Aurora Energy Limited

Network Connection Requirements (NS5.1)

Version 1.1
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Status and Application of these Requirements

All connections on the Aurora electrical distribution network (the Network) are subject to the contractual terms of a Use-of-System Agreement which, among other things, require all consumers covered by the agreement to comply with Aurora's network connection standards. Accordlingly, this document defines the requirements that must be complied with, on a continuing basis, for all consumer installations connected to the Network.

These requirements will be amended periodically, to reflect changes required for continued compliance with legislation and good industry practice. It is the responsibility of installation owners to ensure that compliance with these requrements is maintained at all times. The current version of these requirements will be maintained on Aurora's website (www.auroraenergy.co.nz), and will apply from the date of publication.

Version Control			
Version	**Date**	**Summary of Significant Amendments**	**Approved**
1.0		Basic and technical requirements combined. Legislation references updated. Load control requirements amended and change to 317Hz signalling in Dunedin advised. Protection of Sensitive Equipment added. Service connection transition joint requirements amended.	LRM
1.1	1 June 11	Clauses 10.1 and 10.6 modified re plugin electric vehicles	LRM

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1. PURPOSE AND SCOPE OF THIS DOCUMENT

As required by the Directors of Aurora Energy Limited (Aurora), this document defines the requirements that must be complied with, on a continuing basis, for all consumer installations connected to the Aurora electrical distribution network (the Network).

These requirements will be amended periodically, to reflect changes required for continued compliance with legislation and good industry practice. It is the responsibility of installation owners to ensure that compliance with these requrements is maintained at all times. The current version of these requirements will be published on Aurora's website (www.auroraenergy.co.nz), and will apply from the date of publication.

1.1. Definitions

Unless otherwise defined below, the terms used in this document are as defined in the Electricity Act 1992, the Electricity Safety Regulations 2010, and any subsequent amendements.

Retailer	means an electricity retailer who has a valid Use-of-System contract with Aurora.
Connection Capacity	means the maximum load in kVA a connection can serve. The Connection Capacity is synonymous with the Assessed Capacity, as defined in Aurora's Use-of-System Pricing Methodology.
EGRs	means the Electricty Governance Rules.
ESM	means the *DELTA* Utility Services Ltd Engineering Services Manager.
MCCB	means moulded case circuit breaker.
Metering Point	means the location on a consumer's installation where the Retailer's metering equipment is installed.
Point of Common Coupling	means the point in the Network, electrically nearest to the consumer, at which other consumers are or may be connected.
NZECP	means a New Zealand Electrical Code of Practice.
HV Secondary Network	means a separately owned network of electricity distribution assets that is connected to the Aurora Network.
Network Supply Point	means the point at which an HV Secondary Network connects to the Aurora Network.
Dunedin Area	means that part of the Aurora Network connected to Transpower via the Halfway Bush and South Dunedin grid exit points.
Central Area	means that part of the Aurora Network connected to Transpower via the Clyde, Cromwell and Frankton grid exit points.

Te Anau Area means that part of the Network connected to Transpower via the Heritage Estate network supply point.

2. RELATIONSHIP BETWEEN AURORA AND *DELTA*

Aurora owns the electricity distribution network in Dunedin and Central Otago. Aurora contracts *DELTA* to manage and operate the network.

3. APPLICATIONS FOR NEW NETWORK CONNECTIONS

All applications for new connections to the Network shall be made on the Aurora Connection Application form, available at *DELTA* offices and from www.auroraenergy.co.nz .

All applications shall include details of any notifiable loads as defined in section 10.1.

4. MODIFICATIONS TO EXISTING NETWORK CONNECTIONS

Existing consumers shall seek approval, using the Aurora Connection Application form, before proceeding with any of the following work:

- Installation of any notifiable loads as defined in Section 10.1.
- Replacement of all or part of the mains.
- Increasing the installation load beyond the existing assessed capacity of the connection.
- Installation of load limiting circuit breakers to obtain a low capacity connection as detailed in Section 7.1.

5. APPROVAL TO CONNECT

The following conditions shall be fulfilled before a connection will be livened:

- The Consumer has entered into an agreement with a Retailer to purchase electricity.
- The Consumer's installation has an Electrical Certificate of Compliance in accordance with the Electricity Safety Regulations 2010.
- The mains and metering has been inspected by a *DELTA*-approved inspector, and verified as complying with the Electricity Safety Regulations 2010 and Aurora requirements.
- The consumer, or the consumer's Retailer, has agreed to pay any consumer contribution required for the establishment or upgrade of the connection.

6. NETWORK CONNECTIONS

The type of Network connection provided for a consumer will be dependent upon the connection capacity required, the position of the consumer's main switchboard, and the location and nature of the consumer's property:

6.1. Low Voltage Connections

Low voltage connections are generally made by connection of a LV service main to the LV distribution system, or by connection to the LV side of a transformer located on the consumer's premises.

The requirement for a transformer is dependent upon the connection capacity required, the capacity and present loading on any existing LV distribution in the vicinity, and the distance from the consumer's property boundary to the consumer's main switchboard. Each connection application will be considered individually and the most appropriate connection method chosen. Guidance on connection capacities usually available is as follows:

6.1.1. Urban Areas

The maximum capacity for a particular installation will depend upon the capacity of the LV Network in the vicinity, but generally, connection capacities up to 3 phase 100 amps will be available from the LV distribution system. Connection capacities between 100 and 400 amps may require the installation of a transformer; however some locations may support connections of up to 400 amps directly onto the LV distribution system. Connection capacities in excess of 400 amps (276KVA) will require the installation of a transformer.

6.1.2. Rural Areas

In many rural areas, the HV distribution is 2-phase and only single-phase supply is available. In these areas, the largest capacity connection available without upgrading the HV distribution to 3-phase is 50kVA single phase.

6.2. Secondary Network Connections & HV Consumers

Consumer's may elect to establish an HV Secondary Network, where the consumer owns all assets downstream of the Network Supply Point. This is generally only economic for capacities in excess of 1,000 kVA, or when the consumer has a special need for high voltage. Aurora distributes HV electricity at 6.6kV and 11kV - the voltage used will be the voltage available in the area. It should be noted that Aurora has long-term plans to migrate its distribution from 6.6kV to 11kV, and recommends that HV consumers install dual ratio transformers in 6.6kV areas.

HV Secondary Networks have specific requirements, which are detailed in Section 15.

7. STANDARD CONNECTION CAPACITIES

Aurora's use-of-system charges are based on the assessed capacity of the connection. The standard connection capacities for connections up to 276kVA are generally determined by size of fuse used to protect the consumer's mains. The installed standard distribution transformer size will generally be used to determine the assessed capacity for connections greater than, or equal to, 300kVA. The maximum transformer size installed on the network is limited to 1000kVA. Where capacity greater than 1000kVA is required, multiple transformers will be required. Standard connection capacities are shown in below:

1Ø	1, 8*, 15, 23 kVA
2Ø	28 kVA
3Ø	15*, 24*, 41, 69, 103, 138, 173, 207, 276, 300, 500, 750, 1000 kVA

* Reduced capacity connection with load limitiong circuit breaker – refer section 7.1

Table 1 - Standard Connection Capacities

7.1. "Low Capacity" Connections

The minimum connection capacity is usually a 63 amp single phase supply. Special low capacity connections of 32 amps single phase, 32 amps three phase, or 20 amps three phase can be made if

the consumer installs, at their cost, a load-limiting circuit breaker upstream of the installation metering. The circuit breaker shall automatically disconnect the supply of electricity should the rated connection current be exceeded. The load-limiting circuit breaker shall have provision to be sealed and be of the 6kA 'C' curve type with tripping 5-10 times the rated current.

7.2. Unmetered Connections

Small capacity fixed loads such as telephone box supplies require no meter. To qualify for an unmetered supply, the load shall be less than 1kVA and consist of fixed wired equipment with a predictable annual energy usage in order to comply with EGRs. Load details are to be provided on the LV Connection Application form. The installation main isolator shall be a 5 amp MCCB.

A low-voltage, single-phase 15kVA builders temporary supply connection may be unmetered, subject to the following conditions:

- The purpose of the temporary supply must be for a builder's temporary supply only.
- All power outlets are to be supplied from RCD devices (residual current protection).
- If the connection is still required after 6 months, a re-inspection fee will apply, and for every subsequent 6 months.

