Kyoto energypark

Appendix M

Kyoto Energy Park Scone Overhead Powerline Route Review
Vemtec Pty Ltd
(21 April 2008)

pamada

VEMTEC
Utility Infrastructure Services

KYOTO ENERGY PARK SCONE
Overhead Power Line
Route Review

Developed For

Mark Dixon of
PAMADA Pty Limited

Document Control

Version	Issue Date	Comments
Ver 1	13/12/07	Released for client comment.
Ver 2	21/4/08	Final version for release.
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Approved by:	M. Lampard	Date: 21/4/08

REPORT SUMMARY

This report outlines the key factors, processes and methods that will be adopted and/or evaluated, to determine a new 66,000 or 132,000 Volt overhead line ("Line") route, for establishment of the Network Connection for Pamada Pty Limited's "**KYOTO ENERGY PARK SCONE**" Project.

VEMTEC was commissioned by **Pamada Pty Limited** to undertake the review and produce the report within the framework of the development approval process with the feasibility assessment being completed in the context of the following;

- Research of proposed line routes and possibilities to utilise existing lines.
- Conceptual design of possible routes and review of other obvious options.
- On-site reviews of the options to ensure no field issues are present for the proposed routes.
- Review of NSW legislation for power line routes and the easements.

The major factors influencing the determination of the suitable line routes are;

- Suitability of existing overhead line routes and consequentially the infrastructure for over building.
- the process by which the line route and associated easements will be negotiated with affected property owners;
- broad environmental, ecological and social considerations; and
- typical overhead line structures

The significant future actions required to finalise the determination of a recommended network connection route are;

- A full research of existing and newly required easements in both the context of road easements and the crossing of private property.
- A full technical review of the likely impacts and/or synergies of the proposed network connection on the strategy for the development of the new Scone 66/33/11kV Substation and the Scone area 66kV Network by ***Energy****Australia.*

RECOMMENDATIONS

1. Further investigation, deeper understandings and resolution of all the issues highlighted in the body of the report under the heading "Issues to be Resolved" is essential prior to finalising the proposed Network Connection and the consequently Line Route Option to be adopted.

2. Based on the information gathered during the processes of this review it is recommended that future efforts by Pamada Pty Ltd be directed towards further development of the Scone Network Connection Option, Line Route – Option 2 and associated variations in the vicinity of the Scone Township. This will need to be completed in conjunction with ***Energy****Australia* and must include a business outcome based analysis. We would recommend that this be completed by an independent organisation with knowledge of the power distribution sector.

TABLE of CONTENTS

INTRODUCTION

This document presents VEMTEC's review of the network connection options and costings associated with the development and establishment of an energy park based on renewable technologies by Pamada Pty Ltd ('Pamada'). This energy park is to be located within close vicinity of Scone in NSW. The project is titled the "**Kyoto Energy Park Scone**" and is being established on two sites, namely Middlebrook and Mountain Station. The sites are located approximately 15km west of Scone in the Upper Hunter region of NSW. The intention for the sites is to install up 130MW's of renewable energy generation for an overall working life of the Energy Park of up to 30 years. The anticipated break up of this capacity is 90-126MW of wind energy, 3-10MW of solar photovoltaic and 1MW closed loop mini-hydro plant.

In October 2007, VEMTEC was commissioned by Pamada to undertake a review covering the following points of assessment for the feasibility for Grid Connections for the proposed Kyoto Energy Park Scone

- Research of proposed line routes and possibilities to utilise existing lines.
- Conceptual design of possible routes and review of other obvious options.
- On-site review of the options to ensure no field issues is present for the proposed routes.
- Provide budget estimates for construction of possible routes.
- Review of NSW legislation for power line routes and the easements.

LINE ROUTE DETERMINATION & METHODOLOGY

a) Key Factors in Determination of Line Route Options

The determination of a line route is governed by numerous technical, environmental, property stakeholder and commercial considerations however, the principal aim is to obtain the best compromise of the following:

- where feasible, address property owner concerns and power line location preferences;
- maximise the utilisation of made or unmade road reserves ("Road Reserves");
- maximise opportunities to access clear, open land for the Line route;
- minimise impact of the Line route on existing remnant vegetation, either in road reserves or within private properties; and
- utilise existing power lines where economically feasible and practical.

b) Private Land Use

In some circumstances, it may be deemed necessary, desirable, or mutually beneficial, for the Line route to encroach upon, or pass through private properties. Typical examples of such circumstances include, but are not limited to:

- deviation of the Line route around remnant vegetation within Road Reserves, or other environmentally sensitive areas;
- the support wire ("Stay") of an electricity pole installed in a Road Reserve, may under certain conditions, encroach upon private property;
- a private property may offer a clear and open Line route opportunity;
- a land owner may prefer the Line route to pass through his or her property, in preference to a Road Reserve; or

- a land owner may perceive a benefit of having the Line route passing through their property, as a means of off-setting costs of proposed future power line extensions to their property.

c) Land Owner Negotiation & Consultation

Throughout the process of determining a Line route, each directly affected land owner will be consulted on a broad range of issues. Typical examples include:

- whether the land owner agrees to the Line route passing through, or encroaching upon, his or her land;
- the Line route preference of the land owner. For example a land owner may prefer the Line route to run adjacent to an existing fence line or Title boundary;
- current land use and future development plans for the property (if any); and
- seasonal access conditions or other relevant constraints, which may have a bearing on where and when Line construction activities could be undertaken.

Assuming agreement is reached between a land owner and Pamada, for the Line route to encroach upon, or pass through private property:

- an easement will be registered on Title, in favour of the Line owner;
- the typical easement for a 66,000/132,000 Volt line is 20/30 metres in width (10/15 metres either side of the line), however this can vary depending upon conductor span lengths and specific terrain issues;
- The legal costs of establishing the easement on the Title will be borne by the developers. If a land owner wishes to obtain their own independent legal advice concerning the establishment of the easement, such costs will be borne by the land owner; and
- Typically, the land owner is compensated for the establishment of an electricity easement. Common industry practice is to consider factors such as the market value of the area occupied by the easement, the number of poles and/or pole support "Stays" on the property, and effects on existing land use.

d) Planning & Implementation of Line Construction

Planning and implementation of the construction activities associated with the new Line should take into consideration the following issues:

- any seasonal or other land access restrictions likely to influence construction activities;
- logistics and materials storage considerations;
- the number and availability of accredited construction resources and contractors; and
- Minimising both the number and duration of disruptions to the power supplies of customers affected by the construction works.

During the construction of the Line, affected land owners and the broader community, of key project planning and construction activities should be informed by periodic correspondence and/or local media announcements.

SOCIAL IMPACTS

a) Electromagnetic Fields (EMF)

In Australia, the determination of recommended maximum EMF exposure limits is governed under the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) through its vehicle the Australian Radiation Protection and Nuclear Safety Act 1998 and Regulations

1999 and by other regulatory instruments and public health organisations. The following are direct extracts/copies from the ARPANSA web site.

*"**Australian Exposure Guidelines***
*There are currently no Australian standards regulating exposure to these fields. The National Health and Medical Research Council has issued Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields. These guidelines are aimed at preventing immediate health effects resulting from exposure to these fields. The recommended magnetic field exposure limit for members of the public (24 hour exposure) is 0.1 millitesla (1,000 mG - milligauss) and for occupational exposure (whole working day) is 0.5 millitesla (5,000 mG). [*Note: The earth's magnetic field has a strength of about 50µT (500 mG). This figure is included to help the reader obtain a feel for what the units mean. The earth's magnetic field is not changing direction at 50 to 60 times per second and is therefore not comparable to powerline fields as far as health effects are concerned. N.B. 10 milligauss = 1 microtesla*]"*.

