

Waverley Park 220kV Transmission Line

Expert Witness Statement Underground Overhead Deviation



Waverley Park 220kV Transmission Line

Client: Mirvac Victoria Pty Ltd

ABN: N/A

Prepared by

Bryan McCarthy, AECOM Australia

08-Aug-2014

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1.0 Expert Witness Information

Name:	Bryan McCarthy
Work Address:	L9 8 Exhibition Street Melbourne Vic 3000
Qualifications	Bachelor of Engineering (Civil), University College Dublin (1997)
Affiliations	Professional Engineer MIEAust
Expertise and Experience	<p>Bryan is presently an Associate Director with AECOM. He has had 15 years' experience in the high voltage transmission and distribution industry working in design and construction for transmission lines and substations. His work has included design of lattice steel towers and hollow steel poles for transmission lines and specification and evaluation of underground cables for large scale works. Notable projects include the detailed engineering design of the HV transmission line connection for the MacArthur Wind Farm at Hamilton VIC and the specification and design management of XLPE underground cables for the Adelaide Central Reinforcement project in SA.</p>
Relationship With Mirvac	<p>AECOM has performed a number of studies for both SP AusNet and Mirvac considering the options for power lines at the site. Bryan McCarthy has only had direct involvement in one report associated with this project, as the majority of other reports for Mirvac pre-date the commencement of his employment at AECOM:</p> <ul style="list-style-type: none">- Mirvac Line Diversion – Cost Plan (2014) <p>Those AECOM reports that Bryan McCarthy has not been involved with are:-</p> <ul style="list-style-type: none">- Underground Cable at Waverley Park – Engineering Study and Preliminary Design (2007)- Waverley Park 220KV Cable Project – Report for Above ground Pole Option (2009)- Waverley Park 220kV 220 kV Overhead Transmission Line Project (2009)- EMF Modelling 220 kV Overhead Options (2012)- Mirvac 220kV Transmission Line Diversion – Cost Plan (2013)

2.0 Source of Information

The engagement is to give my opinion on the proposal to retain the 220kV transmission line above ground as opposed to undergrounding it and to prepare an expert report considering the advantages and disadvantages of diverting the SP AusNet 220kV transmission line traversing the Waverley Park site. The two specific arrangements considered in this statement are:

- The undergrounding of the power lines with the required transition enclosures; and
- Retaining the power lines above ground, with the slight realignment of the easement and replacement of 3 towers on the site with hollow steel poles.

The information contained within this statement was obtained from a number of sources, detailed below.

2.1 Existing Documentation

Existing documentation concerning the project was received from Norton Rose Fulbright which included the following:

- Mirvac planning documentation
- AECOM reports
- SP AusNet correspondence

This documentation was used to get a picture of the current situation concerning the development and to provide background knowledge to inform the author with sufficient information to investigate the requirements of the engagement.

2.2 Site Visit

A site visit was conducted with Stephen Boyle (AECOM) and Toby Lyng (Mircvac) on 22 May 2014 to observe the existing arrangement of the transmission line across the Waverley Park site.

During the site visit the general route of the transmission line across the Waverley Park Development was inspected, including tower positions 10, 11 & 12 and the proposed sites for the underground to overhead (UGOH) transition enclosures. I observed that the proposed location for the transition enclosure at the western end of the alignment near tower 12 was quite exposed from a visual impact perspective. I observed that the proposed transition enclosure on the eastern end of the site would need to be located on the Waverley Park side of Jackson Road due to space restrictions in the vicinity of tower 10. This means that both transition enclosures would be sited within the Waverley Park Development site.

It was also confirmed that both towers 10 and 12 currently have conductors in a suspension arrangement which is not suitable for an underground to overhead transition. Therefore to establish an underground section across the site, both towers would need to be replaced with heavy strain towers to essentially terminate the conductor on the structure prior to transitioning to underground cable. These heavy strain towers would be wider and stronger than the existing towers, with larger member sizes that may be more obtrusive from a visual perspective.

The scale model of the proposed development with underground section was also inspected at the Mirvac site office to get a better perspective of the final arrangement for the site.

2.3 Meeting with SP AusNet

A meeting was held with SP AusNet and Mirvac on 8 July 2014 to discuss the proposed amendment to the planning permit to maintain the transmission line above ground. Attendees at the meeting were Farhad Tantra (SP AusNet), David Matassoni (SP AusNet), Anshul Srivastava (SP AusNet), Peter Kilevics (SP AusNet), Robert Lake (SP AusNet), Toby Lyng (Mirvac), Judith Pini (Mirvac), Stephen Boyle (AECOM) & Bryan McCarthy (AECOM).

During the meeting we discussed the technical arrangement and estimated cost for an above ground solution, replacing towers on the Waverley Park site with steel poles. The physical design of the proposed steel poles was discussed to establish the most suitable arrangement for the Waverley Park site. This included discussion on single and double circuit poles and appropriate foundation design options, as well as the proposed physical location of the poles.

It was concluded that the most appropriate arrangement was to utilise two single circuit strain poles in place of tower 10 (subject to a separate permit), a single double circuit strain pole in place of tower 11 and two single circuit strain poles in place of tower 12. The location of the new pole replacing tower 11 would be offset from the existing alignment to provide a more appropriate location to best accommodate the development of the remaining land on the site. This will also ensure that the transmission line runs down the centre of the public space, keeping it further away from dwellings. It was also concluded that the foundation design would most likely be either a gravity based pad and pedestal arrangement or a more compact pile based pad and pedestal. A geotechnical site investigation would be required at each pole position to determine the suitability of the foundations options.

Following the technical discussion there was also some discussion on the estimated cost of the overhead steel pole arrangement. SP AusNet has previously prepared a cost estimate for Mirvac to install the proposed deviation on poles, with an indicative cost of \$7.5M. AECOM has completed a check estimate for Mirvac for the same scope of work, which concurs that the SP AusNet figure is within reasonable bounds. The discussion on estimates focussed mainly on major risks that may affect the cost of the installation including; pole design, foundation design and construction methodology. It was concluded that the estimates were reasonable but that foundation pricing should be revisited to make sure that all costs were correctly captured.

3.0 Documents Referenced in this Report

The documents referenced and relied upon in this report are as follows:

- Australian Standards
 - AS/NZS 1170.0 Structural design actions Part 0: General principles;
 - AS/NZS 1170.2 Structural design actions Part 2: Wind actions;
 - AS/NZS 7000 Overhead line design detailed procedures.
- SP AusNet Standards
 - Design Manual Transmission – Overhead Line
Volume 8 Section 1 Line Design Version 1 24 10 2013
- Other Documents
 - Planning documentation received from Norton Rose Fulbright;
 - Previous AECOM reports on the Waverley Park Development;
 - SP AusNet correspondence relating to Waverley Park Development.

4.0 Background

A double circuit 220kV transmission line presently crosses the Mirvac development site at Waverley Park in Melbourne. The lines form part of the transmission network that runs from Rowville Terminal Station near the corners of Stud and Wellington Roads to Springvale Terminal Station near the corner of the Princess Highway and Westall Road. The lines are owned and operated by SP AusNet.

