BEFORE THE QUEENSTOWN LAKES CITY COUNCIL

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	Proposed Queenstown Lakes District Plan– **Network Utilities**
SUBMITTER	**AURORA ENERGY LIMITED** Submitter No: OS 635

STATEMENT OF EVIDENCE IN CHIEF BY STEVE SULLIVAN

Hearing Date: 14 September 2016

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1. EXECUTIVE SUMMARY

1. Aurora Energy Limited ("Aurora"), is an electricity distribution business formed in 2003 as a wholly owned subsidiary of Dunedin City Holdings Limited. It is predominantly focused on the distribution of electricity to Dunedin city and Central Otago. Aurora is unique among New Zealand electricity distribution businesses as it is solely an asset owner, with management and operations fully outsourced to its sister company Delta Utility Services Limited.

1.1 Aurora's network is hierarchical, or branchlike, in nature. It has a number of high voltage cables and lines which each carry a large amount of electricity and which each supply many thousands of customers. Electricity is transformed off these high voltage lines to thousands of low voltage lines which each serve anywhere between one and a few hundred customers.

1.2 Given the number of customers supplied from each of the high voltage lines, the failure of any one of these high voltage lines has a far greater impact than the failure of one, or indeed many, low voltage lines. Aurora's high voltage lines are critical to its network and critically important to the Queenstown Lakes region.

1.3 Aurora considers the importance of its high voltage lines to the community, needs to be recognised and protected under the proposed Queenstown Lakes District Plan through suitable corridor protection rules. Without such corridor protection rules there is a risk of development under and in close proximity to high voltage lines as no other applicable legislation provides a suitable safeguard.

1.4 Aurora seeks protection over the high voltage lines identified in its submitted plans. The length of these high voltage lines and the length of other lines on the Aurora network are shown below. Aurora is not seeking corridor protection for low voltage lines or the majority of its 11kV high voltage line network.

Description	Total km on the Aurora network in Queenstown Lakes Area	Total km Aurora seeks corridor
33/66 kV lines and cable	147	147
6.6/11kV lines	597	116
6.6/11kV Cable	408	9
400V lines/Cable	536	0

1. INTRODUCTION

1.1 My full name is Stephen John Sullivan.

1.2 I am the Asset Strategy Manager at Delta Utility Services Limited.

1.3 My experience includes over 10 years' infrastructural asset management experience in the New Zealand electricity generation and distribution sectors.

1.4 In my role as Asset Strategy Manager, I lead a team providing a wide range of services which contributes to the management, installation, maintenance and replacement of the Aurora Energy's electrical distribution network. Our aim is to prudently manage not only the physical assets but also any risks which might prevent the supply and distribution of electricity which is secure, reliable and sustainable both now and for future generations.

2. SCOPE OF EVIDENCE

2.1 My evidence will:

a) provide background on the electricity industry and Aurora's place within it;

b) summarise the importance of the Aurora 33kV and 66kV electrical networks;

c) summarise the legislative framework for protection of electricity lines;

d) provide discussion regarding distribution company requirements consistent with the intent of the National Policy Statement on Electricity Transmission (NPSET);

e) set out the importance of corridor protection in the District Plan;

2.2 The key documents I have used, or referred to, in forming my view while preparing

this brief of evidence are:

a) Network Utilities and Energy Generation Chapter of the Proposed District Plan; and

b) Applicable legislation.

3. THE ELECTRICITY INDUSTRY AND AURORAS PLACE IN IT

3.1 The efficient transmission and distribution of electricity plays a vital role in the well-being of New Zealand, its people and the environment.

3.2 In New Zealand, electricity produced by generation companies at various hydro, wind, geothermal etc. plants is transmitted by the national grid operator, Transpower, to network operators like Aurora.

3.3 Aurora takes delivery of the electricity from Transpower's network at various points in Transpower's network known as Grid Exit Points (GXPs). After receipt of electricity at GXPs, Aurora then delivers that electricity through its network to homes and businesses in Dunedin and Central Otago on behalf of electricity retailers who purchase the electricity from generators on the wholesale market and sell it to customers.

3.4 Aurora's network is hierarchical or branchlike in nature in that it has a number of high voltage overhead lines and underground cables which each carry a large amount of electricity. Aurora's high voltage 33kV and 66kV sub-transmission system branches out from Transpower's GXP's.

3.5 Electricity is transformed off these high voltage lines, at numerous substations, to lower voltage lines which each serve anywhere between one and a few hundred customers. Often the transformation from high voltage to low voltage is 33kV to 11kV; although in Wanaka the conversion is from 66kV to 11kV, and then to the 400 volts used in the home.

3.6 Aurora's Queenstown and Wanaka network has approximately 32,000 customer connections – homes and businesses.

3.7 In recognition of the role Aurora plays to ensure distribution of a reliable and secure supply of electricity to Dunedin and Central Otago, and our role in keeping our economy running and improving our community's well-being, Aurora is a Lifeline Utility as named in the Civil Defence Emergency Management Act 2002 (CDEM Act). The CDEM Act informs the National CDEM Strategy which

outlines a vision for a resilient New Zealand and recognises that lifeline utility resilience contributes strongly to community resilience.

3.8 Under the CDEM Act, Aurora is required to ensure it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency. Aurora is also required to undertake hazard and risk analysis and carry out risk mitigation measures.

3.9 In recognition of the importance of this role, Aurora was an active participant in the Otago Lifelines Utility vulnerabilities project which assessed the potential impacts of hazards on the region's lifeline infrastructure and identified mitigation strategies to reduce the risk to our community.

3.10 One of Aurora's identified vulnerabilities is the risk of damage occurring to our critical high voltage distribution lines, or our inability to repair our critical distribution lines easily. This risk can be minimized and/ or mitigated with suitable corridor protection rules in the proposed District Plan.

3.11 The assets that we wish to have protected via suitable corridor protection rules are explained below.

4. AURORA'S QUEENSTOWN NETWORK

4.1 The Queenstown network area is supplied from one bulk supply point operated by Transpower New Zealand Ltd. This supply point is known as the Frankton Grid Exit Point (GXP) and is located at 93 Frankton-Ladies Mile Highway. As a simplification, the 33kV lines and cables that emanate from these GXP's can be thought of as the lines whose primary purpose is to supply power to the greater Queenstown, Frankton and Arrowtown areas under normal operating conditions. They shift the electricity that arrives off the Transpower network to our zone substations which in turn supply around 32,000 customers.

4.2 The 8 zone substations in the Queenstown, Frankton and Arrowtown areas then transform the voltage from 33kV down to 11kV (High voltage to medium voltage). The 11kV voltage is then used to reticulate the power to the smaller distribution transformers located around the streets.

4.3 All medium voltage reticulation in the region is supplied at 11kV. 11kV can be considered a more workable voltage than 33kV because it allows for smaller, more interchangeable equipment to be installed in the public domain. Increasing the voltage does allow greater energy to be delivered for the same conductor size however the cost of insulating higher voltages also increases.

4.4 7 of the 8 zone substations are supplied by redundant 33kV lines or cables. The theory of redundancy is that should a component within a system fail, the system will continue to function because an alternative path is available for the system to operate (N-1). The way redundancy is achieved differs given the natural environment.

4.5 For the zone substation in the Queenstown area, there are three 33kV lines from the Frankton GXP. Two lines above the Highway into Queenstown and the third around the other side of Queenstown Hill through Arthurs Point. A fault on one of these lines will mean we can still supply the electricity demand from the two remaining in service lines.

4.6 For the zone substations in the Arrowtown area, a 33kV ring has been created. This allows for supply to remain available when a section of the 33kV line between substations is not available. The use of a ring also creates route diversity which aids in resilience of supply. The Remarkables skifield substation is feed of this ring via a single overhead line.

4.7 Due to technical constraints associated with the electrical protection of the 33kV Arrowtown ring, any fault on the overhead 33kV line will result in a momentary outage to the Arrowtown zone substations (6-10 seconds); resulting in an interruption to the power supply of customers while the automatic changeover occurs.

4.8 The Frankton Zone substation is located directly next to the Frankton GXP and is therefore supplied by two short 33kV underground cables.

4.9 Aurora's 33kV network supplied off the Frankton GXP is also utilized by Pioneer Generation for supply of their Wye Creek hydro power station. Pioneer Generation also run a smaller hydro power station near Glenorchy; the Oxburn hydro power station. This connects into Aurora's 11kV network.

4.10

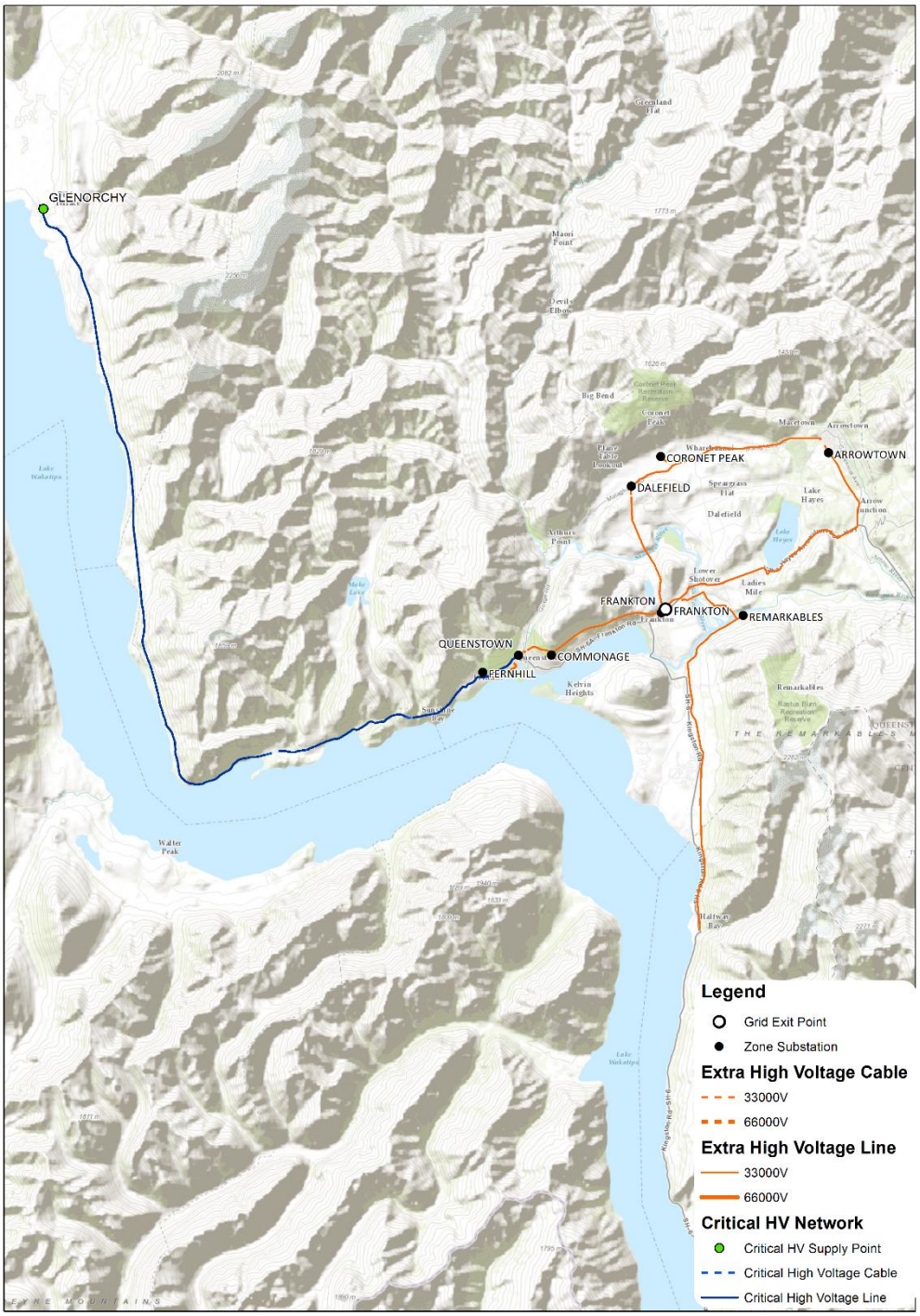
4.11 Between Fernhill and Glenorchy Aurora has an overhead line that is insulated at 33kV but operated at the lower voltage of 11kV. This line is a single circuit with no redundancy.

