High Voltage Customer Network Access Standard

UE-ST-2008.4

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1. Introduction

This document provides the minimum technical requirements for the equipment and installation of high voltage (HV) customer connections to United Energy's (UE) high voltage distribution or sub-transmission network. This document has been prepared based on current network conditions & industry standards and is subject to change.

An information pack for new and existing HV customer connection is available from UE's website at the following URL:

https://www.unitedenergy.com.au/hv-customer-connections/

1.1 Purpose of document

The purpose of this document is to provide new and existing HV Customers with information about their obligations and the technical requirements for connecting to and interfacing with the UE HV distribution and sub-transmission networks.

1.2 Scope

This document applies to HV Customer connections to the UE network at 6.6kV, 11kV, 22kV and 66kV including:

- new HV Customer connections
- modifications to existing HV Customer connections
- temporary HV Customer connections

Typically, connections with a maximum demand greater than 10MVA may be required to connect at 66kV.

There are additional technical requirements if the HV Customer connection includes embedded generation. The technical details for embedded generation capacities < 5 MVA are included in the High Voltage Embedded Generation Network Access Standard (UE-ST-2008.3). Please refer to the National Electricity Rules (NER) chapter 5 for embedded generation capacities ≥ 5 MVA.

1.3 Customer Obligations

UE has developed this standard to meet its obligations to ensure the safe and reliable operation of the HV distribution network for operating personnel, customers, and the general public.

The obligations of HV Customers are to:

- comply with the technical requirements as well as relevant national standards, industry codes, legislation and regulations. In the event of inconsistency, legislation and regulations shall prevail, followed by the technical requirements detailed herein, followed by national standards and industry codes
- not connect additional load or make modifications to existing approved HV installations without prior written agreement with UE
- comply with the UE's connection agreement
- maintain the HV installation in good order such that any malfunction should not create a hazard or cause interference to UE's network. This shall include maintaining the installation's earth system to ensure safe touch and step potentials
- ensure that the HV installation complies with the current Victorian Service and Installation Rules
- submit an application form UE-FM-2930.4 to UE for all new and proposed modified installations and ensuring that all UE requirements are complied with. This form can be found on the Information Pack – HV Customer Connections page on UE's website at https://www.unitedenergy.com.au/partners/hv-customers
- comply with the requirements of the current Victorian Electricity Distribution Code

1.4 UE HV Connection Assessment Considerations

The following items, as a minimum are considered at each stage of the Connection Enquiry and Application to Connect process:

- Network safety, security, stability and reliability
- Any need to refer the connection proposal to AEMO or another Distribution Network Service Provider (DNSP)/Transmission Network Service Provider (TNSP) potentially impacted by the connection.
- Infrastructure and commercial demarcation and crossover, especially when multiple jurisdictions are involved
- Network infrastructure availability, capability, and capacity to facilitate the connection including:
  - Network protection requirements
  - Network infrastructure thermal capacity
  - Network voltage control
  - REFCL requirements
  - HV fault level contribution
  - Power factor of HV load
  - Power quality impacts of HV load
  - HV installation operating profile
- Network augmentation (i.e. infrastructure upgrade) likely to be required to facilitate the connection and the applicable commercial model such as contestability, construction, ownership, the classification of services provided and associated cost
- Network scope of work delivery timeframe
- All other suitable considerations unique to the connection
- Compliance to Victorian Service and Installation Rules
- Compliance to Victorian Electricity Distribution Code
- Compliance to Chapter 5/Chapter 5A of the NER
- Compliance with this document
- Existing and in-progress connection applications at the relevant network location

2. Definitions and Abbreviations

2.1 Definitions[1]

Connection agreement	A legally binding document between UE and the proponent stipulating the commercial and technical terms of the HV installation's connection.
Customer	*A person who:* *1 engages in the activity of purchasing electricity supplied through a transmission system or distribution system to a connection point; and* *2. is registered by AEMO as a Customer under Chapter 2.*
Distributed Energy Resources (DER)	Power generation or storage units that are connected directly to the distribution network
Embedded generating unit	*A generating unit connected within a distribution network and not having direct access to the transmission network*
Embedded generating system	A system comprising of multiple embedded generating units
Generating unit	*The plant used in the production of electricity and all related equipment essential to its functioning as a single entity.*
Generation	*The production of electrical power by converting another form of energy in a generating unit*
High voltage (HV)	*A voltage greater than 1 kV*
HV Customer	A *Customer*, who has a high voltage supply, and who shall have the following agreements in place: • an electricity supply contract with a Retailer • an agreement with a Metering Coordinator • an electricity distribution connection agreement, contract or deemed electricity distribution contract and who may have the following agreements if applicable: • demand agreement • reserve supply contract
HV embedded generation connection	A connection between a distribution network and a retail proponent's premises for an embedded generating unit, for which an offer in accordance with Chapter 5/Chapter 5A of the National Electricity Rules has been agreed

[1] Definitions in italics are consistent with the definitions under the National Electricity Rules

HV incomer	The final span or section of UE high voltage overhead or underground network that is connected to the *Customer's* incoming switchboard.
Inverter energy system	A system comprising of one or more inverters together with one or more energy sources (which may include batteries for energy storage), and controls, which satisfies the requirements of AS/NZS 4777.1:2016 and AS/NZS 4777.2:2020.
Low voltage	A voltage less than or equal to 1 kV, and the voltage most commonly used in by residential, commercial and light industrial *Customers* (typically 230V)
Point of connection	Agreed operational boundary between HV Customer and United Energy. Typically, this is: • the load side terminals of the UE overhead isolation switch connecting to the customer's supply cable • load side of the UE Circuit Breaker or ring main unit (switchgear) connecting to the customer's supply cable
Single Wire Earth Return	Parts of the UE electrical distribution network that use a single live high voltage conductor to supply single-phase or split-phase electric power with higher network impedances, and with distribution supplying low voltages to premises
Standard connection service	*means a connection service (other than a basic connection service) for a particular class (or sub-class) of connection applicant and for which a model standing offer has been approved by the AER.*
Technical requirements document	The document produced by each Distribution Network Service Provider setting out their requirements for Customers to enable a network connection, to which these guidelines apply (this document).