The lines supply power to the south east suburbs via both Springvale and Heatherton Terminal Stations. The existing lines are of overhead construction and the conductors are strung either side of a single lattice structured tower. Each line is on one side of the tower and consist of three phase with each phase consisting of a bundle of two conductors.

The lines also have two conductors on the top of the towers (called earth wires) that do not carry current but act to shield the line from lightning strikes.



Mirvac's planning permit as part of the redevelopment of the Waverley Park site requires them to reconstruct the lines replacing it with underground cables. Mirvac is seeking to vary their planning permit to provide an overhead transmission line mounted on poles instead of the underground cable. This amendment would maintain the transmission line above ground across the development and allow greater flexibility for development of the recreational space in the general vicinity of the line.

For both overhead pole line and underground cable construction there are issues where members of the public may have concerns about either arrangement. These are primarily visual amenity of the physical arrangement and health concerns about EMF and EPR. The report deals specifically with the physical arrangement required to achieve the underground and overhead options. A separate report was prepared by another witness to address EMF and EPR.

5.0 General Assumptions

The Reference Design is for a 220 kV overhead transmission line on steel poles and 220kV underground cables using XLPE. The general assumptions in this report are as follows:

- undergrounding would be carried out in accordance with the detailed design drawings completed by AECOM in September 2009;
- maintaining an overhead solution would be carried out in accordance with the amended plans the subject of this proceeding.
- The following drawings were prepared as part of the overhead pole assessment and are attached in Appendix B:
 - 60327503-SHT-00-EL-1101-A (AECOM)
 - 60327503-SHT-00-EL-1102-A (AECOM)
 - E14190A 48m 160KNU (Valmont)
 - -E14190A 45m 270KNU (Valmont)

A full list of assumptions is provided in Appendix A, that in my opinion are reasonable assumptions for this circumstance.

6.0 Underground Cable Deviation

6.1 Description of Works

The proposed undergrounding of the section of transmission line that traverses the development involves the following key works:

- Installation of new strain termination tower 10A (similar in height to existing tower) in the vicinity of Jacksons Rd;
- New underground overhead transition enclosure with 3 x staggered height landing poles and associated cable sealing ends per circuit, adjacent to new tower 10A;
- Installation of new strain termination tower 12A (higher than existing tower to raise the lines above the acoustic wall) in the vicinity of the Freeway;
- New underground overhead transition enclosure with 3 x staggered height landing poles and associated sealing ends per circuit, adjacent to new tower 12A;
- 3 x underground cables per phase, i.e. 9 cables per circuit installed in a direct buried trench between towers 10A & 12A, approx. 750m in length.

A proposed arrangement for the transition enclosures was previously designed by AECOM in September 2009 for SP AusNet requirements at that time. Detailed design drawings for the proposed arrangement are contained within the following drawing series:

- T1/880/1 to T1/880/49

This arrangement provides a compact and secure design for the Waverley Park site (refer Plan & Sections drawings T1/880/1 & T1/880/2 for overview). The basis of the design requires the overhead conductor on the transmission line to transition to an underground cable via a cable sealing end. Key design parameters for the enclosure design were as follows:

- Compact footprint to minimise total area of the enclosure;
- Aesthetic landing poles to minimise visual impact;
- Aesthetic perimeter fence to minimise visual impact;
- Provision of additional cable circuit per phase to provide redundancy in the event of a cable failure;
- Similar repair time as the overhead line with respect to reinstatement of supply after failure;
- Security against public access.

This arrangement represents one solution that fits the requirements of the Waverley Park site. However, in my opinion there may be possibilities to augment some of the arrangement as detailed in the examples below. It should be noted that the examples below are indicative only and may not be suitable for the Waverley Park site. A detailed review of any alternative arrangement would be required to ascertain suitability for the site.

In particular, the manner in which the overhead conductor is landed from the transmission line to the top of the sealing end could be augmented to other arrangements as follows:

- Standard H-frame landing rack to transition the vertical circuits on the tower to a horizontal arrangement similar to a substation landing. This could be arranged either as a double circuit rack (or individual poles) directly behind the termination tower in line with the current alignment or single circuit racks (or individual poles) on each side of the termination tower at 90 degrees to the existing alignment. Either of these options would require a wider foot print than what is currently proposed;
- Direct landing onto cable sealing ends from the back of a new termination tower adjacent to or within the bounds of the transition enclosure. This could look similar to the images indicated in Figure 1 below, but using a free standing line termination tower rather than the guyed angle tower arrangement indicated in the pictures;

Figure 1 Guyed termination transition (Energy Australia, NSW)



- Special transition tower with staggered cross-arm lengths to allow landing onto cable sealing ends directly below the cross arm terminations. This option would require a specialised tower design with very wide arms that would have a higher visual impact on the surrounding area;
- Use of extended insulation strings staggered at each conductor level to facilitate direct dropper arrangement onto sealing ends as indicated in Figure 2 below:

Figure 2 Extended insulation dropping arrangement (Powerlink, QLD)



6.2 Advantages of Underground Cables vs Overhead Lines

There are a number of advantages associated with undergrounding of the transmission line across the development which include the following:

- Reduced visual impact by removing tower No. 11 in the centre of the development and the two aerial conductor spans on each side of the tower;
- Underground cables do not emit electric fields as the over burden of the backfill material in the cable trench provides a barrier through which the electric field cannot pass;
- Short length of proposed cable run (approx. 750m) can be installed in a single run without the requirement for cable joints;
- Underground section of line is not susceptible to failure from wind events (other than landing poles in the transition enclosure), i.e. eliminates the risk of tower 11 experiencing structural failure during an extreme wind event and causing damage or harm to the public;
- May reduce public perception of electromagnetic field (EMF) issues;

6.3 Disadvantages of Underground Cables vs Overhead Lines

There are a number of disadvantages associated with undergrounding a short section of overhead line including the following:

- Increased footprint and visual impact from installation of two underground to overhead transition enclosures;
- Increased visual impact from two new strain towers, which would be larger and more robust than existing suspension towers;
- Introduces different maintenance requirement for that specific section of line. SP AusNet would require a specially trained maintenance provider to respond to operation, maintenance and fault issues;
- Slight increase in EMF directly above the buried location of the cable;
- Introduces new potential points of failure along the transmission line;
- Increase in time to repair in the case of a cable or sealing end fault;
- Introduces non-standard arrangement into SP AusNet network by operating a hybrid line of both underground and overhead sections;
- Increased risk of public exposure to Earth Rise Potential in the vicinity of the transition enclosures;
- Increased risk of electrocution to public from illegal access to the transition enclosures;
- Underground cable run would potentially relocate the transmission line route closer to some residences;
- Increased risk due to buried electrical asset for anyone performing excavation work in the vicinity of the cable route;
- Landscaping options within immediate proximity of underground cables will be limited.