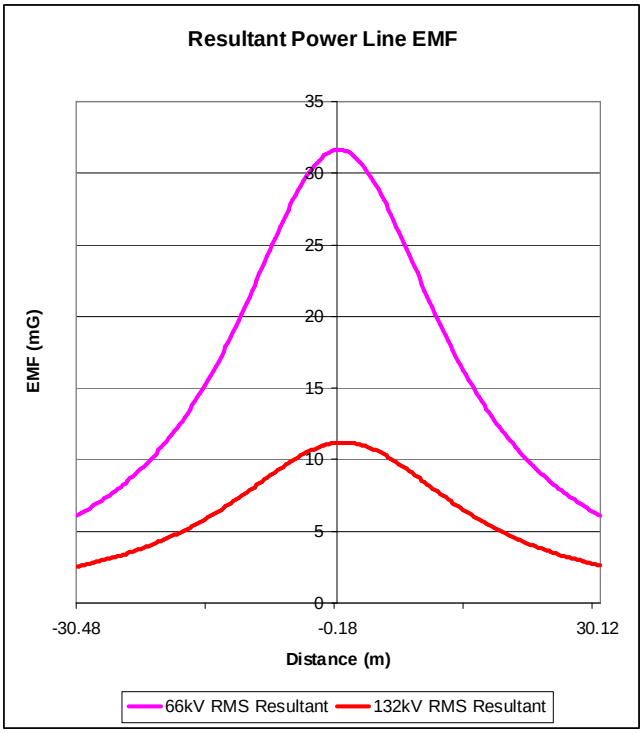
"Residential Exposures
Exposure levels to EMFs around the home are in the range of 0.01 - 0.25 µT (microtesla = 0.1 - 2.5 mG). For homes near powerlines, these levels may be as high as .5 - 1 µT (5 - 10 mG). Immediately under the powerline, magnetic field levels of 6 - 10 µT (60 - 100 mG) may be found."

In summary as per the dialogue above there are currently no specific Australian Standards regulating exposure to power line frequency EMF's. Instead, ARPANSA references the "Interim guidelines on limits of exposure to 50/50 Hz electric and magnetic fields", as issued by the National Health and Medical Research Council (NHMRC)

These exposure limits are:

General Exposure	(24 hour exposure)	1,000 milligauss (mG)
Occupational Exposure	(whole working day)	5,000 milligauss (mG)

Figure 1
Typical 66,000 & 132,000 Volt Line
EMF Profile



The nature of EMF's is that they decay exponentially as a function of distance from their source. In general terms, this means that the EMF arising from the Network Connection Line will diminish rapidly with distance from the Line. Figure 1, provides a typical cross section EMF profile of a 66,000 and 132,000kV Volt line operating at full current rating or energy park capacity. Thus it can be established that given the use of the standard construction design as per the drawings outlined in the line configuration table (or similar) the EMF exposures will be managed at levels well below the currently accepted limits.

This graph shows that typical Magnetic Field strengths, measured a metre from the ground, for a 66kV line to be in the vicinity of 6 mG with the 132kV line being in the vicinity of 2.5mG at a distance of 30m.

As a means of further reference, the following table provides indicative EMF exposure limits of typical electrical appliances:

Source	Electric Field Strength KV/m	Typical Range of Magnetic Field Strength Milligauss (mG)
Electric blanket at surface	2	1.0 to 3.0
Vacuum cleaner at 1m	0.002	1-20
Hairdryer at 30cm	0.04	1-70
Iron at 30cm	0.06	12-30
Toaster at 30cm	0.04	6-70
Video display unit (VDU) At 50cm in front	0.01	0.5-4

There is a move by ARPANSA to introduce a set of new standards known currently as 'Radiation Protection Standard – Exposure Limits for Electric & Magnetic Fields - 0Hz to 3kHz". These standards are currently in a public consultation draft form and have been since 7 December 2006.

These standards introduce a '*basic restriction'* to ensure that there is no biological effect leading to adverse health outcomes. These '*basic restrictions'* are, as noted in the standard, hard to calculate or measure so a set of '*reference levels'* have been proposed. For the case of exposure to Magnetic Fields, which are of concern for power lines, the new exposure limits from section 2.4 (page 8) of the report are:

General public for 50Hz Frequency (ongoing exposure) – 100 micro Tesla

We note that this is a different measurement to the current standards however using the same techniques as those outlined above we can calculate that the field strengths for the lines suggested here are:

66kV Configuration EMF Range	0.624 to 3.16 micro Tesla (30m to 0m from line)
132kV Configuration EMF Range	0.26 to 1.12 micro Tesla (30m to 0m from line)

As can be seen this is significantly less than the proposed standard.

b) Social Benefits

Cost sharing opportunities may exist for land owners wishing to off-set the costs of augmenting the existing network to their properties. Such opportunities would be determined through the proposed land owner consultation process outlined above under the heading "Land Owner Negotiation & Consultation".

CONNECTION OPTIONS

The overall project development timetable and business outcome requirements are the significant drivers for determining the recommended options for network connection. The final evaluation of the options is also dependent on the outcome of the "Network Connection Enquiry" with ***Energy****Australia.*

a) Destinations Considered

There have been three options considered for the destination of the Kyoto Energy Park Scone Network Connection Infrastructure with these locations being the subject of previous work complete by Econnect Pty Ltd in 2005 and 2007 and enquiries with ***Energy****Australia.*

1. 66kV option via the New Scone 66/33/11kV Substation (proposal per ***Energy****Australia* Consultation Paper dated 15th October 2007).
2. 66kV option via the Dartbrook Coal 66kV Feeder at Kayuga.
3. 132kV option via Mussellbrook STS.

b) Options Evaluated

The evaluation of three principal options for connections and each of the associated line route options (along with minor variations as identified) are based on expectations that the Network Connection Enquiry will result in a technical and business related outcome, with

acceptance/approval by ***Energy****Australia*. This along with a continued review of the areas of consideration listed within this report should provide Pamada with a sustainable business outcome.

(i). Voltages Reviewed.

The review covers options for both 66kV and 132kV line voltages for lines constructed with single or double circuit and/or twin conductor configurations. Typical configurations, for each construction option are shown in Dwg 1 through to Dwg 5 and Pic 1 and 2 attached. As a minimum the specific line designs should comply with existing technical standards being implemented within the Electrical Infrastructure Industry hence ensuring compliance with EMF exposure limits.

(ii). Line Losses.

One of the significant inputs into the determination of the option to be recommended/accepted is the business outcome impact of line losses which are a whole of life cost, not a once off like construction. The tabulation below shows the % losses expected, for a nominal line length of 20 kilometres with the loadings as listed, for each of the line construction configurations considered.

Line Configuration Conductor Type 19/4.75 AAC	% Losses for Specified Line Loadings			
	80 MVA	100 MVA	120 MVA	140 MVA
66 kV Single Conductor	8.37%	NA	NA	NA
66kV Twin Conductor	4.19%	5.23%	6.28%	7.32%
66kV Double Circuit	4.19%	5.23%	6.28%	7.32%
132 kV Single Conductor	2.09%	2.62%	3.14%	3.66%

Please note reactive losses have not been taken into account and these percentage losses only relate to resistive load, therefore they only provide a relativity benchmark for each configuration.

(iii). Cables.

For the purposes of this review the cost of construction comparisons included in the tabulations are based on the use of 19/4.75 AAC for all options. 19/4.75 AAC is a commonly used conductor by the Electrical Infrastructure Industry and will ensure good voltage drop characteristics and utilisation of capacity.

(iv). Connection Line Capacities.

Based on the use of 19/4.75 AAC conductors the. “Effective Line Capacity” for each of the options considered is as follows;

- Scone 66 kV Single Conductor 102 MW’s.
- Scone 66kV Double Circuit 205 MW’s.
- Dartbrook 66 kV Twin Conductor 205 MW’s.
- Dartbrook 66kV Double Circuit 205 MW’s
- Mussellbrook 132kV Single Circuit 205 MW’s

ISSUES TO BE RESOLVED

a) Easements

Although significant components of each option are associated with the over building of existing electrical infrastructure assets, NSW industry history and new legislation associated the approvals for easements is likely to result in the requirement for significant effort to gain Electricity Easement approvals. This issue is equally associated with each option and significant land owner interaction will be required to resolve these matters. For each of the routes, in many locations the existing infrastructure, although being constructed on what appears to be road easement, there is no clearance provided between the infrastructure and the boundary fences (assumed to be property boundary - refer Photo No 1).