2.2 Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AS/NZS	A jointly developed Australian and New Zealand Standard
ATS	Automatic Transfer Switch
CB	Circuit Breaker

CBD	Central Business District
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
EG	Embedded Generation
ESS	Energy Storage System
HBRA	Hazardous Bushfire Risk Areas
HV	High Voltage
IEC	International Electrotechnical Commission
IES	Inverter Energy System
LV	Low Voltage
MTS	Manual Transfer Switch
NCC	Network Control Center
NEM	National Electricity Market
NER	National Electricity Rules
NMI	National Metering Identifier
NVD	Neutral Voltage Displacement
POC	Point of Connection
REFCL	Rapid Earth Fault Current Limiter
ROCOF	Rate of Change of Frequency
RMU	Ring Main Unit
SCADA	Supervisory Control and Data Acquisition
SIR	Service & Installation Rules 2014 incorporating Amendment 2 – July 2019 (A2)
SWER	Single Wire Earth Return
TFB	Total Fire Ban

2.3 Terminology

The following terminology has been used in this document:

- The word “shall” indicates a mandatory requirement
- The word “should” indicates a requirement that whilst not normally mandatory, may be imposed on the HV Customer based on connection-specific safety and/or operational requirements
- The word “may” indicates a recommendation that will not be mandatorily imposed on the HV Customer

3. Relevant Rules, Regulations, Standards and Codes

3.1 Standards and Codes

This section lists Australian and international standards and industry codes which shall apply to the design, manufacture, installation, testing and commissioning, and operation and maintenance of all plant and equipment for HV installations connected to the UE network. The latest version of the Australian and international standards and industry codes shall be used. Note this list should not be considered exhaustive.

In the event of any inconsistency between Australian and international standards, industry codes and UE's technical requirements, the following order of precedence shall apply:

1) UE technical requirements

2) Industry codes

3) Australian standards

4) International standards

Table 1: Applicable Standards and Codes

Standard	Title
AS 2067	Substations and high voltage installations exceeding 1 kV a.c.
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3010	Electrical installations – Generating Sets
AS/NZS 3011	Electrical installations – Secondary batteries installed in buildings (all parts)
AS/NZS 60479	Effects of current on human beings and livestock (all parts)
AS 61000	Electromagnetic compatibility (EMC) (all parts)
AS/NZS 1026	Electric cables - Impregnated paper insulated - For working voltages up to and including 19/33 (36) kV
AS/NZS 1429.1	Electric cables - Polymeric insulated – For working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV
AS/NZS 1429.2	Electric cables - Polymeric insulated – For working voltages above 19/33 (36) kV up to and including 87/150 (170) kV
AS 61869	Instrument transformers (multiple parts)
AS/NZS 60076 AS 60076	Power transformers (multiple parts)
AS/NZS 60947 AS 60947 AS/NZS IEC 60947	Low-voltage switchgear and controlgear (multiple parts)
IEC 60255	Measuring relays and protection equipment (multiple parts)
AS 62271 AS IEC 62271 IEC 62271	High-voltage switchgear and controlgear (multiple parts)
IEEE 400.2	IEEE Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) (less than 1 Hz)

3.2 Legislation and Regulation

HV Customers shall comply with all relevant legislation and regulations applicable to the design, manufacture, installation, testing and commissioning, and operations and maintenance of plant and equipment connected to the UE network. The latest versions of the legislation and regulations shall be used.

In the event of any inconsistency between legislation and regulations and UE's technical requirements, legislative and regulatory requirements shall prevail.

Table 2: Applicable Legislation and Regulations

Document Title	Description
National Electricity Rules Chapter 5	Network Connection, Planning and Expansion
National Electricity Rules Chapter 5A	Electricity Connection for Retail Customers
Victorian Electricity Distribution Code	Regulates the distribution of electricity, connections to distribution networks, and the transfer of electricity between distribution systems so that they are undertaken in a safe, efficient, and reliable manner
Victorian Service and Installation Rules	Provides industry agreed technical requirements that meet all legislative and code requirements for the supply and metering related aspects of any connection to the Victorian electricity supply networks. Where the Customer connection is located in areas with rapid earth fault current limiter (REFCL) deployment, the HV installation shall also comply with the REFCL-related requirements stipulated in the Electricity Distribution Code and Victorian Service and Installation Rules. REFCLs are currently installed in UE's Frankston South, Dromana and Mornington substations. Customers affected shall confirm with UE the applicability of REFCL related requirements to their HV installation.
Victorian Electrical Safety (General) Regulations 2019	Provides details on regulatory obligations for electricity installation works in Victoria part-superseding the requirements set down in the Electricity Safety (Installations) Regulations which were revoked in 2019
Victorian Electricity Safety (Registration and Licensing) Regulations 2020	Provides details on regulatory obligations for the registration of electrical contractors and the licensing of electrical workers in Victoria part-superseding the requirements set down in the Electricity Safety (Installations) Regulations which were revoked in 2019
Code of Practice on Electrical Safety for Work on or Near High Voltage Electrical Apparatus ("The Blue Book")	Owners and operators of the electricity supply network, high voltage electrical installations and complex electrical installations are required to comply with the Blue Book.
Professional Engineers Registration Act 2019	All states and territories are responsible for statutory registration of engineers. Statutory registration ensures engineers meet professional conduct, education, training and competency standards. Professional engineers must register in each jurisdiction where they plan to practice

3.3 HV Customer Responsibilities

HV Customers shall ensure that only service providers who are suitably qualified and registered are engaged to carry out work on their assets, and that only Authorised Persons are employed for Authorised Work. The HV Customer shall ensure that their HV installation is designed, constructed, commissioned, tested, operated and maintained in accordance with the above standards, legislation, regulations, codes, the Connection Agreement and this document.

