protection requirements, and extends beyond the enclosure to enable ease of operation. The effort exerted on the handle by the operator should not be more than 250 N.

It is essential that a means be provided to ensure that the individual switchgear functions cannot be switched to any position (i.e. “ON”, “OFF” or “EARTH”) other than that intended by the operator (i.e. a pre-action must occur before the main switching action). An arrangement where the switch-disconnector and earthing switch have separate contacts and operating shafts is preferred.

4.3.3.4 Automation

The Equipment must be capable of remote operation, using motor facilities or similar technology. Remote operation must be able to be retrofitted onto the switchgear unit, preferably in the field. Only the switch-disconnectors (Section 4.4.4) are required to have automation. The Vendor must submit details in the Proposal of how this can be achieved.

4.3.4 Extensibility

The extensible ring main switchgear must be manufactured and supplied in a form that will enable Horizon Power to assemble various numbers of switchgear functions into extended RMUs. The switchgear unit must be suitable for later extensions.

Busbars and/or bus couplers and inter-panel wiring connections must be arranged so that minimal assembly work is required on site. MV bus couplers and associated accessories required to connect to existing extensible ring main switchgear must be supplied together with 1-way extensible ring main switchgear. The MV bus couplers and associated accessories must have the same ratings as the corresponding Equipment specified in Appendices D & I. The Vendor must provide details with its proposal of such assembly requirements.

Any additional bus coupler kits must be supplied as spare parts as required.

4.3.4.1 1-Way

All 1-way unitised ring main switchgear must be supplied as extensible from both left and right sides i.e. double extensible. Horizon Power will couple a 1-way unitised RMU to a 3-way or 4-way RMU, to form a 4-way or 5-way Extended RMU respectively.

4.3.4.2 3-Way & 4-Way

All 3-way and 4-way unitised ring main switchgear must be available as extensible to both left and right sides, or either left or right sides.

4.3.4.3 5-Way

Unitised 5-way ring main switchgear need not be extensible, i.e. non-extensible unitised 5-way ring main switchgear will be acceptable.

Vendors who do not offer unitised 5-way Equipment but instead a combination of 4-way and 1-way extensible ring main switchgear, (i.e. a composite RMU) must be responsible for assembly, testing, packaging and transport as an equivalent unitised 5-way ring main switchgear.

Any Equipment intended as 5-way ring main switchgear that is supplied by the Vendor which requires assembly by Horizon Power will not be considered.

4.3.5 Transport Frames

Transport frames must be provided for all switchgear in either the 4-way or 5-way configuration, to prevent deformation of the equipment and its functionality during handling, lifting or transportation. The areas served by Horizon Power typically require equipment to be transported over large distances by road (unsealed in some remote areas) some as long as 3,000 km. The frame must be designed such that it is installed with the unit.

The transport frames must be:

1) designed so as to maintain the structural integrity and the IAC classification of the Equipment;
2) galvanised mild steel with the same finishing as that of the support stand (Section 5.4).
3) designed to withstand the maximum weight of the Equipment, the cables and terminations as per the arrangement requirements in Section 5.3.
4) For example a transport frame designed for 4-way kiosk must be able to handle the maximum weight of a 3+1 or a 4+0 configuration (whichever is maximum), irrespective of whether it was installed as a 3-way unit.
5) able to accommodate 3-way and 4-way extensible ring main switchgear that can be extended by one extensible switchgear function (fuse switch or a switch disconnector on the transport frames).
6) fastened only onto the stand and not the kiosk at any point. Designs must ensure that removal of kiosk does not require repositioning of the transport frames in any way.

Vendors must submit details of the handling, lifting or transportation instruction for such a design with the Proposal. Separate designs and installation instructions along with details of centre of gravity details must be provided for cases with and without the extensible unit attached to the transport frame.

4.3.6 Internal Arc Classification

The Ring Main Unit itself must comply with the requirements of AS 62271.200 Annex A.2, Accessibility Type AFL. Operators of the Equipment must be protected against the effects of an arcing fault in any of the MV compartment at all times, including while carrying out maintenance work on other compartments. Full arc containment must be possible under these conditions.

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

Arc containment in both the cases must be achieved for the short circuit fault current as per Section 3.1.2 for duration of one (1) second.

The heat and overpressure resulting from internal arc must be vented out of the switchgear through the bottom or rear of the switchgear, ensuring compliance with the requirements above.

A chimney design for releasing exhaust pressure during an internal fault may be considered, but it is the responsibility of Vendor to establish the performance of the arc venting system with suitable test reports, to Horizon Power's satisfaction. Horizon Power will evaluate the information and make a determination to accept or reject the proposal.

4.4 Switchgear Requirements

To demonstrate Equipment performance, the Vendor's proposal must include certified details of type tests of the particular type and rating of the units offered. The specific requirements of energy metering units are detailed in Section 4.16.

4.4.1 Switch Disconnector

Switch disconnectors and earth switches must be load breaking and fault-making type and comply in all respects with AS 60265.1-2001, AS 62271.102-2005 and AS 62271.100-2008. Switches must be designed for interrupting full rated current as stated in Appendix C, as well as small inductive or capacitive currents involved in disconnecting cables or overhead lines.

Each switch-disconnector must be provided with an interlocked earthing switch for earthing the isolated feeder cable. Option of having two independent manual operating mechanisms for switch disconnector and earth switch is also acceptable. The Vendor must ensure that the safety of operators is not compromised by this arrangement, and must ensure the interlock systems are provided as required in Section 4.6. The design must prevent simultaneous closing of the main switch contacts and the earth switch contacts.

The switch-disconnectors and earth switches must be three-phase, spring assisted and manually gang operated. The earth switch contacts must be designed to close onto a fault, and must have the same short circuit capacity as that of the main switch disconnector itself. The front panel of each switch unit must incorporate a mimic display of the switching arrangement with clear signs to ensure a high level of safety in operation. The operating positions must be clearly marked, indicating the "ON" and "OFF" position for both the switch-disconnector and earthing switch.

4.4.2 Fuse Switch

The fuse-switch combinations and earth switch must comply in all respects with AS 2024-1991, AS 62271.102-2005 and IEC 62271-105:2002 (Ed. 1.0)

Fuse-switches with High Rupture Capacity (HRC) fuse carriers must have a "trip all phases" device to disconnect all phases, due to the operation of one or more fuses.

The fuse-switches and earth switches must be three-phase, spring assisted and manually gang operated. The front panel of each switch unit must incorporate a mimic display of the switching arrangement with clear signs to ensure a high level of safety in operation. The operating positions must be clearly marked, indicating the "ON" and "OFF" position for both the fuse-switch and earthing switch.

Each fuse-switch unit, when earthed via its associated earth switch, must be earthed on both sides, upstream and downstream, of the fuses. The fuse carrier

must remain effectively earthed on both sides during fuse replacement by the earth switch provided with the fuse-switch.

Fuse-switches must take fuses complying with IEC 60282-1, IEC 62271-105:2002 (Ed. 1.0) and DIN 43265. Horizon Power's range of standard fuses is detailed in Appendix F. In respect to transformer protection, Vendors must comment on the suitability of these fuses for use with the Equipment, and preferably, provide a fuse selection table based on Horizon Power's standard transformer sizes.

The Vendor must detail the maximum allowable HRC fuse power loss (in Watts) values for the fuse-switch units under normal operation. These values must account for the entire range of service conditions detailed in Section 3.2 and should consider all Equipment configurations. Vendors that offer Equipment with vertically laid out fuse arrangement, must comment in the Proposal on the effect of heat build-up at the upper portion of the fuse housing.

If an over-temperature tripping feature is incorporated with the HRC fuse tripping arrangement, then the operation of the feature must be detailed by the Vendor in the Proposal. The operating characteristic must be detailed in the Proposal for the entire range of service conditions detailed in Section 3.2.

It is acknowledged that in the case of fuse-switch combination units, separate fuse base fittings and/or adaptors may be required to suit Horizon Power's standard range of HRC fuses, which differ in rating and size (i.e. 292 mm for 6.6/11 kV, 442 mm for 11/22 kV and 537 mm for 33 kV applications).

The Vendor must offer and supply suitable fuse adaptors for use on dual rated (6.6/11 kV and 22 kV) Equipment, and must submit details in the Proposal.

Any Equipment that requires mechanical modification (removal and/or fitment of components directly to the Equipment) to facilitate the installation of shorter fuses will not be considered. Preference will be given to fuse adaptors that fit directly to short length fuses.

4.4.3 Circuit Breaker

Circuit breaker (CB) units, if offered, must comply in all respects with AS 62271.100-2005. CB units must have electronic relay operation, and must be self-powered protection units requiring no auxiliary power supply to trip open all three phases, upon sensing a fault condition. The circuit breaker must be of fixed type and designed for interrupting full rated fault current, and for making full fault current (Schedule A). The insulation medium must be SF_6 gas, and the interrupting medium may be either SF_6 or vacuum.

Circuit breakers must be trip-free and be equipped with a stored energy operating mechanism. The operating mechanism of circuit-breakers must provide independent manual closing and stored energy tripping. Opening of the circuit breaker must be by local manual trip button, by protective relay circuit and by remote tripping signal. Closing movement must charge the opening mechanism of the circuit breaker. The circuit breaker must be fitted with an integrated push button for manual tripping.

Circuit-breakers must be class C2-E2-M1 in accordance with AS 62271-100. The rated normal current of a circuit-breaker must be as specified in Schedule A.

The protection system must provide pickup for both over-current and earth-fault conditions.

The Vendor must provide details in the Proposal of the protection system used, including the following:

1) CB and relay operating principle
2) The rated operating sequence of the CB ending in accordance with AS 62271-100
3) Characteristics curves for over-current and earth-fault protection conditions respectively. (The points on the operating curves of the protection system should be sufficiently detailed, such that it may be replicated (graphed) in electronic format using a spreadsheet)
4) Relay settings and programming methods e.g. using a test-pen screwdriver on a rotary switch/dip switch on the relay unit or using a notebook computer, PDA or other handheld device
5) Estimated lifespan of CB equipment and associated protection relays
6) Vendor proposals must state key maintenance parameters (number of tripping and closing operations, expected operating lifetime and whether an operation counter must be provided). Vendors must state whether or not an operation counter for each unit of CB switchgear is provided
7) Frequency of maintenance and details of maintenance required on CB and relay
8) The maximum number of mechanical trip and close operations under different loading conditions e.g. under full load and under short circuit conditions allowed
9) The operating times (i.e. Opening and Closing Times) of the CB unit in milliseconds
10) The minimum MV (load) current for tripping operation of CB
11) The minimum kVA size of transformer (single phase and three phase transformers) that can be protected by the CB, and
12) The usage quantity, safety and reliability statistics of the CB in Australia.

All protection relay and associated electronics must operate under the environmental condition in Section 3.2. This particularly relates to temperature and humidity within the RMU enclosures.

Vendors must state if the current transformers are proprietary or if other makes may be used. If proprietary, vendors must provide the selectable range and specifications.

The Vendor must submit with the Proposal a comparison of CB fault clearing capability with that of an equivalent fuse-switch unit, showing the relative time-current characteristics of both devices (incorporating CB operating time highlighted separately).

Preference will be given to CB and relay equipment that can protect single phase transformers of 25 kVA rating and 3-phase transformers of 63 kVA rating and above, by having sufficient drive current to trip OPEN the CB.

Vendors must state whether the CB unit is suitable for either Secondary injection or Primary injection or both types of injection for tripping Open.

4.4.4 Automation Facilities

Equipment must be provided with motorised facilities only on request from Horizon Power. Vendor must specify in the proposal on how these can be custom fitted onto standard equipment configuration provided.

Switch-disconnectors must be supplied fitted with motorisation and associated accessories. Circuit breakers must have provision for fitting of motor mechanism for charging of springs. Fuse-switch and earth-switches do not need to be motorised.

