Standard: Technical Requirements for Bumpless Transfer of Customer Load between Embedded Generators and the Distribution Network

Standard Number: HPC-9OJ-13-0001-2012

Document Control			
Document Owner		**Approved By**	
Name:	Anthony Seneviratne	Name:	Paul Savig
Position:	Senior Standards Engineer	Position:	Engineering Manager Standards
Date:	18 July 2012	Date:	18 July 2012
Signature:	Digitally signed by Anthony Seneviratne Date: 2012.07.18 12:48:04 +08'00'	Signature:	Digitally signed by Paul Savig Date: 2012.07.18 13:48:45 +08'00'
Authorisation **			
Engineering Services		**Assets & Works**	
Name:	Zlatko Jovanovski	Name:	Brett Hovingh
Position:	Manager Engineering Services	Position:	Manager Assets & Works
Date:	18 July 2012	Date:	18 July 2012
Signature:	Zlatko Jovanovski 2012.07.18 14:26:22 +08'00'	Signature:	Digitally signed by Brett Hovingh Date: 2012.09.18 10:49:39 +08'00'
Date Created/Last Updated		May 2012	
Review Frequency ***		3 Yearly	
Next Review Date ***		May 2015	

** Shall 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.*

**** Frequency period is dependent upon circumstances– maximum is 5 years from last issue, review, or revision whichever is the latest. If left blank, the default shall be 1 year unless otherwise specified.*

Revision Control		
Revision	**Date**	**Description**
0	18/07/2012	Initial Document Creation

STAKEHOLDERS The following positions shall be consulted if an update or review is required:	
Manager Asset and Works	
Manager Engineering Services	
Manager Energy System Planning	

TABLE OF CONTENTS

1 INTRODUCTION

Horizon Power has embarked on a program to facilitate its customers' to reduce their loads on the Distribution Network during peak load periods by connecting Embedded Generation units by Bumpless (seamless) Transfer of load from the Distribution Network to the EG units and from the EG units to the Distribution Network without loss of supply to the customer load.

This document has been prepared to clearly specify the technical requirements to safely carry out this procedure in accordance with legislative requirements, industry standards and Horizon Power's requirements.

This Technical Requirements document follows the principles set out in Horizon Power's "Embedded Generation Connection to Islanded System Network Philosophy" (DM# 3366879)

2 SCOPE

This document is intended to assist Customers intending to operate EG units for Bumpless Transfer of load from the Distribution Network to the EG and vice versa, by specifying the required technical requirements.

This document does not cover continuous (longer than 60 seconds) parallel operation of EG units with the distribution network and export of power to the Distribution Network.

These technical requirements shall provide transparency by explaining the rationale and illustrating the application of the technical requirements when assessing applications for connecting embedded generation for Bumpless Transfer.

3 NORMATIVE REFERENCES

The following documents contain provisions that, though referenced in the text, constitute requirements of these Technical Requirements, but not limited to these documents. At time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. Information on currently valid national and international standards and specifications can be obtained from SAI Global.

Legislation and Standards:

AS 1319:1994 – Safety signs for the occupational environment

AS 1359:1998– General requirements for Rotating Electrical machines

AS 1931.1-1996 – High voltage Test Techniques

AS 2067:2008 – Substations and high voltage installations exceeding 1 kV a.c

AS 2184:1985 – Low voltage switchgear

AS 2344 :1997 – Limits of electromagnetic interference from overhead a.c powerlines and high voltage equipment installations in the frequency range 0.15 to 1000 MHz

AS 2373:2003 – Electric cables

AS 2374.8:2000– Power Transformers

AS 2915:1987 – Solar Photovoltaic Modules – Performance requirements

AS /NZS 3000 – Electrical Installations (Wiring Rules)

AS/NZS 3008 – Electrical Installations – Selection of cables

AS/NZS 3010:2005 – Electrical Installations – Generating Sets

AS/NZS 3017- Electrical Installation – Testing Guidelines

AS/NZS 3100 – Approval and test specification – General requirements

AS/NZS 4509.1:2009 – Stand-alone power systems

AS 4777.1:2005 – Grid connection of Energy Systems via Inverters

AS/NZS 5033 – Installation of Photovoltaic (PV) arrays

AS 60038:2000 – Standard voltages

AS 60034.22-2010 AC Generators for reciprocating Internal Combustion Engines

AS/NZS 60265.1:2001– High voltage switches – Rated voltage above 1kV and less than 52kV

AS 60947.6.2-2004 – Low voltage switchgear and controlgear – Multiple function equipment – Control and protective switching devices (or equipment) (CPS)

AS/NZS 61000 Series – Electromagnetic Compatibility

AS/NZS 7000:2010 – Overhead Line Design Standard

EG-0: 2010 - Power System Earthing Guide Part 1 – Management Principles.

IEC 60255:2009 – Measuring Relays and Protective Equipment

IEC 61400.2:2006 - Design Requirements for small Wind Turbines

Electricity Industry (Network Quality and Reliability of Supply) Code 2005

Electricity Regulations, WA, 1947

Electricity (Licensing) Regulations 1991

ENA Guideline for the preparation of documentation for connection of Embedded Generation within Distribution Networks: May 2011.