The Victorian Electricity Distribution Code obliges customers to inform UE as soon as practicable of any circumstances that would result in the following:

- a proposed change to wiring or plant or equipment in the HV Customer's electrical installation which may affect the quality of the supply of electricity to any other person
- a change to the major purpose for which the electricity is used at the HV Customer's supply address
- a change affecting access to a UE's equipment located at the HV Customer's supply address
- a major change to the amount of electricity likely to be used at the HV Customer's supply address.

Furthermore, the Victorian Electricity Distribution Code obliges Customers to provide technical information of the HV installation in response to UE's reasonable requests. This information is required as part of UE's ongoing obligation to plan, operate and maintain its distribution network in accordance with the National Electricity Rules. The information requested may include but not be limited to:

- the location of load in the distribution system
- existing loads
- existing load profiles
- changes in load scheduling
- planned outages
- forecasts of load growth and/or long-term reduction
- anticipated new loads
- anticipated redundant loads
- any information UE may reasonably require in connection with its operation of a REFCL

HV Customers shall also perform the following duties:

- Advise UE promptly of any proposal to transfer ownership of the HV installation to another entity, and ensure its obligations per this document are transferred to the new owner in their entirety
- Disconnection/decommissioning – subject to the terms of applicable connection agreement/s, the HV Customers shall give timely notice to UE of an intention to vacate any premises that host HV plant and equipment, and/or to disconnect/decommission an HV installation. HV Customers shall cooperate with UE to implement a plan that shall ensure the safe decommissioning and disconnection of the HV installation.
- When planning modifications to an HV installation that would vary the operative conditions of the applicable connection agreement, submit applications for approval of such modifications to UE in a timely manner.
- Develop and maintain up-to-date safety and operating procedures for the HV installation according to the requirements of the Blue Book
- Maintain up to date single line diagram and other documentation of the HV installation
- Maintain protection equipment on the HV incoming supply and ensure adequate protection grading with UE at all times. This shall include augmenting protection and/or amending settings as reasonably requested by UE to align with UE network changes or upgrades. The HV Customer shall cooperate with UE to upgrade/modify the protection in a timely manner, in accordance with a timeline reasonably required by UE.
- Maintain up-to-date records of as-built protection schemes and associated settings, particularly including:
  - protection settings for incoming HV supply CBs and any other devices that may have a direct impact on the UE network and its operations
  - configuration details of incomer and generator auto-transfer schemes
- Undertake preventive maintenance as per equipment manufacturers' recommendations and site-specific requirements of HV switchgear, controlgear, protection devices and associated equipment to ensure necessary functionality is maintained
- Undertake corrective maintenance and rectify any defects or non-compliance of the HV installation in a timely manner such that any malfunction shall not create a hazard to or interfere with operation of the UE network.
- Allow access without delay to the HV installation by UE personnel upon UE's reasonable request. UE personnel may require access as part of planned or unplanned maintenance, and under emergency conditions in order to preserve life or the safety and security of equipment on its network.
- Appoint a responsible person as the single point of contact to liaise with UE in the provision of information and coordination of access and other operational activities at the HV installation and advise UE of 24/7 contact details of the responsible person. HV Customers shall inform UE of any permanent or temporary changes to this appointment and contact details (e.g., when the responsible person takes leave of absence) contemporaneous with the changes taking effect.

- Provide to UE and maintain a list (including contact details) of all HV operators that are qualified to perform Authorised Work within the HV Customer's installation. The HV Customer shall ensure that HV operators are available in a timely manner to assist UE with any emergency operational issues.
- Design, construct and maintain substation earthing systems such that earth potential rises, and step and touch potentials under all reasonably foreseeable conditions are not hazardous to people, plant or equipment, and are compliant with AS 2067 and AS 60479.

4. Connection Enquiries and Applications

The Information Pack – HV Customer Connections[2] available on UE's website provides details of the process to be followed, and forms and checklists to be used when HV Customers make Preliminary Enquiries or submit Connection Applications to connect HV installations to the UE network. All applications and submissions shall be submitted via email to UE's application portal at HVCustomer.Projects@ue.com.au.

Applicants should complete and submit the forms relevant to the stage of the process, complete with the required supporting information and fees (where applicable) to enable UE to make a full and objective assessment within the timeframes prescribed by the NER. Incomplete applications will not be fully assessed until such time as the missing information has been provided by the Applicant. UE will respond by identifying the missing information and a deadline for its submission to allow the assessment to proceed. UE will acknowledge receipt of enquiries and applications it considers to be complete.

Whilst there is no charge to make a Preliminary Enquiry, UE's response to a Customer's Preliminary Enquiry will include details of the estimated fees and charges that UE would impose to fund its assessment of a formal Application to Connect.

Upon completion of its assessment of a successful Application to Connect, UE will propose a Connection Agreement to the Applicant that would detail the technical, programme, and commercial conditions applicable to the establishment and maintenance of the connection. In the event that UE's assessment identifies that network augmentation works would be required to accommodate the HV connection, UE would also provide a separate quotation to the Applicant detailing the scope of the works and the cost of the non-contestable works required to augment UE's network.