4.12 Throughout the 33kV lines there are small sections of underground 33kV cables. These small underground cable sections are known as siphons and are typically created due to land being developed to an extent where it is not practical to retain 33kV overhead lines. It is not Aurora's preference to underground 33kV lines when they are the only source of supply. This is due to the long restoration time associated with fault location, repair and the highly skilled labour required to work on underground lines. Fault location and repair can occur considerably more quickly on overhead lines.

4.13 All of the 33kV overhead lines either follow the legal road corridor or have been installed on specifically designed routes taking into account engineering and environmental issues. Under the Electricity Act 1992, Aurora is only able to locate assets where they were prior to 1992, or along a legal road corridor, or on private property if Aurora holds a property right (easement) over such property.

4.14 To relocate the 33kV overhead lines from the road corridors or their current alignment through property, would involve extensive negotiation with private land owners and cost. Such negotiation may ultimately prove unsuccessful. Any costs incurred to compensate for lost property rights, or injurious affection arising from installation of infrastructure on private property and relocation of assets would also need to be passed onto electricity consumers resulting in higher power bills.

4.15 Further, ground conditions and terrain away from legal road corridors is also often not favourable or practical for relocation of assets i.e. for underground assets ground conditions could prevent trenching, while for overhead lines the contour of the hills determine whether clearances to lines can be achieved.



Frankton Sub Transmission Network and Critical Distribution Electricity Lines

5. AURORA'S WANAKA NETWORK

5.1 The Wanaka network differs from that of the Queenstown network in that Transpower's GXP is located a substantial distance from the network in Cromwell. This GXP is known as the Cromwell Grid Exit Point.

5.2 To supply the large electricity demand in the Wanaka, Cardrona and Hawea areas, a voltage of 66kV is used. Two 66kV overhead lines run from the Cromwell up to

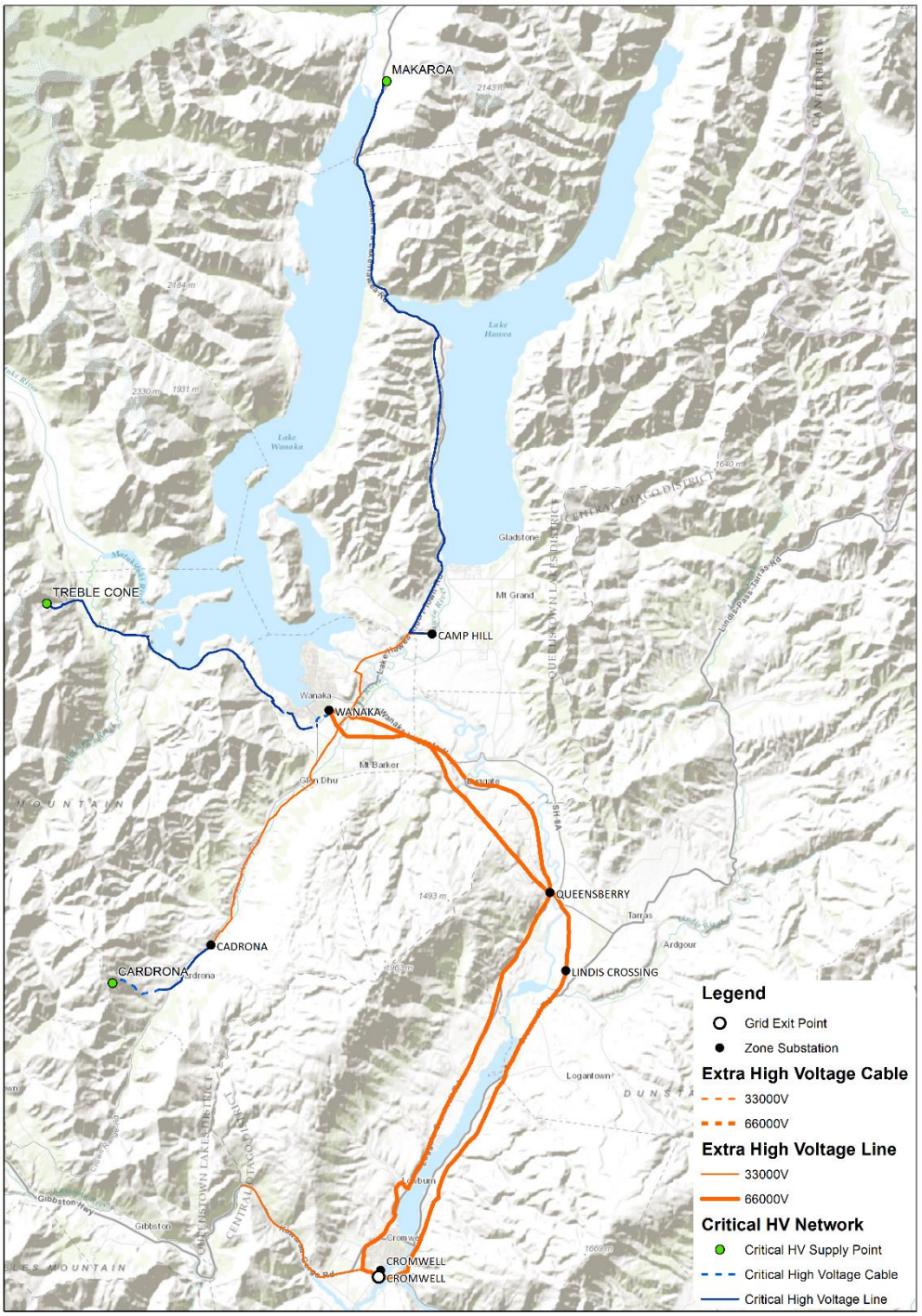
Wanaka, one on either side of Lake Dunstan. These lines terminate at the Wanaka zone substation and are each approximately 55km in length.

5.3 From Wanaka the voltage is transformed from 66kV to 33kV and is presently used to distribute supply the other 2 zone substation in the Cardrona and Hawea area. Approximately 7800 customers are supplied in the Wanaka, Cardrona and Hawea areas. The Wanaka substation is unique in that it transformers voltage from 66kV to 33kV and 11kV.

5.4 The three zone substations in this area are known as Wanaka, Cardrona and Camp Hill. These substation supply the distribution network at 11kV.

5.5 With no nearby GXP, Aurora plays a greater role in the delivery of power to the Wanaka, Cardrona, Hawea areas. There has been considerable demand growth in this area recently necessitating the construction of two new substations. Camp Hill which was been constructed and a new substation to be located at the corner of Riverbank Road and Ballantyne Road which is currently going through detailed design. This substation will allow Aurora to continue to reliably meet the growth in electricity demand for the region.

5.6 This new substation will also enable the Cardrona line to be operated at 66kV as it was constructed to do so. This will improve the efficiency in which electricity is delivered to the Cardrona area.



Cromwell Subtransmission Network and Critical Distribution Electricity Lines

6. CRITICAL 11kV INFRASTRUCTURE

6.1 Auroras 11 kV distribution system consists of a mixture of cables and lines. Across its entire network, Aurora has approximately 2,316km of overhead 11kV or 6.6kV line and 987km of 11kV or 6.6kV underground cable. Aurora also has approximately 1km of submarine cable.

6.2 Within the QLDC's boundaries Aurora has 597 km of overhead 11kV line and 408 km of underground 11kV cable. Aurora does not seek protection for the vast majority of its 11kV lines and cables as it recognizes that not all 11KV line and cable, despite being high voltage and supplying hundreds to thousands of customers, is critical to the community.

6.3 Aurora is seeking corridor protection for approximately 116km of its 11kV line and 9km of 11kV cable. This comprises;

6.4 The 11kV lines and cable from Wanaka to Treble Cone. These lines currently operate at 11kV but in anticipation of future electricity growth towards Glendu Bay and Treble Cone sections of the 11kV line have been constructed and insulated to operate at 33kV. At this time there is no alternative means of supply to the Treble Cone ski field who rely on this line.

6.5 The 11kV spur line from Camp Hill to Makarora which supplies approximately 110 customers for which there is no alternative means of supply.

6.6 The 11kV lines and cable from the Cardrona substation to the Cardrona ski field tee off which is critical to the operation of the ski field and which would also be used to supply the Mt Soho ski field should this development progress.

6.7 The line from Fernhill to Glenorchy which is operated at 11kV but has been constructed and insulated to operate at 33kV. It is likely this voltage conversion will occur within the 10 year planning period to keep up with the electricity demand growth in Glenorchy.

7. LEGISLATIVE PROTECTION OF ELECTRICITY LINES

7.1 In summary the assets we seek to have corridor protection rules for are:

- 147km of 33/66 kV sub-transmission lines;
- 44km of 11KV line and cable between Fernhill and Glenorchy;
- 44km of 11kV line from the Camphill substation to Makaroa;
- 9km of 11kV line and cable between the Cardrona substation and the ski field tee off; and
- 28km of 11kV Line and cable between Wanaka and Treble Cone.

7.2 I believe that given the number and nature of the customers supplied from each of the above lines and cables, that these lines are critically important to the district and region.

7.3 Their importance warrants protection under the Proposed District Plan through suitable corridor protection rules. Without such corridor protection rules there is a risk of development under or in close proximity to high voltage lines as no other legislation applicable to the lines provides suitable safeguard from development that may put this infrastructure at risk.

7.4 The Electricity Act 1992 provides some protection for lines that were legally installed under previous Acts and Regulations i.e. before 1992.

7.5 The Electricity Act 1992 provides a right to occupy exclusively the space occupied by the lines, and to operate, inspect, maintain, replace and upgrade the lines, because the lines have the status of "existing works" under the Electricity Act 1992. These rights are referred to as statutory easement rights or existing use rights.

7.6 However, the Electricity Act 1992 does not include detailed obligations for land owners under the lines and does not prevent underbuild or land use incompatible with the ongoing use and maintenance of the lines. It is possible that buildings could be constructed, and other activities undertaken, beneath the lines. Simply, the Electricity Act 1992 on its own does not afford sufficient protection from activities interfering with lines.

7.7 In addition to the Electricity Act 1992, the New Zealand Electrical Code of Practice 34 (Code) also governs the use of lines corridors. The Code sets minimum safe electrical distance requirements for overhead electric line installations. The Code states that the minimum safe distances have been set primarily to protect persons, property, vehicles and mobile plant from harm or damage from electrical hazards. Appendix 1 contains a copy of the Code.

7.8 Section 2 of the Code covers safe distance requirements for excavation and construction near overhead electric line support structures. These requirements are summarised in the figures at page 6 and page 7 of the Code.

7.9 In summary, the minimum safe distances for excavation near either a pole or a tower, without written consent of the network owner, are as set out in the tables below. These distances are relevant to the earthworks discussion further in my evidence.

Within 2.2m of pole or stay wire	Work is no greater than 300mm in depth
Between 2.2m and 5m of pole or stay wire	Work is greater than 750mm in depth
Within 6m of tower or stay wire	Work is no greater than 300mm in depth
Between 6m and 12m of tower or stay wire	Work is greater than 3m in depth

7.10 In summary, the minimum safe distances between buildings and overhead electric line support structures (i.e. the pole or tower) are as set out in the table below which is copied from section 2 of the Code. These distances are relevant to the 'underbuild' discussion in my evidence below.

TABLE 1 MINIMUM SAFE DISTANCES BETWEEN BUILDINGS AND OVERHEAD ELECTRIC LINE SUPPORT STRUCTURES

Circuit Voltage	Pole	Tower (pylon)
11 kV to 33 kV	2 m	6 m
Exceeding 33 kV to 66 kV	6 m	9 m
Exceeding 66 kV	8 m	12 m

7.11 Section 3 of the Code sets safe distance requirements for the construction of buildings and other structures near existing conductors (i.e. the actual electrical line rather than the pole or tower).

7.12 Depending upon the situation there are many distances set out in Section 2 and 3 of the Code. The distances that are of relevance to the conductors/lines that Aurora seeks protection for under the Proposed District Plan are set out in the table overleaf. In summary, the distances established in the Code do not prevent underbuild near the lines Aurora seeks to protect.

	Exceeding 1kV but not exceeding 33kV	Exceeding 33kV but not exceeding 110kV
	Bare or covered (m)	Bare (m)
Vertically above those parts of any structure normally accessible to persons	4.5	5 5
Vertically above those parts of any structure not normally accessible to persons but on which a person can stand	3.7	4.5
In any direction (other than vertically above) from those parts of any structure normally accessible to persons, or from any part not normally accessible to persons but on which a person can stand	2.1	3.0
In any direction from those parts of any structure not normally accessible to persons	1.5	2.5

7.13 There are numerous instances on the Aurora network of underbuild having occurred under high voltage lines.

7.14 Some examples of where underbuild has occurred on our high voltage network are shown Appendix 2.There are also some photos of how vegetation can affect our infrastructure.