WA Electrical Requirements

WA Distribution Connections Manual

4 DEFINITIONS

The definitions and abbreviations below apply:

Active Energy	A measure of electrical energy flow, being the time integral of the product of Voltage and the in-phase component of current flow across a Connection Point, expressed in Watt hour (Wh).
Active Power	The rate at which Active Energy is transferred.
Apparent Power	The square root of the sum of the squares of the Active Power and the Reactive Power.
Bumpless Transfer	The Customer's load is transferred from the Distribution Network to the Embedded Generation or from the Embedded Generation to the Distribution Network, and there is no loss of Supply to the Customer load.
Chartered Engineer	Chartered Professional Engineer (CPEng) Electrical listed on the National Professional Engineers Register (NPER)
Connection Point	The agreed point of Supply established between HORIZON POWER and the Customer.
Customer	A person who engages in the activity of purchasing electricity supplied through the Distribution Network to a Connection Point and who owns, operates or controls an Embedded Generating unit.
Distribution	Network operating at voltages 33 kV, 22 kV, 11 kV, 6.6 kV or 415 V
Embedded Generation (EG)	One or more generating units (actual generator of electricity and all related Equipment essential to its functioning as a single entity) and connected within a Distribution Network and not having direct access to the transmission network. Horizon Power defines Embedded Generation connected to the Distribution Network in accordance with the generation classes as defined by an Electrical Networks Association Guidelines May 2011: • Micro: 1 watt <2kW; • Mini: 2kW<30kW; • Small: 30kW<1MW; • Medium: 1MW<5MW; and • Large: 5MW <~300MW
Equipment	Means a set of devices assembled for the purpose of

	providing power to the Customer's facility.
Frequency Operating Standard Steady State	Horizon Power manages Frequency at the Connection Point within the following limits: • NWIS - 49.75 to 50.25 Hz • other Systems – 49.00 to 51.00 Hz
Frequency Operating Standard Transient Response	Horizon Power manages Frequency at the Connection Point within the following limitations • NWIS - 48 to 53 Hz • other Systems – 45.00 to 55.00 Hz
Low Voltage	415 V
High Voltage	33 kV, 22 kV, 11 kV or 6.6 kV
Inverter	A device that converts direct current to alternating current
Islanded	One or more Embedded Generation Unit(s) operating without a connection to the HORIZON POWER Distribution Network.
Maximum Capacity of the Power System	Maximum recorded Generation (MVA) at the power station supplying the Network during the previous winter.
Net Load	Total load to be supplied from the HORIZON POWER network to the Customer's facility.
Network	The apparatus, Equipment, Plant and buildings used to convey, and control the conveyance of, electricity to Customers (whether wholesale or retail) excluding any connection assets. In relation to HORIZON POWER, a Distribution Network owned, operated or controlled by HORIZON POWER.
NWIS	North West Interconnected System
Plant	In relation to a Connection point, includes all Equipment involved in generating, utilising or transmitting electrical energy.
Power Factor	Is the ratio of Active Power to Apparent Power. Horizon Power's Network has generators capable of being operated with Power Factors in the range of 0.9 leading to 0.8 lagging.
Protection	Equipment that detects and disconnects elements of the power Network in the event of a fault.
Reactive Power (Q)	The energy (measured in VARs) within a Network that is required to support system Voltage to enable the delivery of Real Power to system loads. The Reactive Power produced by the Network connected generators, synchronous condensers and static VAR compensators shall be in balance

	with the Reactive Power demanded by the system.
Supply	The delivery of electricity.
Synchronising	The process of electrically connecting an independent electrical system to the Distribution Network via a synchronising scheme.
Power System	Is the electrical Network of components used to manufacture transmit and consume electrical energy.
Transformer	A Plant or device that reduces or increases the Voltage of alternating current.
Voltage	The electronic force or electric potential between two points that gives rise to the flow of electricity.
Voltage Operating Standard Steady State	Horizon Power manages Voltage at the Connection Point within the following limits: • Low Voltage - ± 6% • High Voltage - ± 10%
Voltage Operating Standard Transient Response	Horizon Power manages Voltage at the Connection Point within the following limits: • Low Voltage - ± 10% • High Voltage – Should attain previous set point (post switching)

5 TECHNICAL REQUIREMENTS

The technical requirements are an essential part of the process for the connection of Embedded Generation to the Distribution Network. All EG connections shall follow requirements to prevent danger to personnel and damage to equipment and property. The EG shall:

- be prevented from back feeding into the Distribution Network if the mains supply is fully or partially de-energised;
- be prevented from connecting when it is out of phase with the energised Distribution Network and be disconnected from the Distribution Network if one or more phases of the Network supply are lost; and
- include protective devices that will, in the event of a short circuit or other fault on EG or Horizon Power network, disconnect the EG from the mains so that it will not be further damaged by large fault currents flowing from the Distribution Network.