Thus full analysis of the expected cost for the resolution of all these and any vegetation issues identified along both the road and across private property easements, whether existing or new, have not been completed at this stage. Significant work would be required to do so.

Photo N^{o} 1

View of infrastructure location relative to boundary fences in an unnamed road easement of possible concern north of Mussellbrook [*for location reference Map Overlay No 2*].

b) Network Connection Options

The determination of the most appropriate options for Pamada Pty Ltd to pursue is very dependant on the outcome of the Network Connection Application with EnergyAustralia. It is understood that there is likely to be significant network operational stability and reliability issues introduced by the connection of a 90+ MW supply directly into Scone area 66kV network. To fully understand this impact would require detailed evaluation of the connection at the application stage as network conditions are likely to change. There is also an option for consideration of the 132kV connection options which in itself introduces significant new issues associated with the future strategy for network development by EnergyAustralia and possible joint ownership/use of the assets into the future. Avoidance of the issues associated with the 66kV connection options by opting for the 132kV connection option, may not provide the best technical or business related outcome for Pamada and/or EnergyAustralia. From a business perspective, both parties need to consider further investigation and analysis of options for a joint development/funded project for the establishment of the Kyoto Energy Park Scone network connection.

c) Kyoto Energy Park Scone Sub-Station Establishments

The establishment of Kyoto Energy Park Scone Sub-station(s) is completely dependant on the final decisions related to the choice of network connection routes and/or voltage. Whatever the outcome the Mountain Station site will require the establishment of a sub-station, location determined by best fit with the chosen network connection route and consequentially its configuration determined by line voltage. In the case of the Middlebrook site there is likely to be a number of options dependant on the outcomes associated with Mountain Station site decisions. They range from a direct 33kV interconnection between both sites to a direct 66kV line tee off for the option associated with the Scone 66kV Network Connection. The best locations of sub-station(s) will be driven by final line route selection as both sites have a range of suitable sub-station site locations.

SCONE 66kV NETWORK CONNECTION

The Scone 66kV Network Connection option has two proposed line route options (per attached Map Overlay N^{o} 1 - Option 1 approximately 18KM's and Option 2 approximately 13KM's)). In the case of Line Route - Option 1 the Middlebrook Site could be provided with a 66kV tee off or alternatively an interconnection at 33kV with the Mountain Station site however in the case of Line Route - Option 2 a site interconnection would be necessary. There are three variations (1a), (1b), and (1c) considered for the line route section traversing the Scone township area from its western side (intersection of Satur Rd and Liverpool St) to the proposed new Scone 66/33/11kV Substation site on the southeast side of the township.

(a)Line Route - Option 1.

Line Route - Option 1 follows the Bunnan and Satur Roads directly between the Kyoto Energy Park Scone sites and the Scone Township area on its western side. From the intersection of Satur Rd, Moobi Rd and Liverpool St there are three variations for traversing the township to the substation site on the south eastern side as covered under the heading "(c) Line Route - Options 1&2 Variations in Vicinity of Scone Township" below.

(b)Line Route - Option 2.

Line Route - Option 2 starts at the South Eastern corner of the Mountain Station site and follows a route which traverses unnamed road easements in a easterly direction until the intersection with Yarrandi Rd just west of its intersection with Moobi Rd. The route continues along Moobi Rd to its intersection with Satur Rd and Liverpool Street. From this point the route is as per Line Route - Option 1.

(c)Line Route - Options 1&2 Variations in Vicinity of Scone Township.

(1a) Via Liverpool and Aberdeen Street, straight ahead through the Golf Course and across rural land overbuilding the existing 11kV Line which extends directly towards the proposed new substation site.

(1b) Via Liverpool, Aberdeen, Kingdon and Main Streets and New England Highway to its intersection with the 11kV line referenced in variation (1a).

(1c) Via semi rural land to south of the intersection of Middlebrook Rd and Liverpool St to a location south of the golf course on the 11kV line referenced in variation (1a).

While all three variations require further detailed examination Variation (1a) is likely to provide the best outcome although the requirement to traverse the golf course may present a significant challenge in terms of easement negotiations and vegetation management (refer Photo N^{o} 2). Variation (1b) is the least favoured given that the section of the route along Kingdon St where it passes across Kelly St (New England Highway) would be required to go underground or obtain approval from council to go overhead in a location where there is no existing overhead infrastructure (refer Photo N^{o} 3). Variation (1c) requires the negotiation of easement access across semi rural land (refer photo N^{o} 4) where there is only minimal overhead infrastructure in existence.

Photo N^{o} 2

View across golf course from end of Aberdeen St
[*for location reference Map Overlay No 1*].

Photo N^{o} 3

Northwards view along Kelly St from the intersection with Smith St
[*for location reference Map Overlay No 1*].

(d)Line Route - Options 1 & 2 Construction Options.

Line construction options considered were:

- Pole mounted 66kV single circuit.
- Pole mounted 66kV double circuit.

With both these construction options there would be need for overbuilding existing lines in places where there is existing 11kV circuits.

The line design and hence construction configuration at various points along the line route and the overall costs for each option is very dependant on final design requirements which will be driven by the impacts of both easement clearance and vegetation management issues.

Photo N^{o} 4

Southward view across semi rural land from the intersection of Middlebrook Rd & Liverpool St
[*for location reference Map Overlay No 1*].

DARTBROOK 66kV CONNECTION

The Dartbrook 66kV Network Connection option has a proposed Line Route – Option 3 (per attached Map Overlay N^{o} 2 - approximately 30km). It follows the Bunnan, Yarrandi, Moori, Nandowra (also known as Back Mustlebrook Rd) and Dartbrook Roads through the district of Dartbrook to the Dartbrook Mine Site at Kayuga south west of the township of Aberdeen. As per the Scone 66kV Connection Line Route - Option 1 the Middlebrook Site could be provided with a 66kV tee off or alternatively an interconnection at 33kV with the Mountain Station site.

(a) Line Route - Option 3.

This line route presents little variations in terms of possibilities however there is the opportunity for accessing the Mountain Station site via various routes directly to its east via exiting road easements as per the Scone 66kV Connection Line Route - Option 2. These variations would result in a shortening of the route overall but would require an interconnection being established between the Mountain and Middlebrook Station sites. Significant challenges in terms of easement negotiations and vegetation management (refer Photo N^{o} 5) are also present along this entire route as there is little or no clearance between the existing infrastructure alignments and private property boundaries in many locations. Thus final route choice will be very dependant on the outcome of easement negotiations.

Photo N^{o} 5

Southwards view along Nandowra Rd north of Dartbrook
[*for location reference Map Overlay No 2*].

(b)Line Route - Option 3 Construction Options.

Line construction options considered were:

- Pole Mounted 66kV twin conductor
- Pole mounted 66kV double circuit.

With both these construction options there would be need for overbuilding existing lines in places where there is existing 11kV circuits.

The line design and hence construction configuration at various points along the line route and the overall costs are very dependant on final design requirements which will be driven by the impacts of both easement clearance and vegetation management issues.

MUSSELLBROOK 132kV CONNECTION

The Mussellbrook 132kV Network Connection option proposed Line Route – Option 4 route (per attached Map Overlay N^{o} 2 - approximately 42km) follows the Bunnan, Yarrandi, Moobi, Nandowra (back Mustlebrook Rd), Dartbrook Roads through the districts of Dartbrook and Kayuga, past the Dartbrook Mine Site southwards via Kayuga Road to the northern side of the Mussellbrook township. As per the other connection options the Middlebrook Site could be provided with a tee off or alternatively an interconnection at 33kV with the Mountain Station site. As per the Dartbrook 66kV Connection Option there is the possibility of accessing the Mountain Station site via various routes directly to its east via existing road easements. These possibilities would result in a shortening of the route overall but would require an interconnection being established between the Mountain Station and Middlebrook sites. The same issues and challenges exist in this case as for the Dartbrook 66kV Connection Option. There are three variations considered possible for the section traversing across the Mussellbrook township area from its western side to Musselbrook STS on the northeast side of the township.

(a)Line Route - Option 4 Variations in Vicinity of Mussellbrook.