8. OWNERSHIP BOUNDARIES

8.1. General Provisions

In order to define maintenance responsibilities and allocate capital costs, it is necessary to define the boundaries between fittings that are part of the Network, and fittings that are part of a consumer's installation. Aurora has applied the provisions of the Electricity Act 1992 in establishing the following rules for determining the ownership boundaries of new assets.

8.2. Point of Supply

The point of supply is as defined in the Section 2(3) of the Electricity Act 1992. All assets upstream of the point of supply will be owned by Aurora, unless specifically agreed otherwise in writing. Figure 3 to Figure 9 show the point of supply for a range of supply configurations.

The following fittings will be owned by Aurora, irrespective of who owns the property they are located on:

- Incoming HV switchgear, where the consumer takes supply at HV.
- HV substation equipment and HV lines and cables unless this equipment is owned by an HV Consumer.
- The LV mains protection device, i.e. service fuseholder and fuse link, or circuit breaker.

All LV distribution on a private property that is for the exclusive use of one consumer shall be owned by the consumer, from the point of supply. This means that when supply to a consumer crosses a neighbour's property, the consumer is required to arrange an easement in favour of Aurora, over the neighbour's property.

LV distribution on a private property that supplies multiple properties will be owned by Aurora and easements in favour of Auora will be required over this distribution.

LV distribution on a private property that supplies multiple consumers on the property (eg a unit title development) will generally not be owned by Aurora, but Aurora may take ownership if the LV distribution is installed in a right of way and easements in favour of Aurora are created.

8.3. Ownership of Consumer Substation Civil Works

For substations on a consumer's property, the transformers, associated switchgear and earthing facilities are part of the Network. The foundations, building or other weather and physical protective facilities are owned by the consumer.

Specific details of the requirements relating to substations on consumer property are contained in Aurora policy NS 5.11 Substations in Consumer Buildings – Basic & Technical Requirements.

8.4. Maintenance Responsibilities

Maintenance of fittings that are part of the electrical installation is the responsibility of the installation owner. All fittings on a consumer's property that are part of the Network, including all HV mains owned by Aurora, will be maintained by Aurora. Consumers shall provide access to authorised Contractors to carry out maintenance.

8.5. Easements

Aurora requires a registered easement over private property that is occupied by fittings that form part of the Network. Such an easement will give Aurora access rights for the purpose of maintenance or replacement of the fittings, and will place certain restrictions on the property owner to safeguard the fittings; e.g., limiting erection of buildings, or planting of trees, close to the fittings. The easement also affords the land owner legal protection with respect to property damage caused by Aurora or its contractors. Easements are not always required on single lot developments where Network equipment is installed on the consumer's property to supply a single installation on the same property only. Further information is available in the Electricity Easements policy.

9. CONNECTIONS GENERAL

9.1. Connection Overloads

For consumers supplied via LV fuse or MCCB protection, the connection capacity is generally determined by the protection rating. If the consumer's load exceeds the protection rating, protection operation can result.

For consumers supplied at LV via direct connection to the LV terminals of a transformer (refer Section 13.2), the connection capacity of the connection is the transformer rating. Transformers have some overload capacity, and consumers are permitted to utilise this, subject to the transformer loading not exceeding 120% of its rating and the overload being of a temporary nature unlikely to shorten the useful life of the transformer. The consumer's incoming circuit breaker overcurrent protection shall be set to operate at, or less than, this value. The consumer's mains and main switch must be rated to carry the overload. The loading on the transformer shall not exceed the appropriate values for normal cyclic duty defined in British Standard Code of Practice CP1010 "Loading Guide for Oil-Immersed Transformers".

9.2. Multiple Connections

If the consumer has more than one Network connection associated with the same property, the consumer shall not parallel the supplies, or provide any facilities to parallel the supplies. This is to avoid the possibility of back feeds creating hazards on the Network.

10. CONSUMER LOADS

10.1. Notifiable Loads

The following work has special requirements and must be specifically notified:

- Installing appliances subject to load control.
- Installing plugin electric vehicles for charging batteries
- Installing electric motors with capacities greater than the exempt ratings specified in Section 10.2, below. This includes appliances with motors, such as heat pumps and refrigeration units.
- Installing an appliance that may affect the quality of supply to other consumers by the introduction of harmonics, or by causing voltage fluctuations.
- Installation of an individual load that exceeds 40% of the installation's connection capacity (6kW for a 15kVA connection).
- Installation of capacitors that result in the total capacitive load of an installation exceeding 100 kVAr.
- Installation of generators, including photo-voltaic panels – refer to Section 16.

10.2. Exempt Motor Sizes

AC motors, up to and including the ratings shown in Table 2 below, are not subject to starting current limits and may be installed with direct-on-line starting without specific permission.

	Location and Rating		
	Rural	Urban	
		Residential	Non-Residential
Single Phase (Not Exceeding)	0.75 kW	1.5 kW	2.2 kW
Three Phase (Not Exceeding)	4.0 kW	4.0 kW	7.5 kW

Rural - Means areas zoned rural in the Local Authority District Plan.
Urban - Means developed areas that are **not** zoned rural in the Local Authority District Plan.
Residential - Means areas that are zoned residential in the Local Authority District Plan, including rural residential.

Table 2 - Schedule of Exempts Motor Sizes

10.3. Load Power Factor

The power factor of a consumer's load, measured at the metering point, shall not be less than 0.95 lagging.

10.4. Voltage

The Network will be designed and operated to maintain the consumer's voltage within the limits prescribed by Regulation 28 of the Electricity Safety Regulations 2010. The limits for LV consumers are 230 volts ± 6% at the point of supply.

10.5. Voltage Fluctuations

Some electric appliances, such as motors with fluctuating loads and welders, can cause voltage fluctuations in the Network, resulting in annoyance to other consumers. Consumer's electric appliances shall not cause voltage fluctuations, at the point of common coupling, in excess of the compatibility limits specified in AS/NZS 61000.3.11: 2002.

10.6. Load Control

The facility to switch off certain loads at peak times allows Aurora to reduce costs associated with peak loads, including Transpower charges. Consumers with controlled loads pay lower annual line charges, via retailer tariffs, in consideration of the controlled load being switched off during peak times.

It is **mandatory** that the following appliances be controlled:

- Plugin electric vehicles. These must be supplied from an 8 hour controlled circuit (service hours between 10pm and 7am) and connected via a 15amp 3 pin socket – large earth pin.

It is **recommended** that the following appliances be controlled:

- Storage water heaters.
- Residential storage water heaters above 135 litres.
- Storage space heaters and underfloor heating.
- Electric kilns.
- Spa and swimming pools.
- Irrigation pumps.

Modern load control relays can directly switch resistive loads up to 9kW. Older relays are limited to 6kW, and in some cases 4.7kW. Loads in excess of these values will require a contactor which shall be supplied and installed at the consumer's cost.

Consumers must not employ devices that defeat the load control system by switching the controlled load to uncontrolled circuits when, by contractual terms agreed with their electricity retailer, those loads should be off.

Consumers may install water heaters that contain a quick recovery system (a separate top element). The quick recovery element must be connected to an uncontrolled circuit and configured so that it provides a maximum "one-shot" boost duration of one hour, initiated via a manual switch / push-button.

Note: If a consumer requires a two phase 63 amp (28kVA), or 3 phase 35 amp (24kVA), or one phase 100 amp (23kVA) supply to service off peak controllable load, and the capacity above 15kVA is purely for off peak load, then for the purposes of line charges, the connection will be assessed at 15 kVA.

10.7. Motor Starting

The starting of electric motors can cause severe voltage dips on the Network resulting in irritation to other consumers. In addition to complying with starting requirements, running motors with fluctuating loads shall not cause excessive voltage fluctuation.

Section 10.2 defines the maximum motor sizes that may be started direct-on-line without specific approval. All other motors shall be approved by *DELTA* prior to connection. The criteria used for

approval is that the relative voltage changes on motor start-up shall not exceed the values in Table 3, below:

	Maximum Relative Voltage Change	
Frequency of Starting	**At Point of Common Coupling**	**At Zone Substation HV Bus**
In excess of 10 starts per hour.	1%	0.5%
In excess of 3 starts per day, but not more than 10 starts per hour.	3%	1.0%
Not more than 3 starts per day, including not more than 1 start between the hours of 5 pm and 11 pm on any day.	6%	1.5%
Emergency equipment started infrequently (e.g., fire pumps).	12%	2.0%

Table 3 - Schedule of Allowable Relative Voltage Change

In installations where several large motors start automatically, the effect of these motors starting simultaneously when supply is restored after a power interruption needs to be considered. Unless delayed starting is installed to Aurora's satisfaction, the relative voltage change will be assessed on the basis of all motors on automatic control starting simultaneously.

