REQUIREMENTS FOR INVERTER ENERGY SYSTEM GENERATION WITH CAPACITY OVER 10 KW

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2 PURPOSE

The purpose of this Standard is to outline the technical requirements (including protection and control requirements) for the connection of an Inverter Energy System (IES) with total nameplate capacity of 10 kW or greater to Horizon Network's electricity distribution network.

3 ORGANISATIONAL SCOPE

This Standard applies to an IES with total nameplate capacity exceeding 10kW that is connected to Horizon Networks distribution network.

4 DEFINITIONS

For purposes of this Standard, unless otherwise stated, the following definitions shall apply:

TERM	DEFINITION
Anti-islanding Protection	A protection system that detects Islanding and disconnects the distributed generation from the distribution network.
Active Anti-islanding Protection	A method of preventing islanding by actively varying the output of the inverter. AS/NZS 4777.2 describes three methods.

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Auto-reclose	The automatic reclosure of a circuit-breaker after a predetermined time following a fault tripping.
Centralised Protection	A protection system that coordinates multiple distributed generation units at one site, protects the entire distributed generation system (including Anti-Islanding Protection) and ensures the safety of those conducting work on the network and the public.
Code	The Electricity Industry Participation Code
Distributed Generation (DG)	The output of generating plant that is directly connected to a distribution network without direct connection to the grid and is capable of injecting electricity into that distribution network This includes output from electric vehicles (EV) or battery storage systems that export (inject) electricity into the distribution network
High Voltage (HV)	Any voltage greater than 1 kV
Inverter Energy System (IES)	A generator comprising of one or more inverters, which may include multiple energy sources (e.g., solar generation and/or battery storage).
Islanding	A condition in which a distributed generator continues to power an electrical circuit while that circuit is not connected to external grid power. Such a generator is said to be 'islanded'.
Isolation Device	A device such as a circuit breaker or contactor which safely prevents the flow of current
Low Voltage (LV)	Any voltage lower than 1 kV
Neutral Voltage Displacement (NVD)	Protection element that is used to detect single phase to earth faults on an unearthed neutral network, where the zero-sequence currents are insignificant and are insufficient for conventional earth fault protection to detect the fault. (ANSI code 59N)
Non-exporting generation	Electrical power that is used to offset load [within an embedded network], and that is not exported to a distribution network.
Point of connection	Means a point at which electricity may flow into or out of a network.
ROCOF	Rate-of-change-of-frequency protection.
Synchronised or Synchronising	Synchronised is when electrical power at each of two (or more) points have the same voltage magnitude and frequency and zero phase difference. Synchronising is the act of altering electrical power at one point so that it is synchronised with power at another point, which is to bring those two separated points into synchronism. A generator may be synchronised with a network without being connected to that network.
System Operator	Has the meaning in the Code
Network	This refers to the electricity distribution network owned and operated by Horizon Networks.
Grid	This refers to the national electricity transmission grid owned and operated by Transpower.
Transpower	Means Transpower New Zealand, who owns the Grid and has been appointed as the System Operator.

5 COST

All costs associated with the work required to connect to the Network is the responsibility of the installation owner of IES generation unless otherwise agreed with Horizon Networks.

6 STANDARD

6.1 Health and Safety

To minimise the risk to the general public and contractors carrying out works on the Network, the owners of any new IES connection to the network shall notify, and receive approval from, Horizon Networks, prior to connection.

Contractors involved in the connection or disconnection of IES to or from the Network shall be approved by Horizon Networks and must adhere to the relevant Horizon Networks health and safety standards.

To mitigate the risk of network Islanding and subsequent injury of contractors working on the Network, anti-islanding protection shall be installed as per Clause 6.3.3 unless agreed otherwise as per clause 6.3.3.1.

6.2 General

6.2.1 Inverter Energy Systems

IES connected to the Network must comply with all relevant statutory and regulatory requirements and must comply with applicable safety codes and standards, in particular, the latest versions of AS/NZS 4777.1 and AS/NZS 4777.2, or any revisions thereafter.

This document describes requirements in addition to those mentioned in the AS/NZS 4777 standards, which apply to all IES installations with a capacity over 10 kW. Our requirements may depend on the output of the IES (with common thresholds being 30 kW, 1 MW, and 30 MW) or by the voltage level at the point of connection with the Network.