(4a) Via Kayuga Road, Aberdeen Street, New England Highway to the existing line crossing north of McCullys Gap Road and along that line easement in a south easterly direction to Mussellbrook STS.

(4b) From Kayuga Road across farm land in line with the road easement just north of the New England Highway intersection with McCullys Gap Road and then as per Variation (4a) to Mussellbrook STS.

(4c) From Kayuga Road, at a location to be determined north of Variation (4b), across farm land (which is preferably managed by one of the mining companies with interests in the local area) to the New England Highway then southwards down the highway to the intersection with Variation (4b) route.

All three variations require significant further detailed examination; however Variation (4a) is likely to provide the most difficult scenarios given its proximity to housing within the township. While being proposed for an existing road easement, Variation (4b), present serious difficulties given the farms in its vicinity are clearly using the easement for their farming operations. Variation (4c) is a possibility given significant tracks of the land to the north of Mussellbrook between the Kayuga Road and New England Highway are the subject of management by mining companies.

(b)Line Route - Option 4 Construction Options.

Line construction options considered were:

- Pole mounted 132kV single circuit.

The line design and hence construction configuration at various points along the line route and the overall costs are very dependant on final design requirements which will be driven by the impacts of both easement clearance and vegetation management issues.

Line Configuration Listing

Reference	Drawing Number	Description
Dwg 1	520229	132kV Transmission Lines Structure Assembly
Dwg 2	514121	132kV Transmission Lines Structure Assembly
Dwg 3	514159	66kV Transmission Lines Structure Assembly
Dwg 4	514075	66kV Transmission Lines Structure Assembly
Dwg 5	520230	66kV Transmission Lines Structure Assembly
Pic 1	N/A	Typical intermediate construction method
Pic 2	N/A	Typical strain construction method

Note: These drawings and photo's were supplied by ***Energy****Australia*

Map Listing

Map Identifier	Description
Map Overlay No1	Scone 66kV Network Connection Options
Map Overlay No 2	Dartbrook 66kV & Mussellbrook 132kV Network Connection Options

References

Energy*Australia* consultation paper - "Development of New Scone 66/33/11kV Substation (to Address Capacity and Condition Issues in the Upper Hunter Area) – 15th October 2007.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) document "Electromagnetic Fields and Possible Adverse Health Effects", obtained from ARPANSA web site www.arpansa.gov.au.

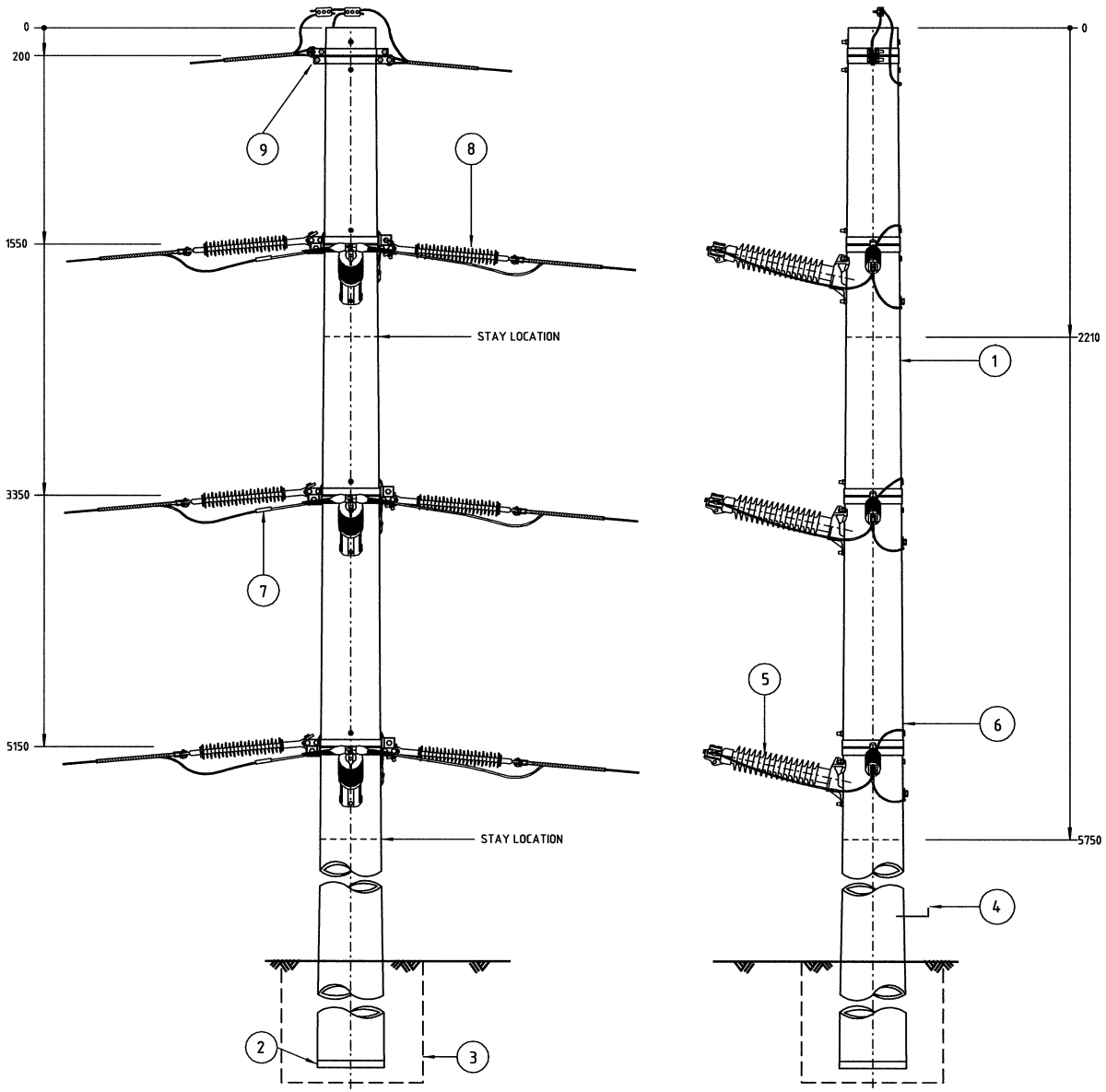
Environment Protection Authority South Australia Web Site http://www.environment.sa.gov.au/epa/index.html.

B-FAST Online Magnetic Field Calculator from http://www.enertech.net/bfast/bfast.html.

National Health and Medical Research Council "Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields (1989) – Radiation Health Series No. 30.

Australian Radiation Protection and Nuclear Safety Act 1998 – Act No. 133 of 1998 as amended - Prepared by the Office of Legislative Drafting and Publishing, Attorney-General's Department, Canberra.

Australian Radiation Protection and Nuclear Safety Regulations 1999 – Statutory Rules 1999 No. 37 as amended - Prepared by the Office of Legislative Drafting and Publishing, Attorney-General's Department, Canberra.



NOTE:

1. 66kV LONGROD INSULATORS TO BE USED UNDER ALL CONDITIONS.

2. THE FOLLOWING INFORMATION IS TO BE OBTAINED FROM THE LINE SCHEDULE:
   a. POLE LENGTH AND STRENGTH.
   b. SPECIAL FOUNDATION REQUIREMENTS.
   c. VARIATIONS TO STANDARD POLE DEPTH.
   d. CONDUCTOR AND OVERHEAD EARTH WIRE SIZE.
   e. STAY REQUIREMENTS.
   f. DEVIATION ANGLE.
   g. ASSESSED EARTHING REQUIREMENTS.

3. LINE POST INSULATORS, ITEM 5, ARE TO BE FITTED WHERE LINE DEVIATION IS LESS THAN 90°.

4. NON-TENSION COMPRESSION SLEEVES TO BE USED WHEN REQUIRED TO JOIN CONDUCTORS.

5. STAYS TO BE INSTALLED SO THAT THE STAY WIRE CLEARANCE FROM THE PHASE CONDUCTORS COMPLIES WITH THE STATUTORY REQUIREMENTS.