The motorisation units must have facilities for remote control suitable for interfacing to Horizon Power's Supervisory Control and Data Acquisition (SCADA) system Remote Terminal Unit (RTU). Motorised equipment and control must operate on 24 V DC. Each switching unit must be provided with a separate Local/Remote switch. The Vendor must submit details with the Proposal on the automation facilities, including schematic diagrams of the motor control and relays, wiring terminals, termination types and other relevant information.

Manual operation, if and when required, must not be impeded by the motorisation of the switch-disconnectors. Interlocking must be provided that prevents the motorised operation when a manual operation is being attempted.

4.4.4.1 Automation of switch-disconnector unit

Local and remote controls must be provided to open and close the switch disconnector. All motorised units must have interposing relays (or equivalent) fitted for switch-disconnector control (open / close). The Switchgear must mechanically latch when the desired control position (open / close) position is reached. The following must be provided:

1) OPEN command (1 interposing relay) – operates on a pulsed control from the RTU;
2) CLOSE command (1 interposing relay) – operates on a pulsed control from the RTU;
3) Open / Close Circuit indication (2 auxiliary switches with opposite indicating contacts per unit); and
4) Local / Remote control indication (1 auxiliary switch).

4.4.4.2 Automation of circuit breaker unit

The motor mechanism must automatically charge the springs once the auxiliary voltage is turned on, without need for any manual charging. Auxiliary switches must be provided for remote tripping and closing of circuit breaker, and should indicate local/remote and trip/close status.

Factory fitted automated controls may be offered as an option. The vendors must submit details with the proposal of the in-built automated control system and other relevant information, including details of the control interface between the vendor and Horizon Power. At its absolute discretion, Horizon Power will assess the suitability of the vendor in this area.

The automated unit must be able to handle a lock out tag out system i.e. no unauthorised switching must be attempted when the earth switch is ON and “locked out” during maintenance. Without affecting the interlock operation as specified elsewhere in this Specification, electrical and mechanical interlocks must prevent motor operation if the EARTH switch is in the "ON" position.

4.5 Insulating and Switching Mediums

Switch unit interrupters must be vacuum or SF_6 gas. The insulating medium must be SF_6. Switchgear that uses oil or air as an insulating medium or interrupting medium will NOT be considered.

4.5.1 Vacuum Interrupters

Vacuum Interrupters may be used for circuit breakers and switch-disconnectors. The contacts for vacuum interrupters must be positively driven in both the OPEN and CLOSE directions, and in no way be dependent on the interrupter vacuum. The vacuum bottles must be sealed for life. Vendors must state the method by which Horizon Power may carry out in-situ tests on the integrity of vacuum in the bottles.

The design of the interrupter must be such that the level of x-rays emitted, under all operating and test conditions, must not constitute a health hazard to any personnel working on the particular switchgear panel, or adjacent switchgear panels, with any panels or parts of the switchgear removed. Vendors must state the levels of x-radiation emitted by the switchgear under all likely operation and test conditions.

Vendors must state whether the vacuum switchgear offered is subject to any random flashovers across the contact gap of an open bottle under voltage conditions less than or equal to the switchgear test and service voltages specified in this Specification.

The detailed procedure for replacing a vacuum bottle must be stated in the instruction manual.

4.5.2 SF6 Gas Interrupters

SF_6 gas interrupters may be used for circuit breakers and switch-disconnectors. The SF_6 gas used must comply with the requirements of AS 62271-200. Equipment that requires the periodic filling of SF_6 gas will not be considered.

A stainless steel label must be fixed to the RMU stating the total mass and volume of SF_6 gas present in the RMU at a specified date.

The Vendor must state in the Proposal the nominal SF_6 gas filling pressure and nominal fill temperature.

4.5.2.1 SF6 Gas Annual Loss

The annual loss rate of SF_6 gas must not exceed 0.1% of the total mass. The Vendor must confirm that this requirement can be achieved, and detail the guaranteed annual loss rate for the Equipment. Any departure from this requirement must be clearly stated in the Technical Schedule.

The vendor must guarantee that pressure of the SF_6 gas will remain above the operating limit, throughout the lifetime of the equipment.

4.5.2.2 SF6 Gas Pressure Gauge/Non-return Valve & Low Gas Switch

A robust SF_6 gauge(s) must be provided for visual indication of SF_6 gas pressure inside the switchgear chamber. The SF_6 gauge must be readily visible from the front of the unit, without the necessity to remove any covers, and be clearly marked to indicate the normal gas pressure by a green area on the gauge face, and the low gas pressure by a red area on the gauge face. The gauge must incorporate temperature compensation or have a gauge face that corresponds to different temperature ranges.

The SF_6 gauge must be fitted to a non-return valve that prevents loss of SF_6 gas. The non-return valve must facilitate the following:

1) The removal of a defective gauge while the equipment is in service,
2) SF_6 gas reclamation at Equipment end of life.

The Vendor must state in Technical Schedule if a SF_6 gas non-return valve is NOT provided.

The switchgear and busbar housing containing SF_6 gas must be sealed for life, except one common access point for the SF_6 gas gauge sensor via the SF_6 gas non return valve.

A separate low pressure SF_6 gas switch must be provided for low pressure alarm. The low pressure switch must be set to operate at the pressure indicating loss of SF_6, and not generate false alarms due to change in ambient temperature.

The Vendor must state in the Proposal, the pressure at which the switch is activated (in bar or kPa) which must be greater than atmospheric pressure.

4.5.3 Loss of Insulating/Switching Medium

Vendors must state the consequences of loss of SF_6 gas or of loss of vacuum on:

1) The voltage withstand capability (across contact and to earth) of an open circuit breaker;
2) The ability of the Equipment to switch load current; and
3) The ability of the Equipment to switch fault current.

4.6 Interlocks

An adequate mechanical interlock system must be provided on the Equipment to prevent mal-operation and to ensure operator safety. The design of the interlock system must prevent the operator from physically overriding the interlock controls. The Vendor must specify in the Proposal, how the following interlock system is achieved in the Equipment:

1) It must not be possible to remove partially or completely the cable compartment covers unless the main switch has first been turned OFF, and then the earth switch turned ON.
2) Once the compartment cover has been removed, it must be possible to switch the earth switch OFF (for testing purposes).
3) It must not be possible to turn the main switch to the ON position while the cable compartment cover is removed at any time.
4) It must not be possible to access the fuse chamber unless the upstream and downstream earth switch has been turned ON.
5) It must not be possible to turn the fuse switch to the ON position if the fuse cover is not properly closed or if the earth switch corresponding to the fuse switch is not in the earth position upstream and downstream or if fuse holder is not placed correctly or if any fuse is blown.
6) The following additional requirements apply if the unit offered has two independent manual operating mechanisms for switch disconnector and earth switches:
    a) It must not be possible to operate the earth switch to ON/OFF unless the ON/OFF switch of the switch disconnector is in the OFF position.
    b) It must not be possible to operate the switch disconnector to ON/OFF unless the earth switch is in the OFF position.

4.7 Padlocking

The Equipment must have robust padlocking facilities for locking each switch operating handle entries in the “ON” or “OFF” position. This provision includes switch-disconnector, fuse-switch, CB and earth switch. These locking facilities must prevent inadvertent operator switching as well as unauthorised switching (e.g. by vandals).
The equipment must have a minimum 10 mm diameter hole for attaching the padlock at the lips of the operating handle entries. The padlocking facility material must be robust and compatible with the life of the extensible ring main unit. The Vendor must ensure that the padlocking facilities are properly secured so that they are not susceptible to damage during transportation.

4.8 Voltage Indication (active phases)

All Equipment must provide a means of permanent voltage indication with ultra-bright indicators on all phases. Provision must also be made for the use of test lamps as an additional means of voltage indication.

The Vendor must detail the method of voltage indication in the Proposal and compliance to IEC 61958 Ed.1:2000 or IEC 61243-5:1997.

The Equipment must have voltage test points to allow phasing out of the Equipment. Vendors must detail in the Proposal any additional equipment required for this purpose.

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

4.9 Fault Indicators (Overcurrent and Earth)

Integrated overcurrent and earth fault indication by Fault Indicators (FIs) must be supplied on the switch-disconnectors of extensible ring main switchgear (MV fuse switches or circuit-breakers are excluded from this requirement). These must have the following features:

1) Locally settable overcurrent and earth fault current thresholds;
2) Locally adjustable automatic timer reset (2-4 hrs) and remote override reset via SCADA;
3) Local visual indication of individual phase faults and separate earth fault indication;
4) Voltage free relay terminals (auxiliary switches) for connection to SCADA for:
    a) Over-current phase fault indication for fault on any of 3 phases (1 aux. switch)
    b) Earth fault indication (1 aux. switch).

Vendors offering Equipment with FIs that require an external power source to carry out the functions stated above (items 1 to 4) are not acceptable.

Fault Indicators that require an internal battery to perform the functions specified in (1) to (4) above will be considered. However the Vendor must state the type, capacity (estimated operating lifespan at both 25°C and 45°C), voltage of battery used, and the method of replacement (whether by soldering or by plug-in connectors).

Local indication of a fault must be prominent, either by brightly coloured flags or ultra-bright Light Emitting Diodes (LEDs). The indication must remain active until the Fault Indicator is reset automatically, or via SCADA. The fault indicator must be supplied with a facility to connect a low current external indicator (e.g., LED). The Vendor must provide details of voltage and current output available for such an external indicator that uses the internal battery supply.

Vendors must submit technical data sheets and functional description of the Fault Indicators (and associated CTs) or current pickup sensors with the Proposal.

Vendors may offer as an alternative Fault Indicators that meet the requirements of this clause and offer additional features, such as load current monitoring, harmonic currents, load current alarms, etc. Vendors must indicate this as “Alternative Proposal” in their Proposal and submit detailed information of the features and accuracy of measurements.

4.10 Termination Facilities

Only cable terminating arrangements that offer a fully insulated design on all circuits with no exposed live parts will be considered.

The Equipment must have cable bushings that meet the requirements of AS 60137 for each phase in the switchgear functions as listed in Table 6.

Table 6: Termination Facilities

Application	Termination Type
Ring Feed Circuits	Terminations must be of the sealed push on elbow type, 630 A (DIN style bushing, M16 screw type bolted, dead break connection – Type C)
Transformer Circuits	Terminations must be of the sealed push on elbow or straight connector type, 200 A (DIN style bushing, plug-in, dead break connection – Type A)
Cable Screens	Earth bars must be supplied with provision for separate connection of all cable screens within each cable compartment (to suit M12 lug termination)

The Vendor must provide details in the Proposal of cable termination facilities offered on the Equipment. Preference must be given for transformer circuits that require a straight through connector.

Cable terminals must be suitable for the use of both copper and aluminium lugs.

4.11 Cable Connections

The Equipment must be provided with a cable box, enclosure or compartment suitable for the terminations and intended cables as specified in Table 7.

The cable boxes must be dry type, suitable for accepting 3 x 1 core aluminium or copper XLPE insulated cables.

The switchgear must be equipped with facilities for earthing and testing of all connecting cables. There must be adequate clearances so that MV testing of a feeder or transformer cable may be carried out with safety for both the tester and equipment when all other parts on the switchgear are energised at the system voltage.

Vendors must state in the Proposal the cable type and maximum size that can be terminated in the cable compartment of all items being offered, and the associated termination to use.

