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05 May 2006

Mr Robert Pullella
Executive Director
Economic Regulation Authority
P O Box 8469
PERTH BUSINESS CENTRE WA 6849

Dear Mr Pullella

SYNERGY RESPONSE TO THE 'DRAFT TECHNICAL RULES' INTRODUCTION

Synergy welcomes the opportunity to respond to the Economic Regulation Authority's (the Authority) Decision and Explanatory Memorandum on the Draft Technical Rules for Western Power's South West Interconnected Network and Draft Technical Rules.

Synergy notes in the Draft Decision that in approving the technical rules, the Authority will ensure that they are consistent with the objectives of section 12.1 of the Electricity Networks Access Code 2004, which include *"reasonableness, not constituting an inappropriate barrier to entry; being in accordance with good electricity industry practice; and being consistent in law."* In formulating our comments to the draft we have endeavoured to keep these guiding principles in mind.

Synergy is interested in the treatment of small standby generators and consequently our comments are restricted to the relevant sections of the Draft Decision that impact on these generators, particularly Section 3.6 Requirements for Connection of Small Generating Units to the Distribution Network. Synergy has implemented a very successful demand-side program, the Peak Demand Savers program (PDS), that forms an important element of the SWIN in delivering capacity to meet peak demand at times of system emergencies. We plan to have contracted 120MW with large commercial and industrial customers under this program for 2007/08. Furthermore, we have identified that opportunities exist for standby generation to make up a significant part of our demand-side program. This will be made up of numerous small generating sets in manufacturing facilities and buildings that could further compliment this important and very cost-effective resource for WA.

However, there are significant barriers to activating this capacity. These include, lack of customer knowledge, lack of resources and skills, and, of most relevance, the cost of connecting to the network. Cost is a particular issue given the relatively small size of many of these installations. Relatively small changes in cost can have a significant impact on the economic viability of a small generator seeking connection to the network.

RESPONSE TO ISSUES RAISED IN THE DRAFT DECISION

Protection Requirements for Small Generating Units

As regards the Authority's request for comment on whether the "...detailed protection requirements specified in Table 3.6 are appropriate", Synergy supports Western Power's statement that a prescriptive approach simplifies, and provides a degree of certainty to smaller distribution level connected generators as regards Western Power's expectations for conformance with the technical guidelines supporting access to the SWIN. Furthermore, from experience in the PDS program, many retail customers with small generators wishing to provide peak demand support to the network lack the in-house technical expertise required to put together a design based on more generic guidelines. In consequence, if a more generic approach were taken, as for connection of large transmission-level generators, many customers would face increased costs as a result of the need to engage a specialist contractor to design and prepare the required protection documentation. These additional costs would act as a barrier to participation in the program.

Synergy offers the following additional comments with respect to Table 3.6 of the Draft Technical Guidelines:

Generator Operating Categories

Clause 3.6.2 (e) (2) and (3) identifies two modes of operation of small generators as 'occasional parallel operation...either exporting electricity to the distribution system or not exporting electricity to it including generating units participating in peak lopping and system peak load management for up to 200 hours per year', and 'short term test parallel operation with the distribution system, and either exporting electricity to the distribution system or not exporting electricity to it....' respectively.

The 'without export' LV sub-categories within both these groups are critical from the perspective of utilising standby generators for alleviating system peaks on critical summer days. Synergy estimates that there are many small LV generators within the SWIN that could operate in the 'without export' mode and thereby provide cost-effective capacity support at times of peak demand. While 'export' and 'no export' categories are shown separately in Table 3.6 for HV installations there is no such distinction made for LV generators. The 'No export' operating mode imposes less risk on network security and therefore the protection requirements for LV generators operating in this mode should be less stringent than those required for generators exporting power to the grid. Requiring all LV generators to comply with the same protection requirements therefore places an additional cost burden on the 'no export' group – thereby imposing a significant barrier to entry to the largest category of all LV generators that could be utilised for system support.

Synergy suggests that the Authority task the Small Generator Working Group (SGWG) to undertake a detailed review of the requirements for LV 'export' and 'no export' generators.

Generator Size Categories

The size ranges of LV generators for which different protection requirements are specified in Table 3.6 of the Draft Technical Guidelines are as follows:

- <150kVA;
- 150 to 250kVA; and
- >250kVA.

These categories were derived from those set out in Table 8-2 of an Australian Business Council for Sustainable Energy report[1], which relates to small renewable generating plant. In addition, the first two bands are very similar in their definition (separated by only 100kVA) whereas the third band is very broad – taking in the rest of the LV generators installed on the SWIN – which presumably could include ratings as high as 5,000kVA for a single generator installation.

From work conducted by Synergy for the PDS program, the majority of individual generators capable of providing peak demand network support on the SWIN are in the 500kVA to 1,500kVA range. There is a need to ensure that protection requirements for generators in this size range are no more onerous than necessary. For example, depending on the characteristics of the network feeders, it may be that the protection requirements for a 1,500kVA generator differ from those for units rated at 2,500kVA to 5,000kVA.

In addition, as noted previously,[2] the size of the generator(s) should be compared to the capacity of the mains supply at the generator connection point. A small standby generator supplied installed in a facility with a large capacity mains supply should need less stringent protection requirements compared to a situation where the generator capacity is closer to the capacity of the mains supply.

Synergy recommends that the Authority undertake a review of the appropriateness of the size categories presented in Table 3.6 of the Draft Technical Guidelines with a view to determining if revised categories would reduce the protection requirements for standby generators installed on the SWIN, and therefore minimise costs and barriers to customers wishing to offer peak demand network support via the PDS program.

Protection Requirements

As a general comment on the protection requirements presented in Table 3.6, Synergy notes that while some progress has been made in this area, many of the concerns tabled at the meeting of the SGWG on 20 October 2005 regarding protection requirements have yet to be addressed.

Therefore, we wish to reiterate three key issues raised at the SGWG meeting regarding the protection types specified in Table 3.6. In aggregate, as written, the requirements:

- Are more onerous than those required by many overseas specifications (from countries that have far more experience with small generator parallel operation);
- Are more onerous than really necessary for some categories of small generators and therefore represent a barrier to entry for these applications; and
- Require further discussion between the small generator industry, Western Power and the SGWG.

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1 *Technical Guide for Connection of Renewable Generators to the Local Electricity Network*, ABCSE, August 2004.

2 *Service Providers Proposed Technical Rules: Issues TRC Small Generators Working Group*, N Schubert, October 2005.

In addition to the above general comments on the specifications presented in Table 3.6, specific remarks on the types of protection equipment required follow:

- Synergy is of the opinion that the protection requirements stipulated for LV generators < 250kVA are overly onerous. We suggest the Authority investigate the scope for limiting the protection for this generator category to under/over voltage, under/over frequency, and loss of mains (single method).
- We also question the requirements for the Rapid (<=1s) and Gradual (<=60s) Bumpless Transfer categories. As currently specified, the same type of protection equipment is required for both categories; hence, it is not apparent why the two categories exist. Synergy contends that the requirements for the Rapid Transfer category should be less onerous than those for the Gradual Transfer category, given that the transfer to the customers' own supply occurs very quickly thereby imposing lower risk to the network during the transfer phase. Further, the requirement for Earth Fault and Overcurrent relays for Gradual Transfer are more onerous than the requirements proposed in international standards (refer Exhibit A). We suggest that the Authority review the protection specifications for both of these categories.
- The listing of protection for LV generating equipment includes a requirement for Loss of Mains, Rate of Change of Frequency, Reverse Power, Directional Overcurrent, and Neutral Voltage Displacement. The primary role of all of these devices is mains decoupling. Clearly, the requirement for multiple devices will add significantly to the cost of a small generator installation or retrofit – estimated to be in the order of $10,000 to $20,000 per device. Therefore Synergy questions the reasonableness and cost efficiency of requiring all four types. Furthermore, the requirements in Table 3.6 appear to be in conflict with clause 3.6.10.3 of the Draft Technical Rules which specifies that *"For sustained parallel operation, islanding protection of <u>two</u> different functional types must be provided to prevent a generating unit energising a part of the distribution system that has become isolated from the remainder of the transmission or distribution system."* This matter requires clarification.
- Clause 3.7.7.4 states that "Overcurrent protection must be provided at the inverter energy system isolating switch...". It is unclear as to whether Overcurrent or Earth Fault protection is required only for inverter systems. Clarification is required on this matter, as Earth Fault protection is a common requirement for connection of small synchronous generators operating permanently in parallel with the distribution system.
- The inclusion of Overcurrent protection is not appropriate as it protects the generator rather than the network, and Synergy suggests that it should therefore be deleted from the Rules.
- Pole slip protection is not called for by either of the overseas specifications reviewed as part of this submission (Refer Exhibits A and B) and we understand that it is generally not required in other international standards. This is a particularly onerous requirement because most suppliers of small generators incorporate integrated digital relays which do not include pole slip type protection. The requirement would therefore necessitate the purchase and installation of an additional protection relay at considerable extra cost (estimated to be in the order of $20,000), which cannot be justified on economic or technical grounds for small generators. This additional cost impost will have a negative impact on the economic viability of many small generator projects that have the potential to provide capacity support under programs such as the PDS. Synergy recommends that the Authority review its position on the requirement for pole slip protection for LV generators, and as part of this review, examine the technical codes of other distribution network service providers to ensure that the requirements for the SWIN are informed by international practice.

We also note that the information contained in Table 3.6 does not provide any detail regarding the settings/operating limits for the types of protection equipment specified. Synergy suggests the Authority examine the scope for including settings and protection device operating limits in the Technical Guidelines for the various generator categories and sizes. Synergy is of the opinion that provision of this additional information would assist in removing barriers to entry for retail customers with small standby generators wishing to provide capacity support by minimising the costs associated with engaging external specialists to undertake detailed design work.

Based on the above comments, Synergy recommends that the Authority reconsider the requirements for protection for small generators and that these requirements are made no more onerous than those that, in aggregate, operate overseas and interstate for similar sized equipment.

Deadlock Issue 3: Provision of Information

Clause 3.3.3 and Attachment 4 cover the data that may be required by Western Power as part of a generator access application. Clause 3.6.3 re-iterates that this requirement also applies equally to small generators.

The data requirements listed in Attachment 4 are very extensive and mostly appropriate for large generators seeking an access for permanent connection to the network. While Western Power can use its discretion as to which data in Attachment 4 is required for small generators, there is a concern that this could be inconsistently applied from one application to the next. If applied in full, a huge amount of data could be requested by Western Power (some of which may not be not even available for small generators) resulting in a costly and onerous exercise for owners of small generators wishing to participate in the PDS program. Synergy is of the view that clause 3.6.3, as written, does not appear to be reasonable for small generators, and represents a barrier to entry.

Synergy is of the view that a simplified and prescribed standardised set of data requirements should be specified for small generator applications. We propose that the Authority task the SGWG with developing a simplified set of data for small generators using international practice as a precedent. For example, the Irish specification G10/94 (Exhibit A) details all of the information required on one page plus asking for some attachments. The EEA in New Zealand also details all the information that a utility requires for a small generator installation in one page, and Orion Energy (Exhibit B) lists all of its requirements in three tables which take up less than one page. These approaches illustrate three important factors with regard to the connection of generators up to this size:

- That such generators cannot have an effect on the system regardless of what the reactance figures etc are and therefore there is no need for the utility to ask for this information.
- These are standard production line products and nothing can be done to change the figures regardless of what the utility company thinks of them.
- As standard line products they are being connected in large numbers in Europe, North America and Asia and therefore there cannot be a problem with connecting such small units to a large system.