CONSTRUCTION ISSUE

ITEM	DESCRIPTION	DRG. No	QTY
9	OVERHEAD EARTHWIRE TERMINATION MOUNTING ARRANGEMENT - 2A	A2-519450	1
8	66kV LONGROD INSULATOR STRING ARRANGEMENT - 3	A3-166231	6
7	SLEEVE - NON-TENSION COMPRESSION (SEE NOTE 4)	A4-514053	3
6	POLE BAND MOUNTING AND BONDING ARRANGEMENT - 2	A3-514158	3
5	HORIZONTAL LINE POST INSULATOR ARRANGEMENT - 2	A2-514130	3
4	POLE STEPS	A3-514084	A/R
3	CONCRETE POLE FOOTING ARRANGEMENT (SEE NOTE 2)	A3-512331	1
2	CONCRETE POLE BUTT PLATE EARTHING ARRANGEMENT	A2-520209	1
1	POLE - CONCRETE, TYPE 5-140 C/E AND TYPE 5-145 C/E	A2-514082	1

ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. DO NOT SCALE.

CAD DRAWING
DO NOT MANUALLY AMEND

AMENDMENTS

0	INITIAL ISSUE	
G.	REDRAWN ON CAD.	19-4-91
H.	STAY AT 5810 DELETED.	P.S.
J.	ITEM 6 DRG NUMBER CHANGED.	28-5-91 P.S.
K	DWN: P.S. CHKED: DATE: BUTT PLATE EARTH ADDED. MATERIAL LIST NUMERICAL LISTING CHANGED.	16-8-95
12	AUTH'D by: P.SUMNER DWN: P.R. CHKED. DATE: DRAWING NUMBER UPDATED. STOCK CODES REMOVED. DISCS CHANGED TO LONGRODS	10/01/2005
	AUTH'D by:	

ASSOCIATED DRAWINGS

EnergyAustralia
DESIGN
145 NEWCASTLE RD WALLSEND, NSW 2287
TEL: 4951 9388 FAX: 4951 9389
Enerserve A Business of EnergyAustralia

SCALE	1:25
DESIGNED	-
DRAWN	PETER SAUNDERS
CHECKED	P.A.S
APPROVED	D.GRIFFITHS
DATE	28/05/91
PRJTRK No.	-
PROJECT NUMBER	STD

STANDARD CONSTRUCTION 66kV TRANSMISSION LINES STRUCTURE ASSEMBLY 5-140 C/E

DRAWING No. 514075 | SHEET 01 | AMD 12 | SIZE A2

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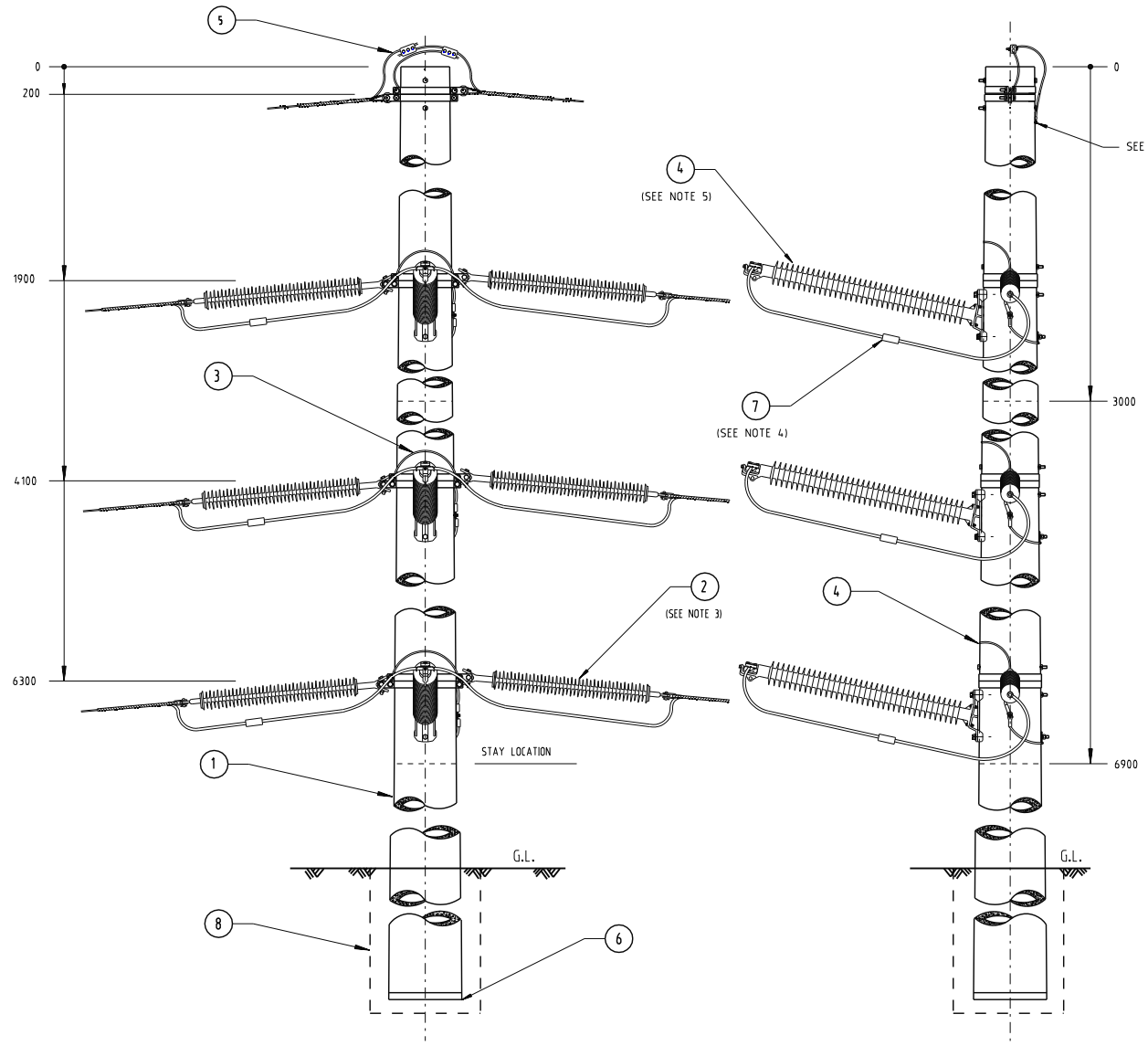


NOTES:

1. THE FOLLOWING INFORMATION IS TO BE OBTAINED FROM THE CONSTRUCTION SCHEDULE.
   a) POLE LENGTH AND STRENGTH.
   b) SPECIAL FOUNDATION REQUIREMENTS.
   c) POLE EMBEDMENT DEPTH.
   d) PHASE CONDUCTOR AND OVERHEAD EARTH WIRE SIZE.
   e) STAY REQUIREMENTS.
   f) DEVIATION ANGLE.
   g) ASSESSED EARTHING REQUIREMENTS.
2. THE MAXIMUM LINE DEVIATION ANGLE TO BE CONSTRUCTED ON THIS ARRANGEMENT IS TO BE DETERMINED BY THE LINE DESIGNER.
3. LONGROD INSULATORS TO BE USED UNDER ALL CONDITIONS.
4. NON-TENSION COMPRESSION SLEEVES TO BE USED WHEN REQUIRED TO JOIN CONDUCTORS.
5. LINE POST INSULATORS ARE TO BE FITTED WHERE LINE DEVIATION IS LESS THAN 90 DEG.
6. THE OVERHEAD EARTH WIRE IS TO BE BONDED TO AN M12 STAINLESS STEEL EARTH FERRULE ON THE CONCRETE POLE.
7. STAYS TO BE INSTALLED SO THAT THE STAYWIRE CLEARANCE FROM THE PHASE CONDUCTORS COMPLIES WITH THE STATUTORY REQUIREMENTS.