Table 7: Standard Cable Type and Size

Application	Service Voltage	Cable Description
Ring Feed Circuits	≤ 22 kV	24 kV 1x1core (per phase) 630 mm^2 Aluminium XLPE insul PVC/HDPE sheathed with Termite Protection 24 kV 3x1core 400 mm^2 Aluminium XLPE insul PVC/HDPE sheathed with Termite Protection 24 kV 3x1core 240 mm^2 Copper XLPE insul PVC/HDPE sheathed with Termite Protection 24 kV 3x1core 95 mm^2, 185mm^2 Aluminium XLPE insul PVC/HDPE sheathed with Termite Protection
Ring Feed Circuits	33 kV	36 kV 3x1core 185 mm^2 Aluminium XLPE insul PVC/HDPE sheathed with Termite Protection 36 kV 3x1core 240 mm^2 Copper XLPE insul PVC/HDPE sheathed with Termite Protection
Transformer Circuits	≤ 22 kV	24 kV 3x1core 35 mm^2 Aluminium XLPE insul PVC/HDPE sheathed with Termite Protection
Transformer Circuits	33 kV	36 kV 3x1core 50 mm^2 AL XLPE insul PVC/HDPE sheathed with Termite Protection

4.12 Cable Entry and Cable Supports

Incoming cables must be bottom-entry for both switch-disconnectors and fuse-switch or circuit-breaker units.

Suitable cable supports in the form of cable mounting plates and cable cleats complete with mounting accessories must be supplied by the Vendor at the base of ring main switchgear units to support incomer cables so that the weight of the cables is not transferred to the switchgear terminal bushings.

The cable box must have a bottom plate and cable clamp. The bottom plate must be of split gland plate type with cable entry holes. Cable clamps must be fixed to the bottom plate at the base of the cable compartment for all switch functions (switch- disconnector and fuse switch).

Suitable rubber bushings must be supplied fitted to each cable entry hole, to cater for the cables specified in Table 5, preventing cables from coming in contact with the sharp edges of the gland plate hole.

Cable gland holes must be vertically aligned with the bushing centres from left to right. The hole centres must be positioned just in front of the bushing, to facilitate perpendicular termination of the cable into the bushing.

Cable supports must be provided for supporting the weight of the cables. Cable supports must be capable of forward and backward adjustment, and left to right

adjustment to ensure the cable is correctly aligned with the bushings at any gland plate.

The cable bushing centre must be located at minimum height of 375 mm above the gland plate on the RMU.

With low-profile switchgear, it is acceptable and may be necessary to have the cable supports extend into the kiosk support stand space, owing to insufficient space to mount vertical cable supports in the incomer chamber of the switchgear.

The top of any cable cleat/clamp must be 400 mm below the centre of the corresponding bushing for ring feeder circuits.

4.13 Earthing

Ring main switchgear, extended RMUs, MV metering equipment and kiosks must have common earth connection points for terminating 4 x 70 mm^2 or 2 x 150 mm^2 cable lugs, for the purpose of making earth connections. All earth bars must be rated for fault currents stated in Section 3.1.2 to allow for the termination of cable screen wires.

The preferred location of these earth connection points must be located inside the front left and right hand panel, near the base of the leftmost and rightmost cable compartments respectively, and away from the cable terminations. The connection points should have ample clearance, to allow measurement of earth connections using clamp-on (stake-less) earth testers, around the attached cables. To facilitate this, connection points should be no closer than 70 mm together. The connection points should be located in a position that allows clamp-on testing by opening kiosk doors, without removing of the kiosk enclosure.

For metering panels, the earth connection point must be located inside the metering panel near the base at a location away from the bus sections and CT and VT terminals.

For kiosks, the earth connection points must be located inside the front, left and right hand panels near the base for easy access and termination.

The cable screen earth bar must be in the cable compartment, positioned above the base of the RMU (i.e. above the ground level) allowing termination of cable screens to be made through the cable compartment door opening. The earth bar must be extended in front of the installed cables ensuring that the installation and removal of the cables is not obstructed by the earth bar. This is to prevent operators from requiring accessing the main earth bar when carrying out testing. However, when removing cables it must not be necessary to remove or refit the earth bar.

All cable screen earth bars must be electrically connected to the common earth connection points above or to the main copper earth bar of the support stand as appropriate (Refer Section 5.6). Where the cable screen earth bars do not terminate at the common earth connection points in the RMU (i.e. they are segregated), the Vendor must supply separate cables for each cable screen

earth bar for termination to the main copper earth bar. All earth connections must be able to withstand the design fault currents as per Section 3.1.2.

The Vendor must supply four (4) of PVC V-90 insulated green/yellow copper cables rated for design fault currents with appropriate lug and bolt/nuts for each earth connection point on switchgear equipment, kiosk and any metering equipment.

The fault rated PVC V-90 insulated green/yellow copper cables must be connected during installation between the RMU and kiosk earth connection points (refer Section 4.13) and main copper earth bar (refer Section 5.6).

4.14 Nameplates

A nameplate must be provided for each item of Equipment, labelled in accordance with AS 62271.1-2012 and AS 62271.200-2005, and fitted such that it is clearly visible on the front of the panel. The true rating of each of the component parts must be marked by etching or stamping on the plate. The serial number must also be etched or stamped on this plate.

The rating plate must be made of stainless steel and must be permanently fitted - by means of rivets or firmly bolted down using stainless steel bolts. Stick-on, glued-on or painted-on nameplate labels are NOT acceptable.

The Vendor must also provide a blank circuit identification label for each unit of switch-disconnector, fuse-switch, circuit breaker and metering panel. The blank identification label must be made of durable weather proof and UV stabilised material of white colour which is removable for labelling by Horizon Power.

The Vendor must submit details in the Proposal of standard method of Equipment identification in the form of an electronic barcode that can be used by Horizon Power for asset tracking purposes.

4.15 Surface Protection of Switchgear Equipment

The Equipment may be installed in severely corrosive condition mainly induced by water, salt laden atmosphere and low levels of industrial pollutants.

Horizon Power requires all exposed internal and external surfaces to be cleaned, prepared and treated with a coating system suitable for severe marine environments corrosion category E-M in accordance with AS 2312-2002. It is not expected that the Equipment will require re-coating during the anticipated lifespan of the Equipment.

The Vendor must state in its Proposal the intended surface protection methods of the Equipment including base material selection and surface preparation (e.g. galvanising, painting, greasing, etc.). The estimated life of the protective coating must also be specified.

Vendors must provide details of all tests (accelerated aging, salt spray, fog, impact, etc.) that prove the effectiveness of the proposed protective coating. All testing must be carried out in accordance with AS 1580.0-2004 or equivalent international standards.

4.16 Metering Equipment (optional)

Requirements for Indoor Ring Main Units (only).

4.16.1 Design

Energy metering units (4-wire) must be suitable for direct connection to adjacent extensible switch-disconnectors and fuse-switches or circuit breaker RMUs.

The design must include a sealed and lockable marshalling enclosure that may be safely accessed from the front of the metering unit, with the main busbars live. The bottom of the marshalling enclosure must be located between 1.0 to 1.5 metres above ground level, for easy access to secondary terminations during commissioning and testing. Only metering components and terminations as specified below must be contained inside the marshalling enclosure. Such ancillary equipment as panel heater wiring and fusing must be excluded from this compartment. An earth stud must be provided within the marshalling enclosure with connection to the earth system via the main earth bar or conductor.

The Metering units must have a continuous primary rating of 400 A at 33 kV, 22 kV and 11 kV, be equipped as detailed in sub-clauses set out below, and must be wired with ferrules numbered in accordance with the drawing in M/D/4/08/4/1 (Rev A).

The metering unit design and construction must facilitate the replacement of CTs and VTs in situ. The design must also be such that all internal busbars lengths between CTs and VTs are minimised.

The Vendor must submit with the Proposal, dimensioned outline drawings, schematic, layout and wiring diagrams of the metering units for review by Horizon Power.

Strong preference will be given to Vendors offering metering units with all exposed busbars and associated mounting hardware fully shrouded and insulated from the environment.

4.16.2 Current Transformers

Three current transformers (CT) must be provided with ratio 200/100/1 A for 33 kV metering units, 200/100/1 A for 22 kV metering units, and 200/100/1 A for 11 kV metering units, of Class 0.5ME2 to AS 60044.1-2007, and rated at 15 VA output at unity burden. The CT must comprise of two cores, one for use by Horizon Power, and the other for use by an MV Customer. The CTs must be wired to drawing M/D/4/08/4/1 (Rev A).

Accuracy requirements for both directions of current flow (P1 to P2 and P2 to P1), MUST be met at the marshalling enclosure terminals.

One CT must be connected in each of the three phases, and must comply in all respects with AS 60044.1-2007. The current ratio change must be made by tapped secondaries with all ratios brought out to the metering terminal block within the marshalling enclosure as detailed in M/D/4/08/4/1 (Rev A).

In drawing M/D/4/08/4/1 (Rev A) the first meter must be Horizon Power's property and the second meter (or equipment) must be the MV Customer's property. The marshalling box must have provision for sealing facilities.

The terminals provided within the marshalling enclosure must be provided as indicated in Drawing M/D/4/08/4/1 (Rev A).

The CT terminal box must have provision for sealing facilities.

4.16.3 Voltage Transformer

One three-phase, or 3 single-phase voltage transformer(s) (VTs) must be provided of ratio:

1) 33/√3 kV : 110/√3 V for 33 kV, or
2) 22/√3 kV : 110/√3 V for 22 kV, or
3) 11/√3 kV : 110/√3 V for 11 kV, and
4) 50 VA per phase, star/star connected, and
5) Class 0.5 M, and
6) Category A, and
7) Uniformly insulated secondary star point brought out and terminated in the metering cubicle as per drawing.

It is important to note that all secondary earthing points on the VTs must be removed from inside the cubicle and terminated on the metering terminal block as indicated on M/D/4/08/4/1 (Rev A) (two meter connection diagram).

The accuracy requirement MUST be met at the marshalling enclosure terminals.

The voltage transformer must be suitable for operation with the high voltage star point connected to ground. The rated voltage factor must be determined in accordance with AS 60044.2-2007. The voltage transformer(s) must comply in all respects with AS 60044.2-2007. The VT terminal box must have provision for sealing facilities.

The voltage transformer(s) must be of the encapsulated type in air with substantial fault rated busbar connections and must NOT be fitted with fuse protection.

All connections from busbars to the voltage transformer(s) must be rigid and self-supporting.

4.16.4 Secondary Wiring

Wiring and ferrule details must be to Drawing No. M/D/4/08/4/1 (Rev A). All small secondary wiring within the metering unit must be 4 mm² of stranded 7/0.85 mm cable, so laid up and restrained that there is no possibility of it coming in contact with the busbars or other live apparatus. VT and all tapped CT secondary terminations must be wired out from their respective terminal boxes to the marshalling enclosure in their respective colours for the individual phases they represent. The S1 terminals from the three CTs must be earthed locally to the main earth bar.

Terminals or intermediate connectors between CT or VT terminal boxes and marshalling enclosure must not be used. Insulated crimp type lugs/connectors are not to be used in any of the CT / VT secondary wiring terminations. Non-insulated crimp connectors are permissible.

The terminals provided within the marshalling enclosure must be of the Weidmuller type with part numbers listed in Table 8. If Weidmuller type is not offered, the Vendor must provide technical details in the Proposal of the equivalent terminals.

Table 8: Terminal Types for Marshalling Enclosure

Type	Catalogue Number	Description
WTL 6/3	1018800000	Measuring disconnecting terminals
STB 21.6 BE	1071000000	Socket / Screw for Slider
WKS 1/2	1604270000	Slider 2 way
WKS 1/3	1604290000	Slider 3-way
WQV 6/2	1052360000	Earth Bridge 2 way

The terminals must accommodate wire size up to 6 mm^2 and be provided with test plug sockets and short circuit bridges for the CTs secondary taps.

Wire identification must be with white wire marking ferrules with engraved letters and numerals filled with non-deteriorating black paint, and must correspond with the wire references on Drawing M/D/4/08/4/1 (Rev A). Ferrules must be mounted as close as practicable to the termination point at both ends of the wire and assembled so that they may be read right-way-up from the normal viewing position.

Wiring must be installed such that it cannot suffer damage from stretching, pinching, fatigue or accidental interference during normal operation or maintenance. Mechanical barriers or protection must be installed to prevent such wire damage.