[2] https://www.unitedenergy.com.au/partners/hv-customers

5. Technical Requirements

This section details the technical requirements for HV Customer connections.

5.1 Labelling and Signage

The labels and signage on the installation, including cables, shall be as per AS 2067:2016 and AS/NZS 3000:2018. Site specific labelling for additional energy sources and operating procedure/s for all energy sources shall be installed at each isolation point that has a possibility of energy feedback from other sources.

5.2 Network Connection and Isolation

Network connection and isolation requirements shall be as per the following:

- Complies with the Victorian Electricity Distribution Code
- Complies with the Victorian Service and Installation Rules 2014 incorporating Amendment 2 (A2)
- Operation, ownership and responsibility for protection and control schemes downstream of the POC including the HV incoming circuit breaker shall reside with the HV Customer

All assets upstream of the POC in the UE network are owned and operated by UE.

5.3 Earthing

Earthing requirements shall comply with AS 2067:2016, AS/NZS 60479.1:2010 and AS/NZS 3000:2018. HV Customers shall ensure that the earth grid potential rise, and step and touch potentials within its installation are maintained at safe levels under all operational conditions.

The HV Customers' earthing systems shall be independent of UE's network earthing systems and shall not be bonded to it. The earth screens of HV incomer cables are typically bonded to the UE network at the UE end of the cable (e.g., at UE zone substation, RMU, or cable head pole). The HV cable screen at the HV customer end will be insulated from the customer's HV installation and earthing system.

Some UE zone substations have neutral earthing resistors installed. System normal conditions are considered to be when neutral earthing resistor is in service. However, neutral earthing resistors will typically be out of service for maintenance on average one day in every four years, during which time, the HV phase to earth fault level at the HV Customer POC will be increased. The design of the earthing systems shall consider the increased risk factors and hazard to personal during such periods.

5.3.1 Earthing System Study

HV Customers shall perform an earthing system study and shall provide a report as part of the Application to Connect. The earthing system study report shall include as a minimum, assessments of the following:

- Earth grid potential rise, step and touch potential assessments as per:
  - Design assessment process provided in AS 2067
  - Design assessment using reputable software in accordance with AS or IEC standards or equivalent

5.4 HV Incoming Cable

HV incoming cables shall be polymeric cables conforming with the parts of AS/NZS 1429 appropriate to the network voltage at the POC.

HV Customer shall supply, install, test and commission the HV incoming cable and make it available for UE to terminate at the POC. Following energisation of the connection and commencement of operations of the HV Customer installation, the POC will be the operational boundary between the HV Customer and UE.

5.5 Switchgear and Control Gear

HV switchgear and control gear within the HV installation shall comply with all relevant standards, codes, legislation and regulations listed in section 3.

Switchgear shall have making, breaking and through-fault current capabilities appropriate to the location of the HV installation within the UE network. UE will provide the system normal 3 phase and single phase to ground fault levels at the HV Customer POC, that being the fault current contributions from the UE network. Any fault current contribution from other sources within the HV Customer's installation shall be calculated by the HV Customer.

Maximum distribution system fault levels permitted by the Electricity Distribution Code are provided in Table 3 below.

Table 3: Distribution System Maximum Fault Levels

DISTRIBUTION SYSTEM FAULT LEVELS		
Voltage Level kV	**System Fault Level MVA**	**Short Circuit Level kA**
<1	36	50.0
6.6	250	21.9
11	350	18.4
22	500	13.1
66	2500	21.9

Source: Electricity Distribution Code, Table 5

Switchgear shall be capable of operating without damage under the steady-state and transient voltage conditions detailed in Table 4 below:

Table 4: Nominal Voltage Variations

<table>
<tr><th rowspan="2">Voltage Level kV</th><th colspan="3">Range of Permissible Voltage Variation for Specified Time Periods</th><th rowspan="2">Impulse Voltage Withstand Level kV peak</th></tr>
<tr><th>Steady-state</th><th>< 1 min</th><th>< 10 s</th></tr>
<tr><td rowspan="2"><1</td><td colspan="3">AS 61000.3.100</td><td rowspan="2">6</td></tr>
<tr><td colspan="2">+13%
-10%</td><td>P-E: +50%,-100%
P-P: +20%,-100%</td></tr>
<tr><td>1 - 6.6</td><td rowspan="3">±6%
(±10% rural areas)</td><td rowspan="3">±10%</td><td rowspan="3">P-E: +80%,-100%
P-P: +20%,-100%</td><td>60</td></tr>
<tr><td>11</td><td>95</td></tr>
<tr><td>22</td><td>150</td></tr>
<tr><td>66</td><td>±10%</td><td>±15%</td><td>P-E: +50%,-100%
P-P: +20%,-100%</td><td>325</td></tr>
</table>

Source: Victorian Electricity Distribution Code, Table 1
Note: The voltage range for time periods less than 1 minute and less than 10 seconds do not apply to AS 61000.3.100. P-E means Phase to Earth and P-P means Phase to phase.

UE presently has REFCL installations at the following zone substations:

- Frankston South (FSH)
- Dromana (DMA)
- Mornington (MTN)

HV Customer installations supplied from UE zone substations equipped with a REFCL, either directly, or as a result of network reconfiguration during or following fault events, shall comply with the additional REFCL-related requirements of the Victorian Electricity Distribution Code and Service and Installation Rules.

5.5.1 HV Incomer Circuit Breaker Operation

Prior to attempting to close an incoming HV circuit breaker, the HV Customer shall contact UE's Network Control Centre (NCC) to request permission to close the said circuit breaker.