CONSTRUCTION ISSUE

ITEM	DESCRIPTION	DRG.No.	QTY.
8	FOOTING - CONCRETE POLE, ARRANGEMENT (SEE NOTE 1)	512331	1
7	JOINT - NON TENSION, COMPRESSION (TO SUIT CONDUCTOR)	514053	3
6	EARTHING - CONCRETE/STEEL POLE BUTT, ARRANGEMENT	520209	1
5	EARTHWIRE - OVERHEAD TERMINATION, ARRANGEMENT -2A	519450	1
4	INSULATOR - 132kV HORIZONTAL LINE POST, MOUNTING ARRANGEMENT -2	514130	3
3	BAND - POLE, MOUNTING AND BONDING ARRANGEMENT -2	514158	3
2	INSULATOR - 132kV LONGROD, STRING ARRANGEMENT -3	520314	6
1	POLE - CONCRETE (AS REQUIRED)		1

DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE

DO NOT SCALE

CAD DRAWING
DO NOT MANUALLY AMEND

AMENDMENTS

0	INITIAL ISSUE		
B.	3-10-90 ALTERATIONS TO ITEMS 2,5,10.	P.S.	
C.	21-1-91 ITEM 5 QTY. CHANGED TO 11.	P.S.	
D.	28-5-91 ITEM 7 DRG NUMBER CHANGED.	P.S.	
E	DWN P.S. CHKED P.A.S. DATE 29-7-94 SCALE CHANGED TO 1.25, NEW NOTE 4 ADDED. AUTHD by I.NICHOLS		
6	DWN GARY HUGHES CHKED PHIL JONES DATE 04/12/2007 DRAWING NUMBER UPDATED. STOCK CODES REMOVED. NOTES AND MATERIAL LIST UPDATED.		
	APP'D by STEPHEN CONNOR		

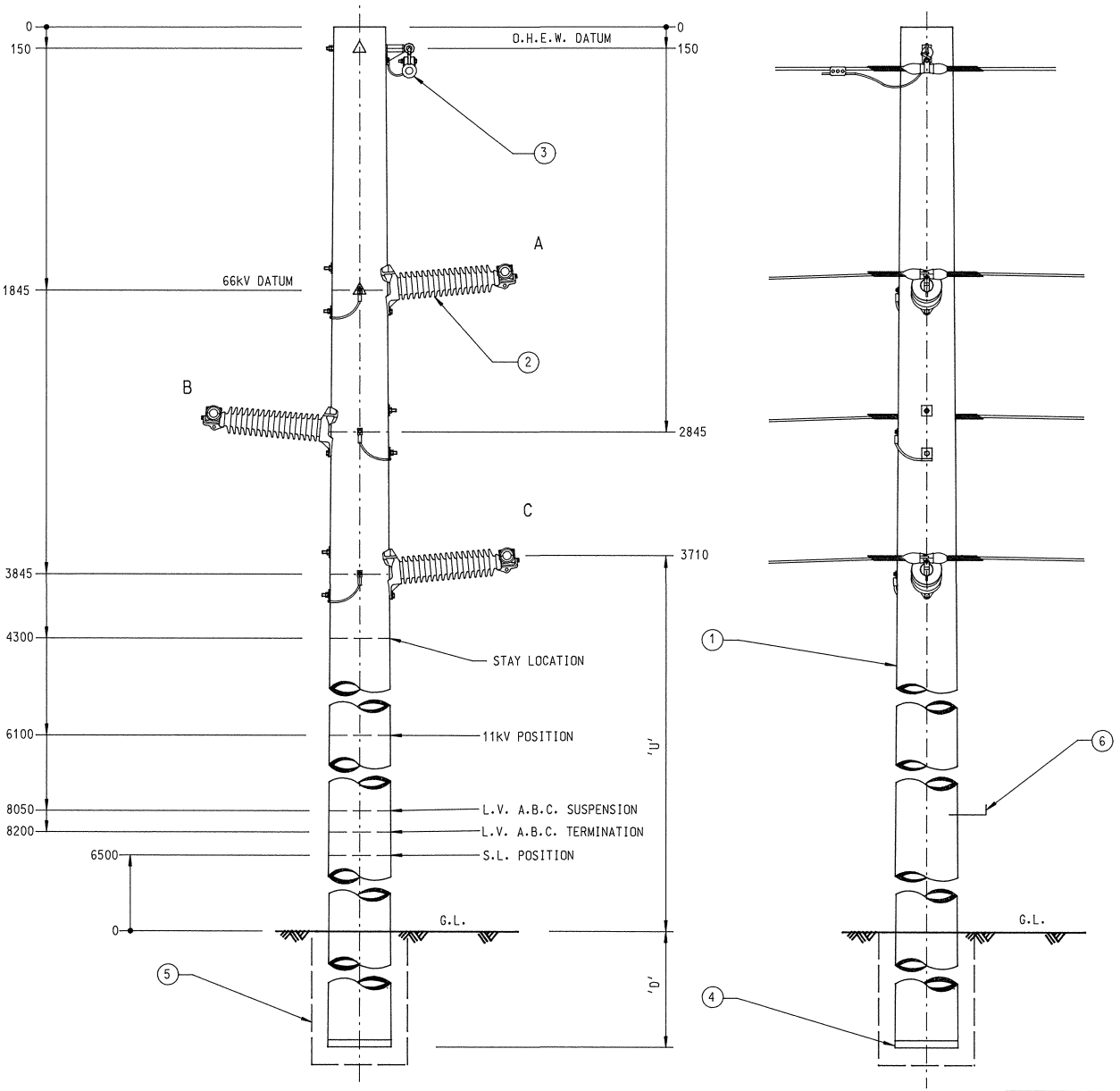
ASSOCIATED DRAWINGS

DESIGN
145 NEWCASTLE RD WALLSEND, NSW 2287
TEL: 4951 9388 FAX: 4951 9389

SCALE	1:25
DESIGNED	I.NICHOLS
DRAWN	P.S.
CHECKED	P.A.S.
APPROVED	I.NICHOLS
DATE	29/07/94
PRJTRK No.	
PROJECT NUMBER	STD

STANDARD CONSTRUCTION
132kV TRANSMISSION LINES
STRUCTURE ASSEMBLY
6-220C/E

DRAWING No. 514121 | SHEET 01 | AMD 6 | SIZE A2



NOTES:

1. THE FOLLOWING INFORMATION TO BE OBTAINED FROM THE LINE SCHEDULE:
   a) POLE LENGTH
   b) SPECIAL FOUNDATION REQUIREMENTS
   c) VARIATIONS TO STANDARD POLE DEPTH
   d) CONDUCTOR AND O.H.E.W. SIZES
   e) STAY REQUIREMENTS
   f) DEVIATION ANGLE
   g) ASSESSED EARTHING REQUIREMENTS
2. POLE STEPS SHALL ONLY BE INSTALLED WHEN 11kV/LV CIRCUITS ARE ADDED.

POLE LENGTH m	'D' STANDARD DEPTH m	'U' m
18.5	2.45	12.33
20.0	2.60	13.68
21.5	2.75	15.63
23.0	2.90	16.38
24.0	3.00	17.28
26.0	3.20	19.08

CONDUCTOR AND LOAD CENTRE OFFSETS	FROM DATUM X	Y
O.H.E.W.	344	-158
LOAD CENTRE O.H.E.W.	0	0
CONDUCTOR 'A'	1014	135
CONDUCTOR 'B'	-1023	-865
CONDUCTOR 'C'	1032	-1865
LOAD CENTRE CONDUCTOR	0	-1000

A2 - 514159

ITEM	DESCRIPTION	DRG.No.	STOCK CODE	QTY.
6	POLE STEP (SEE NOTE 2)	A3-14084	87809	as req'd
5	CONCRETE POLE FOOTING ARRANGEMENT	A3-12331		1
4	CONCRETE POLE BUTT PLATE EARTHING ARRANGEMENT	A2-20209		1
3	OVERHEAD EARTHWIRE SUSPENSION ARRANGEMENT-1	A2-14088		1
2	O'HEAD LINE HORIZ.LINE POST INSULATOR MOUNTING AND BONDING ARR-3	A2-14161		3
1	POLE CONCRETE TYPE 5-200 C/E	A2-14160		1

DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE

DO NOT SCALE

CAD DRAWING
DO NOT MANUALLY AMEND

AMENDMENT NOTES

A. INITIAL ISSUE
B. ITEM 3 DRG NUMBER CHANGED. 28-5-91 P.S.
C DWN: P.S. CHKD: P.A.S. DATE: 19-8-94 DETAIL 'U' AND 'D' LENGTH, OFFSET TABLES AMENDED. AUTH'D by: P. SUMMER