The marshalling enclosure must be accessible at all times while the busbars are live and have provision for sealing and locking the enclosure.

The marshalling enclosure provided with the extensible metering units must be provided with a conduit hole 25 mm diameter for connection to a remotely mounted meter panel. The remote panel will be supplied by Horizon Power.

The marshalling enclosure provided with the metering unit must be located within the metering cubicle provided by the Vendor.

The bottom of the marshalling enclosure must be located between 1.0 to 1.5 metres above ground level for easy access to disconnect the secondary terminations during commissioning and testing. Only metering components and terminations must be contained inside it. Such ancillary equipment as panel

heater wiring and fusing must be excluded from this compartment. An earth stud must be provided within the marshalling enclosure with connection to the earth system via the main earth bar or conductor.

NOTE: The Vendor must supply details of the current and voltage transformers and their characteristics. Factory test results are to be provided indicating compliance with the class of accuracy as specified below.

4.16.5 Terminal Markings of CTs and VTs

The following terminal markings are required and must be clearly and indelibly marked or engraved and must be clearly visible from inside the MV chamber:

1) Voltage transformers (VT)
   a) Primary Winding:
      i) 'A, N' for Red Phase
      ii) 'B, N' for White Phase
      iii) 'C, N' for Blue Phase
   b) Secondary Winding:
      i) 'a, n' for Red Phase
      ii) 'b, n' for White Phase
      iii) 'c, n' for Blue Phase
   c) Phasing:

Ensure that when 'A' is positive with respect to 'N', 'a' is positive with respect to 'n' and similarly for 'B' and 'C'.

NOTE: Where 3 x single-phase electromagnetic VTs are star-connected the terminals 'N' and 'n' form the primary and secondary star points respectively.

2) Current transformers (CT)
   a) Primary Winding: P1 to P2 in the normal direction of current flow.
   b) Secondary winding: s1, s2, s3 - The polarity must be arranged so that current flow into terminal P1 induces current flow out of terminal s1.
3) Labels P1 and P2 are to be placed inside the adjacent marshalling cubicle walls to indicate the orientation of Primary Current flow in the CTs with relation to the RMU housing.

4.16.6 Rating Plates of CTs and VTs

Rating plates must be permanently attached to the CTs and VTs, copies of these labels must be securely attached to the inside of the metering cubicle, and these must be clearly visible while in service. The markings on these plates must comply fully with the requirements of AS 60044.1-2007 and AS 60044.2-2007 respectively.

5 KIOSK AND SUPPORTING STAND

The Vendor must offer and supply suitable outdoor type, low profile, vandal proof kiosks and supporting stands to individually house the offered ring main switchgear.

The kiosk and support stand must be generally designed in line with the requirements of AS 62271.102, with particular emphasis on medium voltage switchgear, and additional requirements as described in the sections below.

5.1 Support Stand

The support stand must have removable front sections to allow cable terminations. There must be no fixed horizontal member on the support stand at the front that impedes the termination of cables into the ring main switchgear. Horizon Power's preferred arrangement of support stand is shown in Drawing I3 (Appendix I).

The support stand arrangement must be designed to withstand the maximum weight of the Equipment installed (along with transport frame), including cables and terminations as per the arrangement requirements in Section 5.3. This includes the situation where the front cable covers of the support stand are removed.

If horizontal cable support bars are required to be provided underneath the cable compartments, it must be possible to remove the support bars without any deflection or distortion to the equipment. Also, it must not affect the removal and refitting of cable gland plates or the bottom plates.

The handles of the cable covers for the support stand must be made of galvanised steel and must be suitable for rough handling. Two accessible holes of minimum 50 mm diameter must be provided on the left and right side of the support stand with protected edges, to allow insulated earth cables from the copper bar on the kiosk to the main copper earth bar located in the support stand.

The support stand must have a minimum height of 1100 mm to provide adequate clearance for termination of cables.

The support stand must be constructed of galvanised mild steel with 6 mm minimum thickness legs. The vendor must ensure that the final design meets structural and performance requirements detailed in this specification.

The Vendor must submit drawings with the Proposal of the support stand offered showing length, depth and height dimensions of each component.

The vendor must provide full structural calculations of the support stand design, and centre of gravity details when installed on stand (without support stand top cover), within three (3) weeks from the date of Notice of Acceptance of Proposal.

If the Equipment offered does not meet the specific requirements of this section, the Vendor must detail in the Proposal, any alternative design that meets the intent of the requirement to the satisfaction of Horizon Power.

5.2 Kiosk

All kiosks must be cyclone rated to withstand the maximum wind velocities described in Section 3.2. Suitable testing must be carried out as per Section 10.1.1.1 to confirm the rating.

Kiosks designed to house transformers and/or low voltage switchgear together with an RMU must not be considered.

Typical arrangement of kiosk is shown in Drawing I2 (Appendix I) that is preferred for Horizon Power's distribution network.

An IP44 degree of protection for the kiosk is preferred, taking into consideration the Internal Arc Classification requirements of the kiosk specified in Section 4.3.6.

The kiosk must be constructed of steel sheets. The vendor must ensure that the final design meets structural and performance requirements detailed in this specification.

The Vendor must submit drawings with the Proposal of the kiosk offered showing length, depth and height dimensions of each component.

The vendor must provide full structural calculations of the kiosk design and centre of gravity details, when installed on a stand without support stand top cover within three (3) weeks from the date of Acceptance of Proposal.

If the Equipment offered does not meet the specific requirements of this section, the Vendor must detail in the Proposal any alternative design that meets the intent of the requirement to the satisfaction of Horizon Power.

5.2.1 Ventilation

Sufficient natural ventilation must be provided to allow adequate airflow inside the kiosk, to prevent high temperature and humidity.

If ventilation louvers are provided, they must of a similar IP rating to that of the kiosk, and must not allow horizontal rain and/or water spray from nearby bore water sprinklers to enter the kiosk.

The vendor must comment on the effectiveness of the ventilation in regulating the temperature within the kiosk, within the operating limits of equipment, considering the insolation and ambient air temperature provided in Section 3.2.

5.2.2 Vermin Screen

Removable stainless steel wire mesh screen (fitted flush against any ventilation louvers or openings) must be provided on the inside of the kiosk. The wire mesh screens must allow natural airflow ventilation, but act as a physical barrier preventing vermin and vegetation from entering the cubicle.

The Vendor must recommend in the Proposal the optimum pore size of the wire mesh screen. The screen must easily detach for cleaning or replacement, without the need to remove the kiosk from the support stand.

5.2.3 Kiosk Doors

The kiosk door must be 3-point lockable, earthed doors to allow access to the Equipment, for ease of operation and maintenance. The kiosk door must prevent unauthorised access to the Equipment, i.e. the kiosk must be vandal-proof and child-proof. The minimum diameter hole for a padlock must be 10 mm.

The 3-point locking system must be of Selectrix EMKA type (or equivalent) with a stainless steel flush mounting handle, having the padlock hasp incorporated into the handle. Doors with separate hasps and handle systems will not be accepted. It must not be possible to unlock the 3-point locking system without removing the padlock.

All hinges must be manufactured from SS316 stainless steel and must have a minimum pin diameter of 10 mm.

Door seals must comprise a neoprene (or identical non sticking poly material) section, held in a metal channel on the door, and compressed by a dished edge on the fixed enclosure, when the door is closed.

A robust door restraint must be provided to hold each door in the 90° open position. The restraint must use a captive design so that it cannot be inadvertently disengaged. The restraint must be self storing in the sense that it will prevent a closed door from rattling.

Kiosk doors must also have provision for the following:

1) Fitment of RTU equipment and an additional bracket for mounting of cutout box to provide LV supply for the RTU.
2) Bracket for placing operating handles and keys for the padlocked switches.

5.2.4 Kiosk Roof

The roof design of the kiosk must be gently sloping from the centre, to enable water to run off and not accumulate anywhere on the roof surface. Kiosk designs incorporating piano type hinges anywhere along the roof section of the kiosk will NOT be considered.

Kiosk designs incorporating roofs that can be lifted open will only be considered if such designs have:

1) Been proven to meet Internal Arc Classification (IAC) by way of test reports
2) Gas struts to assist opening and closing
3) A second means of securing the roof open that does not rely on any gas struts
4) Vandal proof design, and
5) Proven to be free from water ingress problems.

5.3 Kiosk and Support Stands Arrangements

Kiosks and support stands must be supplied and delivered assembled together in matching pairs of two sizes. One size of kiosk and support stand must be

designed for installation of a 3-way or a 4-way ring main switchgear along with the transport frames. The other size of kiosk and stand matching pair must be suitable for installation of a 4-way or a 5-way ring main switchgear, along with the transport frames. A single size kiosk for all switchgear arrangements may also be offered by the vendor.

Suitable provisions must be made in the support stand design for retrospective fitment of one extensible switchgear function on a 3-way or 4-way unit, without removal of the ring main switchgear and MV cables.

Table 9: Kiosk and Support Stand Arrangements

RMU Configuration	Proposed Kiosk Size	Corresponding Support Stand Size
3-way (i.e. 3+0, 2+1)	4-way	4-way
4-way (i.e. 4+0, 2+2, 3+1)	5-way	5-way
5-way (i.e. 2+3, 3+2)	5-way	5-way

Each kiosk and support stand must be designed to securely support the ring main switchgear, without the need for extra components to be supplied.

The support stand must be designed to securely self-support all configurations of RMU which may have differing widths e.g. 3-way (3+0) and (2+1), 4-way (4+0), (2+2), and (3+1) and 5-way (2+3) and (3+2) RMUs. A means of securely self-supporting the right side of the RMU for all configurations during the installation and in-service stages must be provided.

For any void or opening created in the support stand due to the shorter width of an extensible RMU, a blanking plate must be provided to close the opening. The blanking plate design must not require the supply of additional components.

The blanking plate must meet the maximum loading requirements of the RMU, plus a 120 kg person standing on the blanking plate(s). The blanking plates must be of the same depth as the cable compartment base, and fitted to the support stand in order to cover the holes in front. The blanking plates must be marked on each plate from left to right as follows: 3+0, 2+1, 4+0, 2+2, 3+1, 2+3.

The front and rear ends of blanking plates must be supported underneath e.g., by front cover and back panel. They must be able to withstand the overpressure sustained during an internal fault without causing any damage to the support stand or associated installations.

5.4 Kiosk and Support Stand Surface Finishing

All exposed metal surfaces of the kiosk must be protected by the application of a painting system, suitable for severe marine environments Category E-M in accordance with AS 2312:2002 and AS 2312/Amdt 1:2004.

The external colour of kiosk must be Hawthorn Green (Dulux #33709) and must contain an anti-graffiti additive. The Vendor must in their Proposal, detail the intended painting system for the kiosk.

A steel support stand must be hot dip galvanised to AS/NZS 4680-2006, and offered with the kiosk to support the Equipment.

Any panels or components that are assembled by fastening must ensure proper electrical contact is made and maintained when in service. This contact must exist between the corresponding panels or components to ensure an equipotential support stand. The Vendor must, in their Proposal, detail the process to ensure proper electrical contact is made and maintained when in service. It may be necessary to electrically bond assembled (not welded) panels or components with 70 mm^2 PVC V-90 green/yellow copper cable.

5.5 Coupling of Kiosk and Support Stand

The kiosk and support stand must be designed for easy installation and removal of the kiosk (and/or the complete kiosk and support stand) in situ, to facilitate switchgear installation and replacement.

The kiosk must be fixed to the support stand with bolts on the inside of the kiosks close to the front access doors, for ease of assembly. It must be designed such that corrosion does not occur at points of contact. The rear section inside the kiosk is normally inaccessible after installation.