7.0 Overhead Pole Deviation

7.1 Description of Works

The alternative solution to the proposed undergrounding is to keep the overhead line above ground and install a deviation on steel poles through the development. This would involve replacing lattice towers in the immediate vicinity of the development with tubular steel hollow poles. The deviation would replace towers 10 & 12 with twin single circuit strain poles and tower 11 with a single double circuit strain pole. Figure 3 below indicates the proposed deviation from the existing alignment:

Figure 3 Proposed Deviation using Steel Poles (excerpt from drawing 60327503-SHT-00-EL-1001-A)



Mirvac have applied to the Tribunal for an amended permit to substitute amended plans to replace the existing traditional strain towers within the Waverley Park site with steel poles. The application covers tower positions 11 & 12 directly on the Waverley Park site only. A separate application for an amended permit would be made for tower position 10 subject to SP AusNet requirements. Current indications are that this tower would need to be replaced for technical reasons to accommodate the slight deviation induced from the new position of pole 11A.

Conservative load calculations were used to develop the concept details for the steel poles prepared by AECOM in association with Valmont (a steel pole manufacturer) to determine the geometry and strength of poles required for this purpose. Reasonably conservative load conditions were assumed to develop the ultimate strength of the poles. In addition, AECOM has prepared a conceptual set out drawing for the single circuit twin pole arrangement at positions 10A & 12A and a double circuit pole arrangement at position 11A. The arrangements show typical steel poles which are used widely in the electricity transmission industry throughout the world. A typical 220kV pole supplied by Valmont to Transpower NZ for the Highbrook Development in Auckland can be seen in Figure 4 below:

Figure 4 220kV double circuit steel pole, (Transpower NZ)



Image Source: Google Earth Highbrook Dr. Auckland, New Zealand

7.2 Design of Works

In general the overall design of the transmission line deviation would need to meet the requirements of both Australian Standards and SP AusNet internal standards. It should be noted that the tip & butt diameters and height of poles for the Waverley Park location are primarily related to the load conditions at that particular site. The load conditions would clearly be derived using the following standards:

- AS/NZS1170.2 Structural Design Actions Part 2: Wind Actions;
- AS/NZS7000:2010 Overhead Line Design – Detailed Procedures;
- SP AusNet Line Design Manual.

It is industry standard practice to work closely with a manufacturer for the development of the final design of steel poles of this nature. Generally the consultant will prepare load tree drawings and a basic outline of the pole to the manufacturer. The butt and tip diameters, wall thickness of the pole elements and the number of pole sections are custom designed by the manufacturer to provide maximum economy in design and ensure that the finished design can be properly manufactured using the steel sheet pressing equipment available to that specific manufacturer.

New structure designs may need to be load tested at the manufacturer's workshop to confirm the strength rating of the design. Usually for any project with a small number of new pole designs the load testing requirement can be foregone as the structural analysis of steel poles is more deterministic than that of a steel lattice tower.

However, as SP AusNet does not have any such poles on their 220kV network they may require that at least one of the pole designs undergoes a load testing procedure. As the double circuit pole has cross arm attachments with both bolted and welded joints it is most likely that this pole would be more critical due to the higher complexity versus the single circuit poles.

Sometimes it is sufficient to test one of the cross arm sections separately to confirm the strength of the connections to the pole, as opposed to completing a full load test of the complete pole structure. The requirement for testing should be confirmed with SP AusNet prior to commencement of design activities to ensure the test bed site can be booked well in advance.

7.3 Advantages of Poles vs Towers

There are a number of potential advantages involved in using steel poles on transmission lines, including design, installation and aesthetics. The deviation on poles indicated above would have the following advantages over replacing the existing structures with higher steel lattice towers to clear the freeway sound wall:

- More aesthetically pleasing than steel lattice towers and less obtrusive to the eye.
This is dependent on the observer, but in the majority of cases steel poles are perceived as a more elegant structure;
- Smaller foot print on the ground, providing more recreational space.
Poles would be approx. 2m diameter at the base and mounted on a concrete pedestal protruding approx. 200mm above finished ground level. The remainder of the foundation would be approx. 500mm below finished ground level. Therefore the immediate footprint around the pole base would be significantly less than the space taken up by the four legs of a steel tower;
- Reduced risk of public access through climbing.
Typical poles are equipped with climbing step bolts or a climbing ladder mounted 4m above finished ground level to prohibit unplanned access up the pole. Additionally the pole can be fitted with a suitable anti-climb device below the access point to inhibit public access to the climbing steps/device;
- Maintains existing level of reliability of the transmission line.
The transmission line would still have the same structural capacity as the existing alignment and no increase in emergency reinstatement time due to structure failure;
- Surface finish on pole can easily be dulled after galvanising
Naturally the pole would lose the shine from galvanising after approx. 12 months weathering. However, the manufacturer can apply a dulling agent to the galvanised pole to reduce the surface shine and alleviate visual impact;

- Easier and quicker to construct than steel lattice towers.
Generally poles are much quicker to construct than lattice towers. Poles are delivered in sections approx. 11m long and in this case would have a slip-joint for assembly. They can be either “slipped” together in the horizontal or vertical plane, providing flexibility on crane size. Pole assembly is therefore much quicker than assembling sections of a steel lattice tower, which in turn provides greater flexibility to reduce outage time for installing in existing alignments.

7.4 Disadvantages of Poles vs Towers

The deviation on steel poles indicated above would have the following disadvantages over the existing alignment on steel lattice towers:

- Pole heights would be slightly higher than the existing steel towers.
The majority of height increase is required to meet statutory electrical clearance over the new sound barrier on the Monash Freeway span between positions 12 & 13. This would be required regardless of structure type. Some additional increase in pole height is required to achieve correct lightning coverage for the bridging (jumper) conductor;
- Steel poles require a different maintenance plan than existing steel towers.
Poles are more difficult to climb freely and work on from a maintenance point of view. There is a higher likelihood of fall from heights from access by climbing and generally it is preferred to maintain the structure from an elevated platform. Therefore it may be more costly for the asset owner to perform minor maintenance work on the poles, as the maintenance plan may restrict climbing of the structure;
- Twin single circuit poles would be required at each side of the deviation (positions 10 & 12) to enable the two existing circuits on the tower to be transferred to new poles, one circuit at a time.
The main reason for this is to facilitate erection of the poles prior to transfer of the conductor from the existing steel tower, which would reduce line outage times significantly. This would allow one circuit to remain live on the tower structure while the other circuit is transferred to the new pole;
- EMF may be slightly higher due to increased separation between phases at the twin pole locations.
This would be the case at twin pole locations, but the effect would diminish along each span towards the double circuit pole at 11A, where the conductor spacing would be similar to the existing steel tower.

8.0 Opinion on Amended Plans for Planning Permit

Mirvac is seeking to vary their planning permit to provide an overhead transmission line mounted on poles instead of the underground cable. These amended plans were submitted to the Tribunal on 14 July 2014 together with a statement describing the changes from the previous plans and demonstrating how they will improve the proposal.