The HV Customers' incoming circuit breaker/s shall not be permitted to automatically reclose except where otherwise agreed in writing and with special permission of UE. If HV Customers have a critical process or operational requirement to be able to attempt to reclose the incoming circuit breaker automatically, they shall provide details of the requirement and seek permission and approval from UE before implementing the reclose scheme. The HV Customer shall temporarily disable automatic reclosure schemes in response to a direction received from UE NCC if there is an identifiable risk to the security of the network.

Automatic reclosure shall not be permitted following operation of HV Customer's overcurrent or earth fault-based protection.

5.5.2 Interlocks

HV switchgear installations shall have interlocks for each bay between:

- Circuit breaker and disconnector switch
- Disconnector switch and earth switch

If a HV circuit breaker complies with the requirements for disconnecting circuit breakers in IEC 62271 parts 100 and 102, the circuit breaker and its associated earthing switch may be interlocked. If the circuit breaker does not meet this requirement, the circuit breaker and earthing switch shall not be interlocked.

Busbar earthing equipment shall be interlocked with all disconnector switches connected to the same busbar section. Interlocking shall ensure that all disconnector switches are open prior to an earth switch being permitted to close and vice versa.

HV Customers should include interlocks between disconnector switches and earth switches located elsewhere within the HV installation on the same circuits. If the HV Customer chooses not to install interlocks, the Customer shall develop and maintain suitable HV operating procedures to ensure the safe operation of the HV installation, and shall install physical locking facilities in order to reduce the risk of harm due to incorrect operation or human error to as low a level as reasonably practicable. HV Customers shall bear the full responsibility of such HV operational errors and subsequent liabilities.

5.5.3 Line-Side Earth Switch

As described in the Victorian Service and Installation Rules, incoming HV cables shall be capable of being earthed via a fully-rated earth switch located on the supply side of the incoming circuit breaker. The earth switch shall be integral to the high voltage metering installation and may be located either on the line side of the metering cubicle or the line side of the main switch.

In 6.6 kV, 11 kV and 22 kV installations, earth switches shall earth the incoming line directly to ground; earthing via a circuit breaker is not permitted.

UE shall have sole operational control of the line side earth switch, which shall be lockable by UE in either the "OFF" or "EARTHED" positions using operational locks equipped with a 10 mm shackle. Remote operation of the line-side earth switch is not permitted.

5.5.4 Multiple Incoming Supplies

Where a HV Customer installation is supplied by more than one incoming HV supply, the HV Customer shall implement suitable interlocking and control schemes to prevent inadvertent or prolonged paralleling (where approved by UE) of UE's HV supplies. One of the following methodologies shall be implemented by agreement with UE.

5.5.4.1 Manual Break Before Make

- HV Customers shall implement an interlocking scheme that makes it impossible to parallel the incoming HV supplies within the HV installation at any time.
- Load transfers from one HV supply to another within the HV installation shall be via a break before make sequence.

- The HV Customer Authorised Person responsible for operating the HV switchgear shall obtain permission from UE's Network Control Centre prior to any switching. The Authorised Person shall inform Network Control Centre once the process has been completed.

5.5.4.2 Automatic Break Before Make

- HV Customers shall implement an automatic transfer with interlocking such that it is impossible to parallel incoming HV supplies within the HV installation at any time.
- Initiates transfer of load to alternate incoming supply when loss of supply is detected.
- Load transfers from one HV supply to another within the HV installation shall be via a break before make sequence.
- Automatic load transfer schemes shall include the facility to disable the scheme in response to a request from UE Network Control Centre when network operating conditions deem it necessary e.g. when live-line works are being conducted on the relevant HV supply feeders.
- Details on proposed automatic load transfer schemes shall be submitted to UE for approval before being implemented. Unapproved auto load transfer schemes shall not be implemented.

5.5.4.3 Restoration to Normal (make before break)

- A make before break load transfer back to system normal is allowed such that the switching action is completed manually or by a control scheme that automatically completes the switching action in a defined period of time once the scheme is initiated by affirmative operator command (e.g. by operation of two control mechanisms such as separate "enable" and "transfer" pushbuttons). The transfer control scheme shall include interlocking controls that are designed to prevent inadvertent extended duration parallel operation of supplies.
- Sensitive earth fault protection may need to be disabled temporarily during the transfer period. Control schemes shall be implemented to prevent sensitive earth fault protection being disabled for an extended period.
- The HV Customer Authorised Person responsible for operating the HV switchgear shall obtain permission from UE's Network Control Centre prior to commencing the switching sequence. The Authorised Person shall inform Network Control Centre once the process has been completed.
- Details on proposed automatic scheme shall be submitted to UE for approval before being implemented. Unapproved schemes shall not be implemented.

5.6 Protection

5.6.1 General

All protection relays shall be designed, manufactured and tested in accordance with the relevant parts of IEC 60255.

Protection schemes shall be fit-for-purpose, designed specifically for the application and the installation in which they are implemented.

5.6.2 Protection Requirements at HV Point of Connection (POC)

The protection requirements at the POC shall comply with the requirements of the Service and Installation Rules and shall include but not be limited to the following protection functions:

- Inverse time overcurrent
- Inverse time earth fault
- Definite-time sensitive earth fault

Additional protection functions may be required depending on site-specific requirements including high set definite time elements and differential schemes.

Among other things, the purpose of this protection is to ensure that any faults within the HV Customer's installation are automatically isolated from the UE network. Operation of protection shall immediately trip and lock-out a suitably fault-rated circuit breaker e.g. HV incomer circuit breaker. Following a trip, incoming circuit breakers shall not be closed without prior consultation with UE' network control centre.

Protection settings shall be site specific and shall be subject to acceptance by UE.

The design of the protection system shall consider all sources of fault current, both external and internal to the HV Customer's installation.

HV Customers should note that some UE zone substations have neutral earthing resistors installed and shall ensure that earth fault protection is appropriately graded with the neutral earthing resistor in service.