10.8. Capacitors

Capacitors are generally installed in a consumer's installation to provide power factor correction, either as part of a power factor correction unit or associated with individual appliances such as motors or fluorescent light fittings. They can absorb ripple control signal resulting in insufficient signal strength to operate the consumer's and adjacent consumers' ripple control relays.

Aurora operates a 317Hz ripple injection system in the Central area and will be introducing a similar 317Hz system in Dunedin from late 2010. Generally the installation of small power factor correction capacitors has little effect at this frequency, and capacitor banks of up to 100kVAr may be installed without specific permission. For the installation of capacitor loads above 100kVAr in the Central area, specific permission shall be obtained. *DELTA* will determine, in each case, if measures to prevent any problems are required. The design, installation and operation of these measures shall be the responsibility of the consumer.

In the Dunedin area, Aurora operates a 1050Hz ripple injection system, and absorption of the ripple signal can be reduced by the installation of 1050Hz blocking chokes on the Network side of individual capacitors, or groups of appliances containing capacitors. Consumers are permitted to install unblocked capacitor kVAr capacity up to 2% of connection kVA capacity. For 3 phase connections, the maximum kVAr, per phase, is 1/3 the total kVAr allowed. For capacitor loads exceeding this in the Dunedin area, specific permission to connect shall be obtained. *DELTA* will determine if 1050Hz blocking is required in each case. The consumer is responsible for the provision and correct operation of the blocking chokes.

Consumers installing fluorescent lighting loads are advised to use fittings with lead-lag ballasts, which will provide power factor correction without the risk of ripple signal absorption. Electronic fluorescent lighting ballasts do not require capacitors for power factor correction, and do not absorb ripple control signals.

10.9. Harmonic Disturbances

Harmonic voltages and currents introduced into the Network by a consumer's appliances shall not exceed the levels specified in NZECP36 ('Harmonic Levels'). Harmonics are particularly prevalent in variable speed motor drives.

In the Dunedin area, the 1050Hz ripple frequency corresponds to the 21st harmonic. In addition to the requirements of NZECP36, consumers' appliances shall not cause 1050Hz voltages in excess of 0.7% at the Point of Common Coupling. Particular care needs to be taken with regard to appliances utilising solid state inverters.

11. LV MAINS

11.1. Mains & Circuit Sizing

The correct sizing of mains and subcircuits is the consumer's responsibility and shall be in accordance with AS/NZS3000:2007. Note that Regulation 59 of the Electricity Safety Regulations 2010 specifies that the maximum voltdrop between the point of supply to any socket-outlet, or between the point of supply and the supply terminals of any fixed-wired appliance, located in the installation is 5% of 230 volts under maximum load conditions.

It is recommended that all mains neutral conductors be the same size as the phase conductors. This will reduce the chance of neutral conductor overloads due to imbalanced loads and harmonics.

11.2. Aerial LV Mains

Installation of new aerial LV service mains and the alteration of existing LV aerial service mains may be controlled or forbidden by the relevant Local Authority's By-Laws and/or District Plan.

Where permitted, aerial mains shall be copper conductor with a minimum size of 16 mm^2. Electricity Regulation 92 shall be complied with. For open-pair mains, the phase conductors shall be covered with black PVC insulation and the neutral conductor shall be bare. The consumer is responsible for providing supports for conductor insulators and terminations on the property. The mains shall be installed in accordance with AS/NZS3000:2007, and NZECP34 (Electrical Safety Distances). It is recommended that neutral screened cable be used for aerial mains due to the enhanced safety this provides.

The current carrying capacity of LV aerial mains shall be limited to 160A, being the maximum standard fuse link size carried in approved pole top fuseholders.

11.3. LV Underground Mains in LV Underground Areas

LV mains in areas with underground LV distribution will be connected via an LV pillar box. Pillar boxes are available in 100, 200 and 400 amp capacities, and are normally located on the street side of the consumer's property boundary. The *DELTA* Engineering Services Manager (ESM) will, after consulting with consumers, determine the position of the pillar box. In residential areas, pillar boxes are generally placed on the street frontage at the junction of two property boundaries allowing the box to serve two consumers.

Due to physical limitations, pillar boxes are generally not suitable for the termination of steel wire armoured or paper insulated lead sheathed mains cable.

11.3.1. Pillar Box Terminations

The termination of LV mains into pillar boxes is Aurora's responsibility. Consumers shall ensure the mains cable is installed to the pillar box position with sufficient length to facilitate termination. Copper and aluminium cables can be used for underground mains, but for 63 amp and 100 amp connections, aluminium cable cores will require to be terminated with copper tails via AL/CU transition joints. The maximum cables sizes for 63 amp and 100 amp connections are 35mm^2 and 50mm^2 respectively. If the mains exceed these sizes then reduced size tails are required. The consumer is responsible for providing tails and transition joints when required.

Transitions joints are the consumer's responsibility and must be located within the consumer's property.

11.4. LV Underground Mains In An Overhead Area

In areas where the LV distribution is overhead, consumer mains can be connected directly to pole top fuses provided the connection capacity is less than 150 amps, and the conditions in Section 11.4.1 are complied with. In all other cases a boundary pillar box is required for the termination of the consumers mains. This pillar box is then connected to the overhead network. See Figure 2 on page 22 for a diagram of the two connection options.

11.4.1. Pole Top Supply

This involves connection via underground mains running direct from a Network pole top to meter box or main switchboard subject to the following conditions:

(a) A suitable pole must be available on the same side of the street as the consumer, within two metres of the consumer's lateral boundary, and within 5 metres of the general property frontages (Figure 2, page 22).

(b) The physical circumstances, such as ground levels and footpath conditions, are suitable for the installation of an underground cable.

(c) All mains cables shall be copper neutral screened. Steel wire armoured cable is not acceptable. The maximum cable size is 95mm^2.

(d) The cable in the road reserve will be laid parallel, or at right angles, to the street and the cable shall cross the consumer's property boundary at a location determined by ESM that results in the minimum trenching in the road reserve. The consumer shall provide the cable from the property boundary to the pole top connection. The total cable length shall allow for the cabling in the road reserve, and for 9m of cable up the pole, and shall be left coiled at the boundary for installation by the connection contractor.

(e) The cable shall be mechanically protected to 2.5m above ground level, and the protection shall continue 200mm below ground level. Where electrical conduit is used as mechanical protection, grey or black high impact conduit shall be used with galvanised steel saddles and stainless steel screw. The conduit and fixings shall be supplied by the consumer.

11.5. Supply via Unmetered Subcircuit

When electricity is distributed through a building complex, such as a shopping mall, high-rise flats, or office block, different occupiers of the building often require a separate metered supply of electricity. This is achieved by the use of unmetered circuits such as rising mains, ring mains ,and submains supplied from the installation main switchboard.

In order to limit kWh losses, the maximum voltdrop in unmetered circuits between the point of supply and the metering point shall not exceed 2.5%.

Each occupier has a separately metered "network connection" onto an unmetered subcircuit. These unmetered subcircuits are **not** part of the Aurora Network, but Aurora will supply the fuses for the connection of individual consumers to an unmetered subcircuit. The installation of these fuses is the responsibility of the complex owner. The fuses will remain part of the Network, and will be sealed by *DELTA*-approved personnel. The fuses shall be accessible to *DELTA* and the consumer's Retailer at all times. Figure 10(f), on page 26, shows a typical unmetered subcircuit configuration.

12. FAULT LEVEL CONSIDERATIONS

The short circuit rating of consumer's equipment should be not less than the design fault level of the Network to which it is connected. The choice of equipment for connection at low voltage may take into account attenuation in the mains.

The Aurora 6.6kV and 11kV Networks are designed for a maximum short circuit level of 250MVA - 22kA at 6.6kV and 13kA at 11kV. Consumers taking supply at 6.6kV or 11kV shall design their installations for a 250MVA prospective short circuit level.

For consumers supplied from the LV Network in residential areas, the prospective short circuit levels at the consumer's main switchboard will typically be less than 6kA. For consumers supplied from a dedicated transformer, the maximum prospective short circuit levels at the LV terminals of the transformer will be in accordance with Table 4, below.

