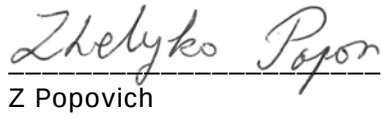
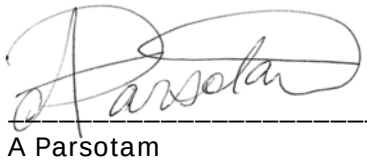
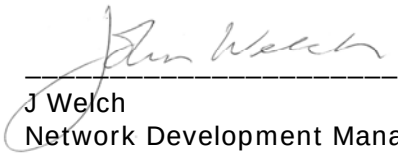
Technical Requirements for Connection of Distributed Generation (DG)

Compiled by: Signature: 
Name: Z Popovich
Position: Protection and Control Manager
Date: 14 December 2007

Reviewed by: Signature: 
Name: A Parsotam
Position: Power Quality Manager
Date: 14 December 2007

Reviewed by: Signature: 
Name: J Welch
Position: Network Development Manager
Date: 14 December 2007

Authorised by: Signature: 
Name: K Edmonds
Position: Asset Performance Manager
Date: 14 December 2007

REVISION REGISTER		
Revision	**Issued**	**Reason for Revision**
0		First Issue
1	14.12.2007	Reference to Standards updated

CONTENTS

1 SCOPE

This document establishes technical criteria and requirements for interconnection of distributed generation (DG) with Vector's electric power systems.

2 PURPOSE

This document defines requirements relevant to the performance, operation, testing, safety and maintenance of distributed generation connected to Vector's network.

3 STANDARDS AND REGULATIONS

All electrical apparatus, materials and wiring supplied shall comply with the latest edition of the New Zealand Electricity Act and the Electricity Codes of Practice.

All equipment shall conform to the latest editions of the Standards listed below.

STANDARDS	TITLE
AS 4777.1 - 2005	Grid connection of energy systems via inverters Part 1: Installation requirements
AS 4777.2 - 2005	Grid connection of energy systems via inverters Part 2: Inverter requirements
AS 4777.3 - 2005	Grid connection of energy systems via inverters Part 3: Grid protection requirements
AS/NZS 61000.3.3:2003	Electromagnetic compatibility (EMC) Part 3.3: Limits – Limits for Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current less than or equal to 16A per phase and not subject to conditional connection
AS/NZS 61000.3.5:1998	Electromagnetic compatibility (EMC) Part 3.5: Limits –Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16A
AS/NZS 61000.3.6:2001	Electromagnetic compatibility (EMC) Part 3.7: Limits – Assessment of emission limits for fluctuating loads in MV and HV power systems (IEC 61000-3-7:1996, MOD)
AS/NZS 61000.3.6:2001	Electromagnetic compatibility (EMC) Part 3.6: Limits – Assessment of emission limits for distorting loads in MV and HV power systems (IEC 61000-3-6:1996, MOD)
IEC 60255	Electrical relays (all relevant standards)
IEC 60068-2	Environmental testing
IEEE Std 519-1992	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

4 DEFINITIONS

Circuit breaker	A switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal conditions such as those of short circuit.
Dedicated transformer	A transformer installed between Vector's network and DG network that serves only the DG and attached loads, if any.
Directional-power relay	A relay that operates on a predetermined value of power flow in a given direction, or upon reverse power so that, when used with DG in a non-export configuration, it will prevent power flow into the Utility's Network
Distributed generation	Electric generation facilities connected to the Utility network at the PCC.
Flicker	A variation of input voltage sufficient in duration to allow visual observation of a change in electric light source intensity.

Fault	A physical condition that causes a device, a component, or an element to fail to perform in a required manner, for example, a short-circuit, a broken wire, an intermittent connection.
Frequency	The number of complete cycles of sinusoidal variation per unit time.
Harmonic distortion	Continuous distortion of the normal sine wave; typically caused by nonlinear loads or by inverters, measured in total harmonic distortion (THD).
Islanding	is a condition in which a portion of the Vector's network is energised by one or more DGs through their PCC(s) while electrically separated from the rest of the Vector's system
Isolated Generation	is a condition where the electrical path at the PCC is open and the DG continues to energise local loads.
Point of Common Coupling (PCC)	The point at which a DG is connected to Vector's network
Power factor	Ratio of real to total apparent power (kW/kVA) expressed as a decimal or percent.
Voltage-restrained over-current relay	A protective relay in which the pickup and over-current tripping times are affected by the voltage. This type of relay is used in applications where it is desirable to have the relay change to a lower pickup current and faster tripping curve during conditions where the voltage is lower than normal.

5 TECHNICAL REQUIREMENTS

5.1 PROTECTION REQUIREMENTS

5.1.1 Availability of Protection

DG owner shall ensure that all it's equipment is protected and that all elements of the protection, including associated inter-tripping, are available at all times. Unavailability of the protection will require the DG plant to be taken out of service.

5.1.1.1 DC Functions of Protection Apparatus

All Protection Apparatus functions shall operate down to a level of 80% of the nominal DC supply voltage.

5.1.1.2 Protection Flagging, Indication and alarms

All protective devices supplied to satisfy Vector's requirements shall be equipped with non-volatile operation indicators or shall be connected to an event recorder. Such indicating, flagging and event recording shall be sufficient to enable the determination, after the fact, of which devices caused a particular trip.

Any failure of the DG owner's tripping supplies, Protection Apparatus and circuit breaker trip coils shall be alarmed within the DG owners installation and operating procedures put in place to ensure that prompt action is taken to remedy such failures.

5.1.1.3 Trip Supply Supervision Requirements

All Protection Scheme secondary circuits, where loss of supply would result in Protection Scheme performance being reduced, shall have Trip Supply Supervision.