The rear of the stand must have tongue in groove arrangement to secure the rear of the kiosk to the support stand, by sliding the kiosk (tongue) under the support stand groove. In order to provide additional support to the kiosk, four (4) groove plates (minimum 12 mm thickness) must be welded on the support stand, and fixed onto positioning plates attached on the kiosk. Vendors must provide details, as well as alternative methods of providing additional support to the kiosk/ support stand. Securely fixed nuts must be fitted on the underside of the support frame to facilitate the easy installation and removal of the two mounting bolts.

Typical arrangement of this is shown in Drawing I1 - I3 of Appendix I.

5.6 Main Copper Earth Bar

The support stands must provide a means for earth bonding the switchgear, kiosk and metering panels. A hard drawn main copper earth bar complete with pre-drilled holes equally spaced at 50 mm suitable for M10 bolts and mounted to the support stand must be provided.

The main copper earth bar cross-sectional area must be no smaller than 40 mm wide x 6 mm thick, and must be the length of the support stand. The main copper earth bar must be tinned at the points where it is secured to the support stand ends as indicated in Drawing I4 (Appendix I). The main copper earth bar, with pre-drilled holes, must be rated to carry 25 kA fault current for 1 second at 6.6 kV, 11 kV and 22 kV system voltages, and 13.1 kA for 1 second at 33 kV system voltage.

There must be two (2) earth connection points provided on all associated switchgear equipment, kiosk and any metering equipment for earth connections. The location of main copper earth bar must be such that short earth cable connections can be made to the main copper earth bar from other earth connection points.

The Vendor must give consideration to the cable supports that may extend into the kiosk support stand space when setting the position of the copper earth bar.

5.7 SCADA/Comms Retrofit

Vendors must make provision in the design of RMU kiosks and support stands to allow for the extra weight of external equipment (up to 30 kg). This equipment may be fixed to the outside, upper section of the back kiosk panel, and include SCADA, communications, battery, charger and antenna equipment. Provision in the form of a channel section that can be drilled to attach the SCADA/Comms enclosure will be acceptable.

6 STORAGE

Components must be capable of being stored without deterioration within the temperature range in Section 3.2 for at least 24 months.

7 RELIABILITY

Vendors must comment on the reliability of the Equipment and the performance of the materials offered over an **operational life of 30 years** under the specified field of application and conditions of service.

Comments must provide evidence in support of the claimed reliability and performance for the Equipment offered, including information on Failure Mode and Effect Analysis.

7.1 Life Cycle Model

The vendor must provide a life cycle model of the switchgear offered, to illustrate inspection schedules and maintenance required during the operational life of the equipment. Maintenance intervals must be in line with the minimum number of switching operations for the individual units given in Appendix C. The vendor must also specify of any additional maintenance/ inspection cycles required due to continuous operation in high temperatures as described in Section 3.2.

8 SAFETY

Material Safety Data Sheets (MSDS) applicable for each different product or chemical ingredient in the product which is considered harmful to personnel or environment in any manner, must be supplied with the Proposal.

9 ENVIRONMENTAL CONSIDERATIONS

Vendors must comment on the environmental soundness of the design and the materials used in the manufacture of the Equipment offered. In particular, comments should address such issues as recyclability and disposability at the end of service life as well as disposability of used or unused materials supplied.

9.1 End of Life Management

The successful Vendor must undertake to reclaim and recycle the SF_6 gas remaining in the switchgear. The successful Vendor must also dispose of toxic by-products within the SF_6 chamber, along with the other parts of the equipment,

in an environmentally responsible manner at the end of the service life of the equipment.

The Vendor must submit a proposal for end of life management with the tender Proposal. The proposal must include all costs associated with carrying out the tasks above. The Vendor will compensate Horizon Power the scrap value of the disposed switchgear, and all recovered SF_6 gas, at rates to be agreed by both parties.

10 TESTS

10.1 Test Requirements

The Vendor must undertake all type, routine, sample and special tests according to this specification and as per the requirement of relevant Australian or International Standards. The tests must be carried out to the satisfaction of Horizon Power's Representative.

Horizon Power reserves the right to reject the equipment even if it passes all the tests but does not comply with the specification when installed on site.

10.1.1 Type Tests

Evidence must be submitted by the Vendor indicating that all type tests required by the relevant Australian and International Standards listed in Table 1 have been satisfactorily carried out on the Equipment.

Where Equipment has been tested to International Standards only, sufficient type test evidence must be submitted to confirm equivalence of Equipment performance to the relevant Australian standard if one exists.

The vendor must carry out as many IAC tests necessary to gain compliance with AS 62271.200 and AS 62271.202 at their own cost. Any design modification done to the equipment, associated kiosks and support stands in order to meet the specification must comply with the IAC test requirements. These tests will have to be carried out by the vendor at their own cost.

The indoor IAC test on the RMU equipment itself must be carried out in accordance with AS 62271.200. The minimum test current must be equal to the rated short circuit withstand current of the ring main unit, for a period of one (1) second.

The outdoor IAC test for the switchgear in kiosk must be carried out in accordance with AS 62271.202 for short circuit withstand current, for one (1) second as above. The Preferred Vendor must perform the IAC type tests with at least two switch disconnectors and one fuse switch unit (2+1 configuration). Type test results of equipment along with kiosks must be provided, with the Proposal to show internal arc compliance (IAC) with requirements of the Standard requirements above or IEC equivalent Standard. The test result must indicate the accessibility type (including sides), and include internal arc current and duration, with supporting test reports.

Horizon Power can provide on request an option for the Vendor to carry out the IAC test for the **outdoor in kiosk arrangement only,** after the kiosk and support

stand design is approved by Horizon Power. In this case the preferred vendor must carry out the IAC test in the kiosk design offered within 60 days of the Notice of Acceptance of approval.

If the various tests associated with fault levels of 13.1 kA on 36 kV RMUs and 25 kA on 24 kV RMUs have not been carried out on the design offered, the Vendor must state what tests it guarantees to have made. The Vendor must also state the testing authority, and must demonstrate that the tests carried out to meet the requirements of this Specification.

10.1.1.1 Impact Test for Cyclone Rating of Kiosk

An impact test must be carried out on the kiosk unit complete with doors, covers and ventilation openings; as described in Section 2.5.8 of AS 1170.2-2011. The kiosk must the pass the test for the maximum wind speed, as per the operating conditions in Section 3.2. The doors must be kept closed during the period of the test.

Details of any visible effects and the position of the impacts on the RMU must be recorded by photographs and included in the test report. This is not limited to deformation on any part of the kiosk and stand, and includes door hinges and tabs.

10.1.1.2 CT and VT Accuracy Tests

Vendors must supply details of the current transformers and voltage transformers and their characteristics with the Proposal.

The accuracy requirements for both directions of current flow and voltage outputs MUST be met at the marshalling enclosure.

Voltage transformers must be tested in accordance with AS 60044.2-2007 for accuracy designated type ‘M’ VTs, typically at 25% and 100% rated burden and 0.9, 1.0 and 1.1 (or greater if appropriate) times rated primary voltage at the marshalling enclosure terminals.

The current transformers must normally be tested in accordance with AS 60044.1-2007 Class ME CTs, typically at 25% and 100% rated burden and 2.5% to 200% rated current for each ratio in both directions at the marshalling enclosure terminals.

Reporting of the accuracy test results must be made by a NATA endorsed laboratory, or equivalent laboratory. Test equipment must be traceable to a national standard. This traceability must be indicated on the test reports provided to Horizon Power.

Test reports must indicate uncertainty calculations. These calculations must be carried out in accordance to the ISO – Guide to the Expression of Uncertainty in Measurement (ISO Guide 98: 1995) to comply with specification of the Western Australian metrology procedure.

The Vendor must provide in the Proposal a sample VT and CT accuracy test report typical of what will be supplied with the Metering units.

The successful Vendor of this Tender must provide copies of the Metering CT and VT accuracy test results to the Horizon Power Representative immediately they become available.

The successful Vendor of this Tender must be responsible for arranging and completing accuracy testing of CT, VT and providing reports to Horizon Power prior to supply and delivery to Horizon Power.

The voltage transformers may also be subjected to an induced high voltage test, at a frequency not exceeding 400 Hz for one minute. The value of the phase to phase induced voltage must be 90% of the power frequency withstand voltage as specified in Table 4 of AS 60044.2-2007.

In both of the above tests, the value of the withstand voltages must be taken to be that applicable to the associated switchgear.

10.1.2 Routine Tests

Routine tests must be carried out on each item of Equipment or component thereof. For components that have not mentioned below, all routine tests as described in the respective Australian or International Standard need to be carried out.

1) Ring Main Unit as per AS 62271.1 and AS 62271.200

All routine tests as described by the above standard need to be carried out. In addition partial discharge measurement tests need to be carried out as per AS 62271.200 Annexure B.

2) Fuse-switch combination per AS 2024-1191 and IEC 62271.105-2011
    a) Mechanical Operating Tests
    b) Power Frequency Dry Tests (Dielectric Test)
    c) Tightness Test
3) High-voltage switches per AS 60265, AS 62271.102-2005 and AS 62271.1
    a) Power Frequency Voltage Tests
    b) Voltage Tests on Auxiliary Circuits
    c) Measurement of Resistance of Main Circuit
    d) Tightness Test
    e) Mechanical Operation and Endurance Tests
4) Circuit- breaker per AS 62271-100
    a) Power Frequency Voltage Tests
    b) Voltage Withstand Tests on Control and Auxiliary Circuits
    c) Measurement of Resistance of Main Circuit
    d) Mechanical Operating Tests
5) All routine tests to be carried out on Current Transformers and Voltage transformers as per AS 60044.1 and AS 60044.2 respectively.

11 DOCUMENTATION

NOTE: All documentation must be in English.

11.1 Installation Instructions

Installation instructions must:

a) be unique to the rated voltage and the type for which the accessory has been designed;

b) be supported by legible illustrations, that clearly indicate the application and assembly of all components of the accessory;

c) reference the bill of materials by utilising the short description and by quoting the relevant part number at least once when describing the components;

d) indicate a date of issue and revision number.

11.2 Bill of Materials (BOM)

The bill of materials must provide the following information for each component:

a) a short description;

b) the quantity;

c) a part number.

11.3 Type Test Certificates/Reports

1) Type test certificates and reports must be submitted with a tender.

2) The type test reports must include an installation instruction and bill of materials that form an integral part of the test report issued by the test authority.

11.4 Management of Switchgear when Submerged in Water

Horizon Power ensures that necessary countermeasures are taken when switchgear is installed in flood prone or low level areas. However in the unlikely event that the switchgear gets submerged in water and/or exposed to moisture; the vendor must submit with the proposal a hazard management plan describing the safe methods that must be engaged in the isolation and subsequent handling of the switchgear.

12 MARKING/PACKING

The Equipment must be suitably packaged, such that it is “fit for use” at any location in Horizon Power’s operational area. Packaging must be capable of preventing damage whilst in storage and during transit to remote locations.

The Equipment must be supplied in suitable packaging which ensures that there is no deformation to any part of the switchgear during transportation. The Equipment must not be supplied on cardboard, non-waterproof fibreboard, or other footings that deform, soften or disintegrate on contact with water and high humidity preventing the use of fork-lift to handle the Equipment.

The Vendor is required to nominate standard pack quantities and standard packs must be clearly marked with the following information:

a) Manufacturer's name
b) Manufacturer's part reference number
c) Horizon Power Order Number
d) Horizon Power Stock Number
e) Gross weight in kg
f) Nett weight in kg
g) Date of manufacture
h) Manufacturer's Serial Numbers of all packaged equipment (to facilitate traceability)
i) Total mass (in kg) of SF_6 gas in all equipment supplied including the quantity of free SF_6 gas in bottle(s) available for operations.

In addition the package must contain:

a) an installation instruction;
b) all necessary components and consumables required to complete the installation in accordance with the instruction i.e. accessory components, cleaning kit and earthing kit;
c) Material Safety Data Sheets (MSDS)

13 SPARE EQUIPMENT

Separate prices are required with the offer for the following:

1) Any spares necessary for the continuous operation of each item of Equipment; and
2) Any special tools or handling equipment required for installation and/or maintenance must be stated in Appendix H of the enquiry document.