General requirements are as follows:

- Installations with nameplate capacity >30 kW must incorporate Centralised Protection that is independent of the inverter protection. The Centralised Protection must comply with requirements outlined in Clause 6.3.5.
- Installations with an HV connection point (>1kV):
  - Must consist of Neutral Voltage Displacement protection as outlined in Clause 6.4.3.
  - May require power quality metering (Clause 6.4.4.1)
  - May require SCADA connectivity (Clause 6.4.6)
  - May require network studies (Clause 6.4.7)
- The owner of a an IES with nameplate capacity >1 MW must notify the System Operator (system.operator@transpower.co.nz) before installation. and the system Operator may have additional requirements that apply to such an IES. Any information shared with the System Operator shall also be supplied to Horizon Networks.
- Installations shall have balanced output with a tolerance of <5 kVA phase unbalance.

The generation capacity of an IES is the combined nameplate rating of the generators comprised in that IES without taking into account any export control limitation.

6.2.2 Compliance

All IES installations are subject to the following requirements:

- Installations shall comply with the Code.
- Installations shall comply with the current version of AS/NZS 3000.
- Installations shall have suitable facilities to allow for secondary injection testing.

- Inverters used shall comply with the current version of AS/NZS 4777.2.
- Installations shall comply with the current version of AS/NZS 4777.1.
- Photovoltaic systems shall comply with the current version of AS/NZS 5033.
- Installations shall comply with the current version of the AS/NZS 61000 suite of standards.

See Clause 7 RELATED POLICIES, PROCEDURES AND FORMS for a more detailed list of relevant standards.

6.2.3 Equipment Ratings and Requirements

All the interface equipment at the IES installations facility must be compatible with the equipment ratings of Horizon's assets at the connection voltage (maximum voltage, basic impulse limit, short circuit ratings, capacity etc.) and the incorporation of the added generation facility must not result in any Network equipment operation beyond its operational rating.

6.2.3.1 Network Headroom Capacity

Generation shall only be connected to the Network if the Network has sufficient capacity to support the generation. As such, new IES installations shall not cause:

- Maximum fault current ratings of Horizon equipment to be exceeded,
- Maximum fault current ratings of the Network to be exceeded,
- Maximum thermal ratings of Horizon equipment to be exceeded,
- Network over-voltages.

Changes to the network may be required to accommodate an IES.

The generator shall ensure that the injection into the network from the generator does not exceed the network capacity if there is a total loss of connected load, or that the generator shall immediately reduce output to not overload the network.

Horizon Networks may prohibit the connection of an IES installation where the network cannot support the generation.

6.2.4 Isolation and Curtailing

IES shall be capable of automatically disconnect from the grid under the following circumstances:

- Plant fault
- An excess voltage or frequency deviation
- Loss of grid supply
- Protection failure
- Instability of VA, VAr, V

6.2.5 Physical Access

For installations with an HV connection point, 24-hour safe and unobstructed access to the point of connection shall be provided to Horizon Networks and/or their service providers at all times.

6.2.6 Revenue Metering

All exporting IES installations must have an export meter installed as per the Code Part 10 and shall be Electricity Authority (EA) compliant.

6.2.7 Labelling

Appropriate labelling shall be installed on relevant parts of an IES, including, but not limited to:

- the Isolation Device.

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- For any equipment that is transferred to Horizon Networks, labelling's shall comply with Horizon Networks Standard HEDL.NW.P84

6.2.8 Short Circuit Protection

The requirements for IES short circuit protection systems are not covered in this standard. All installations must comply with AS/NZS 3000, Electricity (safety) regulations, and all other relevant standards.

6.3 Technical Requirements for All Installations

6.3.1 General

The following sections outline further requirements for IES with HV or LV connections, in addition to the requirements in the AS/NZS 4777 standards.

6.3.2 Network Connection and Isolation

6.3.2.1 Isolation

Unless otherwise agreed by Horizon Networks, the IES installation shall only connect to Horizon's Network via a single connection point.

The installation shall include a circuit breaker capable of isolating the installation from the Network. The circuit breaker must be capable of breaking the maximum network fault current. This circuit breaker shall be located at or immediately before the point of connection to the Network.

The installation shall also provide a second means of isolation separate from the circuit breaker that is capable of disconnecting the entire IES from the Network. The means of isolation shall be able to be locked in the open (disconnected) position.