The fault clearance times for both solid phase-phase and single phase to ground short circuits at the network connection point should be less than 150ms. Fault clearance times longer than 150ms shall be subject to negotiation with UE.

UE will specify as part of the Offer to Connect, protection, control and communications equipment that will be required to operate in conjunction with UE assets, for example, protection relays used for line differential protection schemes, remote trip scheme devices. HV Customer shall supply, install, commission (jointly with UE), operate and maintain these assets for the life of the HV installation.

5.6.3 Current Transformers

Current transformers shall comply with the relevant parts of AS 61869. They shall be rated to withstand all expected operating conditions under both steady-state conditions continuously, and transient short-circuit conditions (see Table 3) for at least 1 second. All aspects of CT design shall be fit for purpose and shall be selected to be appropriate for the installation and application.

For general protection applications, CTs shall typically be accuracy class 5P or 10P, with an accuracy limit factor appropriate to the application.

For unit protection applications where differential current measurement of individual phases is required (e.g. unit protection of generators, transformers or busbars, restricted earth fault protection of transformers) higher accuracy class CTs (e.g. PX class) shall be specified to ensure that CT saturation under high current through-fault conditions does not adversely affect protection performance.

For sensitive earth fault (SEF) protection core-balance CTs are preferred where HV cabling installations permit. CT accuracy errors at low magnitudes shall be considered when phase CT are used for SEF protection.

5.6.4 Voltage Transformers

Voltage transformers shall comply with the relevant parts of AS 61869. All aspects of VT design shall be fit for purpose and shall be selected to be appropriate for the installation and application, including the voltage variations and impulse levels specified in the Electricity Distribution Code (see Table 4).

UE recommends that protective VTs should be specified to have the same voltage factor as required by the Victorian Service and Installation Rules Table 9.13-1 for metering VTs, (i.e., 1.2x continuously / 1.9x for 8 h).

5.6.5 Auxiliary supplies

Auxiliary supplies for protection and control schemes shall be uninterruptible supplies. DC supplies with battery back-up is preferred with a back-up supply autonomy of at least 8 hours. The HV Customer shall install suitable monitoring and alarms to detect failure of the auxiliary supplies.

5.6.6 Protection Studies

HV Customers shall perform a protection study which as a minimum shall include the following considerations:

- Detail functional description and control scheme/philosophy
- Protection relay settings selection and coordination with UE assets including coordination and grading graphs
- Monitoring schemes of tripping supply system and other critical assets (HV CB status, UPS status, etc.)
- CT selection and suitability assessment, including:
  - CT class
  - Accuracy limits against the actual connected burden
  - Protection settings justification against the accuracy limit
- VT selection and suitability assessment, including:
  - VT Class
  - Accuracy limits and protection settings justification against the accuracy limit
- Switchgear ratings and suitability assessment

5.6.6.1 Coordination with UE protection-

The following minimum time discriminations shall be maintained with UE's upstream protection devices for the nominal solid phase to phase and phase to ground fault levels at POC.

- 300ms grading for numerical/digital protection
- 400ms grading for electromechanical, analogue electronic protection

Pick-up settings of current-based protection at the HV Customer POC shall be ≤ 90% of the UE upstream device setting.

For the avoidance of doubt, HV Customer protection schemes are not expected to discriminate with UE's live-line work (LLW) or bushfire mode (TFB) HV feeder protection settings.

Note: New HV Customer applications to connect may result in a need for UE to augment equipment and/or modify protection settings in order to accommodate the new HV Customer installation. However, ensuring optimal protection performance on the UE network will take priority.

5.6.6.2 Sensitive earth fault protection

Definite time sensitive earth fault protection on the HV Customer's incoming circuit breaker shall typically require pick up current of 5A and a time delay not greater than 1s.

HV Customers with significant lengths of HV cable located downstream of incoming circuit breaker should assess the risk of sympathetic tripping (as a result of capacitive discharge currents during upstream network earth faults) and consider the application of directional controlled sensitive earth fault protection.

During HV switching (e.g. make before break load transfers) it may be necessary to temporarily disable sensitive earth fault protection to prevent maloperation. The sensitive earth fault protection shall not be disabled for any longer than is necessary for the transfer to be completed and for the HV connection to be stabilised. Re-enabling of sensitive earth fault protection within a short duration after the completion of the transfer sequence shall be automatically monitored and confirmed. Failure of the sensitive earth fault protection to be re-enabled shall result in an alarm that alerts the HV Customer's operators of the condition, who shall inform UE NCC as soon as practicable.

5.6.6.3 Additional Protection for Embedded Generation

HV Customer installations that include generating equipment that might synchronise with the UE network shall include the following:

- Anti-islanding protection shall be included on the main incoming switchboard as close as possible to the POC, to trip all generating equipment that is in operation when the HV incoming supply is lost
- NVD protection shall be included on the main incoming switchboard as close as possible to the POC

HV Customers with synchronised large embedded generation (i.e. non-IES) may require:

- Remote tripping scheme – to allow UE to automatically trip the embedded generators remotely in the event that UE network protection operates

Embedded generation protection requirements can be obtained from UE's HV Embedded Generation Network Access Standard UE-ST-2008.3.

5.7 Operating Voltage

UE will maintain the nominal voltage at the point of connection in accordance with the voltage and limits of variation specified by the Victorian Electricity Distribution Code. It is the responsibility of the HV Customer to maintain voltage at required levels within its HV installation.

5.8 Metering

HV Customers shall install metering installations in accordance with the requirements of section 9.13 of the Victorian Service and Installation Rules.