Recommendation 7

Paragraph 195 points out that the Authority will continue to consult with the SGWG before formulating its final decision on the technical rules. Synergy commends the Technical Working Committee of the Office of Energy for establishing this group and for continuing its role in providing expert assistance and advice on matters of specific relevance to small generators. As highlighted so far and elsewhere in our submission we believe there is still considerable work to be done to resolve a number of issues with respect to the treatment of small generators in the Rules. Synergy supports the Authority's intention to work with the SGWG to resolve these issues before making a final decision.

RESPONSE TO THE DRAFT TECHNICAL RULES

General Comment on Section 3.6

Synergy strongly supports the separate treatment of small generators as a standalone category in Section 3.6 the Draft Technical Rules. However, we are concerned with the structure and format of this part of the document in that it does not truly provide an independent set of simplified requirements for small generators but requires Users to comply, and be familiar with, all other parts of the Rules. As the first paragraph states, "*It does not diminish the obligation of any User to comply with the other requirements of these Rules, except where specifically stated in this clause 3.*" Therefore this section does not really outline "requirements for connection of small generating units to the distribution network" as the section heading implies, but only documents a set of exception clauses that apply to small generators.

Our view is that the relationship of Section 3.6 to the rest of the document goes against the intent of having a section in the Rules that is meant to provide a simpler set of requirements that are appropriate to the less stringent requirements of small generators. The Draft Technical Rules do not achieve this intent because of the considerable uncertainty to Users as to which other parts of the Rules apply and how these will be judgementally applied by Western Power. *The rules governing small generators ought to be simple, clear and self-contained but the current Draft does not achieve these objectives*. For example, there is no mention in Section 3.6 of the testing requirements that apply to small generators. The implication therefore is that all of the Section 4 provisions covering the testing of generators equally apply to small generators. Clearly, this imposes both uncertainty and potentially onerous and costly requirements that will constitute barriers to entry for this segment of the market.

It is common practice in other jurisdictions for technical requirements for small generators to be published as self-contained sets of rules and we see no reason why this shouldn't be the case in Western Australia. European countries, New Zealand, many jurisdictions in America and other Australian states have produced simple, clear and concise technical requirements for small generators connected to the electricity grid. Several examples of technical requirements from Orion (New Zealand), Electricity Supply Board (Ireland) and Powercor Australia are provided for consideration by the Authority (refer Exhibits A to C).

It is also worth highlighting that the Ministerial Council on Energy (MCE) has recently undertaken a review of the impediments to the take up of distributed generation in the NEM.[3] An issue that the MCE sought comment on was that *"Network connection regulations, including technical standards, can be complex, unnecessarily onerous, or non-existent for small and medium scale renewable and distributed generation"*. A brief review of submissions that addressed this particular issued supported this finding and stressed that connection regulations and technical requirements for small generators should be simple and non-onerous and straightforward to minimise barriers to entry for customers seeking access particularly given the low levels of risk that small units impose on the system. The use of prescriptive technical requirements and standard connection agreements have been suggested as potential ways of overcoming this barrier.[4] Submissions also noted the barriers imposed by excessive connection costs.

Synergy urges the Authority to consider revising Section 3.6 such that it covers all areas applicable to small generators as a self-contained independent section in the Draft Technical Rules, or as a separate standalone document. Specific guidance in the development of a revised section could be provided by the SGWG. Synergy would be pleased to continue to be represented on the SGWG and provide specific advice and assistance on this issue.

Requirement to comply with IEC 60255

Clause 3.6.10.1 (d) requires that all protection equipment must comply with IEC 60255. IEC 60255 is an extensive series of 22+ standards that cover many aspects of electrical relay design, with specific chapters applying to different types of relays. Therefore, not all chapters apply to any one relay. Requiring protection equipment to comply with IEC 60255 in general without specifying which specific chapters (and relevant parts within chapters) apply to the protection requirements that have been specified in Table 3.6 is very confusing and will lead to suboptimal outcomes. Exhibit D, which provides a listing of all the IEC 60255 standards, illustrates how complex and onerous meeting this particular requirement will be for owners of small generators without more detail being provided as to which specific standards apply.

It is also worth noting that compliance with IEC 60255 is not called for in any of the other overseas or interstate specifications and therefore constitutes a case of over specification in an area where this series of standards is not normally applied.

Clause 3.6.10.1 (d) further requires that integrated control and protection equipment may be used provided that it can be demonstrated that the protection functions are functionally independent of the control functions. Firstly no definition is given as to what criteria would constitute a 'demonstration' of the independence of these two functions. Secondly, it is unreasonable to specify that the control and protection functions of small generators should be separated. If the control system fails the generator will be automatically disconnected from the system, which negates the need for separate protection, and therefore this requirement is superfluous. Once again this requirement is not typically called for in other technical rules for small generators.

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3 *Impediments to the Uptake of Renewable and Distributed Generation*, Ministerial Council on Energy Standing Committee of Officials, February 2006

4 *Submission on Impediments to the Uptake of Renewable and Distributed Energy Discussion Paper*, Australian Business Council for Sustainable Energy, March 2006

Clause 3.6.10.1 (e) states that *the disconnection timer for bumpless transfers must comply with IEC 60255*. As noted earlier, this series of standards concerns electrical relays and is not designed to cover timers. An applicable standard that specifically covers timers ought to be quoted instead.

In light of the issues raised, Synergy believes that a thorough review of the application of IEC 60255 should be undertaken based on through research and precedents elsewhere given that compliance could impose significant costs to small generator proponents and thereby constituting a barrier to market entry.

Testing

As raised in an earlier comment, Section 3.6 does not specifically cover the testing requirements that are applicable to small generators. Since the issue of testing is not covered, the implication is that all of the Section 4 provisions apply to generators irrespective of size and type. We would question the practicality of requiring a small generator to comply with the same requirements that would apply to the commissioning of a large power station. While Western Power may apply discretion as to which requirements pertain to small generators on a case by case basis, unless the requirements are clearly stated, proponents will face uncertainty as to how the rules will be applied in their individual circumstances. This is clearly an issue and highlights a shortcoming in the way the Rules treat small generators in that some requirements, such as testing, are not explicitly stated.

SUMMARY

In summary, Synergy contends that the current draft of the Technical Rules are onerous in respect to its treatment of small generators. The rules are technologically biased to large synchronous generators and grant exemptions to small generators which require expertise to interpret. Discretion as to how the rules will be interpreted and applied remains with Western Power thus creating cost barriers and uncertainty for small generator proponents seeking network access. Fair and open access would be better served by a process which recognises the characteristics of the technologies and size of plant and skill and cost base of the access seekers in the design of the rules.

In order to eliminate the significant issues that still exist in the current draft of the technical rules to the use of small generators for capacity support, Synergy supports:

- A set of standalone technical requirements either as a separate document or a truly self-contained section in the Draft Technical Rules that does not rely on other parts of the document;
- A thorough bottom-up review of the protection requirements relating to each specific type of small generator. The objective of this review should be to specify requirements that provide the minimum level of protection that meet network system safety and risk levels, and are consistent with local and international practice with similar sized equipment. This should include consideration of LV generators with and without export capability, more appropriate generator size categories, revision of the protection requirements specified including settings and protection device operating limits, and more specific requirements with respect to IEC 60255;
- A simplified and concise set of prescriptive data requirements to support access applications appropriate for small generators, consistent with local and international practice.

It is essential that these issues be addressed if the Authority wishes to promote fair and open access arrangements for all market participants, including owners of small generation plant. Customers with small generators involved in the PDS program have made an invaluable contribution to ensuring system security in the SWIN for the past two summers. The Rules should not impose onerous barriers that stifle and preclude the continued and growing participation of customers. Rather, the Rules should encourage and stimulate their ongoing involvement in peak demand support programs, with a view to increasing participation in the greater business community.

We would be pleased to discuss our submission in more detail and address any queries please contact me on 9326 4521.

Yours sincerely

GRANT DRAPER
HEAD OF STRATEGIC BUSINESS

EXHIBIT A

REQUIREMENTS FOR CONNECTION OF GENERATORS TO ESB DISTRIBUTION SYSTEM

REQUIREMENTS FOR CONNECTION OF

GENERATORS TO ESB DISTRIBUTION SYSTEM

G10/94

Customer Supply & Marketing
Customer Services Business Unit

REQUIREMENTS FOR CONNECTION OF GENERATORS TO ESB DISTRIBUTION SYSTEM

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Appendices:

FOREWORD

This document sets down the requirements governing parallel operation of Synchronous and Asynchronous generators with ESB Distribution System. It is confined to generators connected at voltages of 38kV or below.

1. GENERAL

1.1 The purpose of these requirements is to protect ESB and ESB customers, personnel and property from any adverse effects of parallel operation. Fulfilment of the requirements shall not guarantee protection of the customer's personnel or property from the consequences of parallel operation with ESB Distribution System.

1.2 The customer must understand that the ESB takes no responsibility or liability for the customer, customer's personnel, premises or plant arising directly or indirectly from:

(a) Parallel operation with ESB Distribution System or

(b) Participation in any tests which are solely undertaken to ensure the safety of the ESB Distribution System.

1.3 The customer shall promptly provide to ESB detailed technical information on the proposed method of connection of the generator, synchronising, interlocking, protection and any other aspect which may be required by ESB.

1.4 The customer shall complete and return the Customer Information Schedule in Appendix A. (Incomplete information will delay the process).

1.5 The customer shall complete and return to ESB the Certificate of Compliance in Appendix B before permission for parallel operation is granted.

1.6 After permission for parallel operation has been granted, no modification to the generator or associated equipment affecting any of the requirements contained herein, shall be carried out without prior written agreement of ESB.

1.7 If, in the opinion of ESB, the customer fails to maintain compliance with the requirements or amended requirements at any stage after permission for parallel operation has been granted, ESB reserves the right to withdraw such permission immediately and without prior notice where circumstances so require.

1.8 Where a defined term of contract does not exist, ESB reserves the right to withdraw permission for parallel operation from the customer at any time on giving six months notice. ESB shall incur no liability whatsoever to the customer arising directly from such termination of permission.

1.9 The customer shall comply with all reasonable requests or instructions which may be given by ESB or its representatives in writing from time to time.

2. CONNECTION

2.1 The installation shall be wired in accordance with the latest edition of the ETCI National Rules for Electrical Installations as from time to time amended and shall also comply with the relevant Safety Legislation, including the regulations on earth fault disconnection, as from time to time amended, where applicable.

2.2 The customer's installation including all directly connected generator and auxiliary equipment shall comply with relevant ESB Supply Conditions. All equipment shall comply with relevant IEC standards as from time to time in force.

2.3 The customer shall bear the costs of all modifications and alterations to ESB Distribution System, undertaken by ESB in order to comply with safe operating practice on ESB networks due to the presence of the customer's generator equipment. The costs shall include the provision of a communications link to ESB National Control Centre for all generators above 5MW.

2.4 Generator equipment operating in parallel with ESB Distribution System shall be subject to the Electricity Supply Acts.

2.5 The customer shall satisfy the relevant authorities that all Statutory or other Regulatory requirements have been complied with (e.g. Local Authority planning permission and any requirements attaching thereto; Health and Safety Acts; and in the case of Hydro installations, requirements of Department of Marine, Central and Regional Fisheries Boards and Office of Public Works).