7.15 Whilst existing cases of underbuild will not be affected or be able to be reversed by the insertion of corridor protection rules in the Proposed District Plan, it will stop any more instances occurring without Aurora having an opportunity to review and participate in the process. It will also increase awareness of the critical distribution lines and the care that needs to be taken when developing in close proximity to them.

7.16 There remain many places on Aurora's high voltage network where such underbuild is possible. Under the Code, notification to Aurora of a build is only required if the build falls

within minimum distances. Historically Aurora has had experience turning up to a site, for inspection or maintenance and finding a new structure under the lines that Aurora had not previously been aware of.

7.17 When such developments occur they can be very difficult and costly to overcome, especially retrospectively, and if they cannot be overcome, as is often the case, then the security of the affected line is compromised.

7.18 Having a structure under a line can cause various issues, including some which a property owner may not be aware of before taking ownership of the property or building:

- Lines (technically called conductors) do occasionally fall to the ground. Fortunately such instances are rare, but it does happen. Often such failures are due to third party activities such as falling trees; but insulators, conductors or conductor joints can fail. Clearly a dropped conductor poses significant risk both in terms of mechanical damage and electrocution.

- The large majority of Aurora's overhead lines are what would be considered distribution lines and in terms of height and intensity are lower and smaller in spans than owned by the national grid owner Transpower. Therefore the proximity to buildings due to underbuild will be closer.

- The maintenance and replacement techniques between a transmission line and that of a distribution line vary greatly. To allow underbuild requires close assessment and management decisions around maintenance procedures.

- Periodically conductors will need to be replaced. Underbuild removes the possibility of the conductor being lowered to the ground if due for replacement. This means any new line needs to be "rolled out" from the top of a tower and the old line "rolled in" from the top of a tower. The new wire is generally pulled through from the support structure at a reduced tension (with bigger sags). If underbuild is present in a span, it may not be possible to reduce the tensions without hitting the buildings or getting uncomfortably close to them. In such instances hurdles, or props, would generally be required to ensure conductors are kept clear of the buildings. Other alternatives are possible, but add considerably to cost and they tend to increase loadings on the support structures during the stringing works. Some existing support structures may not have sufficient capacity to allow such methods to be used safely. All of the above adds time, cost and

safety risks to the replacement process.

- Underbuild also causes problems for maintenance as well as replacement. For instance, if a fault has occurred on a line, and say a damaged meter of the line needs to be replaced, instead of being able to replace the meter section by lifting a maintenance crew up to the line in say a crane or industrial cherry picker, now the entire length of line between the towers needs to be "rolled back" to a support structure and a new section rolled out. This means maintenance crews climbing the support structure and undertaking much more complicated work. This adds time, cost and safety risks to the maintenance. It becomes even more problematic if access to the support structures themselves has become difficult.

- Given access requirements, maintenance of support structure foundations can be problematic if structures exist around them.

- Having structures near lines and towers results in the need for Aurora to communicate with home or business owners as to our maintenance and replacement plans. This in turn means that we need to work in with any requests of the property owner for timing of works and quality of reinstatement (eg tower foundation replacement that involves extensive digging can lead to 'owner requests' for an alternative look).

- Physical inspection of a line with underbuild becomes problematic as inspectors generally walk along the line route looking up at the conductor and joints. Most inspection is visual. Clearly the closer the inspector can get to the line the better. Buildings restrict access. Thermal imaging cameras may sometimes be used, however these are not effective if too far from the line.

- With any underbuild, there is the risk that landowners will install additional aerials and other ancillary structures which may be too close to the live conductors to be electrically safe. Because such additions tend to be of a random nature and often do not require consent there is no practical way for the line operator to be responsive to the risk posed to both the landowner and the security of electrical supply from such installations.

- Maintenance of the buildings under a line also becomes problematic and can be fatal if adequate electrical clearances are not maintained at all times. Replacing roofing and guttering can be particularly hazardous.

- Two types of noise occur with high voltage lines. The first is caused by wind blowing across the conductors, insulators and structures. The second is caused by electrical discharges (corona) along insulators and conductors which produce a crackling sound. For this reason it is prudent to position buildings away from lines.

- Rain water tends to run down conductors and drip off at the low point in the span. If a building is situated under this point, the noise of the water hitting the roof can be noisy for occupants.

7.19 As previously discussed, the Code specifies certain distances that excavation works must be from towers and poles (and associated stay wires). While the Code specifies such distances, and despite communication efforts made by Aurora, Aurora often finds developers/contractors undertaking excavation work prohibited by the Code. When questioned such developers/contractors are either unaware of the Code or simply did not want to read it. Whilst Aurora does not accept this excuse, we recognise the Code is not in plain English and is difficult to follow.

7.20 We therefore believe that having the Code prescriptions effectively repeated in the Proposed District Plan, in plain English, will help reduce the incidence of prohibited excavation work. The benefits of this are that it would help reduce the incidence of the following issues:

- Earthworks too close to the foundations of towers or poles naturally destabilise the support structures and compromise the structural integrity of these supports and associated overhead distribution lines. Such destabilisation has an impact on the networks resilience, particularly given the high voltage critical nature of the lines we are seeking to protect via the Proposed District Plan.

- Contact with conductors occurring. Such contact poses a significant safety risk.

- Earthworks hindering the possibility of the conductor being lowered to the ground for replacement, or hindering the network maintenance or replacement activities and causing additional hazards for Aurora's staff undertaking such works.

- Earthworks also create potentially hazardous environments for workers

underneath the lines, and can cause difficulties when deploying equipment such as a crane or cherry picker.

- Piles of soil are often left under our lines. This can often reduce the clearance distances to the conductor (i.e. electrical line itself) and create safety issues for workers and the public (particularly children who tend to like to scramble to the top of such soil piles).

7.21 In describing the above I have endeavored to show that having structures (buildings/fences/swimming pools) and excavations under, or very near to, a line:

- increases risk to people and property,
- complicates maintenance issues adding significantly to maintenance costs and duration;
- can annoy occupiers for various reasons;
- possibly impacts on the reliability of power supply as repair can be delayed and take longer;
- can create reliability issues due to land use creating discharges (i.e. smoke, dust) that degrades the electrical insulation performance of the line causing power outages; and
- can, if an electrical fault occurs, have the potential to cause significant harm or death as the structure may incur hazardous voltages.

7.22 For many reasons therefore underbuild and excavation or earthworks can have a major impact on Aurora and its customers.

8. NATIONAL POLICY STATEMENT ON ELECTRICITY TRANSMISSION

8.1 The National Policy Statement on Electricity Transmission (NPSET) established a range of policies to direct the management of effects generated by the national transmission network, and the management of effects on Transpower's network generated by development in close proximity to it. Specifically, the NPSET requires local authorities to give effect to Policies 10 and 11, which require them to manage adverse effects caused by development near high- voltage transmission lines.

8.2 Whilst I accept that the NPSET does not apply to distribution lines it is Aurora's view that the local high voltage distribution lines are critical to the district and regional

community. Without a secure the reliable local network, the electricity from the National Grid cannot be distributed to communities. Quite simply exclusion of critical distribution lines from the NPSET does not mean they should be excluded from local Council planning rules.

8.3 As I have set out above the lines that Aurora have identified for protection are critical to the supply of electricity within the Queenstown, Cromwell, Wanaka and Hawea areas. They secure supply for important facilities that need to have secure electricity supply on a day to day basis, but also during disaster events. Aurora is a Lifeline Utility and as such we need to take steps to minimise risk to the lifeline utilities that we are responsible for and be prepared to secure supply in the event of a civil defense emergency. Aurora has sought protection of the critical lines in the proposed District Plan to satisfy our obligations in this regard.

9. THE CORRIDOR PROTECTION RULES SOUGHT BY AURORA

9.1 If Aurora's submission regarding protection of critical assets is accepted it is necessary to consider what width the corridor should be and what controls apply within the corridor.

9.2 The width of the corridor needs be determined by a number of considerations including:

a) Ensuring that the mechanical performance is maintained. i.e. that the environment around that foundations is protected, from say vandalism, and any change of environment does not affect the condition of the mechanical components, i.e. contamination;
b) Ensuring the electrical performance is maintained, i.e. significantly that the insulation is maintained and is not compromised, by trees, mechanical equipment, contamination or unauthorized access;
c) Ensuring that safe operation is maintained in the event of electrical or mechanical failure;
d) Considering reverse sensitivity surrounding electric and magnetic fields, audio noise, radio interference; and
e) Maintaining ability to access for operational and maintenance. This can include access ways for large plant and equipment, and the occasional need for significant excavation.

9.3 The primary concerns are that the line operates in a safe manner without being

compromised and the ability to maintain the line in a safe manner is maintained.

9.4 With the above in mind, Transpower has developed best practice guidelines for the protection of its grid assets. Transpower has used these guidelines to develop the corridor protection rules that they seek to be included in the Proposed District Plan in relation to their line assets.

9.5 Aurora are subject to the same asset management requirements and legislation (excluding the NPSET) for line assets that provide electricity to locations of national and regional importance. These lines in many cases are the same or similar in design to the Transpower Assets.

9.6 Aurora has assessed the corridor protection required for its critical distribution lines. This involved consideration of the distance a conductor swings, which is dependent on the following:

a) Ambient temperature;
b) Power being carried by the conductor;
c) Wind speed;
d) Type and size of the conductor;
e) Tension that the conductor is strung at;
f) Cross-arm configuration; and
g) The length of the span between two support structures.

9.7 The recommended distance of 10 meters either side of the centerline and from the outer edge of foundations associated with support structures, as suggested in the proposed District Plan provisions discussed in the evidence of Ms Dowd is a sufficient area to allow for most of the foreseeable maintenance of Aurora's critical assets.

9.8 Ms Dowd will provide evidence on the controls that will apply in this area.

10. CONCLUSION

10.1 Aurora's QLDC network has approximately 32,000 customer connections – homes and businesses.

10.2 In recognition of the role Aurora plays to ensure distribution of a reliable and secure supply of electricity to the region, and our role in keeping our economy running and improving our community's well-being, Aurora is a Lifeline Utility under the CDEM Act. Under the CDEM Act, Aurora is to ensure it is able t o function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency. Aurora is also to undertake hazard and risk analysis and is carry out risk mitigation measures. One of Aurora's identified vulnerabilities – the risk of

damage occurring to our critical high voltage distribution lines, or our inability to repair our critical high voltage distribution lines easily – can be mitigated with suitable corridor protection rules in the Proposed District Plan. Without such corridor protection rules there is a risk of development under or in close proximity to high voltage lines as no other applicable legislation provides suitable safeguard.

10.3 Given the number of customers supplied from each of the high voltage lines, the failure of any one of these high voltage lines has a far greater impact than the failure of one, or indeed many, low voltage lines. Aurora's high voltage lines are critical to its network and critically important to the City and Region.

10.4 Aurora seeks protection over the high voltage lines identified in its submitted plans. The length of these high voltage lines and the length of other lines on the Aurora network are shown below. Aurora is not seeking corridor protection for low voltage lines or the majority of its 11kV high voltage line network.