6.3.2.2 Dedicated Transformer

Generally, low voltage connections do not require a dedicated transformer for connection to the network however, in some circumstances Horizon Networks may determine that a dedicated transformer is needed. A dedicated transformer is generally required for a high voltage connection.

6.3.3 Anti-islanding

Except for planned and approved Islanding (as noted below) IES installations must not energize any part of the Network that is disconnected from the Grid.

As per the AS/NZS 4777.2 standard, IES shall disconnect from the Network within two (2) seconds of the Islanding occurring on the Network. The IES shall not reconnect until the supply is cold-restored to the inverters.

6.3.3.1 Planned Islanding

Planned islanding of part of Horizon's network around an installation may be allowed. In this case, the installation owner and Horizon Networks must jointly agree to all requirements in writing before proceeding.

6.3.4 Synchronisation and Reconnection

IES that are compliant with the latest version of AS/NZS 4777.2 are expected to incorporate internal synchronisation facilities to automatically synchronise to the Network. In such cases, no extra provisions for synchronisation are required.

All IES synchronising to the network shall be the responsibility of the IES owner. Horizon Networks will not be responsible for any damage to the IES resulting from out-of-synchronised closing.

The IES owner shall provide and install synchronisation equipment at the generator circuit breaker(s). Synchronism checking shall be provided on all generator circuit breakers and any other circuit breakers, unless interlocked, that are capable of connecting the generator output to the network.

Prior to the initial connection of an IES to Horizon's network, the IES owner and Horizon shall agree on the operational procedures necessary for synchronisation. IES synchronisation facilities shall include both Sync check and Sync blocking capabilities.

Horizon Networks owned circuit breakers shall not (without Horizon's consent) be used for the final connection of the IES to Horizon network (synch closing). Synch closing should be carried out across the IES-owned circuit breaker. However, as part of the safety by design process Horizon will endeavour to configure interlocking on its circuit breaker/s at the point of connection with the Network (where applicable) to prevent inadvertent out-of-synch closing.

Following disconnection from the network, subsequent reconnection to the network shall not be initiated until normal network conditions have been restored and have been present continuously for at least one (1) minute.

6.3.5 Inverter Integrated Protection

All inverters within an IES shall have passive Anti-Islanding Protection in-built as per the latest version of AS/NZS 4777.2. This protection shall be available and activated for all IES installations, and must include the following:

- Over-voltage protection,
- Under-voltage protection,
- Over-frequency protection,
- Under-frequency protection.

All inverters within an IES shall additionally have at least one method of Active Anti-islanding Protection in-built as per the latest version of AS/NZS 4777.2. This is to protect against inadvertent islanding when multiple inverters are providing a frequency or voltage reference, and/or because the load and generation are balanced.

6.3.6 Centralised Protection

All IES installations with a capacity over 30 kW shall include both main and backup Centralised Protection. This complies with AS/NZS 4777.1. Inverters within the IES that are compliant with the latest version of AS/NZS 4777.2 may satisfy the main protection requirements, with the Centralised Protection providing the backup protection.

The Centralised Protection shall be installed at or immediately before the point of connection with the Network and must be upstream of all inverters connected to the installation. This protection is in addition to, and fully independent of, the inverter integrated protection.

The Centralised Protection shall be able to trip the IES circuit breakers (Clause 6.3.2.1).

In addition to the above, all IES installations shall adhere to the protection requirements identified in any network study as outline in section 6.4.7

6.3.6.1 Anti-islanding Protection

The Centralised Protection shall consist of passive anti-islanding protection as per AS/NZS 4777.2 standard, and will include the following:

- Over-voltage protection,
- Under-voltage protection,
- Over-frequency protection,
- Under-frequency protection.

6.3.7 Neutral Voltage Displacement Protection

Generally, neutral voltage displacement (NVD) protection is not required for low-voltage connections. NVD protection may be required if the IES installation is capable of energising the upstream HV network in islanded conditions.

6.3.7.1 HV Network Neutral Earthing

The HV network earth reference for the 11kV network is at the zone substation. The HV network earth reference for the 33kV either is at a Horizon Sub transmission substation or Transpower's GXP.

Horizon does not normally allow other earth references as this may cause malfunctioning of Horizon's network protection. However, an HV earth reference at the IES may be acceptable under certain conditions. Any proposal for multiple earth reference points needs to be covered a 'the 'Network Study (clause 6.4.7).