For the purposes of designing installations, consumers should use the figures provided in Table 1 or, on request, a maximum prospective short circuit current can be provided for their point of supply.

Transformer Size (kVA 3-Phase)	**Maximum Prospective Short Circuit Current** (kA)
15	1
30	1.5
50	2
100	4
200	6.5
300	9.5
400	11
500	15
750	22
1,000	28

Table 4 - Maximum Short Circuit Currents at Distribution Transformer LV Terminals (6.6kV & 11kV)

NB: For sizes not included, use the short circuit current of the next larger transformer shown.

12.1. Consumer Contribution to Fault Levels

Design of the Network must take into account the contribution to fault level by consumer's apparatus, such as large motor loads.

13. ELECTRICAL PROTECTION

Regulation 32(1) of the Electricity Safety Regulations 2010 requires that every person supplying a line function service to any consumer shall provide to that consumer a service protective device of appropriate rating to provide protection against short circuits or earth faults on mains, while AS/NZS3000:2007 requires that the maximum current in a cable must not exceed the current rating of the conductor.

13.1. Protection of LV Mains Connected to LV Distribution

Mains will be protected by HRC fuses in service pillar boxes or by pole mounted fuses. The minimum capacity fuse available is 63 amps, and the maximum 400 amps. Consumers shall ensure that the rating of their mains and main switchboard is greater than, or equal to, the service fuse rating. At existing installations that have mains rated less than 63 amps, the consumer shall either provide appropriate protection or upgrade the mains before any additional load is connected.

Connections to installations requiring a capacity less than 63 amps will be protected by 63 amp HRC fuses and should be sized accordingly.

The protection of unmetered sub-circuits is the responsibility of the sub-circuit owner.

13.2. Protection of LV Mains From a Transformer

For connection capacities up to 276kVA (400A), mains protection will be provided by LV HRC fuses or MCCB mounted adjacent to the transformer.

If transformer capacity is greater than, or equal to, 300kVA and it is dedicated to supply one consumer with no LV interconnection, the LV mains can be connected directly to the transformer LV terminals. The transformer HV fuses only provide short circuit protection for LV mains. Consumers are required to provide LV mains overload protection. To ensure the transformer HV fuses can detect phase-to-earth faults at the consumer's main switchboard, the mains shall be sized to carry the rated current of the transformer and be no longer than 20 metres. Distances longer than 20 metres will be subject to approval by the ESM.

When a consumer is supplied from a transformer that is primarily for that consumer's use, but also has an interconnection with the LV Network, the consumer's mains will be protected by HRC fuses for connection capacities up to 400 amps, and by a MCCB for connection capacities between 400 and 800 amps.

Where supply is via paralleled transformers, intertripping from the HV fuse switch to the LV incoming circuit breakers is required, to ensure faults on the transformer HV windings are not backfed via the LV bus.

13.3. Protection of HV Mains

HV mains are generally protected by the feeder protection at the Network zone substation. Each case will be subject to individual design and approval. The consumer's protection must be designed to discriminate with the Network protection, such that faults within the consumer's installation beyond the consumer's incoming circuit breaker or fuse switch will not normally result in tripping of a zone substation feeder circuit breaker.

13.4. Protection Against Unbalanced Voltage

It is possible for one or two fuses of a 3-phase set protecting mains or a transformer to operate, resulting in consumers receiving an unbalanced or reduced voltage supply. Aurora will not accept responsibility for any damage to a consumer's equipment caused by this condition. If a consumer has equipment vulnerable to damage by unbalanced or reduced voltage, they are advised to install their own protection that will automatically disconnect the appropriate equipment.

13.5. Protection of Sensitive Equipment

Modern electronically controlled appliances are less tolerant of fluctuations in voltage and frequency than older appliances. To limit the possibility of damage, consumers are advised to ensure that sensitive equipment is appropriately protected by means of surge protection devices. Aurora will not accept liability for any damage or loss suffered by a consumer as a result of momentary fluctuations in voltage or frequency of the electricity supply.

14. METERING

Consumers shall provide appropriate space within their premises to accommodate metering equipment and load control relays required by Aurora and the consumer's Retailer, or the Retailers' selected metering services provider. All metering shall be in accordance with the EGRs.

15. SECONDARY NETWORK CONNECTIONS & HV CONSUMERS

Secondary Networks are described by the Electricity Commission as either:

- A Customer Network where a single ICP is located at the Network Supply Point, or
- An Embedded Network where a gateway ICP with HV halfhourly metering is established at the Network Supply Point. This option allows consumers at downstream ICPs to select their own retailer; however the Electricity Governance Rules are more complex.

The owner of a Secondary Network is responsible for the maintenance and safe operation of the Secondary Network, along with compliance with the Electricity Act, Electricity Safety Regulations, and where applicable, the Electricity Governance Rules. For a Secondary Network connection the owner may be required, as a condition of connection, to provide details of how they intend to manage their compliance obligations.

Electricity Commission publication "Guidelines for Metering, Reconcilation and Registry Arrangements for Secondary Networks", available from the Commission's website (www. electricitycommission.govt.nz), explains the various characteristics of Secondary Networks, along with the obligations imposed on Secondary Network owners.

Typical configurations for HV Secondary Network connections are indicated in Figure 11 (page 27). Supply will be via an incoming isolation device such as a circuit breaker, isolator, or fuse-switch supplied and maintained by Aurora, but the consumer shall provide suitable accommodation for this equipment.

HV metering units incorporating current transformers and voltage transformers will generally be required for all HV Secondary Network connections. The ownership and provision of the metering equipment can be via various parties, details of which can be provided by *DELTA*. All

costs associated with metering the connection will be the responsibility of the HV Secondary Network owner.

HV Secondary Network connections may be metered at low voltage where all of the following conditions are met:

- The HV Secondary Network is a Customer Network as defined by the Electricity Commission's "Guidelines for Metering, Reconcilation and Registry Arrangements for Secondary Networks".
- No more than one transformer is connected to the Customer Network.
- The LV metering point is immediately adjacent to the transformer and has a meter which measures in halfhour intervals.
- The LV fuses will be owned by Aurora and the connection capacity will be based on the LV fuse size.

Where any of the above conditions change for an LV metered HV Secondary Network connection, the Secondary Network owner will be required, at their cost, to establish HV metering as close as practicable to the Network Supply Point.

When supply is required from paralleled HV feeders to meet loading or security requirements, special protection facilities will be required.

Owners of works (who may be HV consumers) with a distribution capacity of 10MVA or greater must implement a safety management systems in conformance with Regulations 47 to 56 of the Electricity Safety Regulations 2010, and have the safety management system audited on or before 31 March 2012. Owners of works (who may be HV consumers) with an installed distribution capacity of less than 10MVA must ensure they have inspection, maintenance and record-keeping practices in place that comply with Regulations 40 to 46 of the Electricity Safety Regulations 2010; however, they may voluntarily implement an audited safety management system as an alternative.

From 1 April 2010, HV consumers wishing to connect a new HV line to the Aurora network will be required to furnish a copy of a properly completed certificate of compliance covering the HV installation before the physical connection is made.

16. DISTRIBUTED GENERATION

Distributed generation requirements are defined in Aurora's Distributed Generation Connection Requirements policy and Distributed Generation Technical Requirements policy. Both of these documents are available on the Distributed Generation page of the Aurora website www.auroraenergy.co.nz, along with the following application forms:

- Connection of Distributed Generation less than 10 kW
- Connection of Distributed Generation greater than 10 kW

17. COSTS FOR ESTABLISHMENT OF NETWORK CONNECTION

17.1. Cost Responsibilities

All costs associated with the consumer's installation are the responsibility of the consumer. In order to establish a Network connection, Aurora will need to carry out additions or alterations to

its Network. Consumers may be required to make a contribution towards the cost of this work, in accordance with the Capital Contributions policy.

When there is a choice of connection method, the method resulting in the lowest cost to Aurora shall be used; however, if a consumer requires a connection method other than the method resulting in the lowest cost to Aurora, the consumer shall make an additional contribution equal to the difference in cost between the selected method and the lowest cost method. For a pole top mains connection, the additional contribution is not required when the consumer supplies the cable from the property boundary to the pole top fuses.

17.2. Enhanced Supply

When a consumer requires a supply with enhanced electrical characteristics or enhanced reliability beyond that which would normally be provided, then the consumer shall meet the additional costs incurred by Aurora in providing facilities to satisfy those requirements.