The Customer shall provide an Automatic Transfer Switch for Bumpless Transfer of the Customer's load from the Distribution Network to the EG. The Bumpless Transfer shall be either "Rapid Transfer" (when the EG is Synchronised with the Distribution Network for a maximum of one second per event) or "Gradual Transfer" (when the EG is Synchronised with the Distribution Network for a maximum of sixty seconds per event).

The failure of EG protection systems during a fault can cause extensive damage to the EG for which the Customer shall be responsible.

5.1 EG Capacity Limitation

The maximum EG capacity allowable for Bumpless Transfer shall be:

- No greater than 10% of the Maximum Capacity of the Power System; and

- Up to a maximum installed capacity of 1000 kVA with a minimum step load capacity of 25%; and

Only engine driven EG capacity is allowable for Bumpless Transfer.

5.2 Information to be provided by the Customer

The following information shall be provided:

a) The Customer shall provide to HORIZON POWER full information in relation to the design, construction, operation and configuration of the EG as is reasonably required to ensure that the operation and performance standards of the Distribution Network is not adversely affected by the operation of the EG. Details of the information that may be required are included in APPENDIX A.

b) In order to assess the impact of the EG on the operation and performance of the Distribution Network, the EG shall be required to provide data on:
   - Real and reactive power capability of the EG Units; and
   - Flicker coefficients and harmonic profile where applicable, and data on power quality characteristics, including flicker and harmonics, in accordance with AS/NZS 61000 series.

c) Net load data shall be provided in the form of:
   - a typical 24 hour net load curve measured at 15 minute intervals (or better if available); and
   - details of the maximum kVA net load over a 60 second interval, or such other form as specified in the relevant connection agreement.

d) When requested by HORIZON POWER, an EG shall provide details of the proposed operation of the equipment during start-up, shut-down, normal daily operation, intermittent fuel or other variations and under fault or emergency conditions.

5.3 Safety and Reliability

The Customer shall design its facilities in accordance with applicable standards and regulations, good electricity industry practice and the manufacturers' recommendations. The design shall provide minimum safety and reliability standards for the Distribution Network and other customers connected to it.

The safety and reliability of the Distribution Network and the equipment of other customers connected to it shall be paramount and connection applications shall be evaluated accordingly. EGs shall not connect or reconnect to the Distribution Network if the safety and reliability of the Distribution Network would be placed at risk.

Where it is apparent that the operation of EGs installed in accordance with these technical requirements may nevertheless have an adverse impact on the operation, safety or performance of the Distribution Network, or on the quality of supply to other customers connected to it, HORIZON POWER shall consult with the Customer to reach an agreement that may require the Customer to test or modify its relevant Equipment as an acceptable solution.

5.4 Technical Compatibility

The EG shall have technical compatibility with the Distribution Network. The Customer shall ensure that the EG is designed to operate within the Voltage, Frequency and Power Factor limitations as defined in Section 4 “Definitions” in this document. The EG design shall be carried out by persons who are competent in electricity network engineering and the effects of embedded generation sources on the operation of the Distribution Network. The Customer shall provide to Horizon Power a report certified by a Chartered Engineer that the proposed EG configuration, which may include a Transformer(s), conforms with the EG capacity limitations (Section 5.1) and the following detailed criteria to achieve technical compatibility with the Distribution Network.

5.4.1 EG Charateristics

The maximum fault level contribution (in the case of a fault during transfer) from the EG via the Connection point shall not exceed the allowable maximum fault

level at that point as specified by HORIZON POWER, in order to control Distribution Network fault levels.

The Customer shall be responsible for carrying out the required fault level studies.

5.4.2 Circuit breakers

The Customer shall provide a circuit breaker at the Connection point and a separate circuit breaker for each EG unit. Circuit breakers shall be automatically operated, fault current breaking and making types. There shall also be a means of visible and lockable isolation and test points accessible to HORIZON POWER's operational personnel at the Connection point. This may be a withdrawable switch, a switch with visible contacts, a set of removable links or other means approved by HORIZON POWER. It shall be possible for HORIZON POWER's operational personnel to fit safety locks at the isolation point.

Where the Connection point to the Distribution Network is at low voltage level (415V), moulded case circuit breakers and fault limiting fuses with removable links are acceptable for isolation in accordance with this clause.