3. OPERATION

3.1 The generator installation shall at all times be operated in a manner which will not cause or be likely to cause damage to ESB Distribution System or endanger life.

3.2 The customer shall make provision to enable ESB to lock the main incoming circuit breaker in the OFF position, and to apply earths when this is required for work on ESB Distribution System. Locking shall be by separate padlock and shall allow locking of the switch in the OFF position only. The locking arrangements shall be such that it is not possible to close the circuit breaker remotely, i.e., the

closing circuit for the circuit breaker shall be broken. The customer shall grant ESB right of access to the main incoming circuit breaker at all times and shall take whatever action is necessary to meet this requirement.

3.3 The customer shall fit a notice to the main incoming circuit breaker warning that the generator may be operating in parallel with ESB's system.

3.4 The neutral of Medium Voltage (MV) generators shall be unearthed when operating in parallel with ESB Distribution System. The earthing of the neutral of Low Voltage (LV) generators should follow ETCI Requirements.

3.5 In the event that any generator equipment is found to cause deterioration in the quality of supply to other customers (e.g. harmonic distortion, voltage fluctuation), the customer shall forthwith take action to prevent further annoyance and shall cease operating such equipment until corrective action can be taken. ESB reserves the right to withdraw permission for parallel operation, without notice, until it is satisfied, by further testing or otherwise, that adequate provision has been made to avoid nuisance to other customers.

3.6 Where the customer has been granted permission to operate generator equipment in parallel with ESB Distribution System, the customer shall carry out such switching of generators and associated equipment as may be required by ESB from time to time. ESB reserves the right to carry out such switching directly without notice to or permission from the customer.

3.7 All apparatus associated with ESB Distribution System shall be regarded as live unless it has been isolated from the system and earthed in accordance with standard ESB practice.

3.8 ESB shall not be liable for any adverse effects on customer's equipment or personnel which may result directly or indirectly from:-

(a) switching or other operations on ESB Distribution System or

(b) parallel operation with ESB Distribution System.

3.9 ESB shall not be liable for any indirect, consequential or other losses, damages, expenses, claims or liabilities arising under this agreement.

3.10 The customer shall pay all reasonable costs where a customer's generator equipment causes damage to ESB Distribution System.

3.11 The following modes of operation are covered by these requirements:

(a) Continuous Parallel

Unrestricted periods of operation are permitted under continuous parallel mode for asynchronous and synchronous machines.

(b) Peak Reduction:

Subject to the agreement of ESB, standby generators may operate in two short time parallel modes, namely Peak Shaving or Peak Lopping, in order to reduce the customers maximum demand and avail of the Winter Demand Reduction Incentive (WDRI) during the months November, December, January and February.

Peak Shaving

This refers to the parallel operation of a customer's generator where the generator supplies part or all of the customers load. Normally, the generator would operate for 2 hours per day as agreed with ESB.

Peak Lopping

This refers to where the customer's generator supplies all of the customer's load and operates independently of the electricity mains. It is however, operated in parallel for short periods at start-up and shut-down of the generator to facilitate a smooth transfer of power from the mains to the generator. The generator may operate in parallel with ESB for periods not exceeding 3 minutes at start-up and 3 minutes at shut-down of the generator.

(c) Test/Emergency

In additional to parallel operation for Peak Reduction, customers may also operate diesel generators as follows:

(i) Parallel operation for test purposes limited to 6 minutes per 24 hours (outside WDRI period).

(ii) Sustained parallel operation in emergency conditions such as load shedding may be agreed to on a case by case basis as the need arises. The decision to override the timing mechanism outlined in our technical conditions in order to allow sustained parallel operation would have to be made and undertaken by ESB.

(iii) Purely standby usage in the event of failure of ESB supply. Upon restoration, ESB supply shall be resumed.

(iv) Where standby generators do not operate in parallel with ESB Distribution System, the rules of the Electro-Technical Council of Ireland shall apply.

4. SYNCHRONISING/INTERLOCKING

4.1 Synchronising shall be fully automatic and shall prevent closure of interconnecting switchgear when both the generator and ESB sources of supply are dead. It shall only be possible to close onto a dead busbar when either ESB or generator source of supply is isolated.

4.2 The closing operation of switchgear at all points where the customer could parallel unsynchronised generator equipment with ESB system shall be prevented by check synchronising facilities or by the use of mechanical or electrical interlocking to be provided by the customer.

4.3 The normal requirement is that automatic synchronising facilities shall be provided on either the generator circuit breaker or the main incoming circuit breakers. Manual operation of these circuit breakers shall be disabled.

4.4 The customer shall design and install such synchronising arrangements and the specification shall be communicated to ESB and if approved by ESB shall form part of the requirements.

4.5 It shall not be possible for the generator circuit breaker or the main incoming circuit breaker to close or to remain closed unless all three phases of the mains supply are normal.

4.6 In the case of Asynchronous machines, speed control shall be provided to open or prevent closing of the generator circuit breaker or main incoming circuit breaker when the speed varies by more than +/- 5% of synchronous speed.

5. PROTECTION

5.1 The customer's shall ensure that the generator installation is adequately protected at all times and that it is suitable for connection to ESB Distribution System where manual and automatic switching including reclosure is a feature.

5.2 Protection devices installed in compliance with these requirements shall be independent of other equipment and located in a separate, secure and sealable compartment on the protection panel (unless otherwise agreed by ESB).

5.3 Relays shall be accessible from the ground and shall have visible indication of operation. The relays shall monitor the installation at ESB Distribution supply voltage, unless otherwise agreed by ESB.

5.4 The type of relays used shall have internal self-monitoring and fail-safe operation, which results in immediate tripping of the generator circuit breaker or main incoming circuit breaker, should any of the relays become faulty.

5.5 Where the circuit-breaker selected for tripping via the interface protection fails to trip on receiving a trip command, suitable intertripping shall be provided (unless otherwise agreed by ESB) to ensure that an alternative circuit breaker trips to isolate the generator.

5.6 The customer shall ensure that all interface relays, the generator circuit breaker and the main incoming circuit breaker are clearly identified.

5.7 Reclosure of the main incoming or generator circuit breaker following relay operation shall not be possible until all relays have reset correctly.

5.8 In order to ensure disconnection of the generator from ESB Distribution System during abnormal system conditions the following protection shall trip the main incoming circuit breaker or generator circuit breaker as appropriate:

(a) Over and Under Voltage:

To trip the circuit breaker for a voltage variation in excess of 10% from normal - a time delay of less than 1 second shall apply. Protection shall be provided on all 3 phases.

(b) Over and Under Frequency:

To trip the circuit breaker for a frequency variation of +1% to -4% from 50Hz - a time delay of less than 1 second shall apply. Protection shall be provided on a minimum of 1 phase.

(c) Loss of Mains:

To disconnect the generator from ESB Distribution System in less than 0.5 seconds subsequent to ESB mains failure. Mains failure protection shall operate for all possible load conditions. This prevents the occurrence of unsynchronised paralleling when ESB Distribution System is restored.

Where Asynchronous machines are used, Loss of Mains protection shall not be required where the installed power factor correction is less than 80% of the no load kVAR requirement of the machine. Other circumstances exist where Loss of Mains protection may not be required and these will be advised on a case by case basis.

(d) Directional Overcurrent (Electronic Type):

To trip the circuit breaker for a fault current flow to ESB Distribution System. A setting of up to 120% of the generator current rating shall apply. A time delay will be chosen by ESB on an individual case basis but will typically be less than 0.5 seconds.

Protection shall be provided on three phases by a current based quadrature connected relay with a +45° or +60° RCA. (RCA is defined as the angle between the polarising voltage and phase current which gives maximum sensitivity).

For generators whose capacity is less than 1 MVA at Medium Voltage or less than 200kVA at Low Voltage, Directional Overcurrent protection shall not be required.

For an installation comprising more than one generator with export envisaged, the Directional Overcurrent setting will be chosen on an individual case basis.

Where a restriction on export levels exists, the Directional Overcurrent relay will be set at the restricted level.

(e) Earth Fault:

To trip the circuit breaker for an earth fault on ESB Distribution System during parallel operation. A time delay will be determined by ESB on an individual case basis but will typically be 45 seconds.

There are exceptional circumstances where Earth Fault protection may not be required. These will be evaluated on a case by case basis.

(f) Relay D.C Supply

The relay d.c. supply voltage shall be monitored so that failure of this supply results in tripping of the circuit breaker.

(g) Trip Circuit Supervision

The continuity of the trip circuit between the output of each relay and the circuit breaker trip coil shall be monitored such that any discontinuity resulting from disconnection of the trip circuit wiring or an open circuit in the circuit breaker trip coil shall cause an alarm to be sounded and immediate isolation of the generator.

(h) Inrush Currents:

In the case of Asynchronous Generators, the magnitude of inrush current that may be drawn when the generator is paralleled with ESB Distribution System will be considered on an individual case basis. In some cases, the customer may be required to install equipment to reduce the magnitude of the inrush current to the limit specified by ESB.

(i) Frequency of Paralleling:

In the case of Asynchronous Generators, the number of times the customer's generator(s) can be paralleled via ESB Distribution System within a specified period of time, will be defined on an individual case basis.

(j) Power Factor

In general, the operation of the generator(s) shall not give rise to reactive power export to ESB's network.

Requests for reactive power export will be treated on a case by case basis.

In general the operation of the generator(s) shall not cause the power factor of power imported from or exported to ESB's network to be reduced below 0.95 lagging i.e. the magnitude of reactive power (kVAR) drawn from ESB's network shall be less than one third of the real power (kW) imported from or exported to ESB's network.

Accordingly reactive power compensation shall be provided for all asynchronous generators. In exceptional cases, some small asynchronous sets may be allowed to operate with a lower power factor (minimum 0.90). These situations will be examined on a case by case basis.

5.9 Protection requirements for short time Peak Reduction are as follows:

(a) Peak Shaving

In this case, the protection requirements for parallel operation of synchronous generators shall apply in full.

(b) Peak Lopping

In such cases, Over/Under Frequency, Earth Fault and Loss of Mains protection shall not be required. Over/under voltage protection and Directional Overcurrent protection shall be required. The Directional Overcurrent setting shall be less than the current rating of the smallest generator installed (typically 50%).

A timer shall be fitted by the customer which shall be sealed by ESB and which shall limit the period of parallel operation of the generator with the ESB Distribution System to 2.5 hours (Peak-Shaving) or 6 minutes (Peak-Lopping) in any day and which shall cause tripping of the generator circuit-breaker if this time is exceeded. An override switch may be provided by the customer for the timing mechanism so long as it is possible for the ESB to affix a seal to the override switch.

5.10 Summary of Protection Requirements

GENERATOR	OVER/UNDER VOLTAGE	OVER/UNDER FREQUENCY	LOSS OF MAINS	DIRECTIONAL OVERCURRENT	EARTH FAULT
Asynchronous	$\pm$ 10% $\leq$1 sec	+ 1% - 4% <1 sec	< 0.5 sec (if applic)		30% NVD < 45 sec (if applic)
Synchronous					
- Continuous	$\pm$ 10% $\leq$1 sec	+ 1% - 4% <1 sec	< 0.5 sec	< 120% < 0.5 sec (if applic)	30% NVD < 45 sec
- Peak-shaving	$\pm$ 10% $\leq$ 1 sec	+ 1% - 4% < 1 sec	< 0.5 sec	< 120% < 0.5 sec (if applic)	30% NVD < 45 sec
- Peak-lopping	$\pm$ 10% $\leq$ 1 sec			50% < 0.5 sec	

NVD: Neutral Voltage Dispacement

6. TESTING

6.1 Before ESB will grant permission for parallel operation:-

(a) The customer shall fully test the synchronising facilities and protection equipment specified in these requirements to the satisfaction of ESB in accordance with the Test Schedule in Appendix C. Such tests, some of which may require a short duration supply interruption to the installation, are the responsibility of the customer and shall be carried out by the customer or the customer's contractor/consultant and at the expense of the customer. The customer shall ensure that adequate equipment to perform the inspection test is available.