5.9 Power Quality

HV installations shall comply with the requirements of the Victorian Electricity Distribution Code in all respects including compliance with the AS 61000 series of standards in maintaining voltage at the point of connection. HV installations including large inverter-fed equipment (e.g. large variable speed motors), must demonstrate compliance with the requirements of section 4.4 of the Electricity Distribution Code regarding permissible levels of harmonic currents at the point of common coupling nearest to the HV Customer's point of connection. There may be additional requirements to install PQ meters at the POC for large HV Customer loads. This will be decided on a case by case basis.

5.10 HV Embedded Network

HV Customers shall maintain the voltages of the HV and LV electrical reticulation within their installation as per the Victorian Electricity Distribution Code.

5.11 Technical Studies

Technical studies shall be completed as part of the connection application as per Table 5.

Table 5: Technical Studies Required

Technical Studies	
Power Flow Study	–
Fault Level Contribution Study	–
Protection Study	✓
Power Quality Impact Study (including harmonics, flicker, voltage step change, unbalance)	–
Earthing Study	✓
Dynamic System Studies	–

Symbols are used to denote technical studies requirements, where:

✓ Represents that technical studies shall be required
– Represents that technical studies may be required

As part of the application process, UE shall provide the following network data to enable the proponent to complete the required technical studies:

- network fault levels up to the point of connection
- network model (for complex connections with embedded generation > 5 MVA)
- network protection information for UE assets (e.g. protection settings)
- network equipment information for UE assets (e.g. line and conductor ratings)

Where one or more of the technical studies does not meet the assessment criteria, UE shall provide the HV Customer feedback on components of the submission that require further work. UE will also discuss options for:

- Alternative configurations of the HV installation
- Network augmentation options (and associated cost of network augmentation)

5.11.1 Power Flow Study

The requirement for a power flow study shall be discussed with UE as part of the application process. Typically, a power flow study will be required for larger installations with generation where there may be thermal impacts on UE's distribution network or where there are impacts on the HV Customer's maximum demand.

5.11.2 Power Quality Impact Studies

This study is required for HV installations that include large inverter-fed equipment or fluctuating loads.

5.11.3 Fault Level Contribution Study and Protection Settings Report

A comprehensive protection study is required for all HV installations. Fault level contributions and protection settings shall be included in this study. Please refer to the Information Pack – HV Customer Connections[3] on UE's website for further details of the submission items.

5.11.4 Earthing Study

An earthing study is required if alterations or additions are made to the HV Customer's HV installation. Earthing study is required to assess that the earth grid potential rise, and step and touch potentials within its installation are maintained at safe levels under all operational conditions.

[3] https://www.unitedenergy.com.au/partners/hv-customers

6. Testing and Commissioning for HV Installations

Testing and commissioning of the HV installation shall be undertaken by the HV Customer in accordance with the specified codes and standards, equipment manufacturers' specifications and the technical requirements stipulated in this document. Testing and commissioning results shall demonstrate that the installed HV installation meets the requirements of the connection agreement. Testing and commissioning reports shall be submitted by HV Customers in accordance with the timeline stipulated in the HV Customer Connection Application Form, UE-FM-2930.4.

Tests specified shall be site-specific installation and commissioning tests. Manufacturers' type tests or factory acceptance tests of equipment will not be accepted in place of site acceptance tests.

Prior to commencement of commissioning and testing, HV Customers shall submit the following to UE:

- commissioning plan detailing the test regime for HV Customer's installation
- site-specific inspection and test plan, and samples of inspection and test reports
- based on review of the above, UE may request more detailed test methodologies for certain tests on a case by case basis (e.g. line differential testing, blocking scheme tests)

Pre-commissioning tests shall include, but not be limited to the following:

- Overall integrity:
  - Insulation resistance (IR) and contact resistance test of the complete switchboard.
- Incomer CB – IR and contact resistance test:
  - IR – between phases with CB closed
  - IR – between line and load connection with CB open
  - Contact resistance for each phase (minimum 50 A DC current injection subject to the rating of device under test (DUT) being > 50 A continuous as per IEC 62271-100)
- Metering CT and VT NATA test certificates
- Incomer protection CT and any other CT related to protection interface with UE:
  - IR, winding resistance, ratio, polarity, burden, knee point with assessment of accuracy limit for the actual connected burden
- Incomer protection VT and any other VT related to protection interface with UE:
  - Ratio, polarity
- Incomer protection relay test:
  - Secondary injection pickup and timing test. Minimum 3 points on the curve (IDMT, DT) to be tested for timing
  - Sensitive Earth fault (SEF) to be tested with primary injection
  - Directional control where applied
  - CB Trip function test
  - CB Close blocking test (if applicable)
- Interlock testing:
  - Between CB-DS-ES (i.e. Circuit Breaker-Disconnector Switch- Earth Switch)
  - Bus earth and all disconnector switches if bus earth installed
  - Any other site-specific interlocks that interface with UE supply
- DC supplies – battery charger and batteries:
  - Battery discharge capacity test or Battery impedance test
  - Float voltage measurements
  - DC earth fault detection and measurement
  - Alarms
- Final primary injection test on CT and VT – carried out once all secondary testing is completed, all test links restored and measured at each protection device.
- Earth grid test to verify EPR, step and touch potentials by primary injection testing and measurements.