This requirement does not prevent an IES from having an earth reference within the IES for the purposes of isolating and/or supply of power off the Network.

6.3.8 Power Quality

All power quality measurements and limits in this section will be measured or otherwise determined at the point of connection to the Network.

6.3.8.1 Harmonics

The IES installation shall not cause emission or injection of harmonic currents into the Network greater than the allocations given in the latest version of AS/NZS 4777.2.

At the point of connection, the additional voltage harmonics contribution from the IES installation for each harmonic order shall not exceed 30% of the unused headroom allocated by Transpower at each GXP at the time of submission of the complete final application.

6.3.8.2 DC Current Injection

The IES installation shall not inject Direct Current (DC) onto the network greater than 0.5% of the full rated inverter current.

6.3.8.3 Voltage

The IES installation shall not cause voltage fluctuation or flicker greater than allocations in the latest version of AS/NZS 61000. The nameplate capacity of the generation is deemed to be the load capacity for the purposes of applying power quality standards.

Voltage levels at the point of power system connection shall be kept within limits required by the Electricity (Safety) Regulations (± 5% of the nominal voltage) unless agreed otherwise with Horizon Networks.

The installation must operate within the voltage level variation limits set by the Code and comply with Clause 8.23 of the Code at the point of connection with the Network as though it was a point of connection to the Grid.

The required voltage stability envelope shall be 0.95pu to 1.05pu.

6.3.8.4 Power Factor

The IES installation is required to be capable of adjusting the power factor and shall operate in the preferred range of being above 0.95, lagging or leading.

6.3.8.5 Surge Withstand Capability

The IES installation shall have both oscillatory and fast transient surge withstand capability, in accordance with the latest versions of:

- IEEE/ANSI C62.41 category B3 for interconnections; and
- IEC 60255 for protective functions.

6.3.8.6 Electromagnetic fields

Power generated by an IES must conform with the relevant standards for electromagnetic fields.

6.3.8.7 Radio Interference

Power generated by an IES must conform with the relevant standards for radio interference to other devices.

6.3.9 Control and Reactive Power Requirements

Typically, a solar farm will supply power at a unity power factor, however, all inverters used in IES installations shall have both the Volt-Watt and Volt-VAr response modes available and shall be capable of operating both modes simultaneously. The Volt-VAr response shall be smooth enough to not cause voltage flicker or fluctuations (see Clause 6.3.8.3).

Each inverter shall be capable of being set to Volt/VAR control in accordance with AS/NZS4777.2. This method of control changes the reactive power supply/absorption as a function of the terminal voltage.

6.3.10 Ride-through

The installation shall not disconnect from the Network for momentary voltage sags when the system voltage remains within the no-trip zone during system faults or events, as per the current requirements of the Code Part 8, for the North Island.

To allow for under-frequency ride-through, the setpoint for under-frequency tripping shall not be set higher than 47 Hz.

6.4 Additional Technical Requirements for Installations with High Voltage Connection Points

This section outlines technical requirements that apply to installations with an HV connection point in addition to the technical requirements in Section 6.3.

6.4.1 HV Network Earthing

Additional HV neutral earthing points to Network zone transformers would result in increased earth fault levels and may cause mal-operation of the earth fault protection. No additional HV neutral earthing points are to be connected to the network unless otherwise agreed with Horizon Networks.

6.4.2 Centralised Protection

All installations with a nameplate capacity over 30 kW must consist of an independent Centralised Protection as described in 6.3.6. The below sections discuss further requirements for installations with an HV connection point in addition to those outlined in Section 6.3.6.

6.4.2.1 Protection Systems

The protection systems for IES with a HV connection need to detect and disconnect from the network for both faults in the network and the IES. The faults include but are not exclusive to:

- Phase – Phase faults
- Phase – Earth faults
- Loss of a phase

HV protection systems must be compatible with the Network for this purpose, protection systems will be included in the detailed design considered at the network study phase.

6.4.2.2 Anti-islanding Protection

The IES shall have both passive and active Anti-Islanding protection which will detect loss of grid supply and automatically isolate the IES.

In addition to the passive anti-islanding protection outlined in Section 6.3.6.1, all installations with an HV connection point must include one of the following:

- ROCOF and Vector Shift,
- Communications based inter-trip generated from detection of island formation via upstream circuit breaker open status. Suitability to be assessed by Horizon for approval on a case-by-case basis.