(b) Paralleling shall not take place, even for testing/commissioning purposes, without the prior consent of ESB.

6.2 The tests will be witnessed by ESB. It is required that at least two weeks notice of the proposed test date shall be given and agreed with ESB.

6.3 At least twenty-four hours in advance of the agreed test date, the customer shall provide the following information to ESB:

(a) Confirmation that all the customer's pre-commissioning tests have been successfully completed and that testing can proceed on the agreed date.

(b) Details of the proposed test equipment to be used.

(c) Completed pre-commissioning tests results sheet.

6.4 Tests shall be carried out on site. Manufacturers tests certificates shall not be acceptable.

6.5 The customer shall carry out, at its own expense, "Trip Tests" annually and "Full Tests" on a four yearly basis. Records of these tests shall be available for inspection by ESB, on request. The customer shall grant ESB right of access to the generator premises at all times. ESB shall also have the right at any time to carry out (or have carried out by the customer) such further tests as it deems necessary, to confirm the continued satisfactory operation of the installation and the continued compliance with the requirements as outlined herein or as amended in the future. ESB reserves the right to require the customer to install, at its own expense, any additional protection that it deems necessary to ensure continued safe parallel operation.

"Trip Tests" are defined as any tests which satisfactorily demonstrate that operation of a specified relay causes the circuit breaker to trip.

"Full Tests" are defined as the schedule of tests outlined on the attached test schedule. This includes injection testing.

6.6 ESB reserves the right to charge for all costs incurred in witnessing the commissioning tests. It is understood and agreed that ESB shall have the right to set off any money owed by ESB to the customer against any money owing from the customer to ESB.

7. APPROVAL PROCEDURE

7.1 At the earliest stage possible, application should be made to ESB, Customer Supply & Marketing detailing the scheme proposed.

7.2 Customer should complete and return the Customer Information Schedule (Appendix A) and Certificate of Compliance (Appendix B).

7.3 Proposal should comply with "Requirements for Connection of Generators to ESB Distribution System".

7.4 A Connection Agreement between customer and ESB Customer Services Business Unit may be required.

7.5 Where export of electricity to ESB is proposed, a Power Purchase Agreement between Customer and ESB Power Procurement may be required.

7.6 When the scheme has been completed arrangements will be made for witnessing by ESB, of customer's commissioning tests on the interface protection.

APPENDIX A
CUSTOMER INFORMATION SCHEDULE

A1. Customer:

(a) Customer Name : _____
(b) Address : _____
_____
(c) Contact Name : _____
(d) Contact Phone No : _____

A2. Generator:

(a) Generator Make : _____
(b) Rating (kVA)/Power Factor : _____
(c) Parallel Operation Mode (Continuous/Peak Lopping/ Peak Shaving) : _____
(d) Exporting/Non Exporting : _____
(e) Export Size (kVA) : _____
(f) Voltage : _____

A3. Please Provide Schematic/Single Line Diagram Showing

(a) Relevant voltage levels.
(b) Generator size and winding configuration.
(c) Transformer size, ratio and winding configuration.
(d) Circuit breaker location.
(e) Maximum three phase short circuit level in Amps.
(f) Location of alternative ESB supplies.
(g) CT/VT ratios and locations.
(h) Synchronising and Interlocking arrangements (including description).
(i) Relay types and location.
(j) Power Factor Correction location (if applicable).

A4. Please Provide The Following Information

(a) A schedule of the impulse level (BIL) and power withstand of equipment connected at each voltage level.
(b) A calculation sheet showing the fault current available from the private generators due to a metallic three phase short circuit at the main incoming circuit breaker when all the generators operated in parallel with ESB Distribution System are running. The customer should take account of any large motors in the installation performing this calculation (Ref IEC 909).
(c) The direct axis subtransient, transient, and synchronous reactance and respective time constants of each generator to be operated in parallel with ESB Distribution System.
(d) The inertia constant of the generator (s).
(e) Details of how protection circuit and trip circuit supervision shall be achieved in the installation.
(f) Details of the relays to be used including measuring range, proposed settings and calculations used to determine relay settings.
(g) Details of Power Factor Correction (if applicable).

APPENDIX B

To: Customer Supply & Marketing,
Customer Services Business Unit, ESB,
Lr. Fitzwilliam Street,
Dublin 2.

From:
Company:
Address:

Certificate of Compliance

Dear Sirs,

On behalf of ..... I acknowledge that I have read and understood and hereby accept the Requirements for Connection of Generators to ESB Distribution System for the generator plant listed below ("the Requirements"). I confirm that these Requirements have been and will in future be complied with in full and I also confirm that the plant is now ready for the "Testing" in accordance with Part 6 of the Requirements.

I undertake to comply within such time as may be stipulated by ESB as reasonable in the circumstances with any future amendments to the conditions which issue. I confirm that the relevant authorities mentioned in Part 2 of the Requirements have been informed about the generator plant and I also confirm that the installation complies with all statutory or regulatory Requirements.

..... hereby indemnifies Electricity Supply Board (ESB) against all claims, liabilities actions, causes of actions, damages, costs, charges and expenses of any nature for injury or death to any person or damage to any property or any claim arising from its performance or non-performance of the Requirements or due to negligence or breach of duty, statutory or otherwise, of ..... its servants or agents, arising directly or indirectly from the existence of the generator plant, whether in use or not.

..... hereby acknowledge that no liability shall attach to ESB for any loss or injury to persons or property including ESB and ..... personnel and property due to negligence or breach of duty, statutory or otherwise of ..... its servants or agents arising from the granting of permission for parallel operation.

The foregoing indemnity and undertaking shall be supported by a policy of public and product liability insurance effected by ..... in ..... Insurance Company to the amount of IR£1,000.000. A copy of this policy of insurance shall be provided to ESB's Insurance Manager for approval prior to commencement of the testing and no consent shall be forthcoming unless he is satisfied with the policy and the level of deductibles proposed. Proof of payment of annual premium shall also be provided to ESB. The policy will be renewed each year and evidence of this will be provided to ESB.

Generator Plant Details

Location:
Make:
Type (synchronous or asynchronous):
Rating:
Mode of Operation (continuous / peak-shaving / peak lopping):
Signed:
Name:
Position:
Date:

APPENDIX C

TEST SCHEDULE FOR CONNECTION OF GENERATORS

TO ESB DISTRIBUTION SYSTEM

As already stated in the 'Requirements' document, the customer is responsible for carrying out the tests and should ensure that the following are provided :-

(a) All test equipment, including variable voltage supply (3 phase if necessary), variable frequency signal generator, phase shifting current injection kit.

(b) Competent personnel to operate the equipment.

The purpose of the tests is to check each protection element specified in the requirements for :-

- functional operation by secondary injection.
- calibration by secondary injection.
- fail-safe operation.

Operational tests are to be carried out to verify :-

- automatic synchronising and interlocking.
- tripping of the isolating circuit breaker for protection operation.
- fail safe operation of the trip circuit.

The Test Schedule has been drafted to include all protection elements. Depending on the type of machine and operating regime, some protection elements may not be required. If in doubt please check with ESB to confirm which tests are applicable.

TEST PROCEDURE

The following test procedure is an example of the normal means of testing the elements of interface protection. Alternative test procedures may be acceptable but should be advised to ESB prior to tests being arranged.

It is advisable that the people doing the tests understand what is required, and any queries on any aspects of the tests should be directed towards ESB in advance of the agreed date. Two weeks notice of this date is required.

Confirmation that all pre-commissioning tests have been completed and that the protection is ready for final testing should be sent to ESB at least 24 hours in advance of the agreed date.

Note:- Parallel operation for test purposes should not take place without prior written permission from ESB.

The following tests will verify the operation and calibration of individual protection elements. The attached blank 'Test Results Sheet' should be filled in while doing the tests.

1. Voltage Protection

Over Voltage

a. Secondary inject each phase of the over voltage relay in turn raising the voltage until the relay operates for the over voltage setting required.

b. Verify that when the relay operates a trip signal is sent to the circuit breaker.

c. Note the total operating time.

d. Check the reset value.

Under Voltage

a. Secondary inject each phase of the under voltage relay in turn lowering the voltage until the relay operates for the under voltage setting required.

b. Repeat steps 1.b to 1.d outlined for Over Voltage above.

2. Frequency Protection

Over Frequency

a. Secondary inject the over frequency relay raising the frequency until the relay operates for the over frequency setting required.

b. Verify that when the relay operates a trip signal is sent to the circuit breaker.

c. Note the total operating time.

d. Check the reset value.

Under Frequency

a. Secondary inject the under frequency relay lowering the frequency until the relay operates for the under frequency setting required.

b. Repeat steps 2.b to 2.d outlined for Over Frequency above.

3. Directional Overcurrent Protection

a. Using secondary injection, inject each phase of the overcurrent relay in turn raising the current until the relay operates for the required overcurrent setting.

b. Verify that the relay is directional, the characteristic is correct, and that the relay blocks in the reverse mode.

c. Verify that the trip signal is sent to the circuit breaker.

d. Note the total operating time.

e. Check the reset value.

4. Earth Fault Protection

a. Secondary inject the earth fault relay raising the voltage until the relay operates above the required setting.

b. Verify that the trip signal is sent to the circuit breaker when the relay operates.

c. Check that the time delay is correct.

d. Check the reset value.

5. Protection Resetting

Verify that the Isolating circuit breaker cannot be closed unless all protection relays have reset and all three phases are healthy.

6. Protection Failsafe Operation

Disconnect the power supply from each relay in turn and check that a trip signal is sent to the circuit breaker.

7. Trip Circuit Supervision

Disconnect/interrupt the trip circuit from each relay in turn. This should bring up an audible alarm and isolate the generator.

Disable the tripping of the output circuit breaker and simulate the trip condition. Failure of the circuit breaker to trip should isolate the generator via an alternative circuit breaker.

8. Synchronising

a. Check that auto-synchronising operates correctly.

b. Check that interlocking prevents closure onto a dead busbar, for all possible combinations of mains and generators.

c. Check that interlocking prevents unsynchronised paralleling at all possible points of paralleling.

9. Protection Seals, Labelling

Check that all protection relays specified in ESB requirements are in a separate cabinet are labelled clearly and correctly and can be sealed.

10. Loss of Mains

Loss of mains testing will require an interruption in ESB supply. This will be arranged for the date upon which the final witness testing will take place.

The isolating breaker should open for loss of supply from ESB Distribution System.

11. Warning Notices

Check that warning notices as specified in the conditions are fitted.