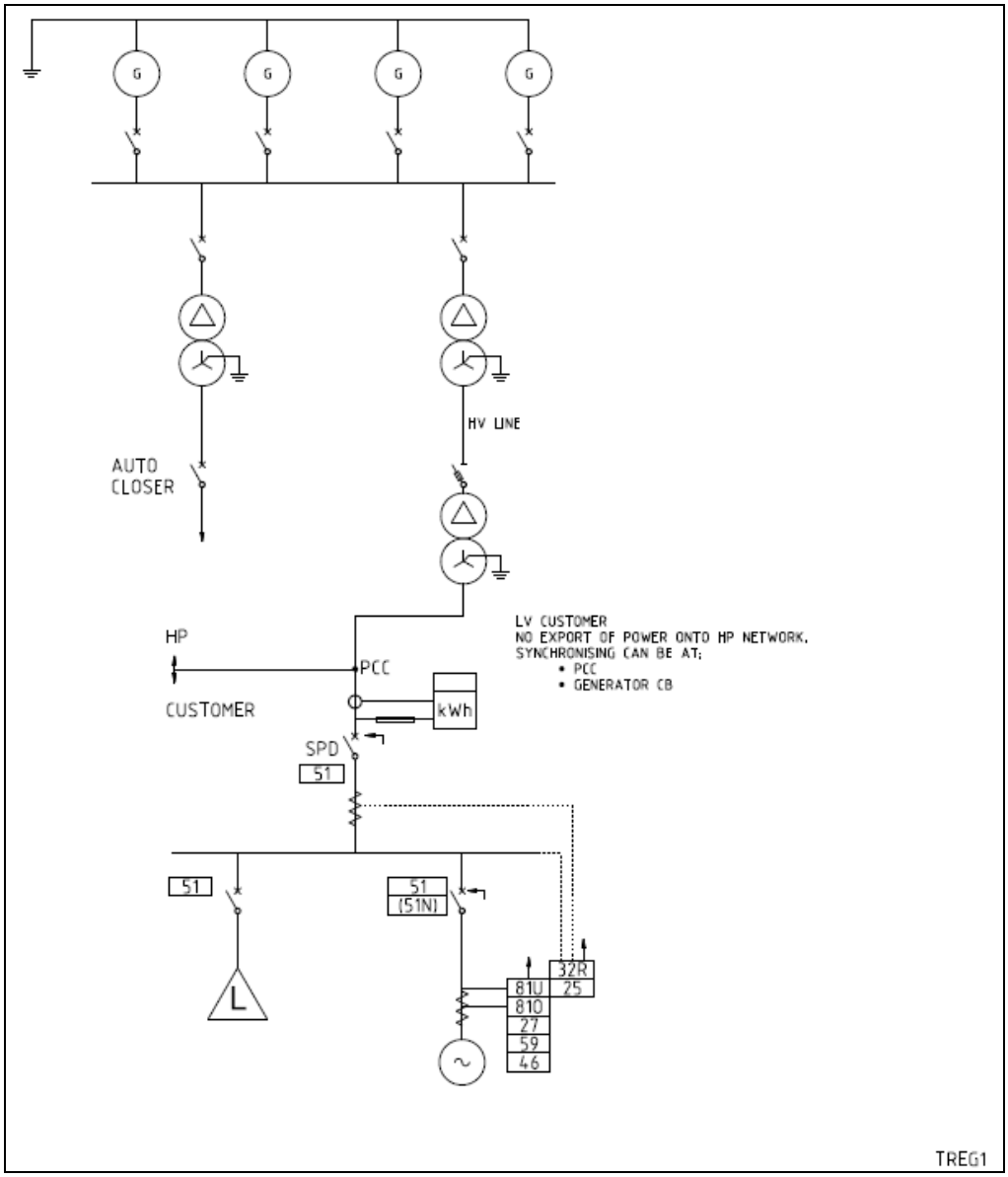
5.4.3 Minimum Protection Requirements

The minimum protection requirements are necessary to protect and limit interference to the Distribution Network and other customers supplied from that network. They are not intended for the protection of the EG itself, which shall remain the responsibility of the Customer. The Customer's Protection shall:

- comply with the IEC 60255 series of standards. Integrated control and Protection may be used provided that it can be demonstrated that the Protection functions are functionally independent of the control functions. i.e. failure or mal-operation of the control features will not impair operation of the Protection;
- clear internal Plant faults and co-ordinate with HORIZON POWER's Distribution Network Protection System;
- ensure that failure of any Protection device cannot result in the Distribution Network being placed in an unsafe operating mode or lead to a disturbance or safety risk to HORIZON POWER's or other customers connected to HORIZON POWER's Distribution Network; and
- be approved by HORIZON POWER.