5.1.1.4 Co-ordination of Protection Settings

DG owners shall provide Vector with full details of proposed protection settings a minimum of 2 months prior to energisation of DG.

The DG owner shall ensure that all their Protection Settings co-ordinate with existing Vector Protection Settings. Where this is not possible, the DG owner will be

responsible for the cost of revising Vector's settings and upgrading Vector equipment, where required.

5.1.2 Network Islanding

The DG owner shall not supply power to Vector's network during any outages of the system. The DG may be operated during such outages to supply the customers own load, only with an open tie to Vector's network.

DG owner that does not operate in parallel with Vector's network is not subject to these requirements.

The DG shall cease to energise the Vector's network within two (2) seconds of the formation of an island.

5.1.3 Synchronising

The DG shall provide and install automatic synchronizing at the generator circuit breakers. Check synchronizing shall be provided on all generator circuit breakers and any other circuit breakers, unless interlocked, that are capable of connecting DG plant to Vector's network.

Prior to the initial synchronization of the DG to the distribution network, the DG owner and Vector shall agree on the operational procedures necessary for synchronization.

Check Synchronising Interlocks shall include a feature such that circuit breaker closure via the Check Synchronism Interlock is not possible if the permissive closing contact is closed prior to the circuit breaker close signal being generated.

In addition, the Check Synchronising Interlocks shall be installed on all DG owners' circuit breakers capable of out-of-synchronism closure, unless otherwise interlocked.

5.1.3.1 Summary of Protection Requirements

REQUIREMENTS	DISTRIBUTED GENERATION SIZE					
	10kW or less	11kW to 50kW	51kW to 100kW	101kW to 500kW	501kW to 1000kW	1001kW to 5MVA
Generator Circuit Breaker	✓	✓	✓	✓	✓	✓
Dedicated Transformer		✓	✓	✓	✓	✓
Disconnect Switch	✓	✓	✓	✓	✓	✓
Over-voltage Protection	✓	✓	✓	✓	✓	✓
Under-voltage Protection		✓	✓	✓	✓	✓
Over-frequency Protection	✓	✓	✓	✓	✓	✓
Under-frequency Protection	✓	✓	✓	✓	✓	✓
Earth-fault protection			✓	✓	✓	✓
Over-current Voltage Restraint Protection					✓	✓
Neutral Voltage Displacement Protection		✓	✓	✓	✓	✓
Synchronisation	✓	✓	✓	✓	✓	✓
Loss of mains	✓	✓	✓	✓	✓	✓
Power factor or Voltage Regulation Equipment			✓	✓	✓	✓
Fault Interrupting Devices				✓	✓	✓

5.2 OPERATING REQUIREMENTS

The DG owner shall provide a 24-hour telephone contact(s).

5.3 MONITORING

Provisions to monitor voltage and frequency on Vector's network side of the PCC and isolation device status shall be provided at the PCC. Monitoring is not required for aggregate DG of 250 kVA or less at a single PCC.

5.4 POWER QUALITY

5.4.1 Limitation of DC Injection

The DG should not inject DC current greater than 0.5% of full rated inverter output current into the PCC.

5.4.2 Limitation of Voltage Flicker Induced by the DG

DG shall not cause a voltage flicker level greater than emission allocations based on AS/NZS 61000.3.3, AS/NZS 61000.3.5 and AS/NZS 61000.3.7. The capacity of the DG shall be considered in the same as capacity of load when applying these standards.

5.4.3 Harmonics

The DG shall not cause emission or injection of harmonic currents into the distribution network (230 V – 66,000 V) greater than emission allocations limits in the table below:

Odd harmonic order number	Limit for each individual odd harmonic current based on percentage of maximum power generation current (fundamental frequency component) at PCC
3^{rd} – 9^{th}	<4%
11^{th} – 15^{th}	<2%
17^{th} –21^{st}	<1.5%
23^{rd} – 33^{rd}	<0.6%
Above 33^{rd}	<0.3%
Even harmonics in above ranges	<25% of respective odd harmonic limits listed above.

5.4.4 Surge Withstand Capability

The interconnection system shall have a surge withstand capability, both oscillatory and fast transient, in accordance with the test levels of IEEE/ANSI C62.41 category B3. The protective function equipment shall have a surge withstand capability, both oscillatory and fast transient, in accordance IEC 60255.

5.5 POWER FACTOR

If the power factor, as measured at the point of common coupling, is less than 0.95 (leading or lagging), the method of power factor correction necessitated by the installation of the generator will be negotiated with Vector as a commercial item.

VAr demand of the DG (induction generators) may be supplied from the distribution network but at Vector's discretion. The installation of VAr support equipment by the generator-owner on the generator-owner's side of the point of common coupling shall be reviewed and approved by Vector prior to the installation of the DG. The VAr support equipment for the DG shall not cause nor lead to cause voltage flicker and or voltage distortion in excess of emission allocation limits specified in appropriate AS/NZS 61000 series of standards.

5.6 TESTING, COMMISSIONING AND MAINTENANCE

Testing and commissioning of the protective equipment shall be agreed between DG owner and Vector. All the testing and associated costs are the responsibility of the DG owner. Vector or Vector's representative reserves the right to witness the testing. The DG owner shall notify Vector in advance with a testing and commissioning plan.

The DG owner shall keep written records of test results and protection settings. A copy of the records shall be sent to Vector.

Vector may direct that the commissioning and subsequent connection of DG to Vector's network shall not proceed if the relevant equipment does not meet the specified technical requirement.

DG owner shall regularly maintain their protection systems in accordance with good electrical industry practice. Records shall be kept of such maintenance and these may be reviewed by Vector.