Both the underground and overhead options evaluated in this report have advantages and disadvantages. Engineering solutions exist that allow both options to be installed at the Waverley Park site, with different outcomes for the public and the asset owner. It is the opinion of the author that the overhead option using poles provides a better overall solution for both the public and SP AusNet. The main reasons for forming this opinion in are as follows (in no specific order of importance):

- 1) The comparative cost to install the underground cable is approx. 3 times that of the overhead pole option, based on detailed cost estimates prepared by AECOM. Considering it is technically possible to maintain the transmission line above ground the extra expenditure for underground cable is difficult to justify;
- 2) The overhead option on poles is consistent with the current arrangement of the transmission line above ground. It maintains the existing operation and maintenance requirements;
- 3) The underground option will make the transmission line a hybrid of both overhead and underground construction which adds complexity to the line from an operation and maintenance point of view. SP AusNet would be required to engage a maintenance Contractor with specialised training for this section of the line. This is likely to add extra cost to the ongoing operation of the asset, to ensure that the specialised Contractor maintains the required level of training and is available on call 24hrs a day;
- 4) It is very rare for a hybrid line to have such a short section of underground cable at high voltages such as 220kV. To gain real benefit from undergrounding, the length of cable run is usually much longer, i.e. kilometres of underground section. The author is not aware of any similar length of underground cable that has been installed within an overhead transmission line in Australia at this voltage level. The expectation to justify such a short run of cable would usually mean that an overhead option is not possible, which is not the case at Waverley Park;
- 5) The underground section of the transmission line may present significant consequences for outage times in the event of one or more cable failures. While there is redundancy built in to the cable design by providing a spare cable per phase, this still requires manual changeover in the event of failure. Should two or more cables fail in the same conductor phase then the complete transmission line would be forced to operate at reduced capacity for extended periods (possibly weeks);
- 6) The underground option provides only marginal benefit to visual impact. While removal of the lattice tower and associated overhead conductor spans in the centre of the development will increase the visual amenity of the area, this would be offset by the visual impact of the transition enclosures required for the undergrounding.

In summary of the above comments I am relying on my own technical interpretation of what provides the best solution for the transmission line, while considering the overall impact on the SP AusNet asset. In my opinion there is not enough evidence to justify the cost of undergrounding such a short section of transmission line. The anticipated benefits do not outweigh the complications involved in operating a hybrid line with both overhead and underground sections. In my own experience maintaining the line overhead should be considered as a first option, unless it is physically not possible to accommodate such a solution, which is not the case at Waverley Park.

I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the Tribunal.

Signed: 

Date: 08/08/2014

Appendix A

Assumptions

Appendix A Assumptions

Arrangement

For the purposes of this statement I have assumed the following arrangements:

1) 220kV Underground Transmission Line Option

It is assumed that in a 220KV cable option, that two cables per phase would be required to carry the same current as the overhead option. A third cable per phase has been included as a redundancy measure in the detailed design previously completed by AECOM in September 2009.

2) 220kV Overhead Transmission Line Option

The proposed option is to maintain an overhead line across the Waverley Park development using steel poles in place of existing tower structures. The overhead solution would include two new spans of conductor along the diversion and maintain the same current rating as the existing line.

Conductor Height and Tower Dimensions

The following assumptions have been made with respect to modelling of the tower and pole arrangements:

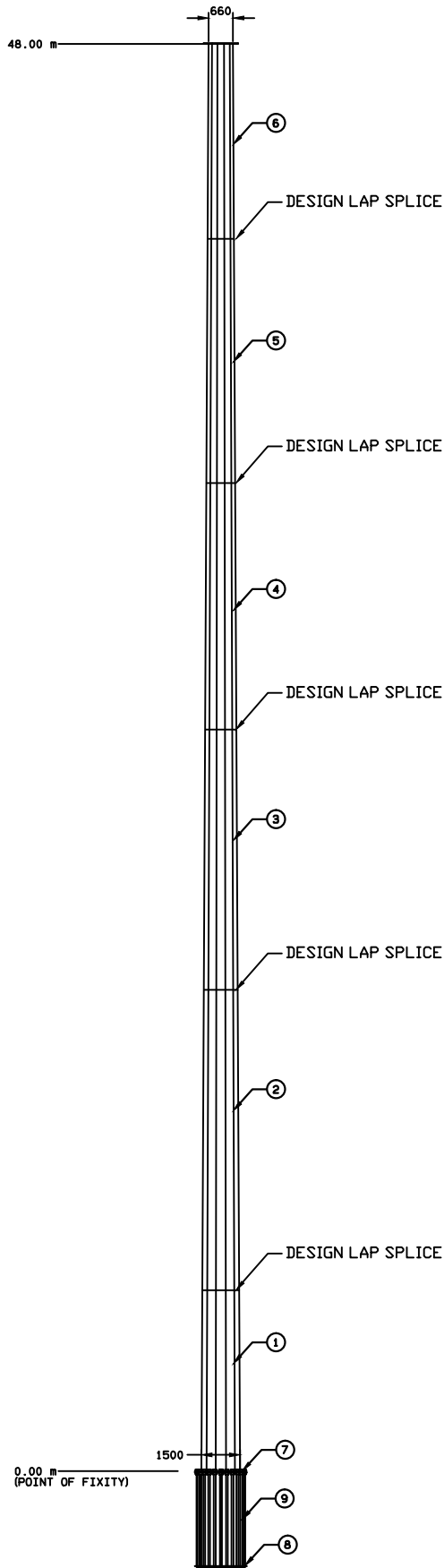
Line Description	Minimum Conductor Height Above/Below Ground	Vertical distance between conductors	Cross Arm Width (Double Circuit)	Easement Width
220KV Lattice	10m	4.9m	9.4m	40m
220KV Pole	9.5m	5.6m	9.5m	40m

3) Other Assumptions

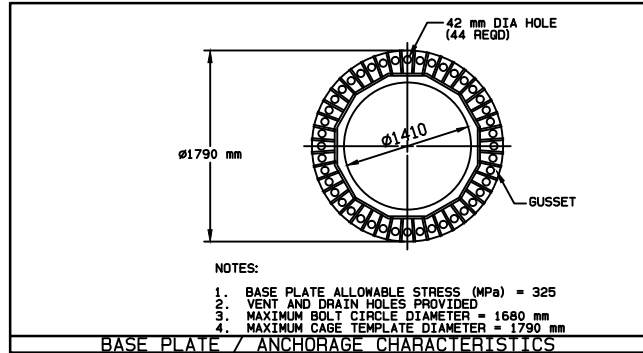
- The proposed undergrounding would be carried out in accordance with the detailed design by AECOM in September 2009;
- Both transition enclosures associated with the underground cable would be located within the bounds of the Waverley Park site;
- Suitable line outages would be available to install either the underground or overhead options;
- SP AusNet would complete the proposed works;
- High shielding angle would be required for the pole structures to prevent lightning strike to the phase conductor or bridging conductor on the pole;
- Pole structure heights are as nominated by SP AusNet in their PLS-CADD model for the proposed works.