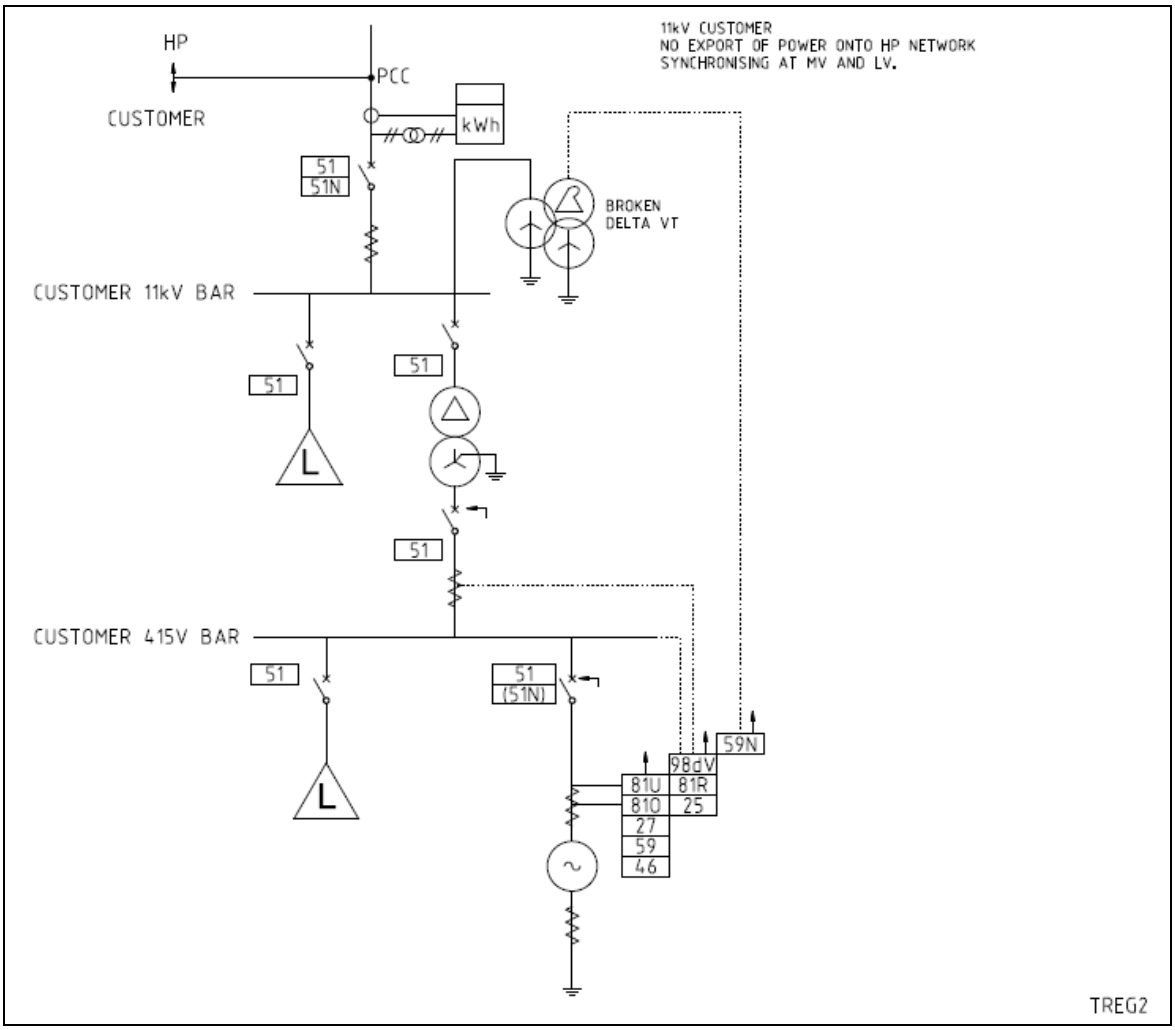
For Bumpless Transfer that is Rapid. (≤ 1 sec), the requirements of sections 5.4.3.2 – 5.4.3.4 are not mandatory when the Connection point is at low voltage (415v) and an Automatic Transfer Switch (Section 5) in compliance with AS 60947.6.2 is installed.

Typical protection arrangement for a Customer connected to HORIZON POWER's distribution network at low voltage is shown in Figure 1 and typical protection arrangement for a Customer connected to HORIZON POWER's distribution network at high voltage is shown in Figure 2.



25	Synchronising check device
32	Directional or reverse power
27	Undervoltage
46	Negative phase sequence
51	Time (IDMT) overcurrent
51N	Time (IDMT) neutral overcurrent
59	Overvoltage
81O	Overfrequency
81U	Underfrequency

Figure 1 – Typical Protection Arrangement for LV Customer



25	Synchronising check device
27	Undervoltage
32	Directional or reverse power
46	Negative phase sequence current
51	Time (IDMT) overcurrent
51N	Time (IDMT) neutral overcurrent
59	Overvoltage
59N	Neutral Voltage Displacement
81O	Overfrequency
81U	Underfrequency
81R	ROCOF (Rate of Change of Frequency)
98	For specific applications when required

Figure 2 – Typical Protection Arrangement for HV Customer

5.4.3.1 *Synchronisation*

HORIZON POWER's Distribution Network circuit breakers are not fitted with synchronising facilities and therefore all synchronising facilities shall be provided within the Customer's facility.

Automatic synchronisation equipment shall be provided at each EG unit circuit breaker; and check synchronising shall be installed on each EG unit circuit breaker and the Connection point circuit breaker; and suitable interlocking arrangements to prevent:

- non synchronised connection to the Distribution Network; and
- connection of the EG in parallel with the Distribution Network unless all phases of the Distribution Network at the Connection point are energised.

Prior to initial synchronisation, the customer and HORIZON POWER shall agree on written operational procedures for synchronisation.

Generator Set/s shall be capable of synchronising within a maximum deviation of:

- 1.5% of both the Voltage amplitude and Voltage phase sequencing of the Distribution Network; and
- 2% of both the Voltage frequency and Voltage phase angle of the Distribution Network

Bumpless Transfer (Rapid or Gradual) is time limited and shall be disconnected by an independent timer if synchronisation fails within this time.

5.4.3.2 *Under/over voltage and under/over frequency Protection*

The Customer shall provide under and over voltage Protection, and under and over frequency Protection at the Connection point and at each EG unit in accordance with Equipment rating.