ASSOCIATED DRAWINGS

SHORTLAND ELECTRICITY

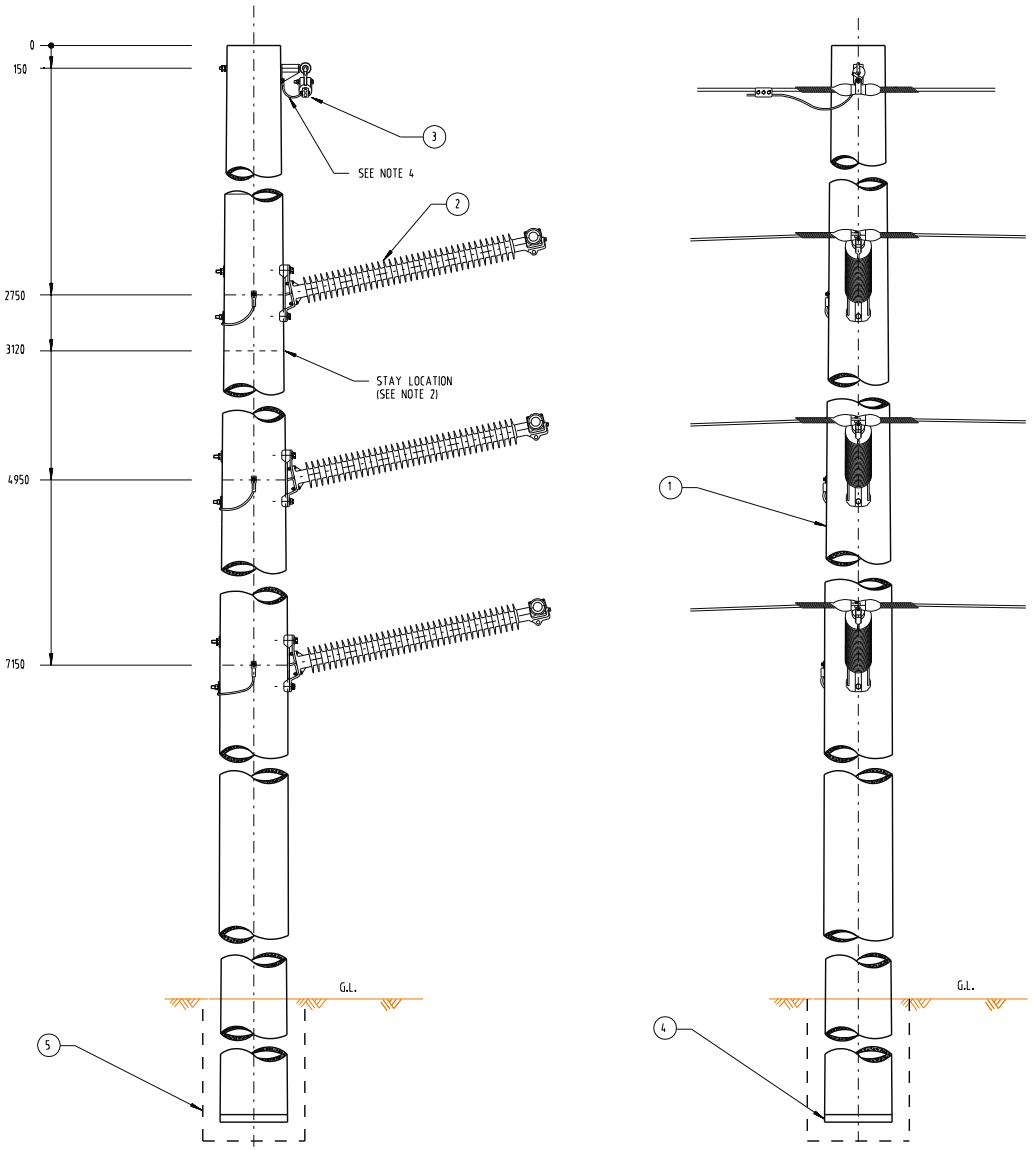
66kV TRANSMISSION LINES STRUCTURE ASSEMBLY 5-200 C/E

SCALE: 1 : 25
DATE: 19 -8- 94
DRAWN: P.S.
CHECKED:
AUTH'D: PAS

AMENDMENT C

DESIGN SERVICES BRANCH
DRAWING AUTHORISED by
D. GRIFFITHS
28 -5- 91

~~14159~~ A2



NOTES:

1. THE FOLLOWING INFORMATION IS TO BE OBTAINED FROM THE CONSTRUCTION SCHEDULE;
   a) POLE LENGTH AND STRENGTH.
   b) SPECIAL FOUNDATION REQUIREMENTS.
   c) POLE EMBEDMENT DEPTH.
   d) PHASE CONDUCTOR AND OVERHEAD EARTH WIRE SIZE.
   e) STAY REQUIREMENTS.
   f) DEVIATION ANGLE.
   g) ASSESSED EARTHING REQUIREMENTS.
2. STAYS TO BE INSTALLED SO THAT THE STAYWIRE CLEARANCE FROM THE PHASE CONDUCTORS COMPLIES WITH THE STATUTORY REQUIREMENTS.
3. THE MAXIMUM LINE DEVIATION ANGLE TO BE CONSTRUCTED ON THIS ARRANGEMENT IS TO BE DETERMINED BY THE LINE DESIGNER.
4. THE OVERHEAD EARTH WIRE IS TO BE BONDED TO AN M12 STAINLESS STEEL EARTH FERRULE ON THE CONCRETE POLE.

CONSTRUCTION ISSUE

ITEM	DESCRIPTION	DRG.No.	QTY.
5	FOOTING - CONCRETE POLE, ARRANGEMENT (SEE NOTE 1)	512331	1
4	EARTHING - CONCRETE/STEEL POLE BUTT, ARRANGEMENT	520209	1
3	EARTHWIRE - OVERHEAD, SUSPENSION MOUNTING ARRANGEMENT -1a	514157	1
2	INSULATOR - HORIZONTAL LINE POST, MOUNTING AND BONDING ARRANGEMENT -3a	514161	3
1	POLE - CONCRETE (AS REQUIRED)		1

DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE

DO NOT SCALE

CAD DRAWING
DO NOT MANUALLY AMEND

AMENDMENTS

0	INITIAL ISSUE	DWN. GARY HUGHES	CHKED. PHIL JONES	DATE 03/12/2007
1	DRAWING NUMBER UPDATED STOCK CODES REMOVED. NOTES AND MATERIAL LIST UPDATED.	AUTH'D by STEPHEN CONNOR		