Appendix B

Steel Pole Concept Design

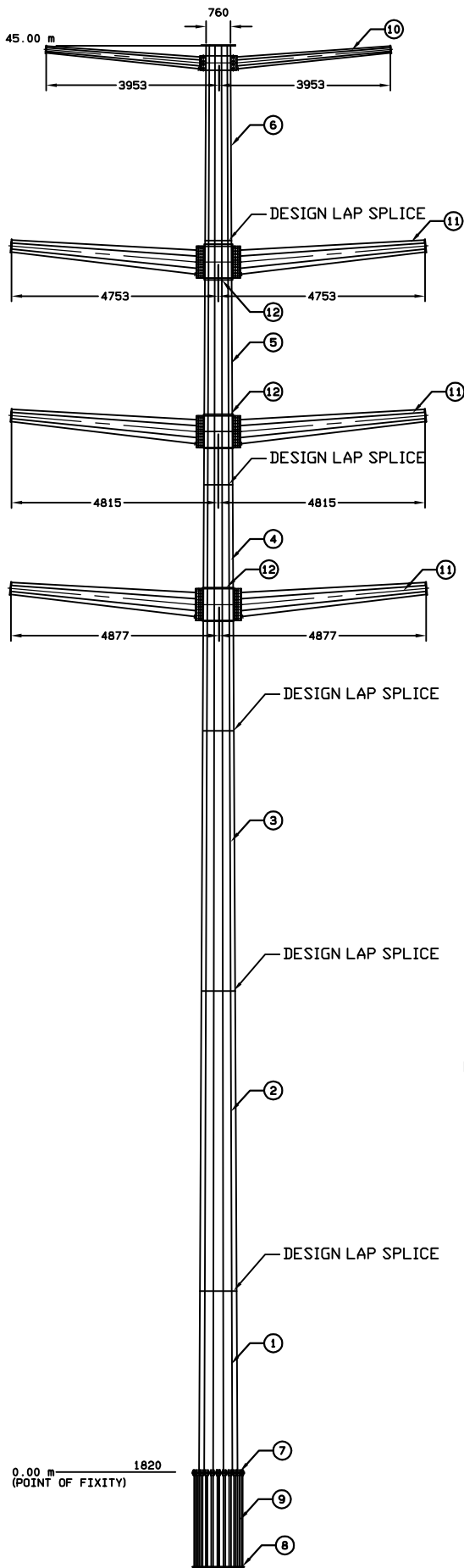


ITEM ID	NO. REQD	FEATURES	MASS (kg)
1	1	SECTION A	17824
2	1	SECTION B	
3	1	SECTION C	
4	1	SECTION D	
5	1	SECTION E	
6	1	SECTION F	
7	1	BASE PLATE	
8	1	BOTTOM CAGE PLATE	
9	44	36mm 40CR MATERIAL ANCHOR BOLT, LENGTH = 2.0m	
	1	TOP CAGE PLATE	
	1	POLE CAP	
	44	GUSSETS	
		GALVANIZING	

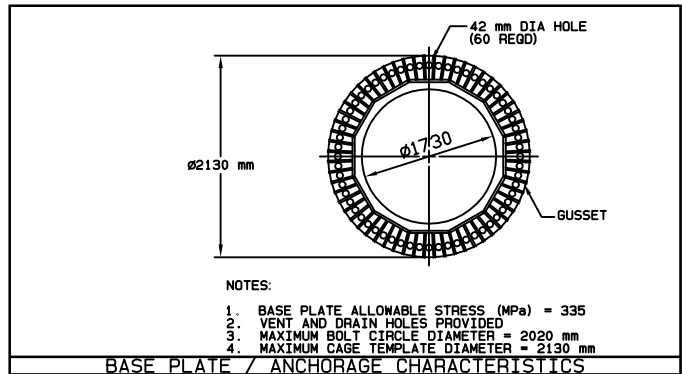


NOTE:
 These plans and elevations are indicative only and are based on assumptions and preliminary reviews as at 10 July 2014. In particular, dimensions are approximate only and the precise location, height and width of the poles has not yet been determined. Final plans and elevations are subject to the approval and requirements of the owners of the powerlines (SP AusNet) and to a detailed engineering study

		Valmont Industries (China) Ltd. 维蒙特工业(中国)有限公司		
		100 RONGCHANG ROAD SHANGHAI, 201611, P.R. CHINA		
QUOTATION #	FILE ID	PROJECT	ENGR	DRAWN
E14190A	48M 160KNU		SXP	HSL
A	VERSION 1	8/7/2014	DESCRIPTION	
REVISION	DESCRIPTION	DATE	48M,160KNU BPM, 220kV MIRVAC WAVERLEY PARK DEVELOPMENT	



ITEM ID	NO. REQD	FEATURES	MASS (kg)
1	1	SECTION A	31847
2	1	SECTION B	
3	1	SECTION C	
4	1	SECTION D	
5	1	SECTION E	
6	1	SECTION F	
7	1	BASE PLATE	
8	1	BOTTOM CAGE PLATE	
9	60	36mm 40CR MATERIAL ANCHOR BOLT, LENGTH = 2.0m	
10	2	J3.57M-4N	
11	6	J4.29M-7N	
12	3	SADDLE	
	2	VANG	
	6	VANG	
	16	BOLT M24x85x55 1N1W1SW	
	120	BOLT M24x100x50 1N1W1SW	
	1	TOP CAGE PLATE (TH=10mm, G235B)	
	1	POLE CAP	
	60	GUSSETS	
		GALVANIZING	