TEST SCHEDULE FOR CONNECTION OF GENERATORS

TO ESB DISTRIBUTION SYSTEM

TEST RESULTS SHEET

SITE DETAILS
Location :
Owner :
Contractor :
Telephone No(s):

GENERATOR DETAILS
Type :
Operating Mode :
Rating :
Voltage :
Supply Details :

PROTECTION FUNCTION	NOMINAL VALUE	OPERATION SETTING	OPERATION VALUE	OPERATION TIME	RESET SETTING
Over Voltage R–N or R–S S–N or S–T T–N or T–R		+10% Time < 1 sec			
Under Voltage R–N or R–S S–N or S–T T–N or T–R		–10% Time < 1 sec			
Over Frequency	50 Hz	+ 1% < 1 sec			
Under Frequency	50 Hz	– 4% < 1 sec			
Directional Overcurrent R Phase S Phase T phase		50% or 120% <0.5 sec			
Loss of Mains R Phase S Phase T Phase Three Phase	See Item 10	Trip on Loss of Mains <0.5 sec			
Earth Fault Detection		Trip for Earth Fault 30% NVD			

OPERATING CONDITIONS	Y/N ?
Automatic Synchronising Interlocking Confirmed Standby/Independent Op. Automatic Restart Time Delay: CB manual operation Disabled ?	
Timing Control: - Hrs of operation	
SEALING: Relays can be sealed.	

GENERATOR SHUTDOWN	ISOLATING CB OPEN Y/N?
Emergency Stop Voltage Relay Frequency Relay Directional O/C Earth Fault Relay Protection Fail-safe Trip Circuit Supervision Loss of Mains Single Phase Three Phase	

SIGNED : .....

DATE : .....

EXHIBIT B

DISTRIBUTED GENERATION BETWEEN 30KW AND 1,000KW (ORION NEW ZEALAND)

1. INTRODUCTION

This document relates to the connection of Distributed Generation which is rated between 30kW and 1,000kW connected to Orion's Distribution Network.

2. DISTRIBUTED GENERATOR DEFINITION

Distributed Generation is electricity generation equipment connected to the customers installation, and capable of generating electricity back to the electricity network, as well as supplying electricity for the customers own use.

For Distributed Generation rated up to 30 kW, there are separate guidelines for connecting to the Distribution Network

These requirements apply to all existing or prospective Distributed Generators that may operate in parallel with the Distribution Network regardless of whether energy is exported or not.

These requirements do not apply to generators that have no connection to the Distribution Network.

3. GENERAL REQUIREMENTS

Before any electricity from a Distributed Generator may be exported into Orion's Distribution Network, the owner of the Distribution Generator must:

1. obtain written permission to connect from Orion;
2. have a contract with an Electricity Retailer; or
3. show that the requirements of the NZEM and/or MARIA or any subsequent Industry agreement for trading electricity will be met.

All Distributed Generators connected directly to Orion's low voltage Distribution Network shall, as a minimum requirement, comply with the requirements of the "EEA Guide for the Connection of Generating Plant" (order from http://www.eea.co.nz, cost $91.50) and shall be installed in accordance with NZECP4:1993 and/or NZS/AS 3000:2000 or any subsequent revision.

The general requirements outlined in AS 4777 for Distributed Generation up to 30kW shall also be followed, where the Generation plant uses inverters.

The installation must also comply with Orion's Network code.

The presence of Distributed Generation shall not restrict Orion's requirements for switching on the Distribution Network.

3.1 Contact Orion

It is important that you contact Orion early in your project development stage to enable Orion to co-ordinate with your requirements. In many cases it will be possible to connect Distributed Generation at the lower end of the 30kW to 1MW rated capacity range, to the existing Distribution Network without major modifications to the Network. However, for other cases there may be significant investigation and network modification required. Should alterations to the Network and/or the connection to the Network be required, there may be charges for this work. Therefore early discussions with Orion are essential.

In the first instance, Orion's contact person's name and contact details are shown on the card attached to the folder. Depending on the size and scope of the project, they will be able to provide the co-ordination with other Orion staff that may be required.

4. INFORMATION

4.1 Basic Details

The owner of the Distributed Generator must provide sufficient information to Orion to enable successful connection to the Distribution Network without affecting other connected Customers. Where the determination of this requires significant research and analysis, this may require a contribution from the prospective Generator owner.

The amount of information required will depend on the size and type of generation, and will remain confidential between the parties unless agreed otherwise. Orion reserves the right to release sufficient information relating to Distributed Generators for the purpose of meeting its obligations to Transpower, if Transpower requires such information under the Common Quality Requirements.

Subject to the Distributed Generator owner agreeing to meet its reasonable costs in doing so, Orion will, use the information provided per Section 4 to model the Distribution Network and to decide what method of connection will need to be employed and the Voltage level at which the connection should be made.

4.2 Technical information for distributed Generators

The information required to be supplied to Orion for all Distributed Generation is as follows:

4.2.1 Data required for each Distributed Generator

Data required for range of power output	30-100 kVA	100-750 kVA	>750 kVA
Type of generator unit - synchronous, asynchronous, etc;	✓	✓	✓
Type of prime mover;	✓	✓	✓
Rated terminal Voltage (kV)	✓	✓	✓
Rated generator capacity (kVA);	✓	✓	✓
Rated minimum power factors (both over and under excited) at rated kVA;		✓	✓
Maximum continuous active power generated (kW);	✓	✓	✓
Maximum short term active power generated (kW);		✓	✓
For asynchronous generators, reactive power requirements (kVAr);	✓	✓	✓
Anticipated operating regime e.g. continuous, intermittent, peak lopping;	✓	✓	✓
Method of Voltage control;	✓	✓	✓
Generator transformer details, if applicable;			✓

4.2.2 Interface Arrangements

Data required for range of power output	30-100 kVA	100-750 kVA	>750 kVA
The means of connection and disconnection;	✓	✓	✓
The means of synchronisation between the Distribution Network and the Distributed Generator;	✓	✓	✓
Generator neutral earthing arrangements;			✓

4.2.3 Technical Data

Data required for range of power output	**30-100 kVA**	**100-750 kVA**	**>750 kVA**
Lowest frequency at which the Distributed Generator can run			✓
Actual low frequency trip setting and time delay	✓	✓	✓
Actual over frequency trip setting and time delay.	✓	✓	✓
Minimum operating power;			✓
Generator kW/kVAr capability charts (at lower Voltage terminals at nominal and ±10% of nominal voltage) at:			
(a) maximum short term power;			✓
(b) maximum continuous power;		✓	✓
(c) 75% Output			✓
(d) 50% output			✓
(e) minimum power			✓
Auxiliary power requirements at:			
(a) Rated power output			✓
(b) Minimum power output			✓
(c) Start up			✓
Start up times to minimum operating power:			
(a) From Cold			✓
(b) From Warm			✓
(c) From Hot			✓
Normal ramp rate			✓
Time for cold start to full rated output;		✓	✓
Inertia constant (secs) (whole machine);			✓
Stator resistance;			✓
Direct axis synchronous reactance;			✓
Quadrature axis synchronous reactance;			✓
Direct axis transient reactance;			✓

Data required for range of power output	30-100 kVA	100-750 kVA	>750 kVA
Quadrature axis transient reactance;			✓
Direct axis sub transient reactance;			✓
Quadrature axis sub transient reactance;			✓
Leakage (positive sequence) reactance;			✓
Negative sequence reactance;			✓
Zero sequence reactance;			✓
Earthing resistance/reactance;			✓
Time constants:			
(a) Direct axis transient open circuit;			✓
(b) Quadrature axis transient open circuit;			✓
(c) Direct axis sub transient open circuit;			✓
(d) Quadrature axis sub transient open circuit;			✓
Generator transformer details (impedance, tap changer, vector group, earthing, maximum overvoltage capability at rated frequency etc.);			✓
Type of excitation system: (block diagram/specifications, forward/feedback gains/time constants and limits);		✓	✓
Speed governor and prime mover data: (detailed functional description of governing system with all subsystems including system control and turbine time).		✓	✓

4.2.4 Further information required by Transpower

There may also be other information required under the terms of a contract between Orion and Transpower in respect of Distributed Generation.

5. CONTROL ARRANGEMENTS

It is preferable for Distributed Generators not subject to despatch, to export reactive energy (kVArh) whenever real energy (kWh) is being exported onto the Distribution Network. Subject to network voltage remaining within agreed limits, the desired power factor should be between 0.85 and 0.9 – see sections 6 and 7 regarding islanding detection requirements.

Orion will advise if continuously acting fast response automatic excitation and/or governor control systems are required to control the Distributed Generator voltage and frequency without instability over the entire operating range of the Distributed Generator. This will depend on the size and type of Distributed Generator and the characteristics of the part of the Distribution Network to which it is connected.

6. PROTECTION

The Distributed Generator shall be equipped with the appropriate protection elements as required by the "EEA Guide for the Connection of Generating Plant". Distributed Generator owners are to consult Orion with regard to any special arrangements or protection that may be necessary due to the characteristics of the Distribution Network.

Protection Requirements			
	Above 30kW > 100 kW	**Above 100 kW > 750 kW**	**Above 750 kW**
Generator Circuit Breaker	✓	✓	✓
Dedicated Transformer			✓
Disconnect/Isolate 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 Network supply (Islanding see section 7)	✓	✓	✓
Power factor or Voltage Regulation Equipment		✓	✓

The protection associated with a Distributed Generator shall co-ordinate with the protection associated with the Distribution Network as follows:

(a) In order to reduce to a minimum the impact of faults on the Distribution Network, the generator must meet target clearance times, that are agreed between Orion and the generator owner, for fault power flowing from the Distribution Network, Orion will ensure that the relevant protection settings are compatible with the target clearance times that are specified by Orion;

(b) The settings of any protection which controls a circuit breaker, or the operating parameters of any automatic switching device at any Network Connection Point, shall be approved by Orion;

(c) It will be necessary for the Distributed Generator protection to co-ordinate with any auto re-close settings specified by Orion, and;

(d) (Any Distributed Generator connected to the Distribution Network may be required to withstand, without tripping, the negative phase sequence loading incurred during the clearance of a close-up phase-to-phase fault by Distribution Network back-up protection and which is within the plant short time rating.

7. ISLANDING

The part of the Distribution Network to which a Distributed Generator is connected, may inadvertently, or during emergency conditions, become detached from the rest of the Distribution Network, creating an "island". Orion will decide based on the local Distribution Network conditions, whether islanding is a credible possibility, and whether it is desirable for the Distributed Generator to continue to generate while connected to the islanded section of the Distribution Network. Orion would generally require that the Distributed Generator disconnect from the Distribution Network upon the detection of islanding.

If no facilities exist for the subsequent re-synchronisation with the rest of the Distribution Network, the Distributed Generator owner will, under Orion's control, disconnect the Distributed Generator prior to reconnection of the island to the rest of the Distribution Network and the subsequent re-synchronisation of the Distributed Generator.

Where Orion determines that islanding is a credible possibility and that the Distributed Generator is to disconnect upon detection, Orion will require that the Distributed Generator always export more reactive power than any credible islanded load can absorb. The Distributed Generator owner is to install equipment that is capable of detecting the resulting reduction in reactive power export/increase in voltage which would be caused by islanding and disconnect the Generator from the Distribution Network.

Under emergency conditions, some Distributed Generators may continue to operate outside the statutory frequency limits. Where Distributed Generators are connected to the Distribution Network at a Voltage level of 11kV or less, it is possible that there could be automatic low frequency load disconnection equipment within the load. Consequently, Distributed Generator owners should ensure that all protection on their Distributed Generator's has settings to co-ordinate with those on the automatic low frequency load shedding equipment. Orion will provide information on this equipment on request.

8. COMMISSIONING TESTS

Where Distributed Generators require connection to the Distribution Network in advance of the commissioning date for the purposes of testing, the Distributed Generator owner must comply with the requirements of the Delivery Services Agreement. The Distributed Generator owner shall provide Orion with a commissioning programme for prior approval by Orion.