17.3. Headworks Contribution

Consumers proposing to increase the assessed capacity (as defined by Aurora's Use-of-System Pricing Methodology) of their connection above 150kVA will be required to make a Consumer Headworks Contribution reflecting the costs associated with the additional capacity they require of existing and future assets upstream of the Network Supply Point.

17.4. Cost-sharing on Joint-use Consumer Substations

Any consumer requesting new or increased supply has the choice of paying for supply based on a distribution substation located on their property, or elsewhere. It is never compulsory that they provide space on their property – the alternative may simply be more expensive for them.

- Where Aurora prefers (for reason of lower cost) a substation located on the consumer's property, and the consumer prefers to pay the higher cost of one located elsewhere, then Aurora will charge the consumer based on the minimum configuration necessary to supply the consumer's load from the remote site, being a single feed regardless of load. The consumer may choose to pay for a more reliable configuration but the additional cost will be excluded from the economic assessment and fully charged.
- Where Aurora prefers a substation located on the consumer's property and the consumer agrees but rejects an LV intertie, then Aurora will charge the consumer based on the minimum configuration necessary to supply their load, being a fused-tee HV supply. The consumer may choose to pay for a more reliable configuration but the additional cost will be excluded from the economic assessment and fully charged.
- Where Aurora prefers a substation located on the consumer's property and the consumer agrees to this and to an LV intertie, then Aurora will charge the consumer pro-rata, based on kVA, for a ring-main unit HV supply. The consumer will then get the benefit of more reliable supply at both HV and LV, and pay a lower cost for providing a useful site to Aurora.

17.5. Temporary Supply

All costs associated with the provision and removal of a temporary connection shall be met by the consumer.

18. SUBSTATIONS ON CONSUMERS PROPERTY

18.1. General Requirements

The standard transformer capacities available are single-phase 15, 30 and 50kVA, and three-phase 30, 50, 75, 100, 150, 200, 300, 500, 750 and 1000kVA. Consumers requiring capacities in excess of 1000kVA will require more than one transformer. When a consumer is supplied by more than one transformer, the LV connections from the transformers shall not be paralleled unless the intertripping facilities detailed in Section 13.2 are installed.

When it is necessary to install a substation on a consumer's property, the consumer shall make available suitable space to accommodate the transformer, HV cable or lines and associated switchgear, and provide easements as required.

The common connection configurations for substations on consumer's property are depicted in Figure 10 on page 26. HV circuits across the consumer's property can be either underground cable or overhead line.

All substations and HV circuits on the consumer's property shall be constructed in accordance with the requirements of the Ground Mounted Substations policy.

Installation of new HV overhead mains may be controlled or forbidden by the relevant Local Authority's By-Laws and/or District Plan. The connection configuration appropriate for each consumer will be decided by the ESM in consultation with the consumer. The following factors are considered when choosing the most appropriate connection method:

- Location of HV distribution lines and cables.
- Location of the consumer's main switchboard.
- Access to the substation (immediate 24 hour access required).
- Supply security requirements.
- Connection capacity.
- Requirement for LV interconnection.
- Cost.

The fused tee connection depicted in Figure 10 (a), page 26, is generally used for supply from the HV overhead Network, for transformer capacities up to 500kVA. Where it is not possible to fit fuses to the tee-off pole, HV fuses will be installed on the first available pole.

The tee connection in Figure 10 (b), page 26, is used for supply from the H.V overhead Network when the transformer capacity is greater than 500 kVA, and a ground-mounted fuse-switch is required to isolate the transformer.

The feed-through connection in Figure 10 (c), page 26, is used for connections to the underground HV Network. The Figure 10 (c) solution, with the switchgear and transformer sharing the same enclosure, is generally the most economic when the transformer location is close to the property boundary. If the transformer location is a significant distance from the property boundary, Figure 10 (d) will be more economical due to a smaller cable being required from the fuse switch to the transformer. The Figure 10 (c, d & e) options usually provide a more secure connection as, after a fault on one of the two cables supplying the substation, supply can normally be restored by switching.

The provision of an LV interconnection from the transformer to the LV Network, as in Figure 10 (e), page 26, requires the transformer to be close to the property boundary. The advantage of this arrangement to the consumer is that an emergency LV supply can be provided should the transformer fail.

18.2. Space Requirements

The space requirements for a substation on a consumer's property will depend upon the substation type and will be individually advised. The following types of substation are used:

18.2.1. Pole Substations

Pole substations on a consumer's property are generally only used in rural locations when the HV supply to the substation is via overhead line. Capacities of 15 to 75kVA are standard; however two-pole substations with capacities up to 300kVA may be constructed with the specific approval of the ESM. The siting of the substation will depend on the location of buildings and the routing of HV lines. Electrical clearances defined in NZECP 34 shall be maintained.

Aurora's specific requirements for pole substations are defined in the Construction of Pole Substations policy.

18.2.2. Indoor Substations

Indoor substations are used when the consumer is unable to provide a suitable outdoor site or for technical or economic reasons. The entire substation can be indoors or just the HV switchgear.

Aurora's specific requirements for indoor substations are defined in the Substations in Consumer Buildings - Basic Requirements policy.

18.2.3. Ground Mounted Substations (Unenclosed, Mini or Micro)

Unenclosed ground mounted substations consist of a pad-mounted unenclosed transformer. They can be supplied via drop-out fuses for capacities up to 500kVA. For transformer capacities greater than 500kVA ground mounted switchgear is required to switch inrush current. This switchgear may be remote from the transformer. It can be accommodated in a switchroom or, if suitable, installed outdoors.

Mini substations are outdoor substations with switchgear and transformer accommodated on a concrete base and of weatherproof construction. These substations have capacities from 100 to 1000 kVA. The space occupied by a mini substation can be up to 2.7L x 1.5W x 1.6H metres, with additional working space required for the operation and maintenance of the substation.

Micro ground mounted substations are small factory-made ground mounted substations with available capacities 15kVA to 100kVA. They do not accommodate HV switchgear and are generally used when an underground connection to the HV overhead Network is required.

Aurora's specific requirements for ground mounted substations are defined in the Ground Mounted Substations policy.