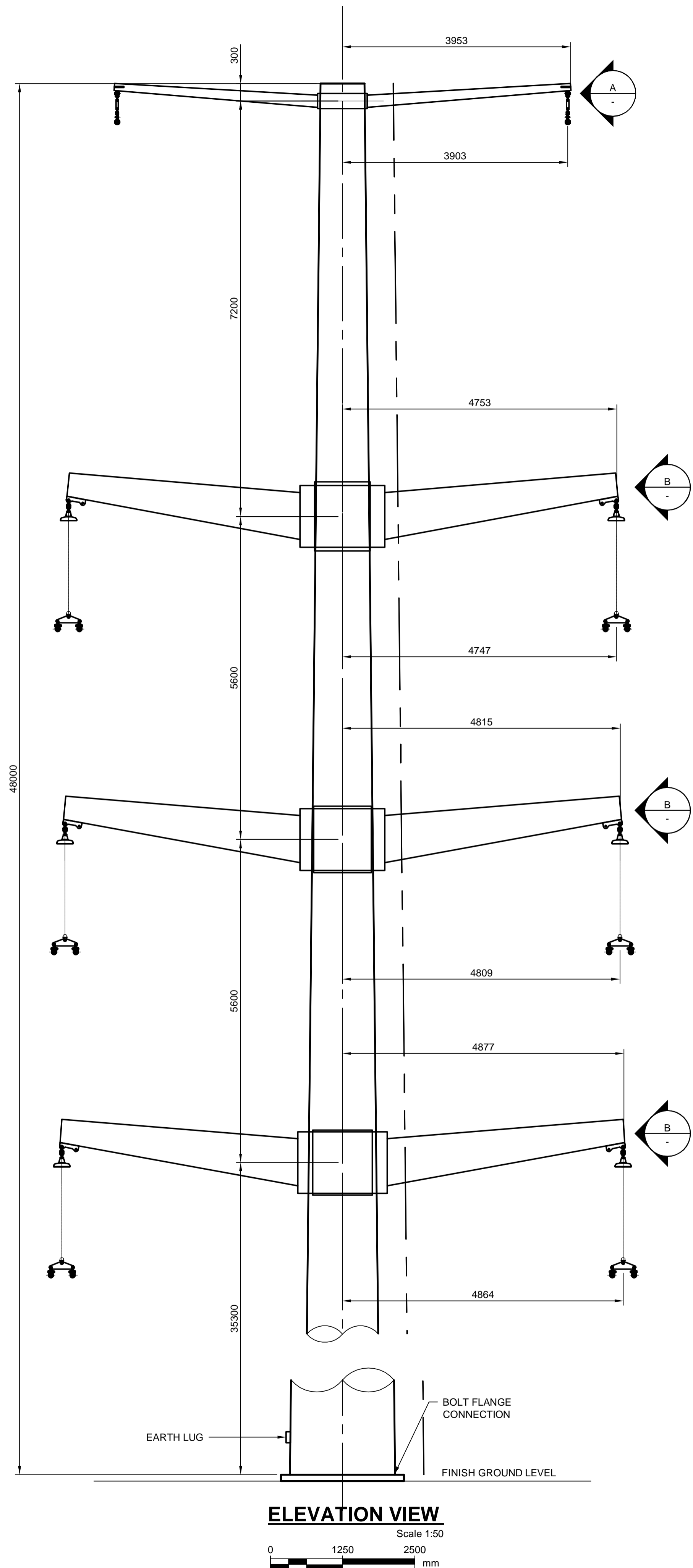


NOTE:

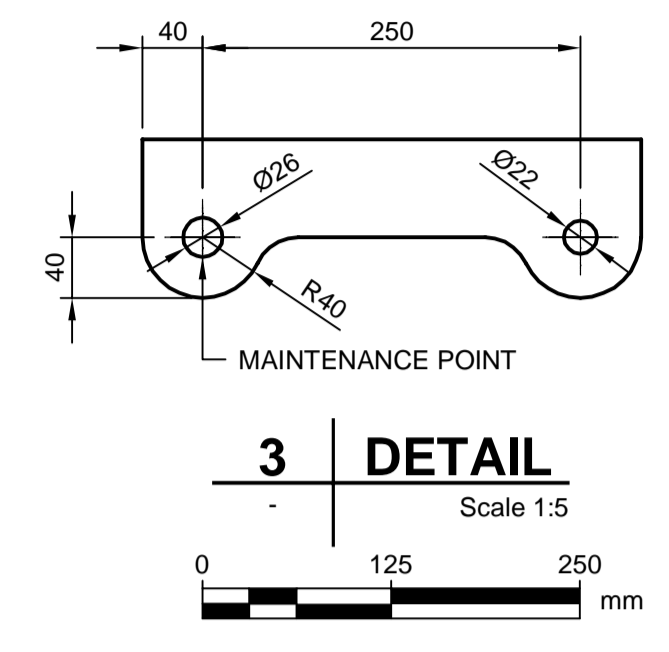
These plans and elevations are indicative only and are based on assumptions and preliminary reviews as at 10 July 2014. In particular, dimensions are approximate only and the precise location, height and width of the poles has not yet been determined. Final plans and elevations are subject to the approval and requirements of the owners of the powerlines (SP AusNet) and to a detailed engineering study

		Valmont Industries (China) Ltd. 维蒙特工业(中国)有限公司	
		100 RONGCHANG ROAD SHANGHAI, 201611, P.R. CHINA	
QUOTATION # E14190A	FILE ID 45M 270KNU	PROJECT ENGR SXP	DRAWN HSL
REVISION A VERSION 1 8/7/2014		DESCRIPTION 45M,270KNU BPM, 220kV MIRVAC WAVERLEY PARK DEVELOPMENT	

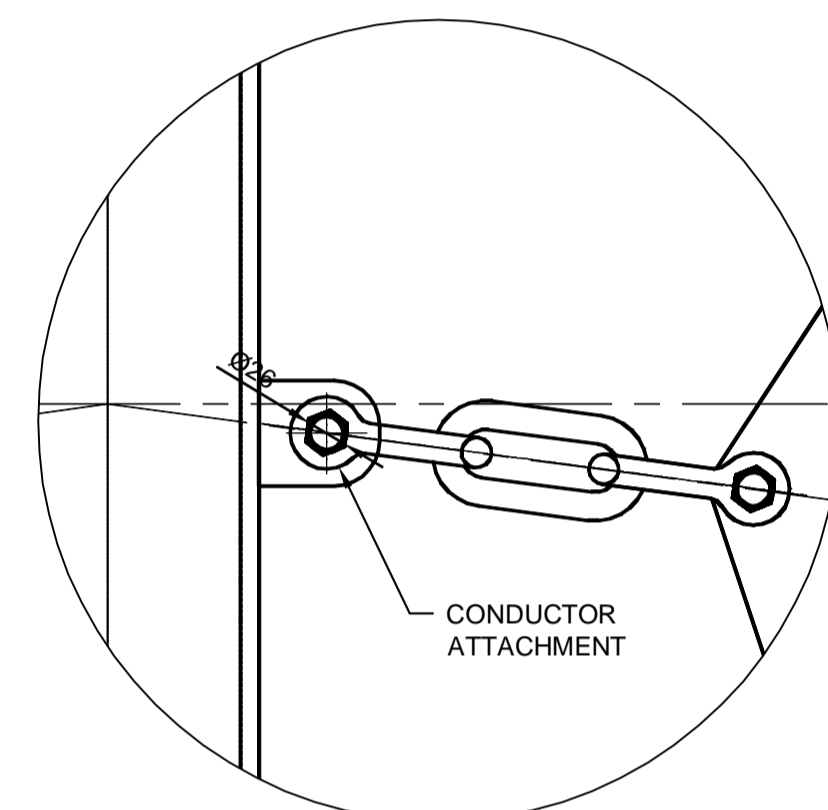
REVISION	DESCRIPTION	DATE
A	VERSION 1	8/7/2014



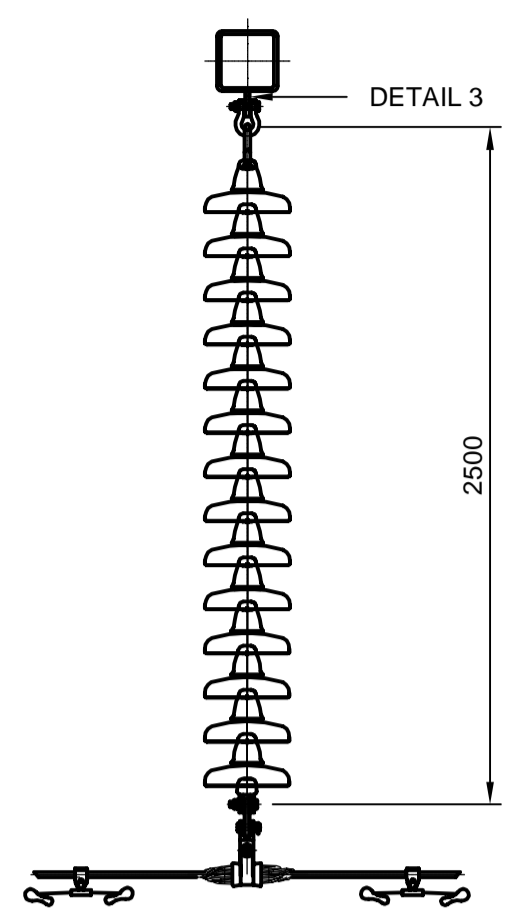
ELEVATION VIEW
Scale 1:50
0 1250 2500 mm