- The under/ over Voltage Protection shall be set to operate if the Voltage at the Connection point is outside the Voltage Operating Standard – Steady State or the Voltage Operating Standard- Transient Response.
- The under/ over frequency Protection shall be set to operate if the frequency at the Connection point is outside the Frequency Operating Standard – Steady State or the Frequency Operating Standard- Transient Response.

5.4.3.3 *Over current, earth fault and sensitive earth fault Protection*

Bi – directional over current and earth fault protection shall be provided at the Connection point to detect faults on the Distribution Network and the Customer's installation Earth fault Protection. This Protection shall be set to grade with HORIZON POWERs Distribution Network protection schemes.

Over current and earth fault current Protection shall also be provided at each EG to detect faults within the Customer's installation and provide back-up Protection for the Protection installed at the Connection point. This Protection shall also be set to grade with HORIZON POWERs Distribution Network protection schemes.

The Customer shall provide for instantaneous disconnection of the EG during network faults.

Customers connected to HORIZON POWERs Distribution Network at high voltage shall have a sensitive earth fault Protection scheme. The earth fault Protection scheme may be earth fault or neutral Voltage displacement (depending on the earthing system arrangement)

5.4.3.4 Reverse power/ power limit protection

Reverse power or power limit protection shall be installed at the Connection point, where the export of power has not been approved by HORIZON POWER. Where the Customer has agreement with HORIZON POWER for a limited amount of power that can be exported to the Distribution Network, power limit protection shall be installed at the Connection point.

5.4.3.5 Islanding (Loss of mains) Protection

Loss of Mains Protection shall be provided at the Connection point to prevent the EG from supplying power into the Distribution Network when the Distribution Network has been fully or partially de-energised. This Protection against loss of external supply (mains) may be rate of change of frequency (ROCOF), Voltage vector shift, directional (export) power or directional over current or any other method approved by HORIZON POWER that can detect a balanced load condition in an islanded state.

5.4.3.6 Failure of Customer's Protection

Any failure of the Customer's EG Protection devices shall automatically trip the EG unit circuit breaker except, where the affected Protection device(s) form part of a Protection system comprised of two fully independent Protection schemes of differing principle, the failure may instead be alarmed within the Customer's installation provided that operating procedures are in place to ensure that prompt action is taken to remedy such failures.

5.4.4 Labelling

When the Customer's facility has multiple sources of supply, as in the case of one or more EG units and HORIZON POWER's supply Connection point, appropriate labels shall be placed both at the source and at the connection point informing operational personnel of:

- the existence of each supply;
- type of supply;
- point of isolation;
- type and location of the switching device; and
- the priority sequence of each supply.

5.4.5 Earthing

The Customer shall ensure that EG installation has an effective earthing system to limit earth potential rise, touch, step and transfer voltages to acceptable levels as per AS 3000 and AS 2067. Neutral earthing of the EG and any interconnection transformers (if any) shall be designed to suit the requirements of HORIZON POWER and the Customer's facility.

The Customer's earthing system shall be designed such that any earth fault contributions from the EG flowing into the network shall be limited to ensure touch, step and transfer voltages on the network are limited in compliance with EG-0 - Power System Earthing Guide Part 1 – Management Principles.

5.4.6 Power factor

The EG shall be capable of operating within a Power Factor range between 0.95 leading and 0.8 lagging and be able to perform a Power Factor correction that is in equilibrium with the Distribution Network at the Connection point HORIZON POWER requires that under all conditions of real and Reactive power flows, the voltage variation at the Connection point is within ± 0.5% with 4% engine governing.

5.4.7 Power Quality

The Customer shall ensure that the EG operation does not cause harmonics, voltage fluctuation and flicker at the Connection point to exceed the levels permitted by the Electricity Industry (Network Quality and Reliability of Supply) Code.

5.5 Technical matters to be coordinated with HORIZON POWER

5.5.1 Matters to be agreed

The Customer and HORIZON POWER shall agree upon the following matters in respect of each new and altered Connection point.

a) design at Connection point, including isolation and earthing point for HORIZON POWER to isolate the EG when undertaking work on the Network;
b) physical layout adjacent to Connection point;
c) back – up (alternative) supply arrangements;
d) Protection back-up;
e) control characteristics;
f) communications and alarms;
g) insulation co-ordination and lightning Protection;
h) fault levels and fault clearing times;
i) switching and isolation facilities;
j) interlocking arrangements;
k) synchronising facilities;
l) under frequency load shedding and islanding schemes; and
m) testing requirements.

5.5.2 Alternative to HORIZON POWER Distribution Network augmentation

As an alternative to Distribution Network augmentation, HORIZON POWER may require the Customer to provide additional Protection schemes to ensure that the operating limits of the Network are not exceeded.

6 OPERATIONAL, COMMUNICATIONS AND TESTING REQUIREMENTS

To provide an acceptable level of safety of the HORIZON POWER network and the EG, operating procedures, testing and maintenance protocols for ongoing operation must be developed and agreed with HORIZON POWER. HORIZON POWER must approve these prior to commissioning the EG for Bumpless Transfer.