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Steve Sullivan

Asset Strategy Manager – Aurora Energy Limited

5 September 2016

Appendix 1: The New Zealand Electrical Code of Practice34

Appendix 2 – Photos of Underbuild and Vegetation encroaching on Lines

BI-2036

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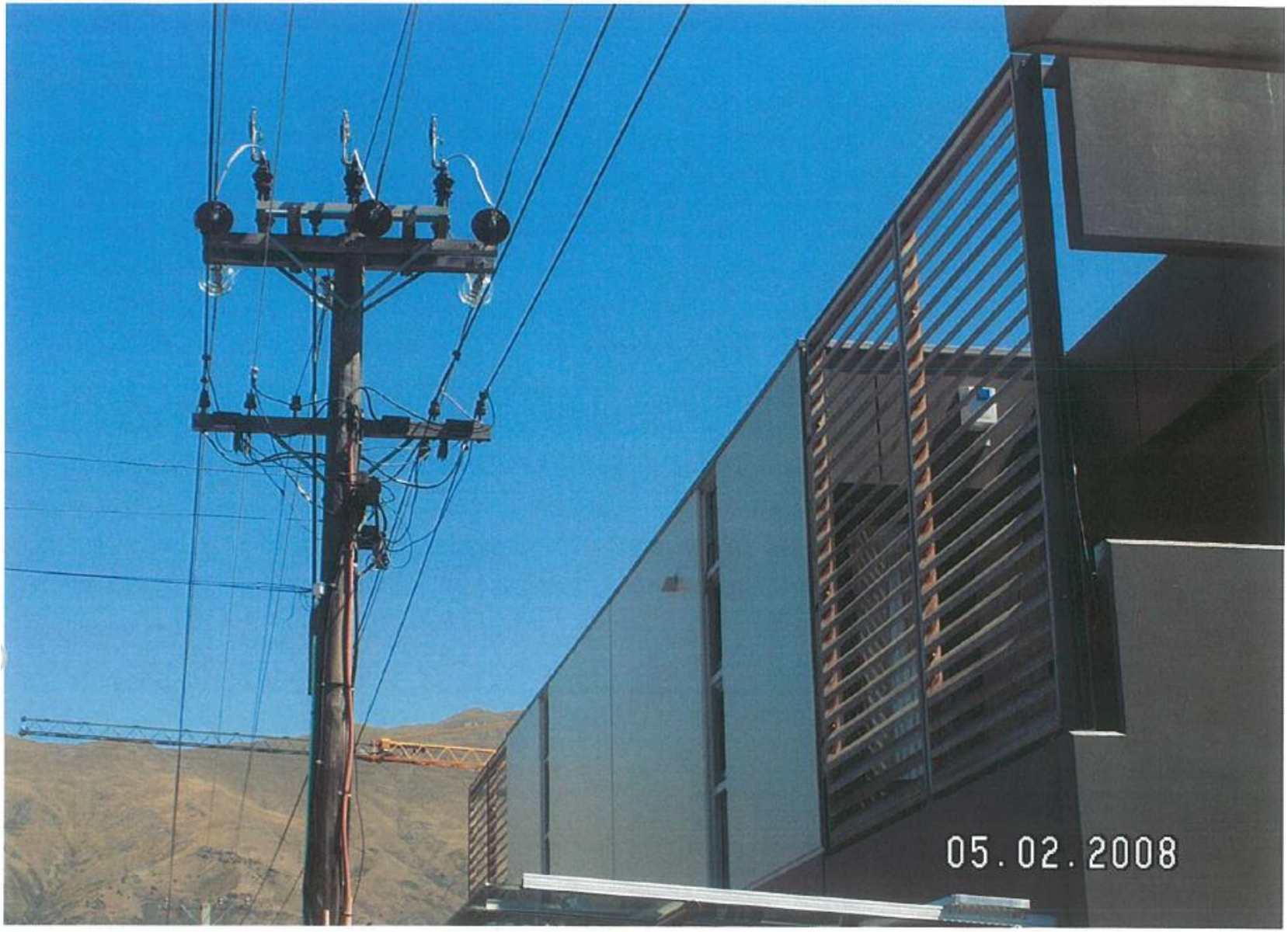

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NZECP 34:2001 ISSN 0114-0663

NEW ZEALAND ELECTRICAL

CODE OF PRACTICE

for

ELECTRICAL SAFE DISTANCES

NZECP 34:2001

NEW ZEALAND ELECTRICAL CODE OF PRACTICE

for

ELECTRICAL SAFE DISTANCES

Issued by:
Manager, Standards and Safety,
Ministry of Consumer Affairs,
Wellington, New Zealand

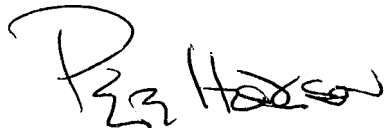
THE ELECTRICITY ACT 1992

Approval of the New Zealand Electrical Code for Practice for Electrical Safe Distances 2001 *(NZECP 34:2001)* and the revocation of the New Zealand Electrical Code of Practice for Electrical Safety Distances 1993 *(NZECP 34:1993)*

Pursuant to section 38 of the Electricity Act 1992, I hereby revoke the New Zealand Electrical Code of Practice for Electrical Safety Distances 1993 *(NZECP 34:1993)* and approve the New Zealand Electrical Code of Practice for Electrical Safe Distances 2001 *(NZECP 34:2001)*.

The New Zealand Electrical Code of Practice for Electrical Safe Distances 2001 *(NZECP 34:2001* was published by the Manager, Standards and Safety, Ministry of Consumer Affairs, acting under delegated authority *(pursuant to section 41 of the State Sector Act 1988)* from the Chief Executive, Ministry of Economic Development on the 3rd day of August 2001.

Dated this 21st day of December 2001.



Minister of Energy

COMMITTEE REPRESENTATION

This Code of Practice was prepared by the Ministry of Consumer Affairs, in consultation with the following:

The Building Industry Authority
Transpower New Zealand Ltd
Electricity Engineers' Association of NZ (Inc)
Institution of Professional Engineers NZ
Tranz Rail Ltd
Telecom NZ Ltd
Telstra Saturn

REVIEW

This Code of Practice will be revised as occasions arise. Suggestions for improvements of this Code are welcome. They should be sent to the Manager, Standards and Safety, Ministry of Consumer Affairs, PO Box 1473, Wellington.

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INTRODUCTION

This Electrical Code of Practice (Code) sets minimum safe electrical distance requirements for overhead electric line installations and other works associated with the supply of electricity from generating stations to end users.

The minimum safe distances have been set primarily to protect persons, property, vehicles and mobile plant from harm or damage from electrical hazards. The minimum distances are also a guide for the design of electrical works within substations, generating stations or similar areas where electrical equipment and fittings have to be operated and maintained.

The Code has been designed to include, in its various sections, requirements that were previously contained in the Electricity Regulations 1997 (the Regulations). Compliance with this Code is mandatory.

- **Section 1** is a general section, including this Code's scope, interpretation and glossary.
- **Sections 2** and **3** cover the safe distance requirements for building works and excavation near overhead electric line support structures. It also covers the construction of buildings and other structures near conductors and the installation of conductors near existing buildings and similar structures.
- **Section 4** covers the requirements for maintaining safe distances between conductors and the ground and water, including restrictions on material being deposited under or near conductors.
- **Section 5** covers the responsibilities of parties who work or operate mobile plant near overhead electric lines and other electrical works.
- **Sections 6 – 8** cover the requirements for safe design and installation of overhead electric and telecommunications systems and other electrical works and controls on access to conductors.
- **Section 9** covers minimum safe approach distance requirements for persons working near exposed live parts.
- **Section 10** covers the responsibilities of owners of electricity supply works for inspection and maintaining records.

SECTION 1
SCOPE, INTERPRETATION, GLOSSARY AND GENERAL

1.1. SCOPE

1.1.1 This Code covers safety issues, in so far as they relate to safe distances to overhead electric lines, telecommunication lines, line equipment and fittings, and personnel working on or near to such lines equipment.

1.1.2 This Code sets out minimum requirements in respect of the following matters:

(a) Excavations or construction near overhead electric line supports;
(b) Limits for construction near conductors;
(c) Limits for the installation of conductors near existing buildings and similar structures;
(d) The separation and height of conductors above ground etc;
(e) The separation of overhead telecommunications lines and conductors;
(f) Overhead electric line access, supports and stays;
(g) Limits on material deposited or placed under or near an overhead electric line;
(h) Operation of mobile plant near conductors;
(i) Safe distances for the design of substations, switchyards and switchboards;
(j) Minimum approach distances to exposed live parts; and
(k) Inspection and records.

1.1.3 The content of this Code does not exempt any person from compliance with any statutory requirements in respect of the matters in clause 1.1.2.

1.1.4 This Code does not apply to:

(a) Distance limits for large loads (e. g. buildings and over-dimension loads) travelling down roads.
(b) Optical fibre ground wire or optical fibre cables that are contained in or wrapped around any conductor.
(c) Hazards from trees.

1.2. INTERPRETATION

The Electricity Act 1992 and the Electricity Regulations 1997 contain definitions that are to be used in conjunction with this Code. These include: associated equipment; direct contact; electrically safe; exposed conductive part; fittings; high voltage; indirect contact; insulated; live or alive; live part; low voltage, and works.

In this Code, unless the context otherwise requires:

1.2.1 **Bare conductor** - means a conductor without covering or not insulated.

1.2.2 **Competent employee** – means an employee who can demonstrate to their employer, at any time, that they have the necessary knowledge, skills and experience to carry out electrical or telecommunications work in the vicinity of overhead electric lines, or exposed live metal, safely and to the standards used by the employer.

1.2.3 **Conductor** – means a wire, cable or form of metal designed for carrying electric current but does not include the wire of an electric fence.

1.2.4 **Distance** (for conductors) - unless otherwise specified, means the distance under the worst case

combination of maximum sag, load current, solar radiation, climatic conditions, etc, and in which the conductor creep process is complete (in the case of a line crossing another line, the worst case is that which results in the minimum spacing between the two lines).

1.2.5 **Mobile plant** - means cranes, elevating work platforms, tip trucks or similar plant, irrigation booms, any equipment fitted with a jib or boom and any device capable of being raised and lowered.

1.2.6 **Overhead electric line** – means conductors and support structures.

1.2.7 **Telecommunication line** - means any overhead wire or wires or conductors of any kind (including a fibre optic cable) used or intended to be used for the transmission or reception of signs, signals, impulses, writing, sounds or intelligence of any nature by means of any electromagnetic system. It includes any pole, insulator, casing, fixture, or other equipment used or intended to be used for supporting, enclosing, surrounding, or protecting any such wire or conductor; and also includes any part of a line.

1.2.8 **Traction systems** - means any overhead conductor or fitting for any train, locomotive, tram, trolley bus or electric overhead travelling crane.

1.3. GLOSSARY OF ABBREVIATIONS USED IN THIS CODE

a.c.	Alternating current
d.c.	Direct current
LV	Low voltage
kV	Kilovolts
m	Metres
mm	Millimetres
V	Volts

SECTION 2
MINIMUM SAFE DISTANCES FOR EXCAVATION AND CONSTRUCTION NEAR OVERHEAD ELECTRIC LINE SUPPORTS

2.1 GENERAL

2.1.1 This section outlines the requirements for building or excavation near overhead electric line support structures (towers, poles and stay wires). The minimum safe distances are designed to limit the chance of damage or hazards being created by the building or excavation. The minimum distances also ensure that the support structures can be accessed for inspection and maintenance.

2.1.2 Excavations and other works near overhead electric line supports can compromise the structural integrity of the overhead electric line.

2.1.3 Metallic or conducting paths near overhead electric line supports can transfer voltage potentials that could create step and touch currents during earth fault conditions.

2.1.4 Any consent and associated conditions given under this section shall be reasonable, and shall not be unreasonably withheld.

2.2 EXCAVATION NEAR OVERHEAD ELECTRIC LINE SUPPORTS

2.2.1 Subject to clause 2.2.2, prior written consent of the pole owner shall be obtained for any excavation or other interference with the land near any pole or stay wire of an overhead electric line where the work:

(a) is at a greater depth than 300mm within 2.2 m of the pole or stay wire of the line; or

(b) is at a greater depth than 750 mm between 2.2 m and 5 m of the pole or stay wire; or

(c) creates an unstable batter.

2.2.2 Clause 2.2.1 does not apply to vertical holes, not exceeding 500 mm diameter, beyond 1.5 m from a pole or stay wire.

2.2.3 Prior written consent of the tower owner shall be obtained for any excavation or other interference with the land near any tower supporting an overhead electric line where the work:

(a) is at a greater depth than 300 mm within 6 m of the outer edge of the visible foundation of the tower; or

(b) is at a greater depth than 3 m between 6 m and 12 m of the outer edge of the visible foundation of the tower; or

(c) creates an unstable batter.

2.2.4 Nothing in clauses 2.2.1 - 2.2.3 applies in respect of normal agricultural cultivation or the repair, sealing, or resealing of the existing surface of any road, footpath, or driveway.

2.2.5 Figures 1 and 2 provide a quick reference to the minimum safe distances for excavation near overhead electric line supports.

2.3 INSTALLATION OF CONDUCTIVE FENCES NEAR OVERHEAD ELECTRIC LINE SUPPORTS

2.3.1 Fences of conductive materials shall not be attached to any tower or conductive pole of a high voltage overhead electric line.

2.3.2 Fences of conductive materials should not be constructed within 2.2 m of any tower or conductive pole of a high voltage overhead electric line between 1 kV - 50 kV.