The setting of ROCOF and Vector Shift schemes in a manner that provides adequate protection, while avoiding nuisance tripping, can be difficult. The IES owner must accept that these schemes may trip for disturbances and events both internal and external to the local network that generation is connected to.

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6.4.2.3 Non-Exporting IES Installations

Non-exporting IES installations shall monitor grid reverse power (GRP) and disconnect from the network or appropriately curtail generation if the installation begins exporting.

6.4.2.4 Availability of Protection

All protection elements of an IES installation, included DC supplies and communications, shall be available at all times. Trip circuit supervision shall be installed to continuously monitor the health of the trip circuit.

If any element of the primary protection becomes unavailable, other than for the purposes of maintenance or testing, the installation shall be immediately disconnected from the network.

If a communications link is installed to facilitate an inter-trip, then this shall be continuously monitored for integrity. In the event, the communications link fails the installation shall be disconnected from the network until the link is restored.

6.4.2.5 Protection Equipment

All protection equipment shall comply with the latest version of IEC 60255. Additionally, all DC functions of protection equipment shall operate down to a level of 80% of the nominal DC supply voltage.

6.4.2.6 Protection Coordination

Protection shall coordinate with both Horizon and Transpower protection, including meeting target clearance times. The costs of checking/re-engineering protection coordination and commissioning shall be the IES owner's responsibility.

IES protection shall coordinate with Horizon Networks and Transpower's Auto-Recloses requirements.

6.4.3 Neutral Voltage Displacement Protection

HV Neutral Voltage Displacement Protection is required for all installations with an HV connection point. IES shall have HV VTs installed for NVD protection.

6.4.4 Power Quality

6.4.4.1 Power Quality Metering

Power quality metering may be required at the point of connection to the Network for installations with an HV connection point, at the discretion of Horizon Networks. The power quality meter is to be installed as close as practical to the point of connection to the Network.

Reports shall be kept and made available to Horizon Networks on request.

6.4.5 Control and Reactive Power Requirements

For IES installations with nameplate capacity above 1 MW, the control mode and reactive power requirements shall be determined via the Network Study (Section 6.4.7).

6.4.6 SCADA and Communications

A communications link may be required with Horizon Networks to provide SCADA commands and indications, at the discretion of Horizon Networks. These commands and indications may include:

- Circuit breaker open command,
- Circuit breaker open and closed indications,
- Voltage and current analogue readings (per phase), with accuracy +/- 1.5%
- Real and Reactive power import/export levels, with accuracy +/- 5%
- Relay health indication,
- Trip circuit health indication,

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- Protection trip issued indication.
- Power Quality Metering (PQM)

Any communications link to Horizon's SCADA shall be continuously monitored for integrity. In the event, the communications link fails the IES installation shall be disconnected from the Network within 2 seconds until the link is restored.

Note that the System Operator requires all installations with nameplate capacity larger than or equal to 30 MW to provide SCADA indications. The System Operator may also require SCADA indications for installations with nameplate capacity lower than 30 MW. The SCADA indication for System Operator shall be specified by the System Operator

6.4.7 Network Studies

For all installations with a capacity ≥ 1 MW, a Network Study shall be carried out to assess the risk and impact of the IES installation on Horizon's Network.

A Network Study may also be required for IES installations with a capacity < 1MW at the discretion of Horizon Networks.

Network Studies must be undertaken by an Electrical Engineering Consultancy with relevant experience, which is accredited to undertake protection settings for Horizon Networks and Transpower (if relevant). The consultant undertaking a Network Study and the scope of that study must be agreed upon between Horizon Networks and the IES owner before the consultant commences any investigative work on the Network e.g., Load flow simulations etc.

Horizon's preferred modelling software is DIgSILENT. Network studies should be completed using the manufacturers' inverter models. The DIgSILENT model is to be made available to Horizon with supporting documentation, including site-specific settings.

6.4.7.1 Dynamic Model

If dynamic stability studies are required, a DIgSILENT model of the IES installation (i.e., inverter and power plant controller model) shall be provided. The developer shall confirm/verify that the DIgSILENT model:

- Has been shown to deliver an accurate dynamic representation of the IES installation.
- Is equipped with a set of model parameters/settings that are proposed for the final IES installation.