9. METERING

Metering is the responsibility of the generator owner (if a MARIA party) or the MARIA party that purchases any exported electricity. However, provided the metering is installed to the requirements of MARIA, the metering can be arranged and owned by any party.

Orion requires metering that will measure both import and export volumes. For generators above 30kW that are connected to Orion's low voltage network the minimum metering requirement will be to measure active energy, in half-hour intervals. For generators above 30 kW that are connected to Orion's HV network, the minimum metering requirement will be to measure active and reactive energy, in half-hour intervals. This will require 4-quadrant "Time Of Use" (TOU) metering to be installed. This metering will require either a telephone connection or a cellular connection for remote interrogation.

You should discuss the metering with your electricity retailer first, as they may install the required metering or choose to modify your existing metering.

A list of approved metering suppliers and installers is available from the internet at: *http://www.nzelectricity.co.nz/C3d2test.htm*, should you elect to arrange the installation.

10. SIGNAGE

Suitable signage shall be attached to all switchboards that can be supplied from any generation in accordance with AS/NZS 3000. Typical signage is shown below:

WARNING

DUAL SUPPLY

ISOLATE BOTH NORMAL AND GENERATOR SUPPLIES BEFORE WORKING ON THIS SWITCHBOARD

Sign on Switchboard to which Generator is connected

WARNING

DUAL SUPPLY

ISOLATE GENERATOR SUPPLY AT GENERATOR DISTRIBUTION BOARD BEFORE WORKING ON THIS SWITCHBOARD

Sign on Intermediate Distribution Switchboard

11. PAYMENTS AND CHARGES

As owner of the Distributed Generation installation you will need to negotiate a contract for the amount of electricity that is sold to an electricity retailer, or to another party via an electricity retailer.

There are specialist companies that provide analysis and price prediction, should you wish to compare any offers from Retailers, or discuss other options to sell the electricity generated.

Orion will credit your retailer for the amount you generate during certain peak related load times Where the distributed generator injects into Orion's network during peak times of peak loading, the need for Orion and Transpower to provide capacity in their networks is reduced.

For generators connected to the low voltage network, Orion will pay for the average real power (i.e. kW) that is exported during the Peak Period. For generators connected to the high voltage network Orion will pay for the average real (i.e. kW) and for the reactive (i.e. kVAr) components of apparent power that are exported during the Peak Period.

In rural areas, the peak load usually occurs during the summer day (due to loads such as irrigation) while in urban areas the peak is often in winter evenings (due to heating and cooking loads). For details of the amount that Orion's will pay for your export generation. Specific rates are detailed in separate pricing documents.
Your Time of Use meter will enable you to be paid by your retailer and/or the purchaser of your exported electricity for the correct amount that you have exported during the peak periods.

There will often be initial one-off Network charges for the connection of your Distributed Generation system, and there may also be other Network modifications required which could require funding arrangements to be agreed between the owner and Orion, therefore early discussions with Orion are essential.

EXHIBIT C

POWERCOR AUSTRALIA
CUSTOMER GUIDELINES FOR EMBEDDED GENERATION OF RATING UP TO 1MW

Customer Guidelines for Embedded Generation of Rating Up to 1 MW

January 2002

Introduction and Purpose

These guidelines are intended to cover the installation of private generating sources of capacity up to one megawatt (1.0 MW) which customers wish to connect to the Powercor grid.

It is intended that such generating sources be allowed to be connected to the grid on the basis that:

- The customer, if they intend to export electricity into the Powercor grid, do so under a Network Connection Agreement with Powercor and a contractual arrangement with their Retailer.
- The customer still requires a supply of electricity from the Powercor grid for at least part of the time.

The guidelines have been prepared in order to:

- Promote customer installations which are safe for both the customer and for Powercor line maintenance personnel.
- Protect customer installations against damage under fault conditions.
- Ensure that other Powercor customers are not exposed to hazards or to disruptions of supply.

Sister documents provide guidelines for smaller plant, up to 20 kW in capacity, which incorporate sine wave dc/ac inverters for grid connection, and for generators above 1 MW which are intended to operate in parallel with the Powercor grid with significant export of power.

Powercor Policy

Powercor is supportive of initiatives by electricity customers to install environmentally – friendly generating sources and will allow such installations to be interconnected with the grid provided that:

- Reliability and quality of the grid supply to other customers is not adversely affected.
- The safety of other customers and of Powercor employees and contractors is not put at risk.
- The customer's plant is of an approved design and capable of operating for extended periods.

Retailers have already introduced various programs through which customers may support the use of renewable resources on a larger scale for the generation of electricity.

600 kW generating plant fuelled by biogas

Customer Equipment Types

The types of generating equipment covered by these guidelines include, but are not limited to the following:

- Photovoltaic arrays, fuel cells and other sources which are connected to the customer's loads and to the grid by dc/ac sine wave inverters.
- Wind generators which are connected to the mains by asynchronous generators or by static frequency converters.
- Synchronous generators driven by hydro turbines.
- Synchronous generators driven by gas engines, gas turbines or diesel engines.

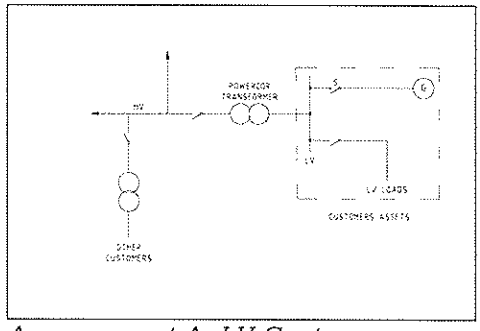
The last mentioned category includes commercial standby generating plant which is operated in parallel with the grid either by arrangement with Powercor for purposes of demand management or for routine on-load testing.

Rotating generators of rating greater than 50 KW should be of the synchronous type having an internal source of field excitation. Asynchronous (induction) generators above this rating may unduly load the grid and may not be connected to the grid without Powercor's specific agreement.

The details of the local network may require additional limitations.

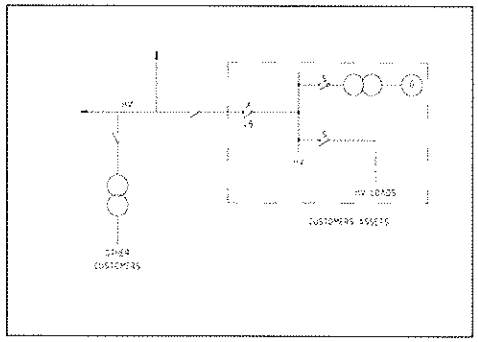
Typical generator examples are shown in the diagrams below:

Arrangement A represents a property supplied from a dedicated Powercor transformer. The embedded generator or inverter-connected source is connected to the customer's main switchboard and may export to the Powercor grid. An export limit of less than 1MW may apply, depending on the rating of Powercor's transformer.



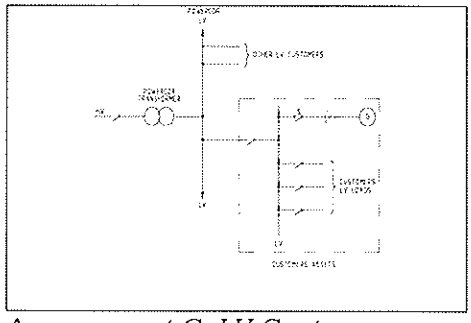
Arrangement A- LV Customer

Arrangement B represents a commercial or industrial premises having a high voltage distribution system. The embedded generator is connected to the customer's high voltage main switchboard and may export to the Powercor grid. Under these guidelines, a connected synchronous generator may be of rating up to 1MW.



Arrangement B- HV Customer

Arrangement C represents a commercial or industrial premises having a low voltage distribution system. The embedded generator or inverter-connected source is connected to the customer's low voltage main switchboard and may export to the Powercor grid both at low voltage, and at high voltage via Powercor's distribution transformer. In this case an export limit of less than 1MW may apply regardless of the generator type. This limit is determined by the local low voltage network and/or the rating of Powercor's transformer.



Arrangement C- LV Customer

In all cases the following safeguards are needed to prevent danger to life and damage to your equipment:

- Your generating plant, regardless of type, must be prevented from back-feeding the Powercor network if the mains supply is externally de-energised.
- Your generating plant, if of the synchronous type, must be prevented from connection out-of-phase onto the energised Powercor mains.
- Your equipment must include protective devices which will, in the event of a short circuit or other fault on your generator, disconnect your plant from the mains so that it will not be further damaged by large fault currents flowing from the external grid.
- Your equipment should be protected against incoming surges which may be caused by a lightning strike on overhead Powercor lines.

Your generating plant must also be equipped with controls which enable satisfactory operation over a variation in grid voltage. Under the Electricity Distribution Code, steady state grid voltage at the point of supply to the customer may vary by up to plus/minus 6% of nominal value.

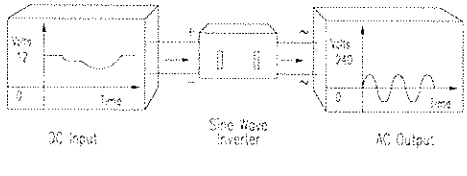
The Electricity Distribution Code also requires that the power factor of a customer's installation at the point of supply falls within the range 0.85 lagging to 0.85 leading when drawing more than 50% of maximum demand . For customers operating embedded synchronous generating plant, Powercor requires that the synchronous generator(s) send out electric power at a power factor in the range 0.85 to 0.95 leading, as measured at the generator's terminals.

Inverters

An inverter is an electronic device which converts DC (direct current) power to AC (alternating current) electrical power. The electrical distribution grid uses AC (50 Hz frequency) whilst most small generating equipment such as fuel cells and solar arrays generate DC power. An inverter has thyristors or other types of semiconducting devices to chop the DC source voltage to produce an AC output waveform (for example 24 V DC to 240 V AC, which is suitable for most electrical appliances).

As the output of the inverter usually is not perfectly sinusoidal, the output waveform will contain harmonics and high frequency noise. The harmonics and noise can create telephone interference and also interfere with sensitive equipment connected to the distribution grid near the inverter.

To connect to the Powercor network it must be of the grid interactive type and be approved by Powercor.

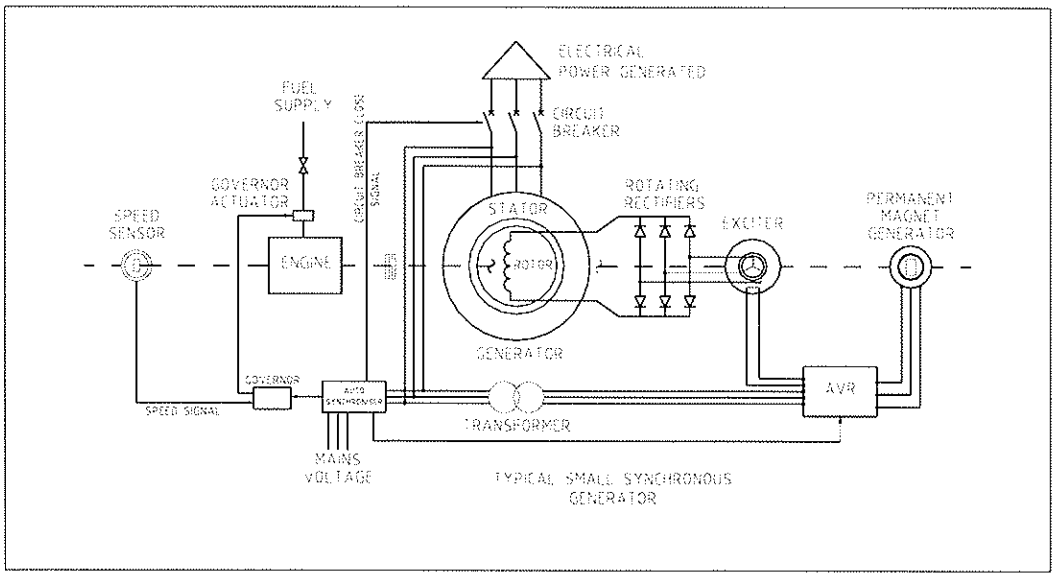


Synchronous Generators

A synchronous generator is an AC machine in which the rotor speed, and hence the frequency of the output voltage is constant. The magnetic field of the machine is produced by a dc current, the generation of which requires an auxiliary power supply to the generator.