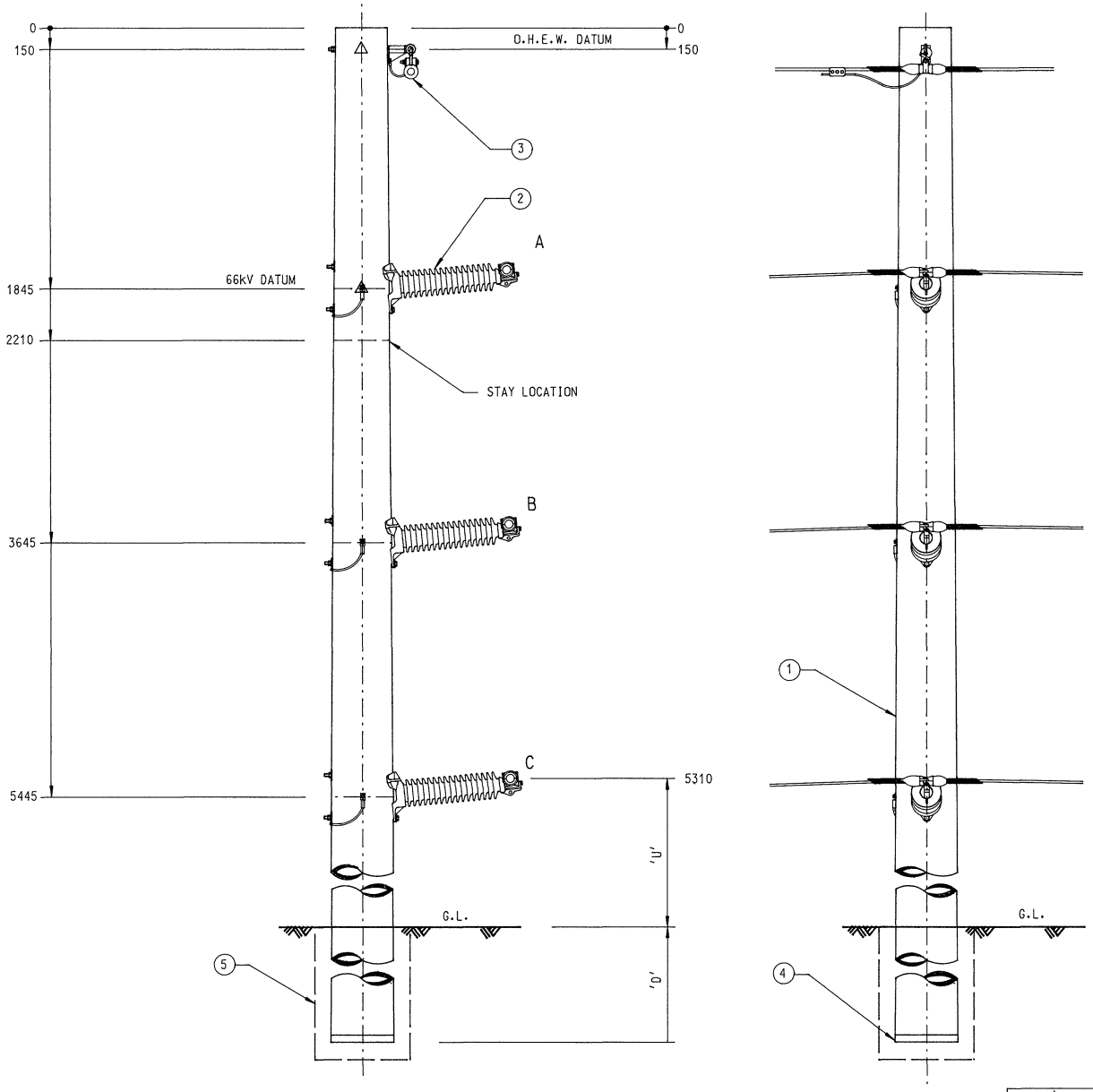
ASSOCIATED DRAWINGS

EnergyAustralia
DESIGN
145 NEWCASTLE RD WALLSEND, NSW 2287
TEL: 4951 9388 FAX: 4951 9389
Enerserve A Business of EnergyAustralia

SCALE	1:25
DESIGNED	
DRAWN	P.S.
CHECKED	P.A.S.
APPROVED	I.NICHOLS
DATE	24/11/04
PRJTRK No.	
PROJECT NUMBER	STD

STANDARD CONSTRUCTION
132kV TRANSMISSION LINES
STRUCTURE ASSEMBLY
6-240C/E

DRAWING No. 520229 | SHEET 01 | AMD 1 | SIZE A2



NOTES:

1. THE FOLLOWING INFORMATION TO BE OBTAINED FROM THE LINE SCHEDULE:
   - a) POLE LENGTH
   - b) SPECIAL FOUNDATION REQUIREMENTS
   - c) VARIATIONS TO STANDARD POLE DEPTH
   - d) CONDUCTOR AND O.H.E.W. SIZES
   - e) STAY REQUIREMENTS
   - f) DEVIATION ANGLE
   - g) ASSESSED EARTHING REQUIREMENTS

POLE LENGTH m	'D' STANDARD DEPTH m	'U' m
18.5	2.45	10.74
20.0	2.60	12.09
21.5	2.75	13.44
23.0	2.90	14.79
24.0	3.00	15.69
26.0	3.20	17.49

CONDUCTOR AND LOAD CENTRE OFFSETS	FROM DATUM X	Y
O.H.E.W.	344	-158
LOAD CENTRE O.H.E.W.	0	0
CONDUCTOR 'A'	1014	135
CONDUCTOR 'B'	1030	-1665
CONDUCTOR 'C'	1046	-3465
LOAD CENTRE CONDUCTOR	0	-1800

A2-520230

ITEM	DESCRIPTION	DRG.No.	STOCK CODE	QTY.
5	CONCRETE POLE FOOTING ARRANGEMENT	A3-12331		1
4	CONCRETE POLE BUTT PLATE EARTHING ARRANGEMENT	A2-20209		1
3	OVERHEAD EARTHWIRE SUSPENSION ARRANGEMENT-1a	A2-14088		1
2	O'HEAD LINE HORIZ.LINE POST INSULATOR MOUNTING AND BONDING ARR-3a	A2-14161		3
1	POLE CONCRETE TYPE 5-240 C/E AND 5-250 C/E	A2-14184		1

DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE

DO NOT SCALE

CAD DRAWING
DO NOT MANUALLY AMEND

AMENDMENT NOTES

A. INITIAL ISSUE DWN: P.S. CHKED: P.A.S.
B DWN: CHKED: DATE: AUTH'D by:

ASSOCIATED DRAWINGS

SHORTLAND ELECTRICITY

66kV TRANSMISSION LINES STRUCTURE ASSEMBLY 5-240 C/E

SCALE: 1 : 25
DATE: 19 -8- 94
DRAWN: P.S.
CHECKED: ~~PAS~~
AUTH'D:

AMENDMENT A

DESIGN SERVICES BRANCH
DRAWING AUTHORISED by
I. NICHOLS

~~20230~~ A2

PIC 1 - Typical intermediate construction method

Pic 2 - Typical strain construction method

EXISTING NETWORK
11kV
33kV

LINE ROUTE - OPTION 1

BOWMAN RD

Site Access

SITE SUBSTATION

LINE ROUTE - OPTION '1B'

WTG 1
WTG 2
WTG 3
WTG 4
WTG 5
WTG 6
WTG 7
WTG 8
WTG 9
WTG 10
WTG 11
WTG 12
WTG 15
WTG 16
WTG 17
WTG 18
WTG 19
WTG 20
WTG 21
WTG 22
WTG 23
WTG 24
WTG 25
WTG 26
WTG 27
WTG 28
WTG 29
WTG 30
WTG 31

Closed-loop hydro plant

Manager's Residence

Visitor's Education Centre

Solar Array

LINE ROUTE - OPTION 2

LINE ROUTE - OPTION '2B'

YARRAWA RD

LINE ROUTE - OPTION 1

PHOTO N°4

PHOTO N°2

PHOTO N°3

VARIATION - OPTION '1B'

VARIATION - OPTION '1C'

VARIATION - OPTION '1A'

PROPOSED NEW SCONE SUB 66/33/11 kV

Map Overlay No.1

N.T.S

Scone 66kV Network Connection - Options

ACN 070 489 039
Building 2, Level 3
18 Compark Circuit
Mulgrave VIC 3170

Ph 03 8542 0701
Fax 03 8542 0704
Email:vemtec.drafting@vemco.com.au

VEMTEC
Utility Infrastructure Services

EXISTING NETWORK

11kV

33kV

66kV

LINE ROUTE - OPTION 1

LINE ROUTE - OPTION 3 & 4

PHOTO N°5

DARTBROOK
ANGLO COAL SUB

LINE ROUTE - OPTION '3A'
(DARTBROOK
CONNECTION)
66kV & 132kV

VARIATION - OPTION '4A'
132kV

VARIATION
- OPTION '4B'
132kV

MUSWELLBROOK
132/33 kV STS

PHOTO N°1

Map Overlay

No.2

N.T.S

Dartbrook 66kV & Mussellbrook 132kV Network Network Connection - Options

ACN 070 489 039
Building 2, Level 3
18 Compark Circuit
Mulgrave VIC 3170

Ph 03 8542 0701
Fax 03 8542 0704
Email:vemtec.drafting@vemco.com.au

VEMTEC
Utility Infrastructure Services