All spares must be labelled with manufacturer's part number.

It is required that the validity period of the Proposal, as far as spares are concerned, be extended until such time as Horizon Power places an order for spares.

APPENDIX A REVISION INFORMATION

(Informative) Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification of errors or queries.

Each Standard makes use of its own comment sheet which is maintained throughout the life of the standard, which lists all comments made by stakeholders regarding the standard.

A comment sheet found in **CS10# 1907890** can be used to record any errors or queries found in or pertaining to this standard. This comment sheet will be referred to each time the standard is updated.

Date	Rev No.	Notes
18/11/2013	0	Original Issue
20/01/2017	1	First Revision: Changed required fault level from 18.4 to 25 kA. Changed 'BIL' to 'Lightning Impulse'.

APPENDIX B QUALITY ASSURANCE (TO BE COMPLETED BY STORES)

DOCUMENT NUMBER	HPC-8DJ-07-002-2013		**QUALITY ASSURANCE**	**DM NUMBER**	
DEVICE DESCRIPTION	**LABEL MATERIAL NO.**		**DISTRIBUTION TRANSFORMER PURCHASE**	**ASSET OWNER**	
	ASSET ID/ STOCK NO				
MANUFACTURER		**DIMENSION**			

ITEM	OPERATION/EQUIPMENT/FACILITY	DOCUMENT REF.	WHO CHECKS	INITIAL	DATE/ TIME	QUALITY ASSURANCE CRITERIA	PASS Y/N	COMMENTS
1								
1.1	Name of Manufacturer					*******		
1.2	Week & Year of Manufacture					*******		
1.3	Horizon Power Order Number					*******		
1.4	Horizon Power Stock Number					*******		
1.5	Rating Plate Voltage					*******		
1.6	Physical Appearance							
1.6.1	Paint Colour (Kiosk only)					Hawthorn Green		
1.6.2	Paint Chips (Kiosk and Support stands)					*******		

1.6.3	Physical Damage					*******		
1.7	Packaging (if not already assembled)					Fit for transport to site		
2	DOCUMENTATION							
2.1	Material Safety Data Sheets					Clear, Legible and in English		
2.2	Switchgear Documentation & Drawings					Clear, Legible and in English		
2.3	Test and Inspection Reports					Clear, Legible and in English		
2.3.1	Routine test (For every batch)					*******		

SYMBOLS AND ABBREVIATIONS								
H = HOLD POINT	S = SUPERVISOR							
W = WITNESS POINT	T = TECHNICIAN, EL = ELECTRICIAN	REVISION						
V = VERIFICATION POINT	E = ENGINEER	DATE						
S/C = SUBCONTRACTOR	PM = PROJECT MANAGER	APPROVED BY						

APPENDIX C RING MAIN UNIT INFORMATION

ITEM	REQUIREMENTS	UOM	24 kV 3-PH SWITCHGEAR OPERATING AT 6.6 OR 11 kV NOMINAL SYSTEM VOLTAGE	24 kV 3-PH SWITCHGEAR OPERATING AT 22 kV NOMINAL SYSTEM VOLTAGE	36 kV 3-PH SWITCHGEAR OPERATING AT 33 kV NOMINAL SYSTEM VOLTAGE	CHECKLIST FOR VENDOR TO COMPLETE**
D1.0 GENERAL						
D1.1	System highest voltage	kV (rms)	12	24	36	☐
D1.2	Nominal system Voltage	kV (rms)	11	22	33	☐
D1.3	Lightning impulse withstand voltage	kV (peak)	95 (75)*	150 (125)*	200 (170)*	☐
D1.4	Power frequency withstand voltage (1-minute) (rms)	kV-min (rms)	28	50	70	☐
D1.5	Rated frequency	Hz	50	50	50	☐
D1.6	Internal arc withstand (1 s) (rms)	kA/1 s	25	25	13.1	☐
D1.7	Design fault level (minimum 1 s) (rms)	kA/1 s	25	25	13.1	☐
D2.0 BUSBAR SYSTEM						
D2.1	Rated current (rms)	A	630	630	630	☐
D2.2	Rated short-time withstand current (1 s) (rms)	kA/1 s	25	25	13.1	☐

D3.0 SWITCH-DISCONNECTOR						
D3.1	Rated normal current (rms)	A	630	630	630	☐
D3.2	Power frequency withstand voltage (1 min) (rms)	kV	28	50	70	☐
D3.3	Lightning impulse withstand voltage	kV (peak)	95 (75)*	150 (125)*	200 (170)*	☐
D3.4	Rated short-time withstand current (1 s) (rms)	kA/1 s	25	25	13.1	☐
D3.5	Rated Peak withstand current	kA	50	50	40	☐
D3.6	Making capacity (peak)	kA	50	50	40	☐
D3.7	Short-circuit breaking capacity	kA	25	25	13.1	☐
D3.8	Load breaking capacity	A	630	630	630	☐
D3.9	Busbar Current Rating	A	630	630	630	☐

D3.10	Suitable cable types and maximum cable sizes supported	-	24 kV 3x1core 400 mm^2 Aluminium XLPE insul PVC/HDPE sheathed	24 kV 1x1core (per phase) 630 mm^2 Aluminium XLPE insul PVC/HDPE sheathed	36 kV 3x1core 185 mm^2 Aluminium XLPE insul PVC/HDPE sheathed	☐
			24 kV 3x1core 240 mm2 Copper XLPE insul. PVC/HDPE sheathed,	24 kV 3x1core 400 mm2 Aluminium XLPE insul PVC/HDPE sheathed	36 kV 3x1core 240 mm2 Copper XLPE insul PVC/HDPE sheathed	☐
			12 kV 3-core 240 mm^2 & 300 mm^2 Copper MIND PLY(E) SWS (preferable but not essential)	24 kV 3x1core 240 mm2 Copper XLPE insul PVC/HDPE sheathed		☐
				24 kV 3x1core 95 mm^2 & 185 mm^2 Aluminium XLPE insul PVC/HDPE sheathed		☐
D3.11	Minimum number of mechanical switching operations at no load	no.	1000	1000	1000	☐
D3.12	Minimum number of mechanical switching operations at rated normal current (630 A)	no.	100	100	100	☐
D3.13	Minimum number of mechanical switching operations at rated short circuit current	no.	5	5	5	☐
D3.14	Padlocking facility provided with minimum padlock hole size (mm)	mm	10 mm hole	10 mm hole	10 mm hole	☐

D3.15	Facilities for voltage indication (via LED lamp) and phase concordance provided per 3-ph feeder	-	Yes	Yes	Yes	☐
D3.16	Over-current and earth-fault indicator (self powered and remote telemetry ready) provided per 3-ph feeder	-	Yes and capable of phase discrimination preferred	Yes and capable of phase discrimination preferred	Yes and capable of phase discrimination preferred	☐
D3.17	Switchgear main electric circuits degree of protection (IPxx)	-	IP64	IP64	IP64	☐
D3.18	Switchgear drive mechanism degree of protection (IPxx)	-	IP3X	IP3X	IP3X	☐
D3.19	Switchgear MV cable compartment (with access cover closed) degree of protection	-	IP3X	IP3X	IP3X	☐
D3.20	Auxiliary terminals for RTU/SCADA remote status indication and switchgear remote Open – Close control are provided	-	Yes	Yes	Yes	☐
D4.0 EARTH-SWITCH						
D4.1	Earth-Switches are provided for Switch-Disconnectors, Fuse-Switches and Circuit Breakers (if offered) panels	-	Yes	Yes	Yes	☐
D4.2	Power frequency withstand voltage (1-min) (rms)	kV	28	50	70	☐
D4.3	Lightning impulse withstand voltage	kV (peak)	95 (75)*	150 (125)*	200 (170)*	☐
D4.4	Rated short-time withstand current (1s)	kA/1 s	25	25	13.1	☐
D4.5	Rated Peak withstand current	kA	50	50	40	☐
D4.6	Busbar Current Rating	A	630	630	630	☐

D4.7	Stranded earth conductor size	mm^2	70/150	70/150	70/150	☐
D4.8	Minimum number of mechanical switching operations at no load	no.	1000	1000	1000	☐
D4.9	Minimum number of mechanical switching operations at rated short circuit current	no.	5	5	5	☐
D4.10	Padlocking facility provided with minimum padlock hole size (mm)	mm	10 mm hole	10 mm hole	10 mm hole	☐
D4.11	Auxiliary terminals for RTU/SCADA remote status indication are provided	-	Yes	Yes	Yes	☐
D5.0 FUSE-SWITCH						
D5.1	Rated current (rms)	A	200	200	200	☐
D5.2	Power frequency withstand voltage (1-min) (rms)	kV	28	50	70	☐
D5.3	Lightning impulse withstand voltage	kV (peak)	95 (75)*	150 (125)*	200 (170)*	☐
D5.4	Rated short-time withstand current (1 s) (rms)	kA/1 s	25	25	13.1	☐
D5.5	Rated Peak withstand current	kA	50	50	40	☐
D5.6	Making capacity (peak)	kA	50	50	40	☐
D5.7	Short-circuit breaking capacity	kA	25	25	13.1	☐
D5.8	Load breaking capacity	A	200	200	200	☐
D5.9	Busbar Current Rating	A	630	630	630	☐

D5.10	Suitable cable types and maximum cable sizes supported		22 kV 3x1c 35 mm^2 Al, w/HD Cu screen, XLPE insul PVC/HDPE sheathed	22 kV 3x1c 35 mm^2 Al, w/HD Cu screen, XLPE insul PVC/HDPE sheathed	33 kV 3x1c 50 mm^2 Al, w/HD Cu screen, XLPE insul PVC/HDPE sheathed	☐
D5.11	Trip all 3-phases device fitted to trigger on fuse operation	-	Yes	Yes	Yes	☐
D5.12	Minimum number of mechanical switching operations at no load	no.	1000	1000	1000	☐
D5.13	Minimum number of mechanical switching operations at rated normal (200 A) current load	no.	10	10	10	☐
D5.14	Minimum number of mechanical switching operations at rated short circuit current	no.	5	5	5	☐
D5.15	Padlocking facility provided with minimum padlock hole size (mm)	mm	10 mm hole	10 mm hole	10 mm hole	☐
D5.16	Switchgear main electric circuits degree of protection (IPxx)	-	IP64	IP64	IP64	☐
D5.17	Switchgear drive mechanism degree of protection (IPxx)	-	IP3X	IP3X	IP3X	☐
D5.18	Switchgear MV cable compartment (with cover closed) degree of protection (IPxx)	-	IP3X	IP3X	IP3X	☐
D5.19	Auxiliary terminals for RTU/SCADA remote status indication	-	Yes	Yes	Yes	☐
D6.0 CIRCUIT-BREAKER						
D6.1	Rated current (rms)	A	200	200	200	☐
D6.2	Power frequency withstand voltage (1-min) (rms)	kV	28	50	70	☐
D6.3	Lightning impulse withstand voltage	kV (peak)	95 (75)*	150 (125)*	200 (170)*	☐