Synchronous generators can operate connected to the grid or independent of it. To connect to the grid the following equipment is needed:

- Synchronising equipment (usually automatic).
- Automatic Voltage Regulator, which controls the field current.
- Governor, which automatically controls the fuel input to the engine/turbine to to keep speed and power output at the set levels.
- When connected to the grid, a synchronous generator is electrically locked in phase with the external grid.



Asynchronous Generators

An asynchronous or induction generator is basically an induction motor driven above synchronous speed by the prime mover. Asynchronous generators usually maintain their magnetic fields by drawing magnetising current from the external grid, which can place additional demands on the grid.

They are not capable of operation isolated from the grid. When connected to long overhead lines safety problems due to over voltage may occur.

Prime Mover

Synchronous and asynchronous generators convert mechanical power to electrical power; the prime mover supplies the input mechanical power to the generator. The prime mover may be a turbine or a reciprocating engine. For generators less than 1 MW the prime mover is generally an engine.
Small turbines are usually driven either by the:

- expansion of steam
- combustion of gas
- flow of water (hydro)

Reciprocating engines used for power generation can be driven by:

- natural gas, LPG or biogas
- petrol
- diesel fuel/distillate

Synchronising Equipment

The grid voltage and the generator voltage are AC. In the case of synchronous generators, the generator voltage and the grid voltage must remain in phase (synchronised) at all times. If a generator is connected to the grid and a disturbance causes the generator to lose synchronism the generator voltage, current and power will fluctuate greatly.

Other customers connected to the grid will be disturbed; also the generator and the engine/ turbine may be damaged.

A synchronising relay is required to ensure that the generator is synchronised with the grid prior to connection. A pole slipping relay detects the loss of synchronisation and can be used to initiate the disconnection of a generator.

In the case of asynchronous generators, synchronising equipment is not needed.

Protective Systems

Protective devices are required to prevent damage to the generator if a fault occurs on the generator or close to it. The types of protection used depend on the size and the importance of the generator. Typical protection installed on generators smaller than 1 MW includes:

- Overcurrent
- Reverse power
- Under/over voltage
- Rotor earth fault
- Stator earth fault
- Under/over frequency
- Loss of synchronism (pole-slipping)
- Loss of mains

Where the generator is connected to the Powercor grid via a distribution feeder equipped with automatic reclosing, the loss of mains protection must disconnect the generator in a time which is safely less than the automatic reclose setting which is typically 3 seconds.

Surge Protection

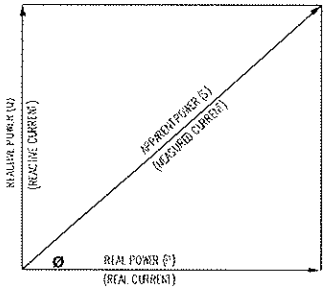
If lightning strikes overhead power lines near a generating plant, the generator insulation is liable to be damaged and requires protective devices to divert the surge away from the generator. Overvoltages may also occur when switching occurs in the power network.

Surge arresters are used to protect equipment from such overvoltages. They are installed in parallel with the equipment they are protecting. They are designed to conduct away surge currents only when a large overvoltage occurs.

Power Factor

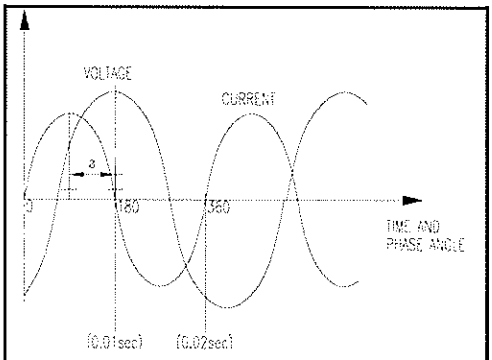
Generators can produce both active and reactive power. Active power carries out useful work whilst reactive power serves only to maintain magnetic and electric fields in the external network. Power factor is determined by the ratio between active power (P) and reactive power (Q). Power factor = cosine [arctan (P/Q)].

Reactive power produced by the generator and exported into the grid can cause additional losses in the distribution system but can also assist in controlling local network voltage. Generators are usually designed to operate over a power factor range of 1.0 to 0.8 leading.



POWER FACTOR DIAGRAM

MEASURED CURRENT IS THE VECTOR SUM OF THE CURRENT WHICH CARRIES REAL POWER (REAL CURRENT) AND THE CURRENT WHICH IS REQUIRED TO MAINTAIN MAGNETIC FIELDS (REACTIVE CURRENT)



Automatic Voltage Regulators (AVR)

An AVR controls the output voltage of a generator. The AVR senses the generator terminal voltage and adjusts the generator field current accordingly. The AVR must be able to respond quickly to disturbances to help the generator remain stable and to ensure that the voltage remains within acceptable limits.

Governors

Governors monitor the speed and power output of the engine or turbine and adjust the fuel flow via valves to keep the synchronous generator at the correct speed. The generator must operate at 50 Hz or otherwise it would lose synchronism with the grid.

Governors also control the power output of the generator.

Planning and Selection

Powercor is not able to offer assistance in the planning and selection of your proposed generating equipment other than the advice relating to the interface with the Powercor grid.

The Sustainable Energy Authority Victoria(SEAV) has details of Accredited Consultants and

Suppliers who are experienced in this area.

You are strongly advised to carefully estimate your equipment costs and continuing running costs to ensure that your installation is financially viable if you intend to export electricity into the grid.

Be careful to purchase generating equipment having a suitable technical specification and which is equipped for interconnection with the grid (see technical boxes below).
The following equipment selections are subject to Powercor's approval:

- Sine wave inverters.
- Anti-backfeed protection.
- Governing, excitation and synchronising equipment (synchronous generators)
- Interconnecting switchgear and associated protection relays.

Installation and Connection to Grid

The installation of generating sources should always be carried out strictly in accordance with the manufacturer's recommendations, and must meet the requirements of your local council's planning and building departments.

The use of inflammable fuels is subject to state government regulation, as are the emission of exhaust gases and noise.

The electrical controls, cabling and connection to the Powercor grid must be carried out by a registered electrical contractor.

Your new installation must be checked by a licenced electrical inspector prior to connection to the Powercor grid.

Where it is wished to export more than 20 KW into the Powercor grid, your plant must generate three phase ac power. For connection to the grid, you must confirm with Powercor that a three phase line is available to your premises.

Your new installation may not be connected to the Powercor grid prior to the successful completion of tests at your premises which must be witnessed by a Powercor officer.

Generating Plant Fuelled by Gases or Inflammable Liquids

If your installation uses an engine, gas turbine, fuel cell or other equipment which is fuelled by natural gas, LPG, biogas, petrol, diesel fuel, distillate or other inflammable source, you are obliged to comply with the following regulations (where applicable):

- Gas installation code (AG601)
- Code for industrial and commercial gas-fired appliances (AG501)
- EPA policy on noise emissions
- EPA policy on atmospheric emissions
- MFB and CFA requirements
- Local municipal planning and building regulations

Where electrical equipment (including generators) are located at or close to sources of inflammable gas or vapour, it is also necessary to follow the Hazardous Area Standards (see Standards Association Of Australia HB13) in order to mitigate risks of explosion. For generating plant it is common to provide protection ventilation (AS1482) and to exclude as many electrical accessories as possible from the hazardous area.

Notes to your Electrical Contractor

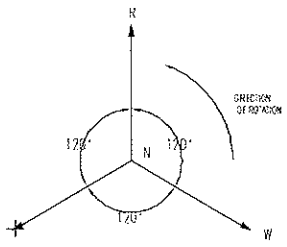
1. *Electrical installation work for generating plant fuelled by gases or inflammable liquids should not be commenced without a documented design which takes into account the requirements of the above codes and standards.*

2. *You are advised to confirm that the proposed grid interface equipment (switchgear,protective systems,sine wave inverters, synchronous generator ancillary equipment, etc) are of types approved by Powercor.*

Three phase and Single phase power

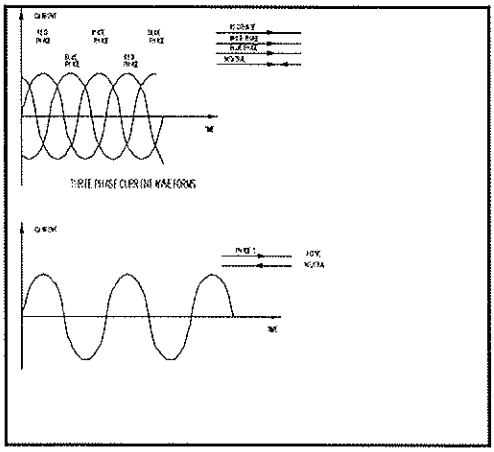
Generally all power is distributed in three phases. A vector representation of the three phases is shown below. Each phase voltage is of equal magnitude but separated by 120° from the other phases. For a low voltage (LV) system the line to line voltage is 415 V. An industrial site generally has a 3 phase connection.

The power supply connected to most houses is single phase. That is, only one of the 3 phases and the neutral is connected to the house distribution board. The phase to neutral voltage is 240 V, which is 415 V divided by the square root of 3.



VECTOR REPRESENTATION

R = RED PHASE
W = WHITE PHASE
B = BLUE PHASE



Site Test Requirements

Prior to the installation being connected to the grid electrical, tests will be required to be performed by a registered electrical contractor or licensed electrical inspector. The number and type of tests required depends on the whether the installation is high or low voltage. Typical tests performed are:

- Earthing system resistance
- Insulation resistance
- High voltage test
- Performance test of AVR and governing systems
- Functional test of all protective relays
- Functional test of all safety circuits and interlocks

Powercor Responsibilities

- Powercor is responsible for the safe and reliable transport of electricity to your premises and to the premises of all its other customers.

- Powercor reserves the right to inspect your installation by prior arrangement.

- Powercor may be obliged to disconnect your generating plant if it is causing nuisance to other customers connected to the grid.

Customer Responsibilities

- The customer is responsible for the safe installation, operation and maintenance of his generating source. The installation must conform to Australian Standards, AS/NZ 3000:2000, and the Service & Installation Rules and should be regularly inspected and maintained in accordance with the manufacturer's instruction manuals.

- The customer is responsible for the safety of any person operating or maintaining generating equipment and accessories which are on his premises.

- The customer is responsible for fitting adequate protective devices to prevent damage to his generating equipment under conditions of short circuit, voltage surges or other faults.

- The customer is responsible for meeting all current codes and regulations dealing with the storage and use of inflammable fuels, with levels of noise and atmospheric emissions, and with personnel safety and health.