2.3.3 Except with the prior written consent of the overhead electric line owner, fences of conductive

materials shall not be constructed within 5 m of any tower or conductive pole of a high voltage overhead electric line of 66 kV or greater. As part of the consent, the overhead electric line owner may prescribe the design of any such fence to be constructed within this 5 m distance.

2.3.4 Where the construction of an overhead electric line would cause a contravention of the principles of clause 2.3.3, the line owner shall, at the line owner's cost, carry out an engineering study and undertake such remedial work as is necessary to maintain electrical safety.

2.3.5 Figures 1 and 2 provide a quick reference to the minimum safe distances for installation/ construction of conductive fences near overhead electric line supports.

2.4 CONSTRUCTION OF BUILDINGS AND SIMILAR STRUCTURES NEAR OVERHEAD ELECTRIC LINE SUPPORTS

2.4.1 Except with the prior written consent of the overhead electric line owner, no building or similar structure shall be erected closer to a high voltage overhead electric line support structure than the distances specified in Table 1. The distances in Table 1 are to be measured from the closest visible edge of the overhead electric line support foundation, and the nearest part of the outermost part of the building. Refer to section 3 of this code for minimum safe distances between buildings (and other structures) and conductors.

TABLE 1 MINIMUM SAFE DISTANCES BETWEEN BUILDINGS AND OVERHEAD ELECTRIC LINE SUPPORT STRUCTURES

Circuit Voltage	Pole	Tower (pylon)
11 kV to 33 kV	2 m	6 m
Exceeding 33 kV to 66 kV	6 m	9 m
Exceeding 66 kV	8 m	12 m

2.4.2 Figures 1 and 2 provide a quick reference to the minimum safe distance requirements for the construction of buildings and other structures near overhead electric line supports.

FIGURE 1 MINIMUM SAFE DISTANCES FOR EXCAVATION AND CONSTRUCTION NEAR POLES OR STAY WIRES

ANY WORKS
Prior written consent from line owner required for excavation or interference with any land near a pole or stay wire of an overhead electric line where the work creates an **unstable batter**.

Section 2.2.1 (c)

ANY WORKS
Prior written consent from line owner required for excavation or interference with any land at a greater depth than **750mm between 2.2m and 5m** of a pole or stay wire of an overhead electric line*

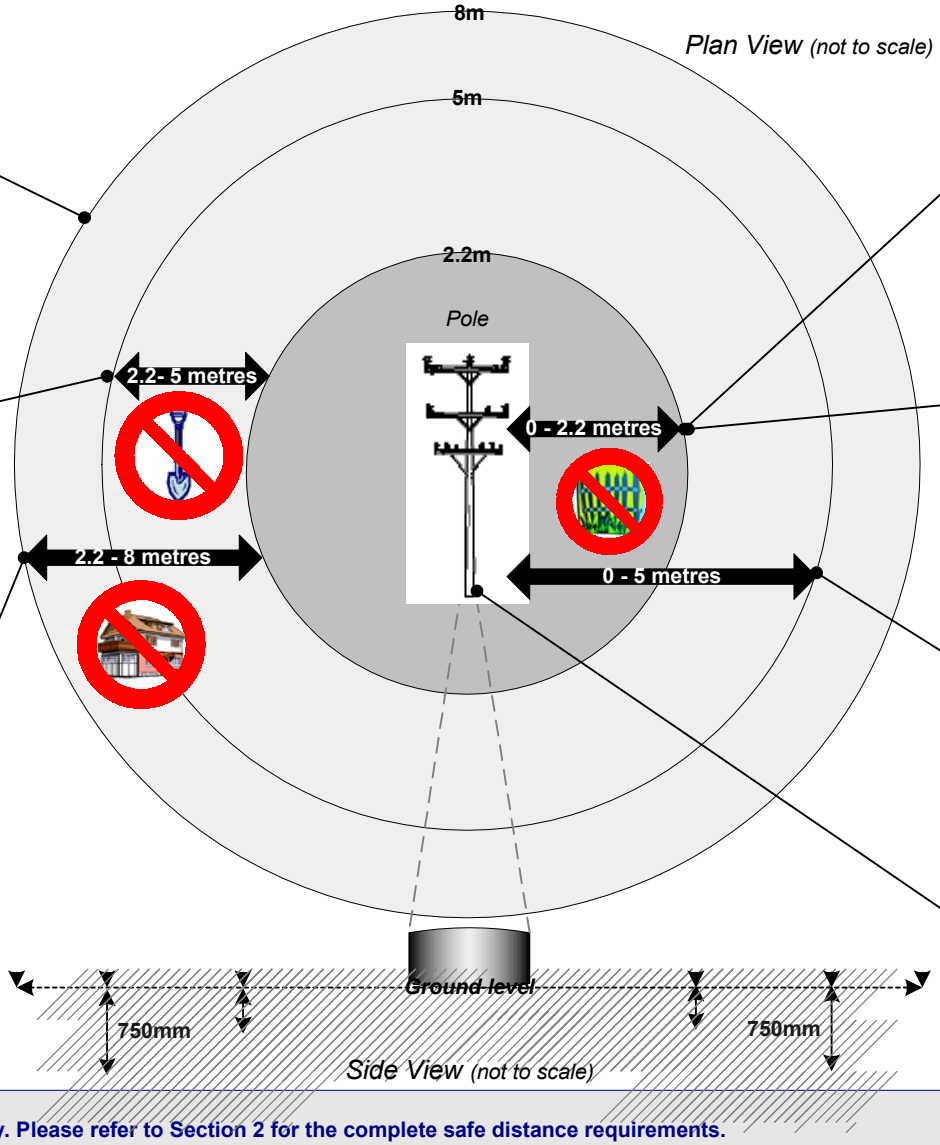
Section 2.2.1 (b)

CONSTRUCTION
Except with the prior written consent of the line owner, no building or similar structure shall be erected closer to a pole or staywire than:

- **2.2m** (11 kV- 33 kV lines)
- **6m** (33 kV - 66 kV lines)
- **8m** (Exceeding 66 kV)

Distances to be measured from closest visible edge of an pole foundation, and the nearest part of the outer most part of the building.

Section 2.4.1 Table 1



ANY WORKS
Prior written consent from pole owner required for excavation or interference with any land at a greater depth than **300mm within 2.2m** of the pole or stay wire of an overhead electric line*

Section 2.2.1 (a)

Conductive fences should not be constructed within **2.2m** of any conductive pole of a high voltage overhead electric line between **1 kV - 50 kV**

Section 2.3.2

FENCES
Prior written consent from line owner required to construct conductive fences within **5m** of a conductive pole of a high voltage overhead electric line of **66 kV** or greater. The line owner may prescribe the design of such a fence

Section 2.3.3

FENCES
Conductive fences shall not be attached to any conductive pole of a high voltage overhead electric line.

Section 2.3.1

Notes
- **This diagram is for quick reference only. Please refer to Section 2 for the complete safe distance requirements.**
- Nothing in clauses 2.2.1 - 2.2.3 applies in respect of normal agricultural cultivation or the repair, sealing, or resealing of the existing surface of any road, footpath, or driveway (Section 2.2.4).

* Clause 2.2.1 does not apply to vertical holes, not exceeding 500 mm diameter, beyond 1.5m from the pole or stay wire.

FIGURE 2 MINIMUM SAFE DISTANCES FOR EXCAVATION AND CONSTRUCTION NEAR TOWERS

ANY WORKS
Prior written consent from tower owner required for excavation or interference with any land near any tower supporting an overhead electric line where the work is at a greater depth than **300mm** within **6m** of the outer edge of the visible foundation of the tower

Section 2.2.3(a)

ANY WORKS
Prior written consent of the tower owner required for any excavation or other interference with the land near any tower supporting an overhead electric line where the work is at a greater depth than **3m**, between **6 - 12m** of the outer edge of the visible foundation of the tower

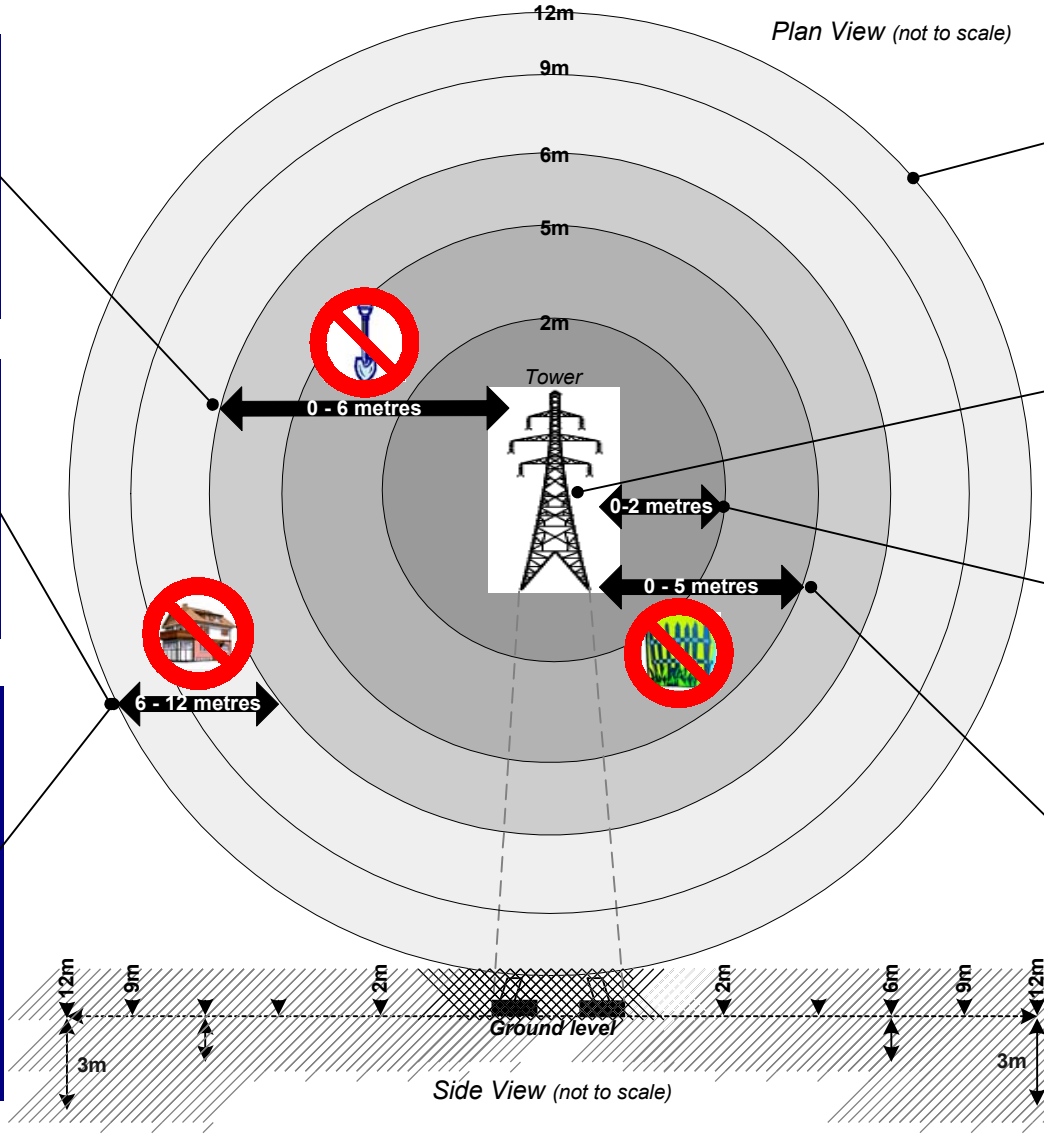
Section 2.2.3(b)

CONSTRUCTION
Except with the prior written consent of the line owner, no building or similar structure shall be erected closer to a tower of an overhead electric line than:

- **6m** (11 - 33 kV lines)
- **9m** (33 - 66 kV lines)
- **12m** (Exceeding 66 kV)

Distances to be measured from the closest visible edge of a tower, and the nearest part of the outermost part of the building

Section 2.4.1 Table 1



ANY WORKS
Prior written consent of the tower owner required for any excavation or other interference with the land near any tower supporting an overhead electric line where the work creates an **unstable batter**

Section 2.2.3(c)

FENCES
Conductive fences shall not be attached to any tower of a high voltage overhead electric line

Section 2.3.1

FENCES
Conductive fences should not be constructed within **2m** of any tower of a high voltage overhead electric line between **1 kV - 66 kV**

Section 2.3.2

FENCES
Prior written consent from line owner required to construct conductive fences within **5m** of any tower of a high voltage overhead electric line of **66 kV or greater.**
The line owner may prescribe the design of such a fence

Section 2.3.3

- **This diagram is for quick reference only. Please refer to Section 2 for the complete safe distance requirements.**
- Nothing in clauses 2.2.1 - 2.2.3 applies in respect of normal agricultural cultivation or the repair, sealing, or resealing of the existing surface of any road, footpath, or driveway (Section 2.2.4).