Within 48 hours of energisation, the following tests shall be performed:

- HV Switchboard power frequency withstand test

- HV incomer cable test (testing shall be conducted according to IEEE 400.2 or equivalent)
  - IR test – each core with remaining cores and earth (i.e. duration 60s)
  - Sheath / screen test IR (i.e. duration 60s)
  - Polarisation index (i.e. duration 10 minutes)
  - Step voltage test (i.e. minimum duration 60s for each step)
  - VLF (very low frequency) test (i.e. minimum duration of 30 minutes)
  - Post-VLF, IR test (i.e. duration 60s)

Post-test documentation shall include the following, with certification being provided on behalf of the HV Customer by an appropriately qualified and authorised person:

- Completed and certified commissioning plan
- Completed and certified Inspection and test plan and reports
- Certificate of Electrical Safety
- HV Clearance Certificate

7. Operations and Maintenance

HV installations shall be operated and maintained to ensure compliance with their connection agreement and all legislation, codes, and/or other regulatory instruments at all times.

The following documentation is to be maintained current at the HV installation in compliance with relevant codes and is to be readily accessible by UE's representatives and ESV (Energy Safe Victoria):

- A single line diagram showing all electrical metering points, protection functions and zone of coverage
- A record of all approved protection settings
- A copy of the approved operating procedures
- Maintenance plan and records

In addition, the HV Customer shall:

- Maintain and operate the HV installation in a safe condition
- Ensure that any changes to the HV installation are performed by qualified, licensed personnel lawfully permitted to perform the work and that the proponent holds a Certificate of Electrical Safety (CES) issued in respect of any of the changes
- Seek UE approval prior to altering the connection in terms of an addition, upgrade, extension, expansion, augmentation or any other kind of alteration, including any changes to protection functions or settings.

If any breach of this technical standard is suspected, UE may undertake an investigation. If the investigation reveals a breach, the proponent shall be required to rectify this breach and pay UE for the costs associated with the investigation and associated works undertaken by UE.

Appendix A: Sample Agreements

Sample agreements associated with HV connections can be obtained from the Information Pack – HV Customer Connections[4] on UE's website.

[4] https://www.unitedenergy.com.au/partners/hv-customers

Appendix B: HV Customer Connection SLD

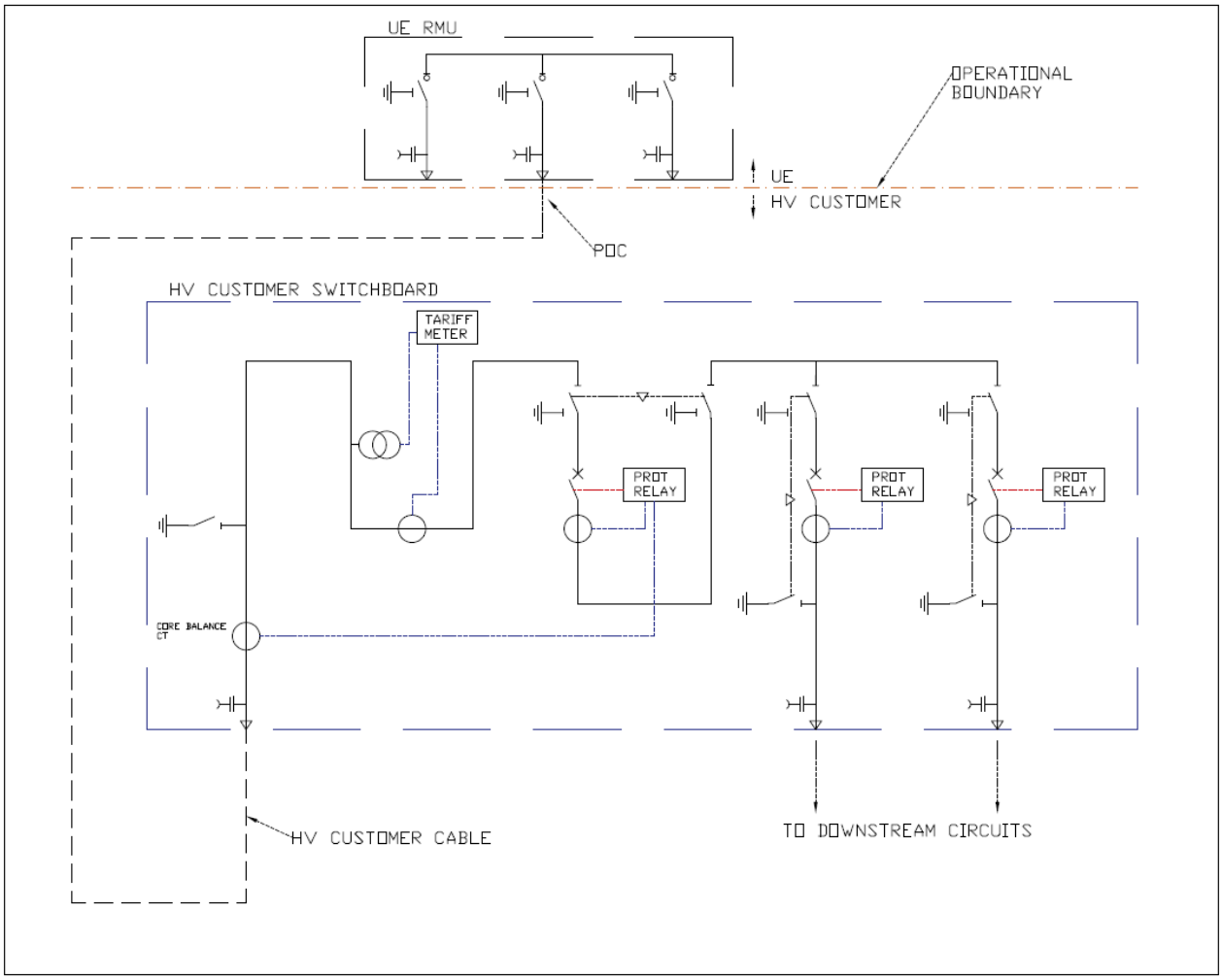


Figure 1: Typical HV Customer Connection SLD

UE-ST-2008.4 HV Customer Network Access Standard

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