Victorian Electricity Distribution Code

The Electricity Distribution Code, which is administered by the Office of the Regulator-General, further defines the responsibilities of Distributors and their Customers. The Code, which considers embedded generators in Chapter 7, is available at website http//www.reggen.vic.gov.au/

Energy Pricing and Metering

Subject to approval of your proposed installation, Powercor will enter into a Network Connection Agreement. You will need to enter into an agreement with a Retailer to purchase electricity which is exported into the grid. The agreement would typically cover the price paid by the Retailer, hours of operation, and total annual amount of electricity.

The form of the Network Connection Agreement may be obtained from your local Powercor customer connection adviser.

When your generator is in operation, you will experience: reduction in your imported electricity, which may approach zero export of surplus electricity into the grid.

Exported electricity must be separately metered so that the correct payments may be made.

A project fee and Network extension works costs will be applied for interconnection of generating sources to the Powercor grid.

Metering arrangements must be made with your relevant Retailer.

The Retailer will arrange to have electronic metering installed at your premises which will separately meter energy (kilowatt hours) which is drawn from the grid and energy which is exported into the grid.

The provision of this metering will typically incur a metering fee. Contact your Retailer for Metering Fees.

Forms of Agreement

1. All generating customers located within Powercor's boundaries must enter into a Network Connection Agreement with Powercor for connection to the Powercor grid. Where modifications to the local grid are needed to accommodate your generating plant, you must also enter into an Extension Works contract

2. You also need an Agreement with your relevant Retailer for the sale and purchase of electricity.

   Your local customer connection adviser will discuss these forms with you.

Installation Approvals

The embedded generation installation will need to be inspected by a licensed electrical inspector and Powercor Engineer. The Office of the Chief Electrical Inspector maintains a listing of licensed electrical inspectors.

Communications and Attendance

Powercor operations and maintenance personnel may need to contact you at short notice prior to carrying out any urgent maintenance work on the nearby network.

Safety considerations may require a visit to your premises by Powercor operations personnel to check the status of your generator installation. On application, you will be asked to provide contact details for these purposes.

Insurance

Most building insurance policies will not cover risks associated with generating plant.

You are advised to contact your own insurance company to check coverage and make additional arrangements.

Operation and Maintenance

Your equipment should be regularly inspected and maintained in accordance with the manufacturer's guidelines.

Maintenance and Operation of Gas-fuelled Prime Movers

For safety reasons, the maintenance of gas-fuelled generating plant should only be carried out by specialist maintenance engineers who are experienced and qualified in the field.

Application Form

Customers seeking to install electrical generating plant must fill out the application form to be obtained from your local Powercor customer connection adviser.

Please provide all details requested on the form in order to avoid delays in approval.

The customer connection adviser will ask that details of your equipment (see the listing P 17) be attached to your application. He will also ask for a sketch of the electrical wiring proposed by your electrical contractor (see the examples included). For most generator installations, the customer connection adviser will wish to convene a meeting with a Powercor engineer present.

For customers residing within Powercor's boundaries the name of the retailer must be stated. Powercor will forward a copy of its Notice of Approval to the nominated retailer.

Information and Queries

Refer Information Sheet.

Disclaimer

While Powercor makes efforts to ensure that this information and material is current and accurate, the information and material is provided to you on the understanding that:

- Powercor makes no warranty, guarantee or promise, express or implied, in relation to the content or accuracy of this information and material.
- You will seek verification and/or professional advice from an independent source before relying on or acting upon any of this information and material.
- Powercor is not liable or responsible in any way for the results of any actions taken on the basis of this information and material.

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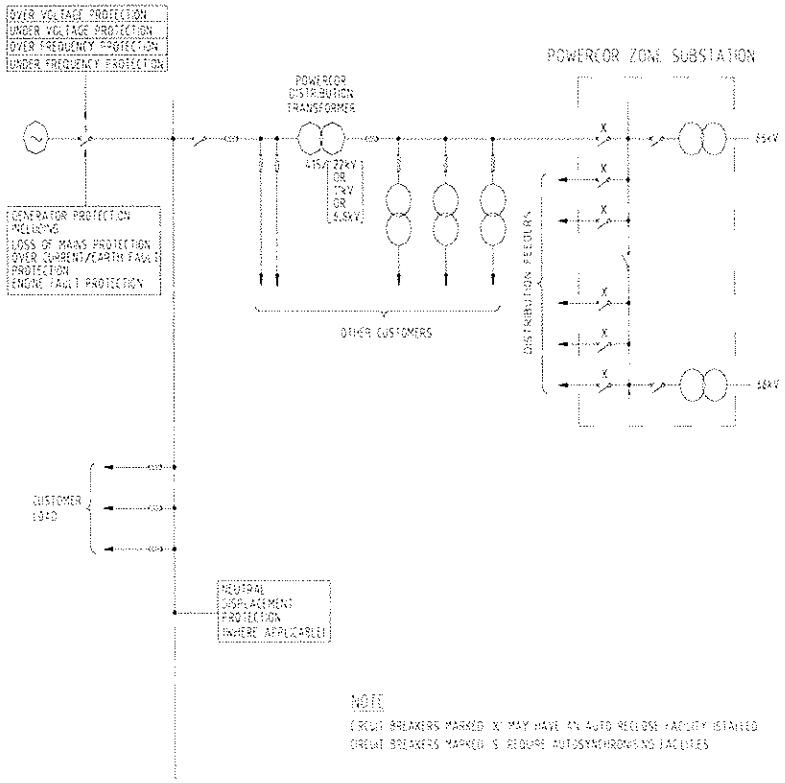

Example:- LV Grid Connection

Information Sheet

For general advice and information on Accredited Consultants and Suppliers please contact the Sustainable Energy Authority(SEAV) on **1300 363 744**.

To Contact Powercor
(For Grid Connection)

Customer Enquiries:	**132 206**
Service Difficulties & Faults:	132 412
Business Customer Enquiries:	132 334
New Connections:	1300 360 410
Interpreter Service:	131 450

Head Office

Powercor Australia Ltd
40 Market Street
Melbourne
Victoria Australia 3000
Ph: +61 3 9683 4444
Fax: +61 3 9683 4499

Postal Address:
Locked Bag 14090 MCMC
Melbourne Victoria 8001

Other Powercor offices are located at:

Ballarat	Norman Street, Ballarat
Bendigo	601-611 Napier Street, Bendigo
Geelong	Roseneath Street, North Geelong
Horsham	17 McLachlan Street, Horsham
Mildura	Eleventh Street, Mildura
Shepparton	8–10 Wheeler Street, Shepparton
Sunshine	20 Hertford Road, Sunshine
Warrnambool	7 Strong Street, Warrnambool

Electrical Measurement Units

Quantity	*Unit*	*Unit Symbol*
Current	*ampere*	*A*
Potential Difference	*volt*	*V*
Power	*Kilowatt*	*kW*
Reactive Power	*Kilovar*	*kVAr*
Apparent Power	*kilovoltampere*	*kVA*
Frequency	*hertz*	*Hz*
Energy	*kilowatthour*	*kWh*

Glossary of Terms

grid	*the electrical distribution network*
DC	*Direct current. The direction of current flow does not change.*
AC	*Alternating current. The direction and magnitude of current oscillate to a sine wave function.The Australian grid operates at 50 Hz (50 oscillations per second); USA and some other countries operate at 60 Hz.*
Inverter	*An electronic device that converts DC power to AC power. A sine wave inverter produces a sine wave output with very low harmonic distortion*
Renewable electricity	*Power that comes from a renewable source such as solar, hydro and wind.*
Voltage Regulation	*The drop in voltage between no load and full load.*
Voltage Regulator	*(for a synchronous generator) The ancillary device which controls the dc field current of the machine in order to regulate the output ac voltage of the machine to a set value regardless of the load current.*
Governor	*A control device on a reciprocating engine or turbine which regulates the flow of fuel to produce a set power output at a given speed.*
Retailer	*The supplier of electrical energy (as a market commodity) to a customer in any location.*

Distributor	*The owner and operator of the electricity distribution network (grid) to which the customer is connected. The retailer's energy must be delivered to the customer via the distributor's poles and wires (network); the distributor charges for this service.*
Embedded Generator	*An entity which owns and operates generating plant which is connected to the distribution network and not to the transmission network. Embedded Generators do not trade on the National Electricity Market but sell their export electricity to retailers.*
Efficiency	*Output power divided by input power.*
Harmonics	*Whole numbered multiples of the fundamental frequency. For example, the fifth harmonic = 5 x 50 Hz = 250 Hz.*
Total Harmonic Distortion	*The square root of the sum of all the harmonic components, divided by the fundamental component.*

Application Information:- Grid Connection
(Embedded Generation Up to 1 MW)

Name: Telephone No:

Address:

Account No: Electricity Retailer:

National Metering Identifier No.(NMI)

Energy Generation Source:
(Eg Biomass, Wind, etc)

Supplier(s) of Generating Equipment:

. Electrical Consultant - Telephone No:

. Electrician - Telephone No:

Equipment Details

For Rotating generator

- Driving machine:
- Fuel:
- Generator manufacturer:
- Model no:
- Continuous rating (kVA):
- Voltage:
- No. of phases:
- Type of excitation:
- AVR Model No:
- Type of engine governor:
- Governor Model No:
- Protective devices (list)
- Autosynchroniser Model No:

For Grid Connection via Inverter

- Type of Inverter:
- Manufacturer: Rating(W):
- Inverter Model Name: Model No:
- Compliance Number:

Proposed Point of Connection:

Proposed Protective Device at Point of Connection:

Other Installation Details: (Additional Sheets if necessary)

Circuit Diagram(Refer Examples)

EXHIBIT D

IEC 60255 SERIES

IEC 60255 SERIES

IEC 60255-11 Ed. 1.0 b:1979	Electrical relays - Part 11: Interruptions to and alternating component (ripple) in d.c. auxiliary energizing quantity of measuring relays
IEC 60255-12 Ed. 1.0 b:1980	Electrical relays - Part 12: Directional relays and power relays with two input energizing quantities
IEC 60255-13 Ed. 1.0 b:1980	Electrical relays - Part 13: Biased (percentage) differential relays
IEC 60255-16 Ed. 1.0 b:1982	Electrical relays - Part 16: Impedance measuring relays
IEC 60255-21-1 Ed. 1.0 b:1988	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section One: Vibration tests (sinusoidal)
IEC 60255-21-2 Ed. 1.0 b:1988	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section Two: Shock and bump tests
IEC 60255-21-3 Ed. 1.0 b:1993	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section 3: Seismic tests
IEC 60255-22-1 Ed. 2.0 b:2005	Electrical relays - Part 22-1: Electrical disturbance tests for measuring relays and protection equipment - 1 MHz burst immunity tests
IEC 60255-22-2 Ed. 2.0 b:1996	Electrical relays - Part 22: Electrical disturbance tests for measuring relays and protection equipment - Section 2: Electrostatic discharge tests
IEC 60255-22-3 Ed. 2.0 b:2000	Electrical relays - Part 22-3: Electrical disturbance tests for measuring relays and protection equipment - Radiated electromagnetic field disturbance tests
EC 60255-22-4 Ed. 2.0 b:2002	Electrical relays - Part 22-4: Electrical disturbance tests for measuring relays and protection equipment - Electrical fast transient/burst immunity test
IEC 60255-22-5 Ed. 1.0 b:2002	Electrical relays - Part 22-5: Electrical disturbance tests for measuring relays and protection equipment - Surge immunity test
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