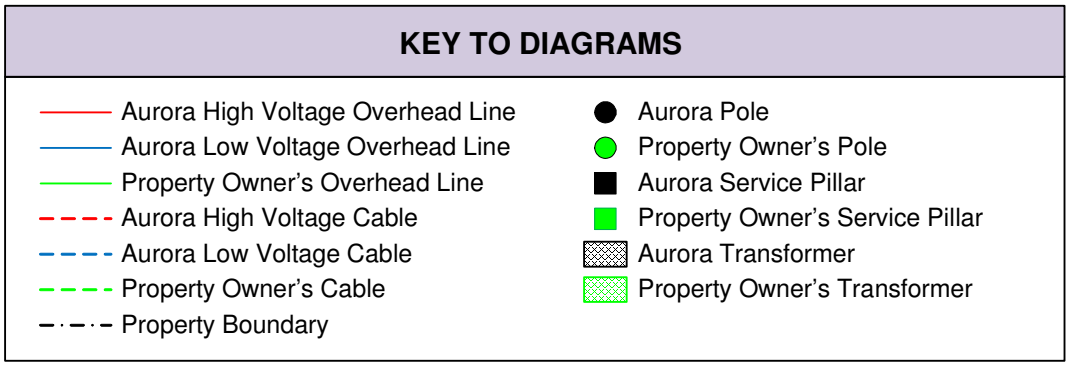

Figure 1 - Key to Diagrams

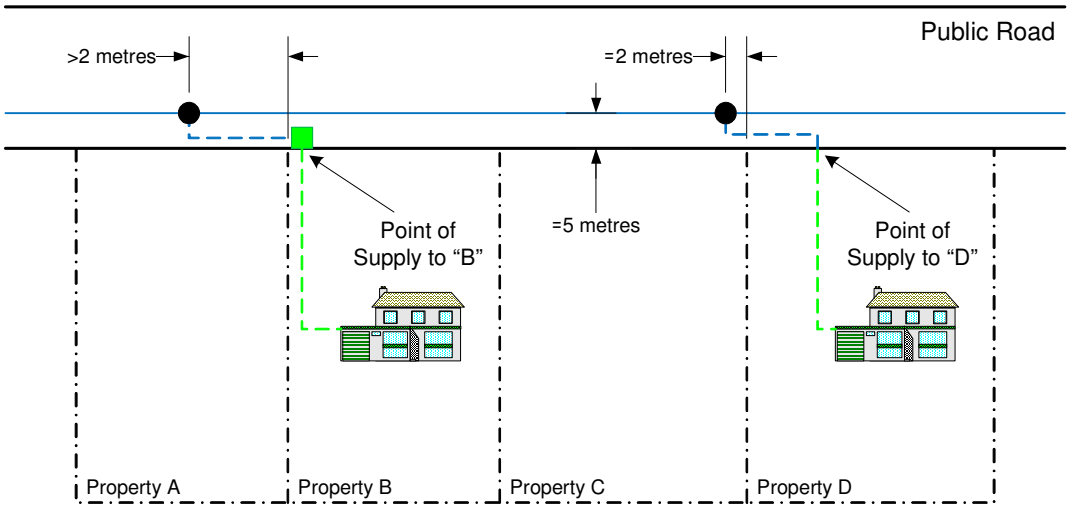

Figure 2 - Underground Connections in Overhead Suppy Area

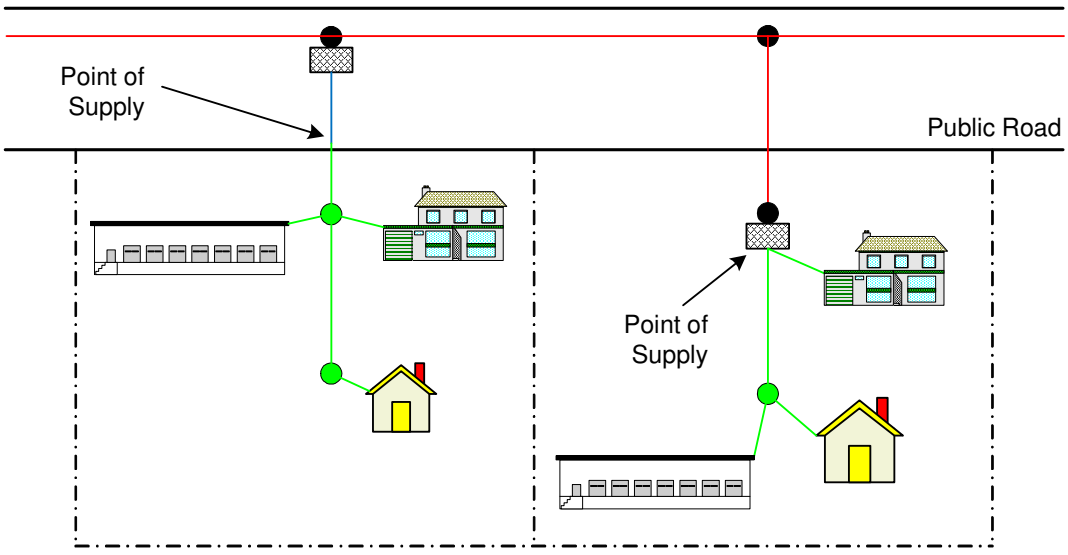

Figure 3 - Point of Supply Explanatory Diagram 1

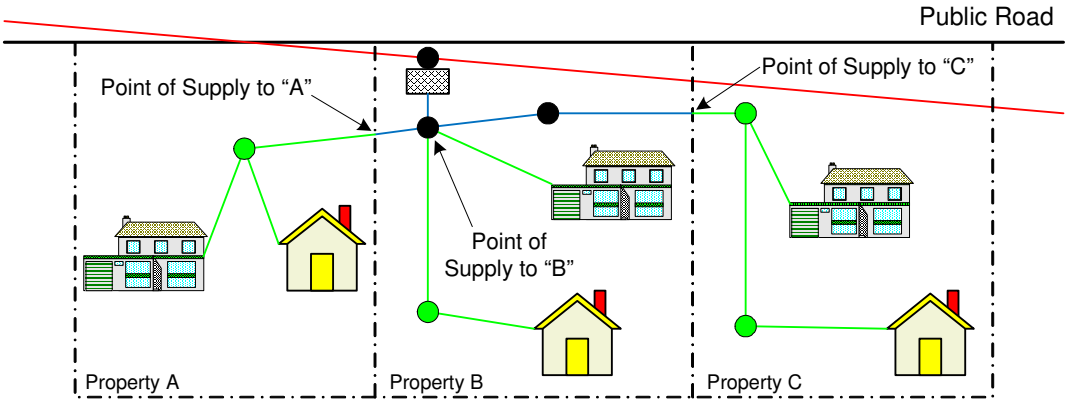

Figure 4 - Point of Supply Explanatory Diagram 2