6.4.7.2 Harmonic Model

If harmonic studies are required, the following harmonic model information shall be provided:

- The harmonic current spectra (H1 through H40) associated with the inverter(s) of the IES installation.
- The harmonic impedance (H1 through H40) of the inverter(s) of the IES installation. This information is usually supplied as Norton Equivalent impedances for each harmonic order.

Additional components of a Network Study may include, but not be limited to, the following:

- Single Line Diagram (SLD),
- Fault level impact,
- Confirm that equipment and network ratings (fault current, normal current, and thermal) are not exceeded,
- Load flow studies (HV network voltage level acceptable in steady state) for various loadings/scenarios,
- Precautions against anti-islanding,
- Impact on network dynamic voltages i.e., voltage variations for cloud cover,
- Quasi-dynamic simulations,
- All studies conducted under normal and alternative network configuration,
- Proposed protection elements and settings,
- Coordination with Horizon protection and Transpower protection if relevant,

- Implications on existing protection settings and elements in the network,
- Power quality and harmonic assessment,
- Operational procedures including synchronisation and return of supply,
- Summary of risks/consequences,
- Consideration of the effects of the installation taking into account Horizon's current Asset Management Plan, including its 10-year Network plan,
- Recommendations for Network changes (if required),

An IES installation shall be allowed to connect to the network only if Horizon Networks and System Operator (if relevant) finds the results of the network studies acceptable and/or all the remedial works (identified in the network study) are complete before commissioning of the IES.

It is possible that changes to the network may be required, which will be at the cost of the installation owner unless otherwise agreed with Horizon.

EMT network models may be required depending on the fault levels calculated for the connection of the proposed IES to Horizon Networks.

6.5 Summary of Technical Requirements

Requirements	Distributed Generation Size and Connection Voltage			
	< 30 kW	≥ 30 kW		≥ 1 MW
	Low Voltage		High Voltage	
Generator Circuit Breaker	REQUIRED	REQUIRED	REQUIRED	REQUIRED
Disconnect Switch	REQUIRED	REQUIRED	REQUIRED	REQUIRED
Active Anti-islanding Protection	REQUIRED	REQUIRED	REQUIRED	REQUIRED
Backup Protection Requirements [2]				
Centralised Protection	n/a	REQUIRED	REQUIRED	REQUIRED
Passive Anti-islanding Protection	n/a	REQUIRED	REQUIRED	REQUIRED
ROCOF and Vector Shift	n/a	n/a	REQUIRED [1]	REQUIRED [1]
Communications Based Inter-trip	n/a	n/a		
Neutral Voltage Displacement Protection	n/a	At Horizon Networks' discretion	REQUIRED	REQUIRED
Power Quality and Control				
Availability of Volt-VAr and Volt-Watt Response Modes	REQUIRED	REQUIRED	REQUIRED	REQUIRED
Network Momentary Voltage Sag Ride Through	REQUIRED	REQUIRED	REQUIRED	REQUIRED

Requirements	Distributed Generation Size and Connection Voltage			
	< 30 kW	≥ 30 kW		≥ 1 MW
	Low Voltage		High Voltage	
Power Quality Meter Installation	n/a	n/a	At Horizon Networks' discretion	At Horizon Networks' discretion
Other				
SCADA Communications	n/a	n/a	At Horizon Networks' discretion	At Horizon Networks' discretion
Network Studies	n/a	n/a	At Horizon Networks' discretion	REQUIRED

(1) Mandatory requirements with an alternative.

(2) All inverters that are compliant with AS/NZS 4777.1 provide the main protection. Only backup protection elements to be applied in the centralised protection are shown above.

Note: The above table provides a summary of salient requirements for the IES installations, however, the above list does not constitute the full list of requirements that must be adhered to.

6.6 Commissioning

The proposed protection settings for the installation shall be provided to Horizon Networks a minimum of two (2) months before commissioning. Protection settings shall be agreed upon in writing before commissioning.

Approval to liven on to Horizon Network shall require an Electrical Certificate of Compliance for the IES LV and HV connections within its site.

For all installations with HV connection points, the IES owner shall provide signed and dated protection settings sheets and certification that protection requirements are completed and that the protection system is functional. A testing and commissioning plan shall be agreed on prior to commissioning, with minimum testing requirements including:

- Secondary injection testing of relay logic,
- Setpoint accuracy,
- Correct operation of disconnection devices,
- Scheme logic,
- Reconnection,
- Primary anti-islanding.