SECTION 3
SAFE DISTANCE REQUIREMENTS BETWEEN CONDUCTORS AND BUILDINGS (AND OTHER STRUCTURES)

3.1 GENERAL

3.1.1 This section sets safe distance requirements for the construction of buildings and other structures near existing conductors, to prevent inadvertent contact with or close approach to conductors. At higher voltages, contact may be made via a power discharge across the gap.

3.1.2 This section also sets safe distance requirements for the location and construction of conductors near existing buildings and other structures.

3.1.3 The construction of buildings, scaffolding and other structures shall be in accordance with the Building Code.

3.1.4 This section does not apply to telecommunications lines.

3.2 PROCESS FOR ESTABLISHING SAFE DISTANCES

3.2.1 Prior to any planned construction, the following process must be undertaken to comply with the Code. The landowner/ building owner shall:

3.2.1.1 Establish, if necessary with the assistance of the overhead electric line owner, whether the proposed building/structure is at a greater distance from the conductor than the recommended distances for new buildings from conductors under normal conditions specified in Table 2.

3.2.1.2 If the proposed building/structure is at a greater distance, then no further action is required by the building owner to comply with this section of the Code with regard to conductor distances.

3.2.1.3 If the proposed building/structure does not (or may not) comply with the requirements of Table 2, then the overhead electric line owner shall be consulted. A specific engineering study must be carried out by a competent person, to establish actual distances in accordance with the requirements of Table 3 (refer section 3.3). Table 3 sets out the minimum safe distances (which are closer than those specified in Table 2) under worst case conditions.

3.2.1.4 Based on the outcome of the engineering study, which shall be provided by the landowner/building owner, the overhead electric line owner will advise whether:-

(i) the proposed building/structure complies with Table 3 and construction can proceed without restriction; or

(ii) temporary arrangements during building construction need to be made, with the written agreement of the overhead electric line owner, to restrain conductor movement or to provide suitable insulation that will allow closer approach to conductors than those specified in Table 2. As part of the written agreement, the overhead electric line owner may prescribe reasonable conditions for the temporary arrangements; or

(iii) the proposed building/structure does not comply with Table 3 requirements, and therefore construction is prohibited.

3.2.2 For any overhead electric line owner planning to build a new conductor near to an existing building, a similar process to that set out in clause 3.2.1 must be followed, the costs of any

necessary engineering study being borne by the line owner.

3.3 SAFE DISTANCES FROM CONDUCTORS WITHOUT ENGINEERING ADVICE

3.3.1 Table 2 sets out the safe distances from conductors under normal conditions without engineering advice for conductor spans up to 375 m with supporting structures at equal elevation.

TABLE 2 SAFE DISTANCES FROM CONDUCTORS WITHOUT ENGINEERING ADVICE

Circuit voltage	Maximum span length (m)	Minimum distance beneath conductors under normal conditions (m)	Minimum distance to the side of conductors under normal conditions (m)
Not exceeding 1 kV	50	4	3.5
Exceeding 1 kV but not exceeding 11kV	80	5.5	5
Exceeding 11 kV but not exceeding 33 kV	125	7	8.5
Exceeding 33 kV but not exceeding 110 kV	125	7.5	9.5
Exceeding 110 kV but not exceeding 220 kV	125	8.5	11
275 kV d.c. & 350 kV d.c.	125	8.5	7.5
Not exceeding 33 kV	250	8	12
Exceeding 33 kV but not exceeding 110 kV	250	8.5	12.5
Exceeding 110 kV but not exceeding 220 kV	250	10	14
275 kV d.c. & 350 kV d.c.	250	10	11
Not exceeding 33 kV	375	9.5	20.5
Exceeding 33 kV but not exceeding 110 kV	375	10	21
Exceeding 110 kV but not exceeding 220 kV	375	11	22.5
275 kV d.c. & 350 kV d.c.	375	10.5	18
For all other spans		Engineering advice required	

(voltages are a.c. except where specified as d.c.)

NOTES

(a) Observance of potential conductor motion is required to ensure safe distances during construction.

(b) Where supporting structures are not located on equal elevations, a specific engineering study may be required to ensure distances are in accordance with Table 3.

3.4 MINIMUM SAFE DISTANCES OF CONDUCTORS FROM BUILDINGS AND OTHER STRUCTURES WITH SPECIFIC ENGINEERING ADVICE

3.4.1 Table 3 sets out the minimum safe distance of distances for conductors from buildings and other structures where a detailed engineering assessment has been carried out.

3.4.2 The minimum safe distances from a conductor of an overhead electric line to any structure, building or line support *(other than a support for the line under consideration or any line crossing the line under consideration)* shall not be less than those specified in Table 3.

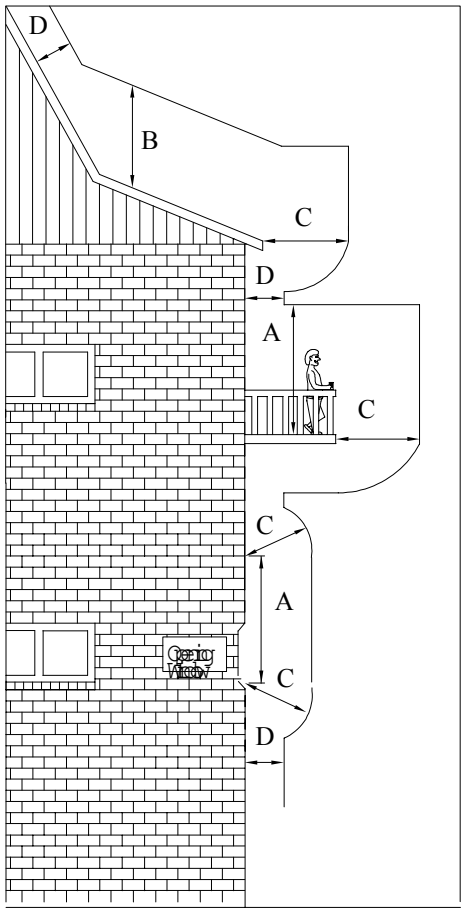
3.4.3 The Table 3 distances do not apply to insulated conductors or cables supported along the façade of a structure or building.

3.4.4 Figures 3 and 4 illustrate the application of the Table 3 to a particular building. The letters A to D refer to the distances A to D as set out in Table 3.

3.4.5 The distances specified in A and B of Table 3 shall also be maintained above an imaginary horizontal line extending outward for the distance specified in C.

3.4.6 For Figure 4, the greater distance of either A, or B (from Table 3) plus the height of the balcony, shall apply, as this latter calculation may result in a distance greater than A.

FIGURES 3 AND 4 BUILDING ELEVATION AND BALCONY SECTION



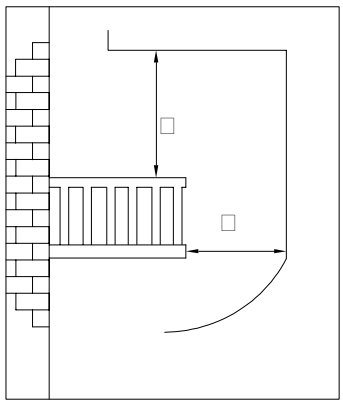


TABLE 3 MINIMUM SAFE DISTANCES OF CONDUCTORS FROM BUILDINGS AND OTHER STRUCTURES WHERE SPECIFIC CALCULATION OF CONDUCTOR MOVEMENT HAS BEEN CARRIED OUT

Safe distance conditions	Not exceeding 1 kV			Exceeding 1 kV		Exceeding 1 kV but not exceeding 33 kV	Exceeding 33 kV but not exceeding 110 kV	Exceeding 110 kV but not exceeding 220 kV	Exceeding 220 kV a.c. or d.c.
	Insulated m	Bare neutral m	Bare active m	Insulated with earthed screen m	Insulated without earthed screen m	Bare or covered m	Bare m	Bare m	Bare m
A Vertically above those parts of any structure normally accessible to persons	2.7	2.7	3.7	2.7	3.7	4.5	5	6.5	7
B Vertically above those parts of any structure not normally accessible to persons but on which a person can stand	0.1	2.7	2.7	0.1	2.7	3.7	4.5	6	6.5
C In any direction (other than vertically above) from those parts of any structure normally accessible to persons, or from any part not normally accessible to persons but on which a person can stand	0.1	0.9	1.5	0.1	1.5	2.1	3	4.5	5
D In any direction from those parts of any structure not normally accessible to persons	0.1*	0.3*	0.6*	0.1	0.6	1.5	2.5	3.5	4
E In any direction from the ground	Refer to Table 4								

* This distance can be further reduced to allow for termination at the point of attachment

SECTION 4
SAFE DISTANCES OF CONDUCTORS FROM THE GROUND AND WATER

4.1 GENERAL

4.1.1 This section sets the minimum safe clearance distances for conductors from the ground and water, including minimum safe distances for any excavations or other alterations.

4.1.2 Unless specifically identified, the requirements of this section do not apply to traction system conductors or to telecommunications lines, substations and generating stations.

4.2 MINIMUM SAFE DISTANCES OF CONDUCTORS FROM THE GROUND AND POOLS

4.2.1 Conductors of any overhead electric line, including any switching connections and transformer connections mounted on poles or structures, shall have distances from the ground not less than specified in Table 4.

4.2.2 Table 4 does not apply to existing overhead electric line conductors, or their replacement, where those conductors complied with the Regulations in existence at the time of their installation.

4.2.3 Conductors shall not be installed less than 5 m above the water level of any swimming pool.

4.3 MATERIAL DEPOSITED UNDER OR NEAR OVERHEAD ELECTRIC LINES

4.3.1 No material shall be deposited under or near an overhead electric line so as to reduce the conductor distance to ground to less than the distances required by Table 4 of this Code.

TABLE 4 MINIMUM SAFE DISTANCES OF CONDUCTORS FROM THE GROUND

Circuit voltage	Vertical distance to ground (m)			Radial distance (m)
	Across or along roads or driveways	Any other land traversable by vehicles (including mobile plant) but excluding across or along roads or driveways	Any land not traversable by vehicles (including mobile plant) due to its inaccessibility (e.g. steepness or swampiness)	In any direction other than vertical on all land
Not Exceeding 1 kV and insulated	5.5	4.0	2.7	2
Not Exceeding 1 kV	5.5	5.0	4.5	2
Exceeding 1 kV but not exceeding 33 kV	6.5	5.5	4.5	2
Exceeding 33 kV but not exceeding 110 kV	6.5	6.5	5.5	3
Exceeding 110 kV but not exceeding 220 kV	7.5	7.5	6.0	4.5
Exceeding 220 kV a.c. or d.c.	8.0	8.0	6.5	5

NOTES:

(a) Voltages are a.c. except where specified as d.c.

(b) The term ground includes any unroofed elevated area accessible to plant or vehicles.

(c) Distances specified in Table 4 are for conductors that have fully undergone mechanical creep (permanent elongation). This is deemed to have occurred after 10 years in service.

4.4 SAFE DISTANCES OF CONDUCTORS OVER NAVIGABLE WATERWAYS AND BOAT RAMPS

4.4.1 The height of conductors over a navigable waterway shall be determined in consultation with the Maritime Safety Authority of New Zealand (MSA). The booklet titled "New Zealand System of Buoys and Beacons", produced by MSA, shall be used as a guide.

4.4.2 Where conductors are installed over a boat ramp, suitable notices shall be provided on either side of the ramp, to provide a warning of the conductors' presence and an indication of the conductors' height and voltage.

4.4.3 No overhead conductors shall be installed within 9 m in any direction of a boat ramp.

4.4.4 Overhead conductors installed between 9 and 12 m of a boat ramp shall be insulated.

4.4.5 No boat ramp shall be constructed within 9 m in any direction of an overhead electric line without prior written consent of the electric line owner.

4.5 SAFE DISTANCES OF CONDUCTORS OVER RAILWAY TRACKS

4.5.1 The safe distances above rail level at the crossing of the railway for all overhead electric line conductors, when at maximum sag, shall not be less than those specified in Table 5. Where electric traction is in use, refer also to clause 6.2.2.