D6.4	Rated short-time withstand current (1 s) (rms)	kA/1s	25	25	13.1	☐
D6.5	Rated Peak withstand current	kA	50	50	40	☐
D6.6	Making capacity (peak)	kA	50	50	40	☐
D6.7	Short-circuit breaking capacity	kA	25	25	13.1	☐
D6.8	Load breaking capacity	A	200	200	200	☐
D6.9	Busbar Current Rating	A	630	630	630	☐
D6.10	Suitable cable types and maximum cable sizes supported		22 kV 3x1c 35 mm^2 Al, w/HD Cu screen, XLPE insul PVC/HDPE sheathed	22 kV 3x1c 35 mm^2 Al, w/HD Cu screen, XLPE insul PVC/HDPE sheathed	33 kV 3x1c 50 mm^2 Al, w/HD Cu screen, XLPE insul PVC/HDPE sheathed	☐
D6.11	Trip all 3-phases device fitted to trigger on Circuit Breaker operation	-	Yes	Yes	Yes	☐
D6.12	Minimum number of mechanical switching operations at no load	no.	1000	1000	1000	☐
D6.13	Minimum number of mechanical switching operations at rated normal (200A) current load	no.	1,000	1,000	1,000	☐
D6.14	Minimum number of mechanical switching operations at rated short-circuit current	no.	5	5	5	☐
D6.15	Padlocking facility provided with minimum padlock hole size (mm)	mm	10 mm hole	10 mm hole	10 mm hole	☐
D6.16	Switchgear main electric circuits degree of protection (IPxx)	-	IP64	IP64	IP64	☐
D6.17	Switchgear drive mechanism degree of protection (IPxx)	-	IP3X	IP3X	IP3X	☐
D6.18	Switchgear MV cable compartment (with access cover closed) degree of protection (IPxx)	-	IP3X	IP3X	IP3X	☐

D6.19	Self powered protection relay to trip Open Circuit Breaker is provided	-	Yes	Yes	Yes	☐
D6.20	Protection relay is capable of protecting 25 kVA single-phase transformer is provided	-	Preferable	Preferable	Preferable	☐
D6.21	Protection relay is capable of protecting 63 kVA 3-phase transformer is provided	-	Preferable	Preferable	Preferable	☐
D6.22	Auxiliary terminals for RTU/SCADA remote status indication are provided	-	Yes	Yes	Yes	☐
D7.0 METERING EQUIPMENT						
D7.1	Continuous Primary Rating	A	400	400	400	☐
D7.2	Current Transformer Ratio	no.	200/100/1 A	200/100/1 A	200/100/1 A	☐
D7.3	Current Transformer Output (VA) at unity burden	VA	15	15	15	☐
D7.4	Current Transformer Accuracy Class	-	0.5ME2	0.5ME2	0.5ME2	☐
D7.5	Voltage Transformer Ratio	no.	11/√3 kV: 110/√3 V	22/√3 kV: 110/√3 V	33/√3 kV: 110/√3 V	☐
D7.6	Voltage Transformer Output (VA) per phase	VA/ph	50	50	50	☐
D7.7	Voltage Transformer Burden (Ohm)	Ohm	Vendor to state	Vendor to state	Vendor to state	☐
D7.8	Voltage Transformer Accuracy Class	-	0.5M	0.5M	0.5M	☐
D7.9	Metering Panel (with access cover closed) degree of protection (IPxx)	-	IP3X	IP3X	IP3X	☐

*Note: For underground applications with a nominal system voltage of 22 kV, equipment with a rated lightning impulse withstand voltage of 125 kV may also be considered. For underground applications with a nominal system voltage of 33 kV, equipment with a rated lightning impulse withstand voltage of 170 kV may also be considered

**If Vendor is unable to meet any of the requirements above the “Deviation from Proposal” needs to be completed in Appendix E with the Section Number and alternative rating if any offered.

APPENDIX D COMPLIANCE DOCUMENT

The Vendor must indicate below whether this offer is fully compliant with the nominated clause in this Specification. A YES must ONLY be indicated if the offer is 100% compliant with the relevant Clause. If NO is indicated and supporting documents are submitted, then mark the ATT box with the attachment number.

	CLAUSE NUMBER	YES	NO	ATT.
1.	SCOPE			
2.	NORMATIVE REFERENCES			
2.1	Standards			
2.2	Definitions and Abbreviations			
2.2.1	*Definitions*			
2.2.2	*Abbreviations*			
2.3	Drawings			
3	REQUIREMENTS			
3.1	Power System Particulars			
3.1.1	*Rated Voltages*	☐	☐	☐
3.1.2	*Design Fault Levels*	☐	☐	☐
3.1.3	*Nominal System Frequency*	☐	☐	☐
3.1.4	*System Insulation Levels*	☐	☐	☐
3.2	Standard Operating Conditions	☐	☐	☐
3.2.1	*Seismic Disturbances*	☐	☐	☐
3.2.2	*Wind Loads*	☐	☐	☐
3.2.3	*Clearances & Insulation*	☐	☐	☐
3.2.4	*Dimensions*	☐	☐	☐
4	RING MAIN UNITS (RMU)			
4.1	General	☐	☐	☐
4.2	Application	☐	☐	☐
4.3	Design and Construction	☐	☐	☐
4.3.1	*Loss of Service Continuity*	☐	☐	☐
4.3.2	*Functions*	☐	☐	☐
4.3.3	*Requirements*			
4.3.3.1	*Rated Parameters and Performance*	☐	☐	☐
4.3.3.2	*Equipment Housing*	☐	☐	☐
4.3.3.3	*Operation*	☐	☐	☐
4.3.3.4	*Automation*	☐	☐	☐

CLAUSE NUMBER		YES	NO	ATT.
4.3.4	*Extensibility*	☐	☐	☐
4.3.4.1	*1-Way*	☐	☐	☐
4.3.4.2	*3-Way & 4-Way*	☐	☐	☐
4.3.4.3	*5-Way*	☐	☐	☐
4.3.5	*Transport Frames*	☐	☐	☐
4.3.6	*Internal Arc Classification*	☐	☐	☐
4.4	Switchgear Requirements	☐	☐	☐
4.4.1	*Switch Disconnector*	☐	☐	☐
4.4.2	*Fuse Switch*	☐	☐	☐
4.4.3	*Circuit Breaker*	☐	☐	☐
4.4.4	*Automation Facilities*	☐	☐	☐
4.4.4.1	*Automation of switch-disconnector unit*	☐	☐	☐
4.4.4.2	*Automation of circuit breaker unit*	☐	☐	☐
4.4.4.3	*Cable-connected remote console*	☐	☐	☐
4.5	Insulating and Switching Mediums	☐	☐	☐
4.5.1	*Vacuum Interrupters*	☐	☐	☐
4.5.2	*SF_6 Gas Interrupter*	☐	☐	☐
4.5.2.1	*SF_6 Gas Annual Loss*	☐	☐	☐
4.5.2.2	*SF_6 Gas Pressure Gauge/Non-return Valve & Low Gas Switch*	☐	☐	☐
4.5.3	*Loss of Insulating/Switching Medium*	☐	☐	☐
4.6	Interlocks	☐	☐	☐
4.7	Padlocking	☐	☐	☐
4.8	Voltage Indication (active phases)	☐	☐	☐
4.9	Fault Indicators (Overcurrent and Earth)	☐	☐	☐
4.10	Termination Facilities	☐	☐	☐
4.11	Cable Connections	☐	☐	☐
4.12	Cable Entry and Cable Supports	☐	☐	☐
4.13	Earthing	☐	☐	☐
4.14	Nameplates	☐	☐	☐
4.15	Surface Protection of Switchgear Equipment	☐	☐	☐
4.16	Metering Equipment	☐	☐	☐
4.16.1	*Design*	☐	☐	☐

	CLAUSE NUMBER	YES	NO	ATT.
4.16.2	*Current Transformers*	☐	☐	☐
4.16.3	*Voltage Transformers*	☐	☐	☐
4.16.4	*Secondary Wiring*	☐	☐	☐
4.16.5	*Terminal Markings of CTs and VTs*	☐	☐	☐
4.16.6	*Rating Plates of CTs and VTs*	☐	☐	☐
5.	KIOSK AND SUPPORTING STAND	☐	☐	☐
5.1	Support Stand	☐	☐	☐
5.2	RMU Kiosk	☐	☐	☐
5.2.1	*Ventilation*	☐	☐	☐
5.2.2	*Vermin Screen*	☐	☐	☐
5.2.3	*Kiosk Doors*	☐	☐	☐
5.2.4	*Kiosk Roof*	☐	☐	☐
5.3	Kiosk and Support Stands Arrangement	☐	☐	☐
5.4	Kiosk and Support Stand Surface Finishing	☐	☐	☐
5.5	Coupling of Kiosk and Support Stand	☐	☐	☐
5.6	Main Copper Earth Bar	☐	☐	☐
5.7	SCADA/Comms Retro-fit	☐	☐	☐
6.	STORAGE	☐	☐	☐
7.	RELIABILITY	☐	☐	☐
7.1	Life Cycle Model	☐	☐	☐
8.	SAFETY	☐	☐	☐
9.	ENVIRONMENTAL CONDITIONS	☐	☐	☐
9.1	End of Life Management	☐	☐	☐
10.	TESTS			
10.1	Test Requirements	☐	☐	☐
10.1.1	*Type Tests*	☐	☐	☐
10.1.1.1	*Impact Test for Cyclone Rating of Kiosk*	☐	☐	☐
10.1.1.2	*CT and VT Accuracy Tests*	☐	☐	☐
10.1.2	*Routine Tests*	☐	☐	☐

CLAUSE NUMBER		YES	NO	ATT.
11.	DOCUMENTATION	☐	☐	☐
11.1	Installation Instructions	☐	☐	☐
11.1	Bill of Materials (BOM)	☐	☐	☐
11.3	Type Test Certificates/Reports	☐	☐	☐
11.4	Management of Switchgear when Submerged in Water	☐	☐	☐
12.	MARKING/PACKING	☐	☐	☐
13.	SPARE EQUIPMENT	☐	☐	☐

APPENDIX E DEPARTURES FROM TECHNICAL SPECIFICATION

The Vendor must nominate the Clause and describe the departure:

CLAUSE NO	DEPARTURE

APPENDIX F STANDARD STOCK HRC FUSE INFORMATION

MV fuses for ground-mount switchgear

System Voltage	Fuse Rating (A)	Horizon Power Standard 3-phase Transformer Sizes (kVA)	HP Stockcode
SIBA Air HRC	(For use with non-extensible RMU and extensible RMU switchgear)		
7.2 kV	31.5	100/160/200	
	50.0	315	
	100.0	630	
	160.0	1000	
	Fuse Extender (set)		XA2355
12 kV	25.0	100/160/200	
	31.5	315	
	50.0	630	
	80.0	1000	
	Fuse Extender (set)		XA2355
24 kV	10.0	100/160/200	
	16.0	315	
	31.5	500/630	
	40.0	1000	
36 kV	6.3	50/63/160	
	8.0	315	
	20.0	630	
	40.0	1000	