Horizon Networks may require a representative to be present for commissioning. Written records of commissioning test results and protection settings shall be kept, and a copy provided to Horizon Networks.

6.7 Post-Commissioning

After commissioning, protection systems must remain functional. Any failure of generator protection or circuit breaker secondary circuits must be alarmed within the installation. Operating procedures shall be in place to manually disconnect the IES when necessary.

The installation shall be regularly maintained and tested, in line with good industry practice. Test and maintenance records shall be kept and made available to Horizon Networks on request. Horizon Networks shall be notified of any scheduled or unscheduled disconnection.

Protection settings shall be password protected. Changes shall not be made (including changes to protection settings) to the installation without prior approval, in writing, from Horizon Networks.

As-built information shall be provided to Horizon, including drawings, protection settings, schematics, and any asset-related data required for Horizon's GIS system (to be agreed with Horizon).

Any asset replacement or alternation are made within IES e.g., inverter, PV array, battery, etc. an updated Certificate of Compliance and protection setting changes must be forward to Horizon Networks. The replacement asset inside the IES-owned site shall meet the relevant technical requirement applicable at the time of replacement.

6.7.1 Operational Procedures

Operating procedures and protocols for any IES installation with an HV connection point shall be developed in conjunction with Horizon Networks. The objectives of the operating protocols and procedures are to protect the Network and maximise the IES's access to the Network, within agreed limits. When required the IES installation owner shall comply with instructions issued by Horizon Networks, Transpower, or the System Operator in accordance with the Code.

6.7.1.1 Operational Control

- Horizon Networks maintains the right to have operational control of the connection switchgear.
- Horizon Networks will determine the nature of the operation control, which can include remote control via the SCADA and/or manual operation
- Horizon Networks has 24-hour legal access to the point of connection to the Network
- Horizon Networks requires there be established operational procedures relating to:
  - Contact details for planned activities or unplanned events and emergencies
  - Isolation to allow work on Horizon's network and the IES to be undertaken safely
  - Standard protocols for re-livening after an outage either on the Horizon network or the IES

7 RELATED POLICIES, PROCEDURES AND FORMS

The requirements of the latest versions of the reference documents listed below should also be considered:

REFERENCE	TITLE & DESCRIPTION
The Code	Electricity Industry Participation Code
Electrical (Safety) Regulations	New Zealand Electrical (Safety) Regulations
AS/NZS 3000	Electrical Installations – Wiring Rules
AS/NZS 4777.1	Grid connection of energy systems via inverters, Part 1: Installation Requirements
AS/NZS 4777.2	Grid connection of energy systems via inverters, Part 2: Inverter Requirements
AS/NZS 5033	Installation and safety requirements for photovoltaic (PV) arrays
AS/NZS 5139	Electrical Installations – Safety of battery systems for use with power conversion equipment
AS/NZS (IEC) 61000 Suite	Electromagnetic Compatibility (EMC) Suite of Power Quality Standards

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REFERENCE	TITLE & DESCRIPTION
AS/NZS (IEC) 62116	Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures
NZECP 35	New Zealand Electrical Code of Practice for Power Systems Earthing
EEA (NZ) Connection of Small-Scale Inverter Based Generation	Guideline for the Connection of Small-Scale Inverter based Distributed Generation
EEA (NZ) Power Quality Guidelines	Guidance and advice on power quality to meet the requirements of the Electricity (Safety) Regulations 2010
EEA (NZ) Connection of Generation Plant	Guide of the Connection of Generation Plant
IEEE/ANSI C62.41	IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
IEC 60255 Suite	Measuring relays and protection equipment (all relevant)
IEC 60068 Suite	Environmental testing

8 CONTACT FOR FURTHER INFORMATION

If you have any queries regarding the content of this Standard or need further clarification, contact the Asset & Innovation Manager.

Contact Person	Company	Contact details
Asset & Innovation Manager	Horizon Networks	Horizon Networks website query

System Operator can be contacted via system.operator@transpower.co.nz.

9 REVISION HISTORY

REVISION	PUBLISH DATE	DESCRIPTION OF CHANGE
1.0	18/10/2021	Initial Issue