TABLE 5 MINIMUM DISTANCES VERTICALLY ABOVE RAILWAY TRACKS

Conductors	Distance (m)
Earthed conductors	5.5
Stay wires	5.5
Conductors up to and including 33 kV	6.5
Conductors above 33 kV but not exceeding 220 kV	7.5
Conductors above 220 kV a.c. or d.c.	8

SECTION 5
SAFE DISTANCES FOR THE OPERATION OF MOBILE PLANT NEAR CONDUCTORS

5.1 GENERAL

5.1.1 This section does not apply to live line work or to any conductor forming part of the mobile plant or any collector wire, insulated cable, or flexible cord used for the purpose of supplying electricity to the mobile plant.

5.1.2 Mobile plant working near an electric overhead electric lines can damage the line and be hazardous for the plant operator, the mobile plant and people in the vicinity.

5.1.3 Conductors can be displaced from their normal position by wind or temperature change. This requires special consideration by mobile plant operators.

5.1.4 This section does not apply while mobile plant is in transit on a road and the relevant requirements of the Traffic Regulations 1976 are observed.

5.2 MINIMUM APPROACH DISTANCE

5.2.1 The distance between any live overhead electric line and any part of any mobile plant or load carried shall be **"AT LEAST 4.0 METRES"**, unless the operator has received written consent from the overhead electric line owner allowing a reduced distance.

5.2.2 When an approval has been obtained pursuant to clause 5.2.1, and subject to clause 5.5.1, the minimum approach distance between a conductor and any mobile plant shall not be less than specified in Table 6.

5.2.3 Figure 5 provides a quick reference guide to the minimum safe distances for use of mobile plant near conductors of overhead electric lines.

5.3 WORKING ABOVE OVERHEAD ELECTRIC LINES

5.3.1 Mobile plant or any load carried shall not operate above the conductors of any overhead electric line unless the operator has received written consent from the overhead electric line owner to work above the overhead electric line.

5.3.2 The use of helicopters above overhead electric lines is governed by the Civil Aviation Rules.

5.4 CONSENT FOR REDUCED MINIMUM APPROACH DISTANCES

5.4.1 The application for written consent from the overhead electric line owner shall be made with reasonable notice.

5.4.2 The overhead electric line owner's written consent shall advise:

(a) The voltage of the overhead electric line and the minimum approach distance to be observed, which shall not be less than the requirements of Table 6; and

(b) Any other reasonable conditions to be observed while working in proximity to, or above, the overhead electric line.

(c) The section of line to which the consent applies.

TABLE 6 REDUCED MINIMUM APPROACH DISTANCES
(where written consent has been obtained)

Circuit voltage	Minimum approach distance (m)
Not exceeding 1 kV – insulated conductor	0.15
Not exceeding 1 kV – conductor not insulated	1.0
Exceeding 1 kV but not exceeding 66 kV	1.0
Exceeding 66 kV but not exceeding 110 kV a.c. or d.c.	1.5
Exceeding 110 kV but not exceeding 220 kV a.c. or d.c.	2.2
Exceeding 220 kV d.c. but not exceeding 270 kV d.c.	2.3
Exceeding 270 kV d.c. but not exceeding 350 kV d.c.	2.8
Exceeding 350 kV d.c. or 220 kV a.c.	4

5.5 REDUCED MINIMUM APPROACH DISTANCES FOR COMPETENT EMPLOYEES

5.5.1 Where the operator of any mobile plant is a competent employee working on, or in the proximity of, an overhead electric line, the approach distances may be reduced in accordance with the safety practices determined by the overhead electric line owner.

5.5.2 Direct contact of insulated elevating work platform with live conductors shall be acceptable only under approved live working procedures. Whenever a special reduced minimum approach distance is applied, the maximum practicable clearance from conductors shall be maintained.

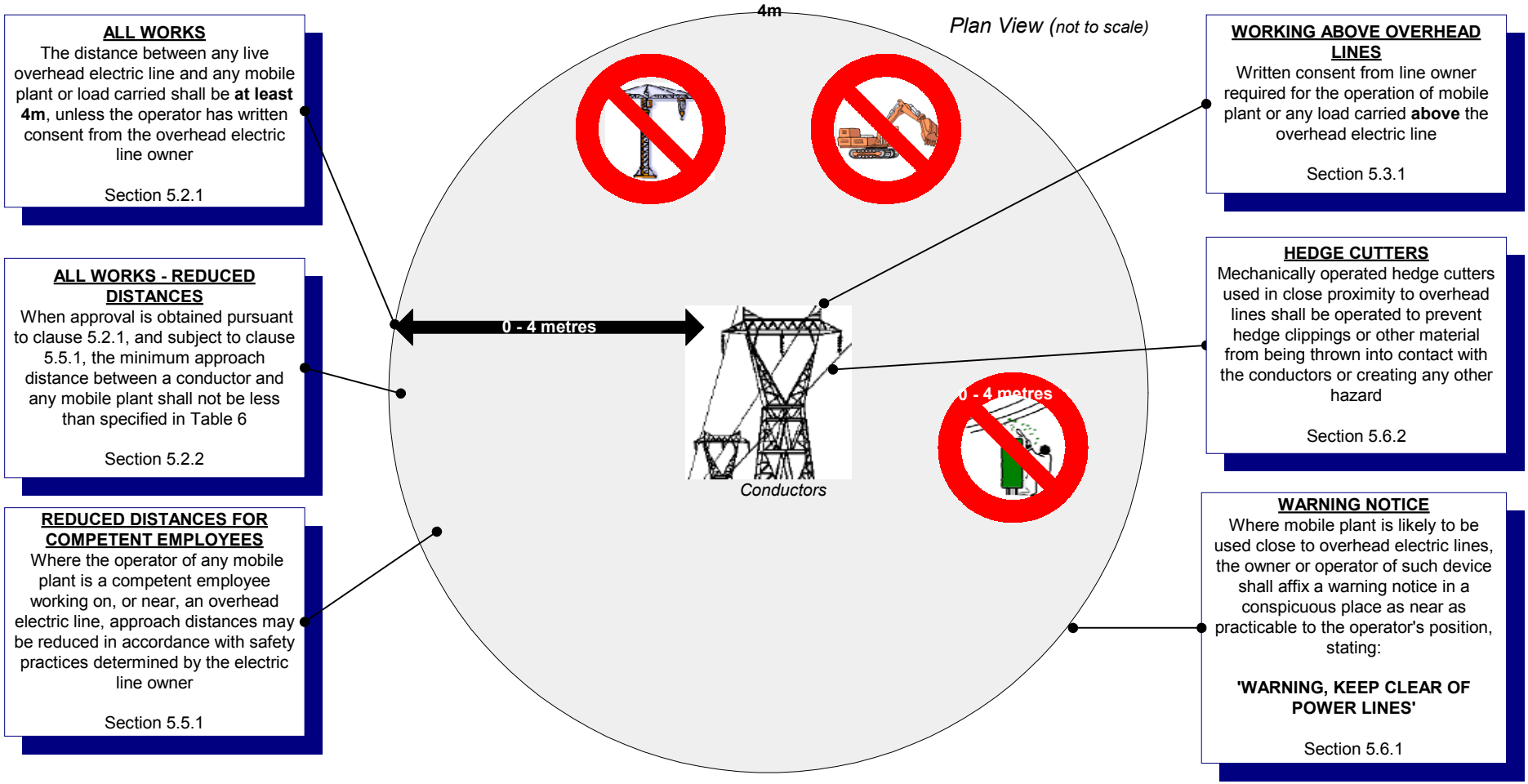
5.6 OTHER REQUIREMENTS

5.6.1 Where any mobile plant is likely to be used at any time in the proximity of overhead electric lines, the owner or operator of such device shall affix an approved warning notice in a conspicuous place as near as practicable to the operator's position. The notice shall be maintained in a legible condition and shall state:

"WARNING, KEEP CLEAR OF POWER LINES".

5.6.2 Any mechanically operated hedge cutter used under or in close proximity to any overhead electric line shall be operated to prevent hedge clippings or other material being thrown into contact with the conductors or creating any other hazard.

FIGURE 5 MINIMUM SAFE DISTANCES FOR THE OPERATION OF MOBILE PLANT NEAR CONDUCTORS



ALL WORKS
The distance between any live overhead electric line and any mobile plant or load carried shall be **at least 4m**, unless the operator has written consent from the overhead electric line owner

Section 5.2.1

ALL WORKS - REDUCED DISTANCES
When approval is obtained pursuant to clause 5.2.1, and subject to clause 5.5.1, the minimum approach distance between a conductor and any mobile plant shall not be less than specified in Table 6

Section 5.2.2

REDUCED DISTANCES FOR COMPETENT EMPLOYEES
Where the operator of any mobile plant is a competent employee working on, or near, an overhead electric line, approach distances may be reduced in accordance with safety practices determined by the electric line owner

Section 5.5.1

WORKING ABOVE OVERHEAD LINES
Written consent from line owner required for the operation of mobile plant or any load carried **above** the overhead electric line

Section 5.3.1

HEDGE CUTTERS
Mechanically operated hedge cutters used in close proximity to overhead lines shall be operated to prevent hedge clippings or other material from being thrown into contact with the conductors or creating any other hazard

Section 5.6.2

WARNING NOTICE
Where mobile plant is likely to be used close to overhead electric lines, the owner or operator of such device shall affix a warning notice in a conspicuous place as near as practicable to the operator's position, stating:

'WARNING, KEEP CLEAR OF POWER LINES'

Section 5.6.1

Notes

- **This diagram is for quick reference only. Please refer to Section 5 for the complete minimum safe distance requirements.**
- Mobile Plant includes cranes, loaders, excavators, drilling or pile driving equipment or other similar device.
- The provisions of Section 5 do not apply to live line work or to any conductor forming part of the mobile plant or any collector wire, insulated cable, or flexible cord used for the purpose of supplying electricity to the mobile plant (section 5.1.1) or while mobile plant is in transit on a road and the relevant requirements of the Traffic Regulations 1976 are observed (section 5.1.4).

SECTION 6
MINIMUM SAFE DISTANCES BETWEEN CONDUCTORS OF DIFFERENT CIRCUITS, TELECOMMUNICATION LINES AND STAY WIRES

6.1 GENERAL

6.1.1 This section sets minimum safe distances for overhead electric lines to prevent conductors contacting other conductors, or stay wires, or approaching sufficiently close to cause a fault condition. This section also applies to telecommunications lines.

6.1.2 The requirements of this section do not apply to substations and generating stations and unless specifically identified, traction system conductors.

6.1.3 The distances specified in Table 7 do not apply where the conductors of all relevant circuits are insulated. In the case of any of the insulated conductors operating at a voltage in excess of 1 kV, the conductor, or bundle of conductors, shall include an earth screen.

6.1.4 Where two circuits of different voltage cross each other, are attached to the same support, or share spans, the conductors of the higher voltage circuit should be placed above those of the lower voltage circuit. Earth wires may be above power circuits.

6.1.5 Telecommunications lines shall always be below power circuits.

6.2 CONDUCTORS OF DIFFERENT CIRCUITS ON DIFFERENT SUPPORTS *(UNATTACHED CROSSINGS)*

6.2.1 Under still air conditions, the vertical distance between any conductor or telecommunications line of the lower circuit at minimum sag and any point to which a higher circuit conductor may sag under the influence of short time overload current and solar radiation shall not be less than specified in Table 7.

6.2.2 The minimum vertical distance to a traction system is 2 m.

TABLE 7 MINIMUM VERTICAL DISTANCES BETWEEN CONDUCTORS
(unattached crossings)

Higher voltage of either circuit	Minimum distance between conductors (unattached crossing) (m)
Below 1 kV a.c.	0.6
1 kV to 33 kV a.c.	1.2
Exceeding 33 kV but not exceeding 66 kV a.c.	1.8
110 kV a.c.	2.4
220 kV and 270 kV d.c.	2.8
350 kV d.c.	4

6.3 CONDUCTORS *(SAME OR DIFFERENT CIRCUITS)* ON THE SAME SUPPORT *(ATTACHED CROSSINGS)* INCLUDING SHARED SPANS

6.3.1 Where a detailed engineering study of the over-voltages and the conductor motion has not been undertaken, the distances between conductors of different circuits at any point on the same support under normal working conditions shall not be less than specified in Table 8.