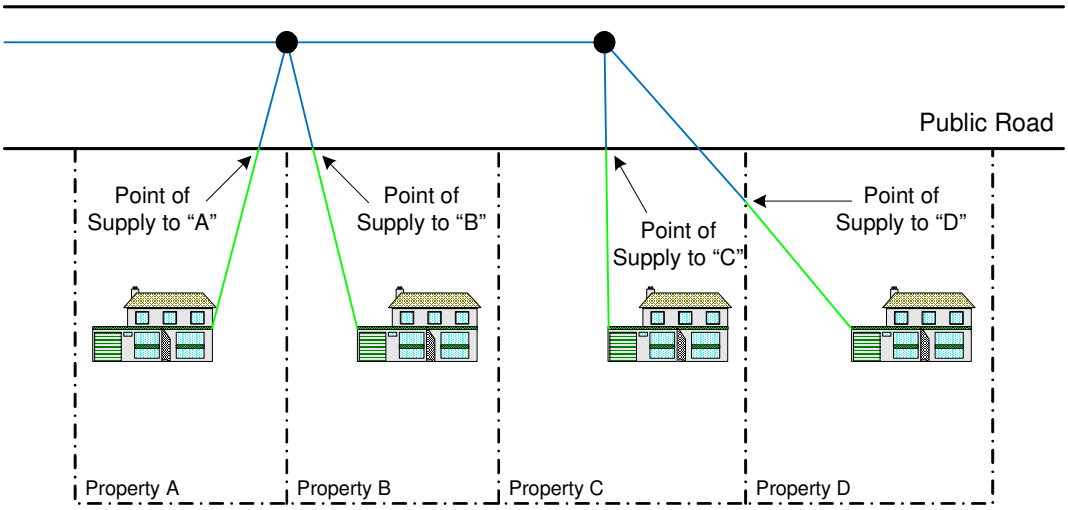

Figure 5 - Point of Supply Explanatory Diagram 3

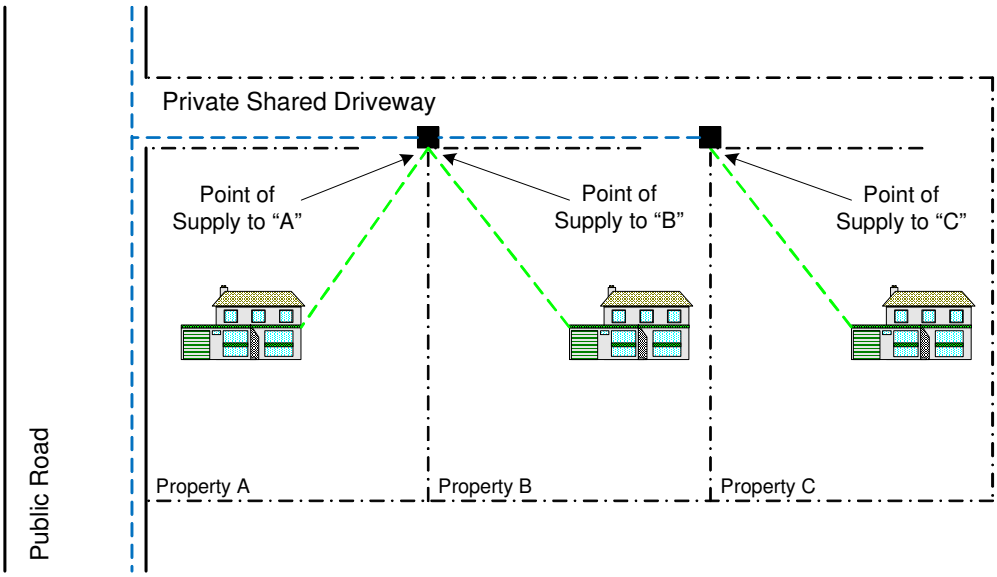

Figure 6 - Point of Supply Explanatory Diagram 4

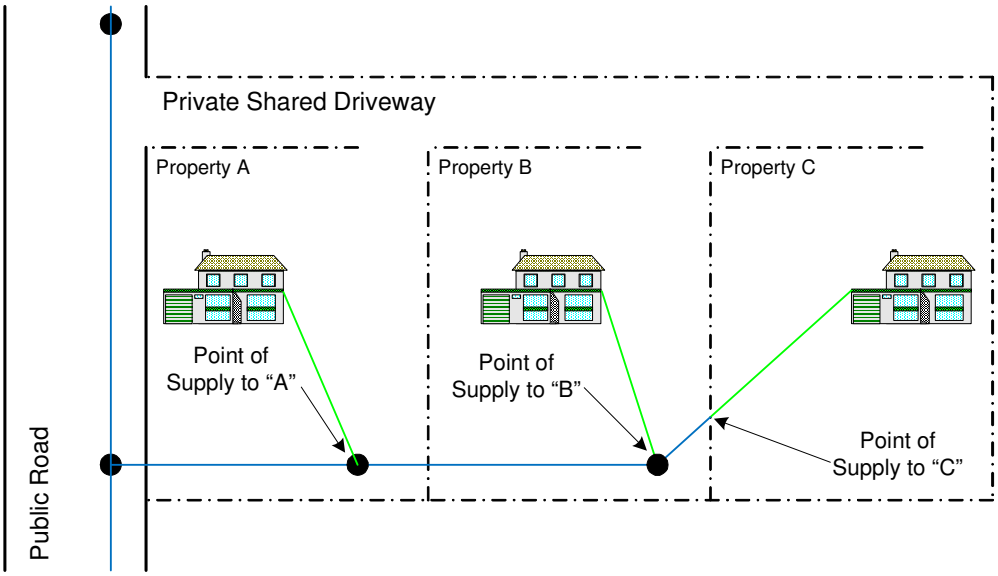

Figure 7 - Point of Supply Explanatory Diagram 5

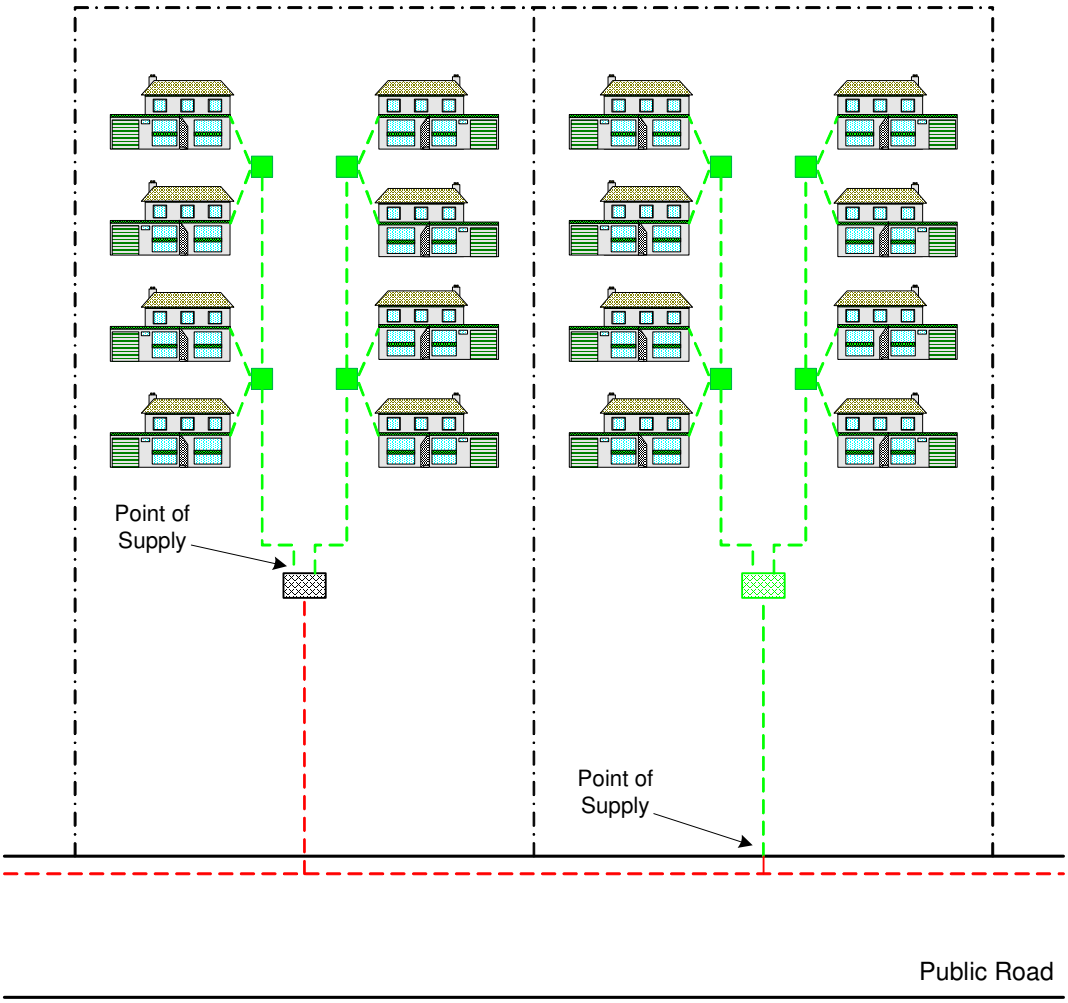