APPENDIX G SCHEDULE OF EQUIPMENT

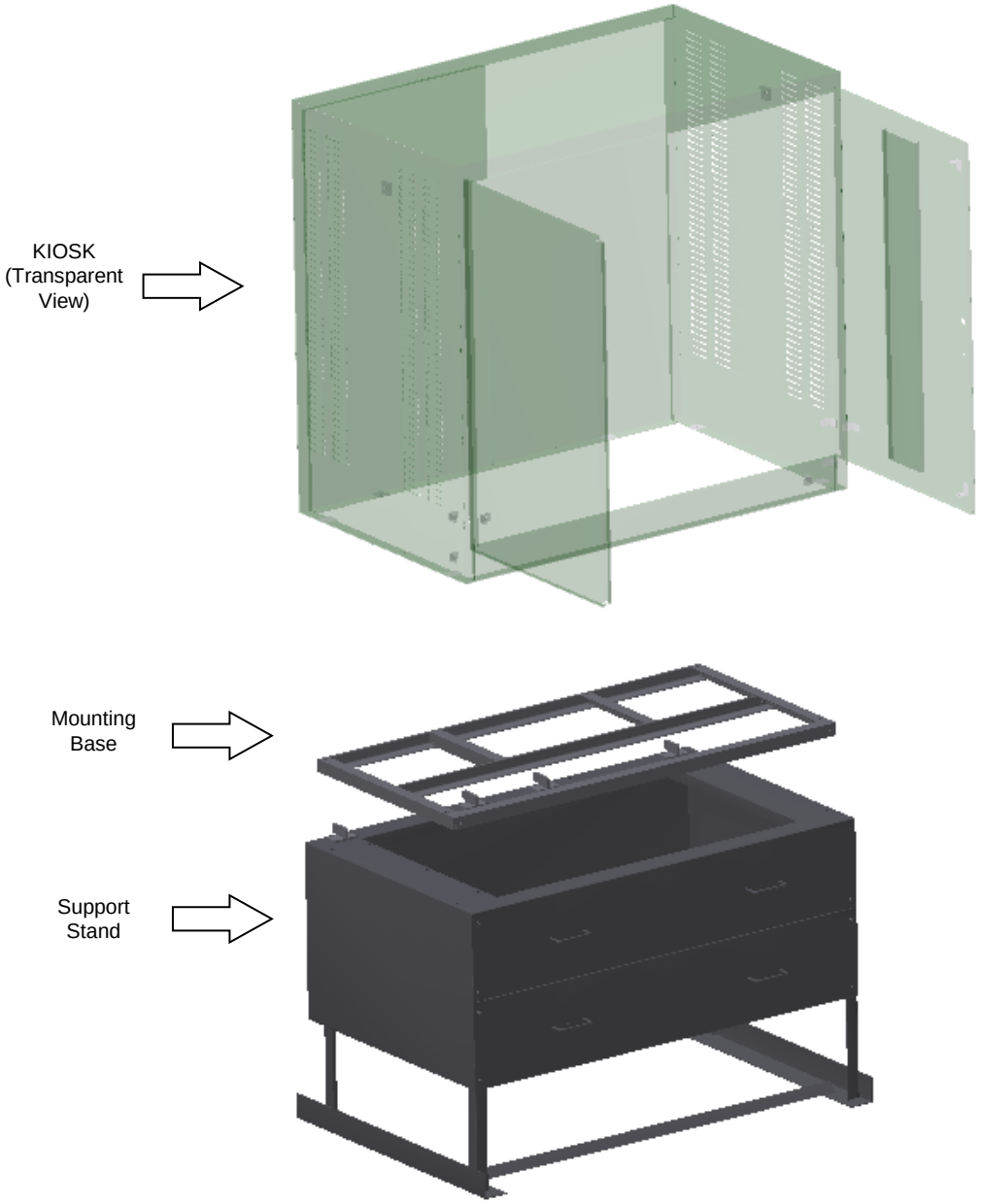
ITEM NUMBER	RMU CONFIGURATION	DESCRIPTION
1	3+0	3-WAY UNIT; EXTENSIBLE 3 x AUTOMATABLE SWITCH DISCONNECTORS
2	2+1	3-WAY UNIT; EXTENSIBLE 3 x AUTOMATABLE SWITCH DISCONNECTORS 1 x FUSE SWITCH
3	2+2	4-WAY UNIT; EXTENSIBLE 2 x AUTOMATABLE SWITCH DISCONNECTORS 2 x FUSE SWITCH
4	3+1	4-WAY UNIT; EXTENSIBLE 3 x AUTOMATABLE SWITCH DISCONNECTORS 1 x FUSE SWITCH
5	4+0	4-WAY UNIT; EXTENSIBLE 4 x AUTOMATABLE SWITCH DISCONNECTORS
6	2+3	5-WAY UNIT; NON-EXTENSIBLE 2 x AUTOMATABLE SWITCH DISCONNECTORS 3 x FUSE SWITCH
7	3+2	5-WAY UNIT; NON-EXTENSIBLE 3 x AUTOMATABLE SWITCH DISCONNECTORS 2 x FUSE SWITCH

APPENDIX H ADDITIONAL INFORMATION REQUESTED

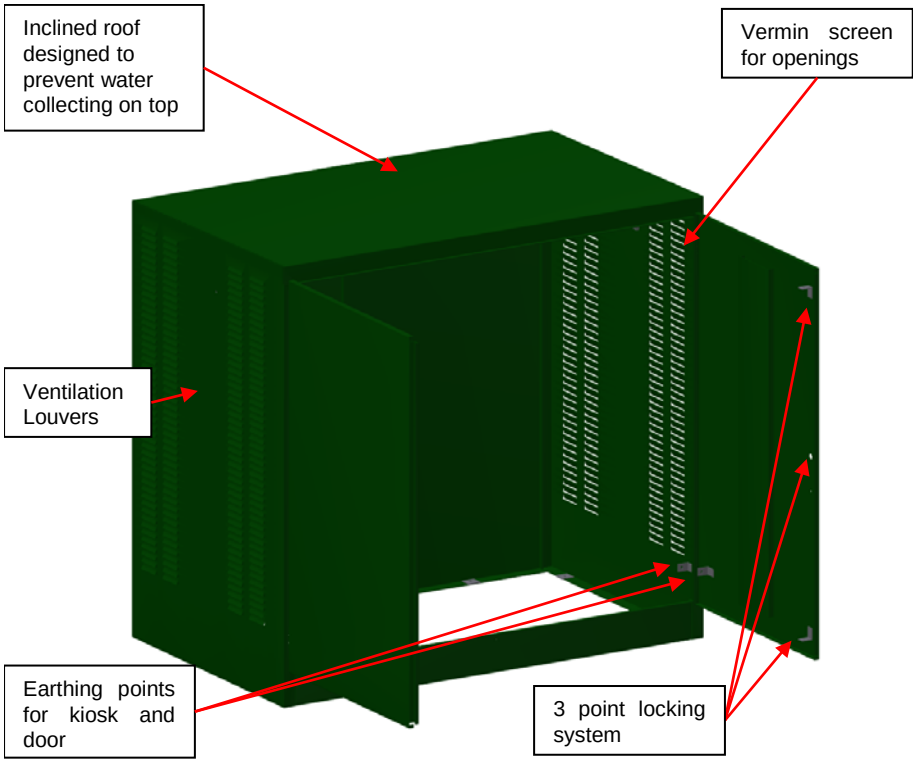
The Vendor must nominate the Clause and provide details of information requested:

CLAUSE NO	ADDITIONAL INFORMATION

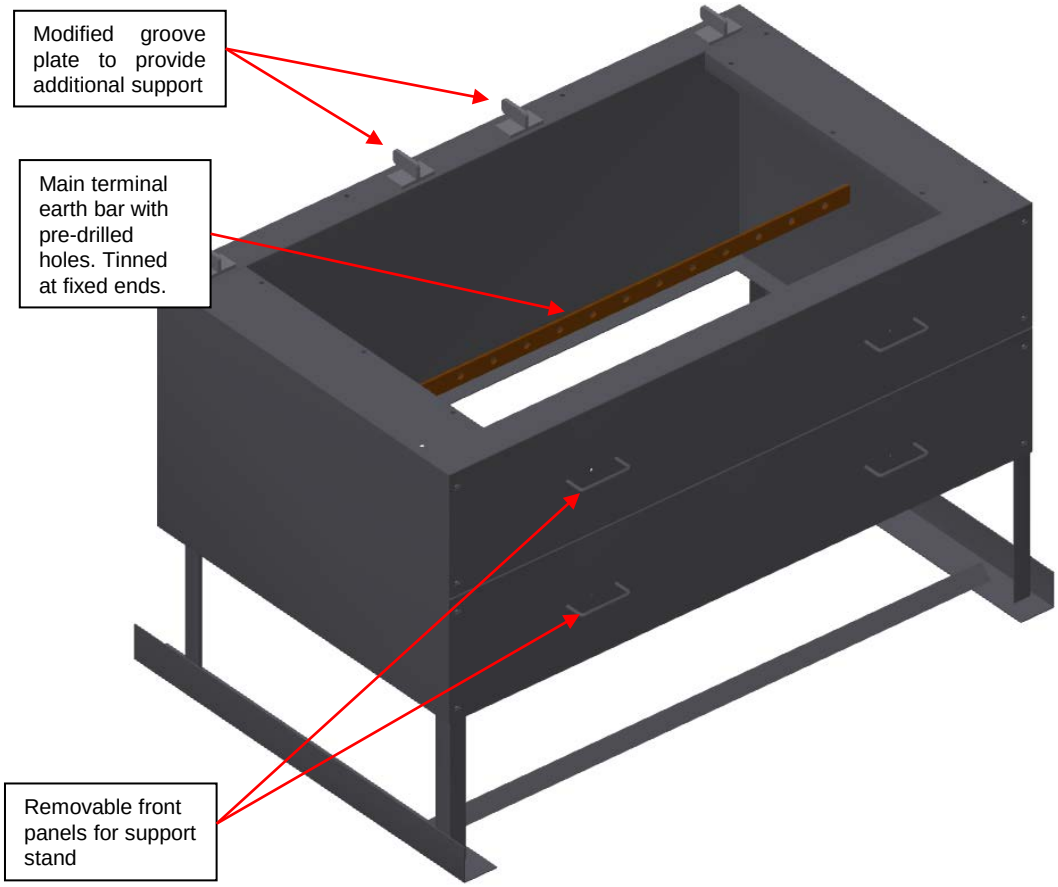
APPENDIX I RMU AND SUPPORT STAND DRAWINGS



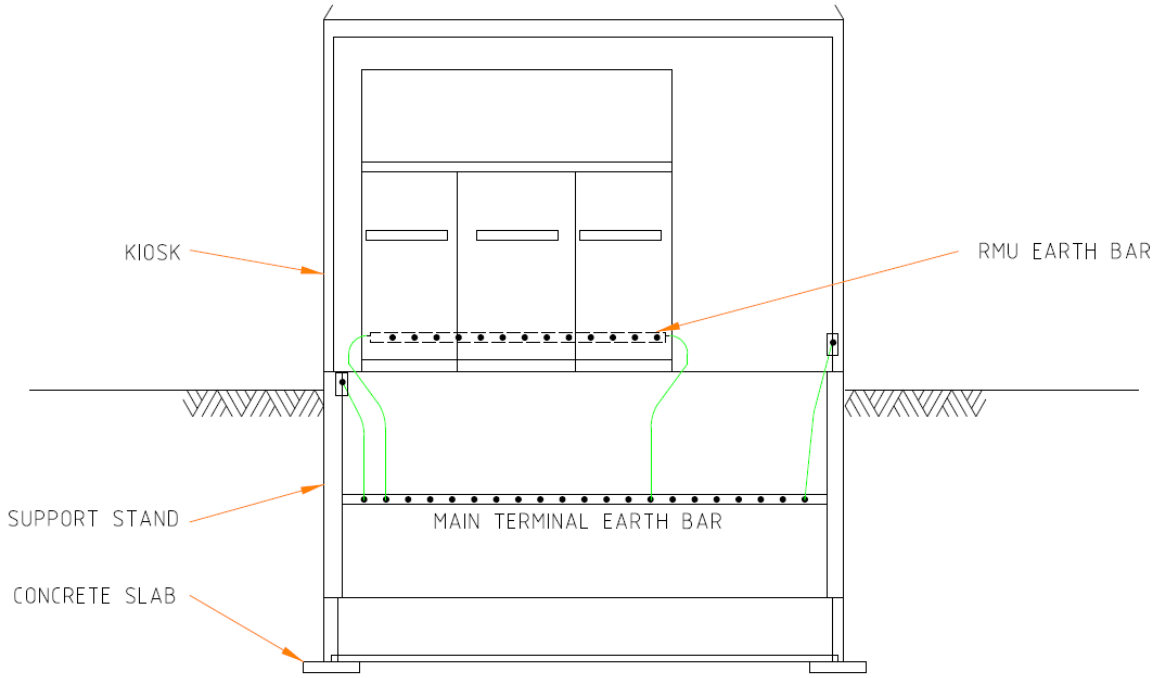
Drawing I1: Exploded view of RMU enclosure



Drawing I2: Typical kiosk design



Drawing I3: Typical support stand design



Drawing I4: Earth Connection on RMU

Legend:	
	70 mm² /150 mm² (See Section 4.13 for details) Gn/Y Cu Cable to be supplied by Vendor.