TABLE 8 MINIMUM SAFE DISTANCES BETWEEN CONDUCTORS *(attached crossings)*

Higher voltage of either circuit	Lower voltage of either circuit	Distance between circuits (m)
Not exceeding 33 kV a.c.	Less than 1 kV	1.0
	Greater than 1 kV	1.2
Exceeding 33 kV but not exceeding 110 kV a.c.	Less than 1 kV	1.5
	Greater than 1 kV	2.0
Exceeding 110 kV a.c. or d.c.	All	2.5

6.3.2 The distances in Table 8 may be reduced if a detailed engineering study of the maximum probable over-voltages and conductor motion establishes that there will be no adverse effects from a shorter distance.

6.3.3 Where lines operate at less than 1 kV, adequate measures should be taken to protect against unacceptable voltage rise between the lower voltage line and any structure energised due to the occurrence of a fault on the higher voltage line.

6.3.4 Where conductors are taken down a pole or other support to or from a transformer or other fittings, the distance between any conductors *(not being insulated to full working voltage)* shall be not less than the following:

(a) 600 mm between any line of low voltage and a line of 11 kV.

(b) 750 mm between any line of low voltage and a line of 22 kV.

(c) 900 mm between any line of low voltage and a line of 33 kV.

6.3.5 A reduced distance may be used at or near the terminals of any such transformer or other fittings where those terminals have a lesser distance between them than the minimum distance specified.

6.4 TELECOMMUNICATION LINES NEAR CONDUCTORS AND STAY WIRES

6.4.1 Subject to clauses 6.4.2 and 6.4.3, the minimum distance at any time between any telecommunication line *(including traction communication lines or signal wires)* and a conductor or stay wire shall not be less than the distances specified in Table 7.

6.4.2 Notwithstanding the distance specified in Table 7, at a shared support, the minimum distance of:

(a) a telecommunications line from a high voltage conductor that is not insulated shall not be less than 1.6 m; and

(b) a bare telecommunications line from a bare low voltage conductor shall not be less than 1.2 m.

(c) a covered telecommunications line from a bare low voltage conductor shall not be less than 0.6 m.

(d) For insulated conductors, and/or covered low voltage conductors, and covered telecommunications conductors, the distance shall not be less than 300 mm. This distance also applies to shared spans.

6.4.3 The minimum distance requirements specified in Table 7 between conductors and telecommunication lines do not apply to fibre optic cables that are:

(a) bound to a live conductor for support; or

(b) contained inside the lightning protection or earth conductor.

6.4.4 A bare catenary wire supporting a telecommunication line is deemed not to be bare for the purpose of this sub-section if the catenary is earthed at not less than every 10th pole in straight runs and at every pole when a cross-over or tee junction occurs.

SECTION 7
DESIGN AND INSTALLATION REQUIREMENTS FOR SUPPORTS AND STAY WIRES OF OVERHEAD ELECTRIC LINES, AND CONTROL OF ACCESS

7.1 SUPPORTS

7.1.1 All supports *(including stay wires, stay anchors, and other supporting equipment)* for conductors shall be so located as to avoid undue obstruction to pedestrian or vehicular traffic.

7.1.2 Poles or other supports shall not be erected closer than 4 m to the centre of the nearest railway track *(being measured horizontally from the centre of the nearest two rails to the nearest face of the pole or other support)* unless by agreement with the owner of the railway.

7.1.3 Live conductive parts less than 4.5 m above ground level, and attached to any pole or other support, shall be protected in such a manner as to prevent any accidental contact in reasonably foreseeable circumstances.

7.1.4 Any metal attached to a pole or other support, that is placed less than 2.5 m above ground level and that could become accidentally charged, shall be in direct contact with the earth, earthed or else adequately protected to prevent human contact.

7.2 STAY WIRES

7.2.1 Any stay wire less than 2.5 m from the ground in any direction that is likely to be a hazard shall be conspicuously marked.

7.2.2 Stay wires that are less than 2.5 m from the ground shall be earthed unless they are in direct contact with the earth. Alternatively, an insulator having a wet flashover value not less than that of the overhead electric line shall be inserted in the stay in a suitable position.

7.2.3 Stay wires that are erected across the part of any public road used by vehicular traffic shall have a minimum vertical distance above the ground of 5.5 m.

7.2.4 Stay wires shall not be less than 300 mm from any bare telecommunications line.

7.3 CONTROL OF ACCESS

7.3.1 Every conductor of an overhead electric line shall be so erected that it is not readily accessible to any person without the use of a climbing device.

7.3.2 Climbing steps on overhead electric line support structures shall not be placed at a height of less than 3 m above ground level.

SECTION 8
SAFE DISTANCES FOR THE DESIGN OF SUBSTATIONS, GENERATING STATIONS, SWITCHYARDS AND SWITCHROOMS

8.1 GENERAL

8.1.1 Safe distances in substations, generating stations, switchyards and switch-rooms where access to electricity supply works is required for operation, maintenance and installation activities, undertaken by competent employees, shall be suitable for the activities being undertaken and shall allow safe and unobstructed egress in emergency situations.

8.2 METALCLAD SWITCHGEAR

8.2.1 At the front of any low voltage and high voltage metalclad switchgear, there shall be a clear and unobstructed passageway at least 1 m wide and 2.5 m high.

8.2.2 Where frequent access is required for work at the sides or rear of any metalclad switchgear, there shall be clear and unobstructed passageways at least wide 1 m wide and 2.2 m high.

8.3 BARE CONDUCTORS WITHIN EARTHED ENCLOSURES

8.3.1 This subsection does not apply to bare conductors on or within panels or within fenced enclosures within buildings.

8.3.2 Any passageway at the side of or under any earthed enclosure containing bare conductors shall be clear and unobstructed and at least 800 mm wide and 2.2 m high.

8.4 BARE CONDUCTORS IN SUBSTATIONS, SWITCHYARDS, GENERATING STATION BUILDINGS AND OTHER LOCATIONS

8.4.1 In substations, switchyards, generating station buildings and other locations where there are bare conductors, the design and layout of the conductors shall be such that persons can carry out work without hazard.

8.4.2 Safety to persons shall be maintained by the provision of adequate distances to live parts for maintenance, vehicular access and pedestrian access, and if necessary to barriers or fences.

8.4.3 In fenced or other enclosed areas where access is restricted to situations where all conductive parts have been de-energised, distances may be reduced below those required by clauses 8.4.1 and 8.4.2, in accordance with a specific engineering design.

8.4.4 The distance from any bare conductor to any boundary fence or wall or similar enclosure boundary shall not be less than specified in Table 3.

8.4.5 The distances specified in Table 3 are generally applicable for bare conductors adjacent to substation buildings or other structures. These distances do not apply for situations where conductors are supported on buildings or other structures and may be reduced with a specific engineering design.

SECTION 9
MINIMUM SAFE APPROACH DISTANCE LIMITS FOR PERSONS WORKING NEAR EXPOSED LIVE PARTS

9.1 GENERAL

9.1.1 This section sets out minimum safe approach distances limits for persons working near exposed live parts.

9.1.2 Minimum safe distances limits are provided for non-competent persons. Reduced safe distances are provided for where;

(a) the owner of the live parts gives written permission; and

(b) competent employees are working near exposed live parts.

9.1.3 Minimum safe distances from exposed live parts shall be maintained at all times. Where necessary, insulating barriers shall be used to maintain minimum safe approach distances.

9.1.4 This section does not apply to work near conductors of extra-low voltage, or live line or live substation work.

9.1.5 Figure 6 illustrates the measurement of minimum safe approach distances from exposed live parts.

9.2 MINIMUM APPROACH DISTANCE LIMITS FOR NON-COMPETENT PERSONS WORKING NEAR EXPOSED LIVE PARTS

9.2.1 For non-competent persons working near exposed live parts, where written consent from the owner of the live parts has not been obtained, the minimum safe approach distances limits are:

(a) For circuit voltages 110 kV and below - 4 m.

(b) For circuit voltages above 110 kV - 6 m.

9.2.2 Where written consent from the owner of the live parts has been obtained, the minimum safe approach distance limits for non-competent persons working near exposed live parts shall not be less than those specified in Table 9.

TABLE 9 MINIMUM SAFE APPROACH DISTANCE LIMITS FOR PERSONS FROM EXPOSED LIVE PARTS (*Where consent from the owner of the live parts has been obtained)*

Circuit Voltage	Distance Limits (m)
Below 1 kV	0.5
11 kV	1.5
22 kV	2.0
33 kV	2.5
66 kV	3.0
110 kV	4.0
220 kV and above	6.0

9.3 MINIMUM SAFE APPROACH DISTANCE LIMITS FOR COMPETENT EMPLOYEES FROM EXPOSED LIVE PARTS

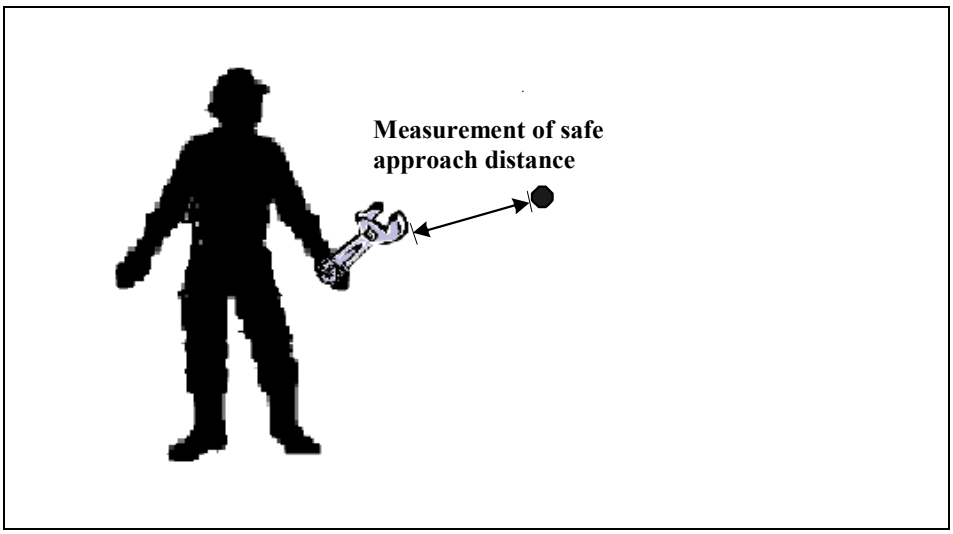
9.3.1 The minimum safe approach distance limits for competent employees carrying out electrical or telecommunications work near exposed live parts shall not be less than those set out in Table 10.

9.3.2 The minimum safe approach distance for competent employees shall be maintained by keeping all parts of the body, clothing and any hand held tools (except those tools designed for contact with live parts) beyond the safe distances set out in Table 10.

TABLE 10 MINIMUM SAFE APPROACH DISTANCE LIMITS FOR COMPETENT EMPLOYEES FROM EXPOSED LIVE PARTS

Nominal Voltage	Distance Limits (m)
Not exceeding 1 kV a.c. or d.c.	0.15
Exceeding 1 kV but not exceeding 6.6 kV a.c. or d.c.	0.25
Exceeding 6.6 kV but not exceeding 11 kV a.c. or d.c.	0.3
Exceeding 11 kV but not exceeding 22 kV a.c. or d.c.	0.45
Exceeding 22 kV but not exceeding 33 kV a.c. or d.c.	0.6
Exceeding 33 kV but not exceeding 50 kV a.c. or d.c.	0.75
Exceeding 50 kV but not exceeding 66 kV a.c. or d.c.	1
Exceeding 66 kV but not exceeding 110 kV a.c. or d.c.	1.5
Exceeding 110 kV but not exceeding 220 kV a.c. or d.c.	2.2
Exceeding 220 kV d.c. but not exceeding 270 kV d.c.	2.3
Exceeding 270 kV d.c. but not exceeding 350 kV d.c.	2.8
Exceeding 220 kV a.c or 350 kV d.c.	4

FIGURE 6 MEASUREMENT OF MINIMUM SAFE APPROACH DISTANCES



SECTION 10
REQUIREMENTS FOR INSPECTION AND RECORDS

10.1 INSPECTION

10.1.1 The owners of electrical works shall inspect and review overhead electric line installations at intervals not exceeding five years to ensure that the requirements of sections 2 to 8 have not been compromised by changed circumstances.

10.2 RECORDS

10.2.1 The following records shall be maintained to ensure that safe minimum distances are not compromised and to provide information to other parties:

(a) Asset register;

(b) Results of periodic inspections; and

(c) Dispensations or justifications for reduced distances (where applicable).