An authorised person must be available at all times when the EG is in operation to receive communications from the HORIZON POWER Network Control Centre so that any emergencies affecting the EG can be urgently attended. The Customer must provide to HORIZON POWER the name and contact information for the person responsible for the operation of the EG.

A secure communication system must be arranged between HORIZON POWER's Network Control Centre and the Customer.

Operating protocols are to be established to identify responsibilities for ongoing operations and maintenance. Operational requirements as agreed shall be written into an appropriate agreement between HORIZON POWER and the Customer.

The duty of ensuring that the operating conditions of the EG are met resides with the Customer. The Customer must develop a compliance monitoring program to demonstrate ongoing compliance with applicable standards and regulations, including but not limited to protection and other equipment maintenance and testing and audit of testing. There must be a system in place to notify HORIZON POWER of material changes to the Customer's system.

Specific requirements for certification, testing and commissioning of EGs are provided in APPENDIX B

APPENDIX A – INFORMATION TO BE PROVIDED BY THE CUSTOMER

A1.EG Facility Details

a) Address
b) Description of facility, for example, is it a green or brownfield site, is there a process steam or heat requirement, any other relevant information
c) Site-specific issues which may affect access to site or design, eg other construction onsite, mine site, environmental issues, soil conditions
d) Number of EG units and ratings (kW)
e) Type: eg synchronous, induction
f) Manufacturer for e) above
g) Connected to the network via: eg, transformer, u/g cable etc
h) Prime mover types: eg reciprocating, turbine, hydraulic, other
i) Manufacturer for h) above
j) Energy source: eg natural gas, landfill gas, distillate, wind, solar, other
k) Total EG capacity (kW)
l) Power station export capacity (kV A) if applicable
m) Forecast annual energy generation (kWh)
n) Normal mode of operation - Bumpless Transfer (rapid or gradual)
o) Power sales, peak lopping, demand management, exercising, emergency back up
p) Proposed arrangement & site layout of the EG including prime movers, generators, transformers, synchronising circuit breakers and lockable disconnect device. Each component should be identified so that the plan can be cross-referenced to the data provided
q) Single line diagram & earthing configuration
r) Details of generator maximum kV A output over 60 second interval
s) A typical 24 hour load power curve measured at 15 minute intervals or less
t) Calculation of expected maximum symmetrical 3 phase fault current contribution
u) Data on power quality characteristics for wind generators (including flicker and harmonics) – if applicable
v) Where required by HORIZON POWER, aggregate data required for performing stability studies

A2.Load Details

a) Expected peak load at facility (kW)
b) Forecast annual energy consumption (kWh)
c) Expected life

A3.Transformer[1] Details (if applicable)

a) Identifier[2]
b) Number of windings (number)
c) Rated KVA of each winding (kVA)
d) Principal tap rated voltages (kV/kV)
e) Positive sequence impedances (each wdg)[3]- (a+jb)%
f) Negative sequence impedances (each wdg)[3] - (a+jb)%
g) Zero sequence impedances (each wdg)[3] - (a+jb)%
h) Tapped winding (text or diagram)
i) Tap change step size (kV/kV)
j) Tap change range (%)
k) Number of taps (number)
l) Tap changer type, on/off load (on/off)
m) Tap change cycle time (seconds)
n) Vector group (text or diagram)
o) Earthing arrangement (drawing)

[1] A separate data sheet is required for each transformer

[2] Where there is more than one transformer, the identifier should be the same as used on the single line diagram

[3] Base quantities shall be clearly stated

A4.Synchronous Generators[4]

a) Identifier[5]
b) Make
c) Model
d) Rated kVA
e) Nominal terminal voltage
f) Number of pole pairs
g) Speed (rpm)
h) Rated kW
i) Minimum Load
j) Inertia constant (H) for generator only (kW-sec/rated kVA)
k) Inertia constant (H) for all rotating masses connected to the generator shaft (for example, generator, turbine, etc). Include gearbox (if any) (kW-sec/rated kVA)
l) Short circuit ratio
m) Neutral earthing impedance[6] (a+jb)%
n) Zero sequence impedance[6] (a+jb)%
o) Negative sequence impedance[6] (a+jb)%
p) Direct axis transient reactance[6] (%)
q) Direct axis sub-transient reactance[6](%)
r) Maximum lagging (overexcited) reactive power at rated kW (kVAr export)
s) Maximum lagging (underexcited) reactive power at rated kW (kVAr import)
t) Lagging reactive short time capability at rated kW, terminal (kVAr for time)
u) Capability chart (indicate effect of temperature and voltage)

[4] A separate data sheet is required for each EG unit

[5] Where there is more than one EG Unit, the identifier should be the same as used the single line diagram

[6] Base quantities shall be clearly stated

A6.Inverter Connected Generators[1]

a) Identifier
b) Make
c) Model
d) Maximum kVA output over a 60s interval
e) Maximum fault current contribution (kA rms symmetrical)
f) Control modes (voltage, power factor)
g) Reactive capability curve
h) Long term flicker factor for generator[37]
i) Long term flicker factor for windfarm[7]
j) Harmonics current spectra[3]
k) Maximum Speed (rpm)

[1] A separate data sheet is required for each generator unit not part of the EG for bumpless transfer

[7] In accordance with IEC 61400-21

APPENDIX B – TESTING AND COMMISSIONING OF EMBEDDED GENERATION CONNECTED TO THE HORIZON POWER DISTRIBUTION NETWORK

B1 Application

This appendix specifies the specific requirements for the certification, testing and commissioning of generating units connecting to the Distribution Network accordance with clause 5.3.