Figure 8 - Point of Supply Explanatory Diagram 6

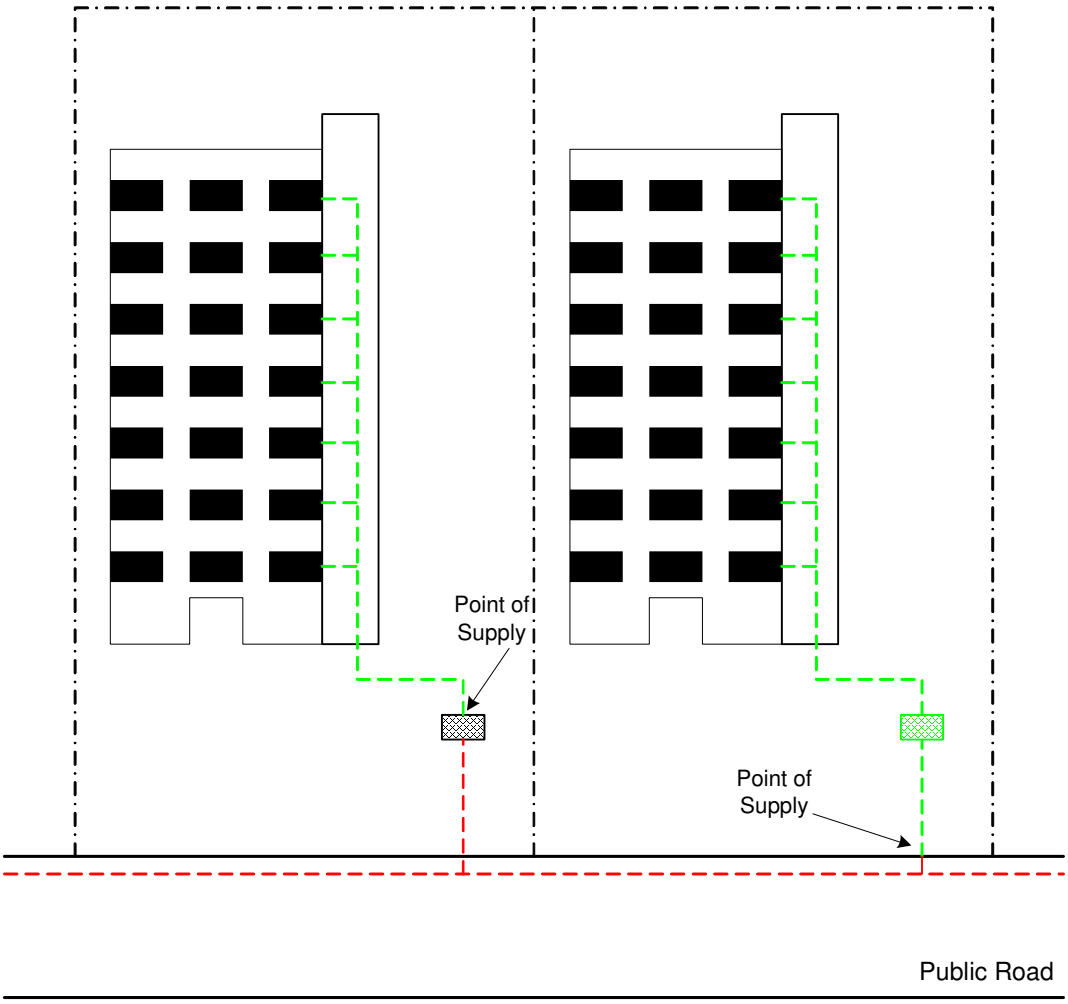

Figure 9 - Point of Supply Explanatory Diagram 7

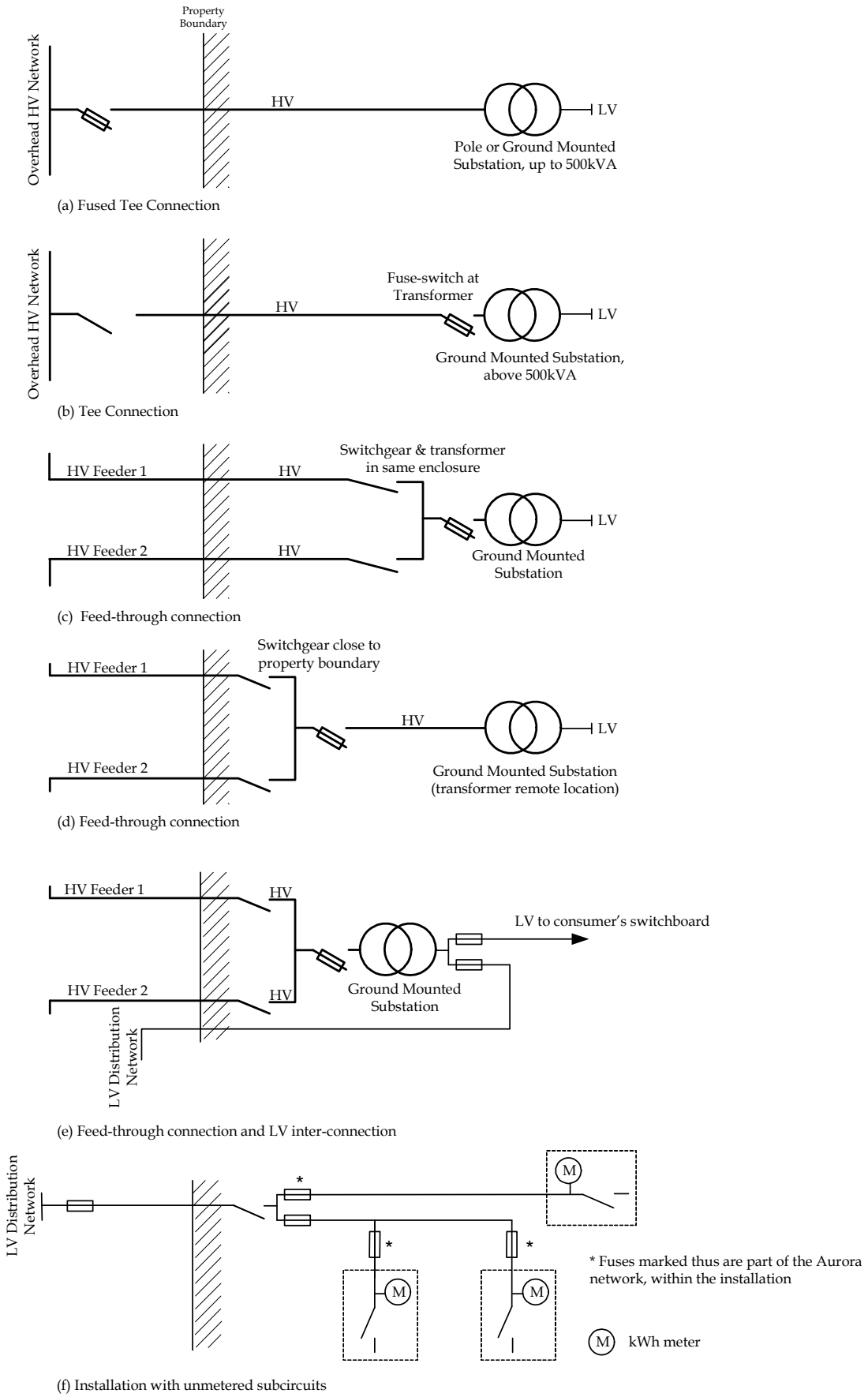

Figure 10 – Typical Connection Configurations

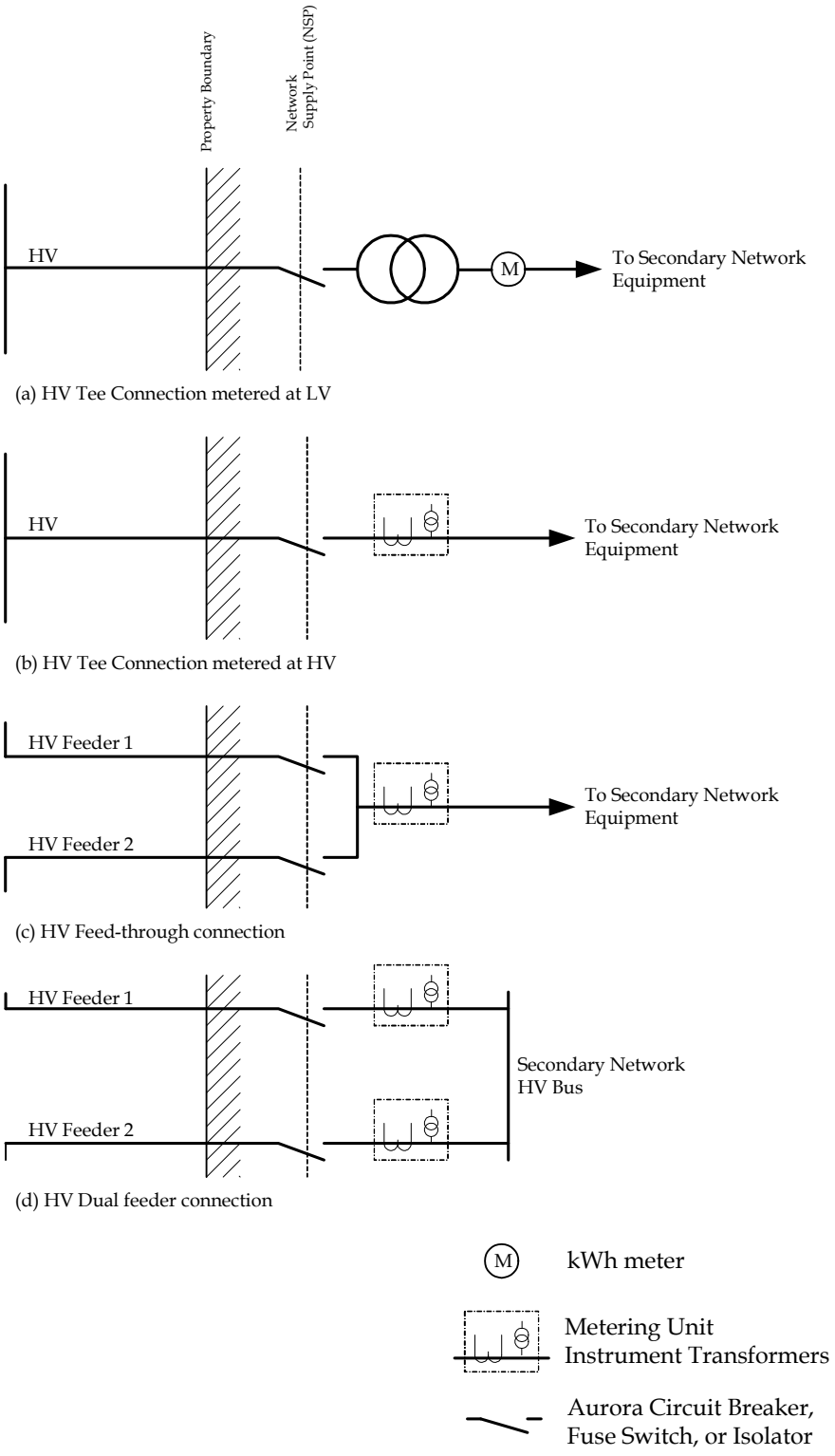

Figure 11 - Typical Configurations for HV Secondary Networks