B2 Certification

The Customer shall provide certification by a chartered professional engineer with National Professional Engineers' Register Standing in relevant areas of expertise that the facilities comply with the Technical Requirement in this document, the relevant connection agreement, good engineering practice and relevant standards. The certification shall confirm that the following have been verified:

1. The single line diagram approved by HORIZON POWER has been checked and accurately reflects the installed electrical system;
2. All required switches present and operate correctly as per the single line diagram;
3. The specified generation facility is the only source of power that can be operated in parallel with the Distribution Network;
4. The earthing systems complies with Australian Standards AS 3000 and AS 2067 and do not rely upon the HORIZON POWER Distribution Network earthing system;
5. Electrical equipment is adequately rated to withstand specified network fault levels;
6. All Protection devices (that serves a network protection function, including backup function) complies with IEC 60255 and has been correctly installed and tested. Interlocking systems specified in the connection agreement have been correctly installed and tested;
7. The islanding protection operates correctly and disconnects the EG station from the network within 2 seconds;
8. Synchronizing and auto-changeover equipment has been correctly installed and tested;
9. The delay in reconnection following restoration of normal supply is greater than 1 minute;

10. The protection settings specified in the connection agreement have been approved by HORIZON POWER and are such that satisfactory coordination is achieved with HORIZON POWER's protection systems;
11. Provision has been made to minimise the risk of injury to personnel or damage to equipment that may be caused by an out-of-synchronism fault
12. Systems or procedures are in place such that the testing, commissioning, operation and maintenance requirements specified in the Technical Requirements and the connection agreement are adhered to; and
13. Operational settings as specified.

B2 Pre-commissioning

Commissioning may occur only after the installation of the metering equipment, if any.

B3 Commissioning Procedures

The commissioning of a EG unit shall include the checks and tests specified in clauses B.5 to B l4.

B4 Operating Procedures

• The single line diagram shall be checked to confirm that it accurately reflects the installed plant;

• The documented operating procedures agreed with HORIZON POWER have been implemented as agreed;

• Naming, numbering and labelling of plant agreed with HORIZON POWER has been followed; and

• Operating personnel are familiar with the agreed operating procedures and all requirements to preserve the integrity of the protection settings and interlocks and the procedures for subsequent changes to settings.

B5 Protection Systems

• Protection devices have been manufactured and installed to required standards;

• The settings and functioning of protection systems required for the safety and integrity of the Distribution Network shall operate correctly (at various power levels) and coordinate with HORIZON POWER's protection systems. This shall include the correct operation of the protection systems specified in the connection agreement and, in particular,

- islanding protection and coordination with automatic reclosers export/import limiting protection;
- automatic changeover schemes; and
- fail-safe generator shutdown for auxiliary supply failure or loss of Distribution Network supply; and
- Any required security measures for protection settings are in place

B6 Switchgear Installations

Switchgear, instrument transformers and cabling have been manufactured, installed and tested to required standards.

B7 Transformers

• Transformer(s) has been installed and tested to required standards; and

• Transformer parameters (nameplate inspection) are as specified and there is correct functioning of on-load tap changing (when supplied).

B8 Earthing

• The earthing connections and the design value(s) of earthing electrode impedance are delivered; and

• The earthing systems comply with Australian Standards AS 3000 and AS 2067 and do not rely upon the HORIZON POWER Distribution Network earthing system

B9 EG Units

B9.1 Voltage Changes

• Voltage transients at the Connection point on connection are within specified limits; and

• Step changes in voltage on connection and disconnection (both before and after tap changing) are within required limits.

.***B9.2 Harmonics and Flicker***

Distribution Network flicker and harmonics levels before and after connection to be measured and confirmation that agreed limits have not been exceeded (not required for directly connected rotating machines).

B10 Interlocks and Intertripping

Correct operation of interlocks, check synchronizing, remote control, permissive interlocking and inter-tripping.

B11 Operational Communications

Operational communications systems as per connection agreement.

B12 Signage and Labelling

Signage and labelling comply with that specified in the relevant connection agreement.

B13 Additional Installation Specific Tests

HORIZON POWER may specify additional installation specific tests and inspections in respect of the physical and functional parameters that are relevant for the bumpless transfer operation of the EG and coordination with the Distribution Network.

B14 Routine Testing

• The Customer shall test EG unit protection systems, including backup functions, at regular intervals not exceeding 3 years for unmanned sites and 4 years for manned sites and keep records of such tests.

B15 Non-routine Testing

HORIZON POWER may inspect and test the EG to re-confirm its correct operation and continued compliance with the Technical Requirements, connection agreement, good engineering practice and relevant standards. In the event that HORIZON POWER considers that the installation poses a threat to safety, quality of supply or to the integrity of the Distribution Network, it may disconnect the EG.