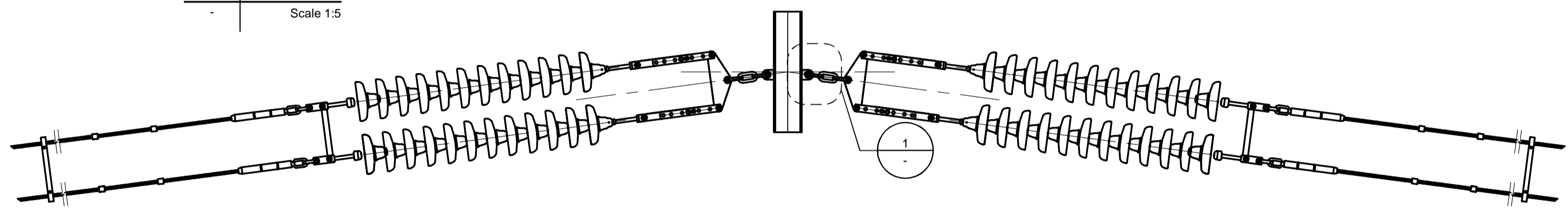
3 | DETAIL
Scale 1:5
0 125 250 mm



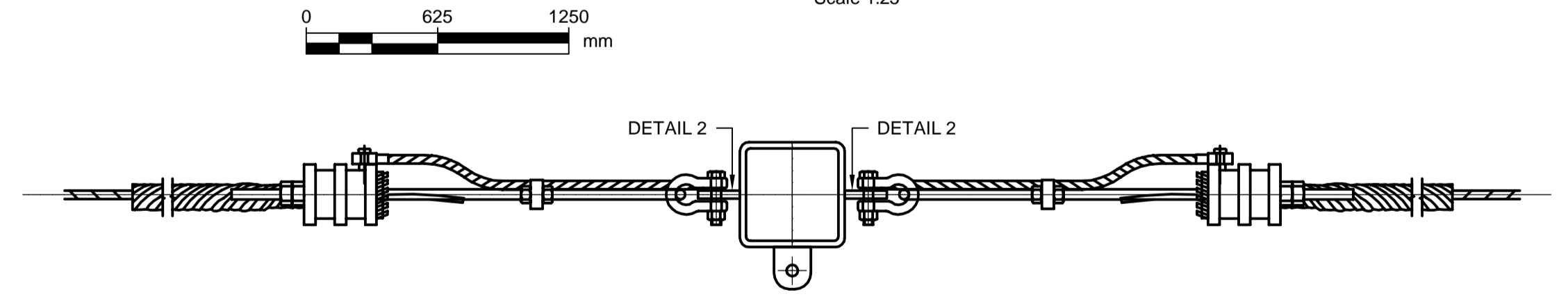
1 | DETAIL
Scale 1:5



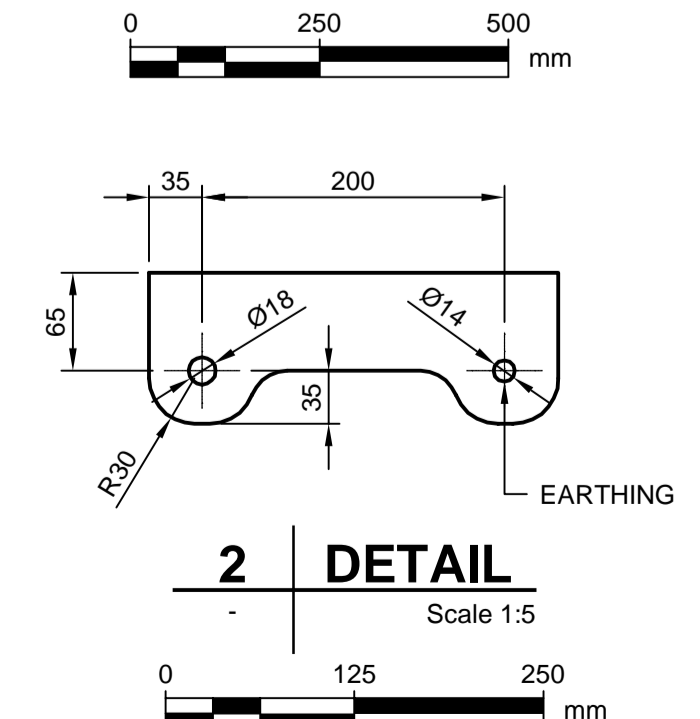
B | VIEW
Scale 1:25
0 625 1250 mm



CONDUCTOR STRAIN INSULATOR ARRANGEMENT
Scale 1:25



A | OPGW STRAIN ARRANGEMENT
Scale 1:10



2 | DETAIL
Scale 1:5
0 125 250 mm

NOTES:
THESE PLANS AND ELEVATIONS ARE INDICATIVE ONLY AND ARE BASED ON ASSUMPTIONS AND PRELIMINARY REVIEWS AS AT 10TH JULY 2014. IN PARTICULAR, DIMENSIONS ARE APPROXIMATE ONLY AND THE PRECISE LOCATION, HEIGHT AND WIDTH OF THE POLES HAS NOT YET BEEN DETERMINED. FINAL PLANS AND ELEVATIONS ARE SUBJECT TO THE APPROVAL AND REQUIREMENTS OF THE OWNERS OF THE POWERLINES (SP AUSNET) AND TO A DETAILED ENGINEERING STUDY.

NOTES:

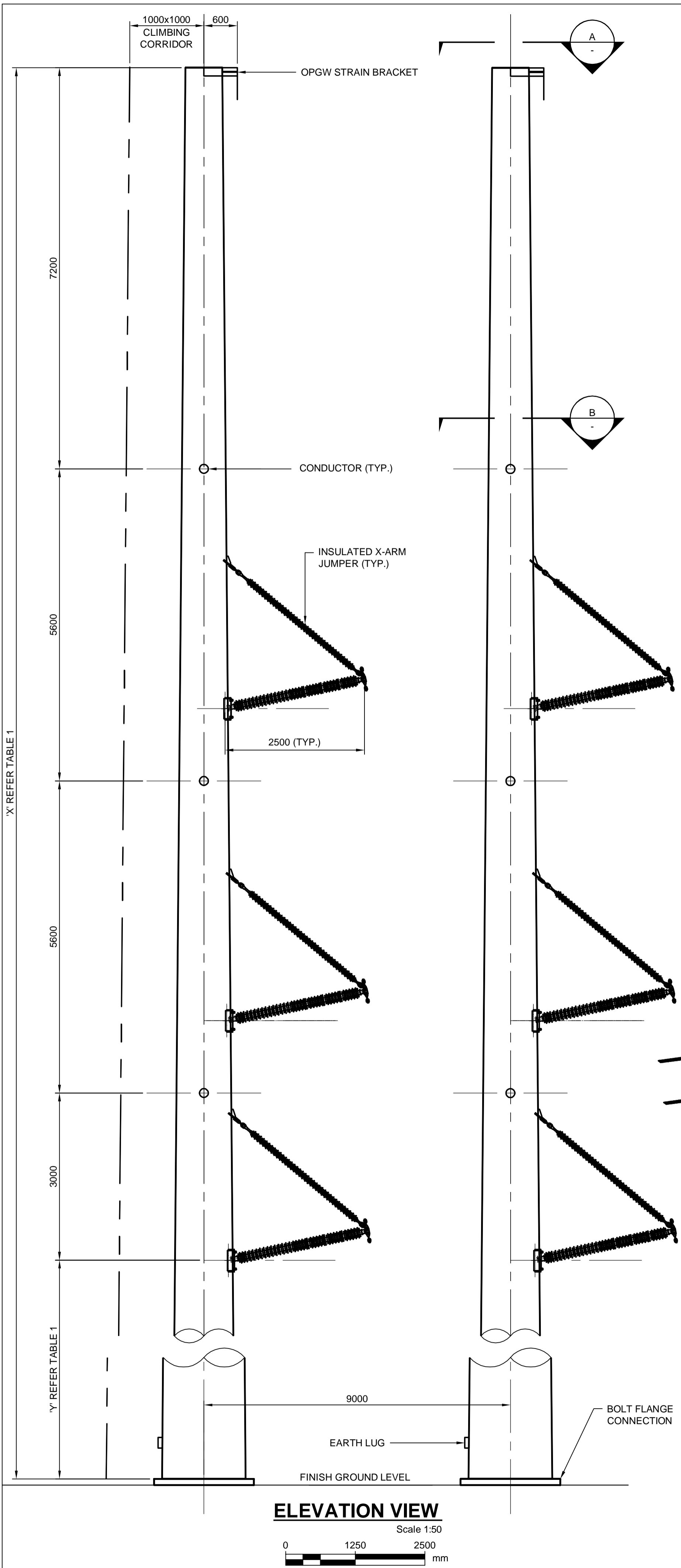
- DIMENSIONS IN MILLIMETRES AND SUBJECT TO DETAILED DESIGN.
- PHASE CONDUCTOR LINE HARDWARE FITTINGS AND EARTHWIRE LINE HARDWARE FITTINGS TO AS1154.
- FALL RESTRAINT ATTACHMENT POINTS TO BE PROVIDED STARTING 5 METRES ABOVE GROUND LEVEL. FALL RESTRAINT TO BE LOCATED BETWEEN CLIMBING STEP BOLTS.
- PERSONNEL ACCESS TO BE PROVIDED USING EITHER - a) STEP BOLTS @ APPROX. 350mm VERTICAL CENTRES or b) PERSONNEL ACCESS LADDER OVER THE LENGTH OF THE STRUCTURE STARTING 5 METRES ABOVE GROUND LEVEL.
- POLE DIAMETER AT GROUND LEVEL AND TOP TO BE SUBMITTED BY MANUFACTURER FOR APPROVAL.
- HOLD DOWN BOLTS TO BE HOT DIP GALVANIZED TO AS/NZS 4680.
- POLE AND ALL COMPONENTS TO BE HOT DIP GALVANIZED TO AS/NZS 4680 (DULL FINISH).
- PLAN VIEW AND DETAILS ARE DRAWN ON THE ASSUMPTION THAT THE POLE HAS 12 SIDES. SUBJECT TO DETAILED DESIGN.
- THE ATTACHMENT DETAILS ARE FOR GUIDANCE TO THE DETAIL DESIGNER WHO MAY DECIDE FOR MANUFACTURING AND STRENGTH REASONS TO PROPOSE ALTERNATIVES.
- ALL POLE SECTION CONNECTIONS TO BE SLIP JOINTS.
- POLE TO BE DESIGNED FOR MINIMUM SERVICE TEMPERATURE OF -5 DEGREES C.
- FOR POLES WHICH ARE SUPPLIED IN MULTIPLE SECTIONS AND UTILISE SLIP JOINTS, JACKING FORCES AND MINIMUM/MAXIMUM OVERLAP SHALL BE SPECIFIED. JACKING CLEATS SHALL BE PROVIDED ON EACH SECTION.
- DESIGN OF STEEL POLES AND CROSS ARMS TO BE CARRIED OUT IN ACCORDANCE WITH ANY OF THE FOLLOWING REFERENCE STANDARDS: AS/NZS 4065, AS4100, AS/NZS 4600, AS/NZS 4676 AND ASCE 48-05, USING APPROPRIATE STRENGTH REDUCTION FACTORS FOR EACH PARTICULAR STANDARD DOCUMENT.
- ALL STRAIN INSULATOR ATTACHMENT POINTS TO BE RATED TO BREAKING STRENGTH OF STRAIN INSULATOR ASSEMBLY.
- ALL OPGW STRAIN ATTACHMENT POINTS TO BE RATED TO BREAKING STRENGTH OF STRAIN OPGW ASSEMBLY.
- FOR POLE DETAIL REFER TO VALMONT CONCEPT DRAWING E14190A 48m 270kNU.

BM	SB	SB
DESIGNER	CHECKED	APPROVED

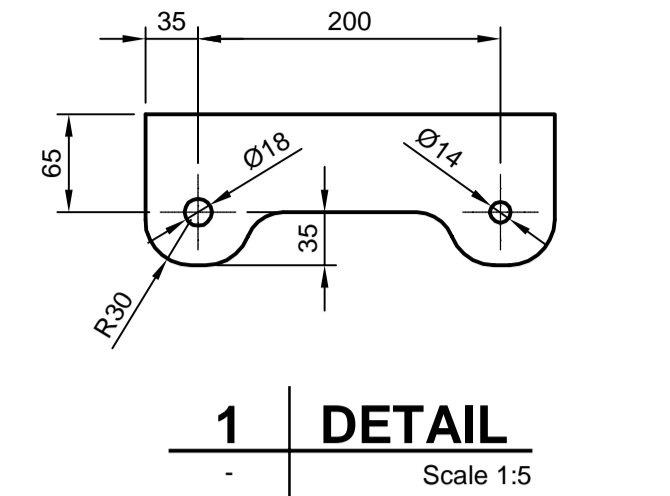
ISSUE/REVISION

A	11.07.14	FOR INFORMATION ONLY
I/R	DATE	DESCRIPTION

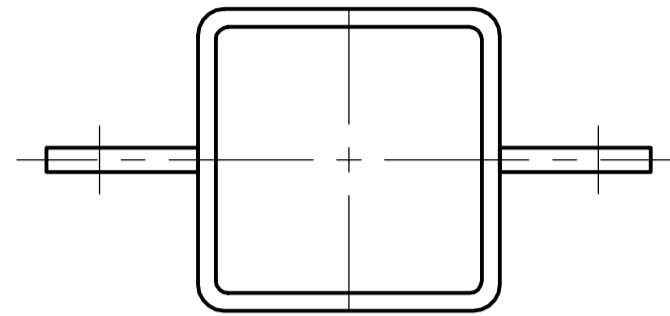
This drawing is confidential and shall only be used for the purpose of this project. The signing of this title block confirms the design and drafting of this project have been prepared and checked in accordance with the AECOM quality assurance system to ISO 9001-2000.



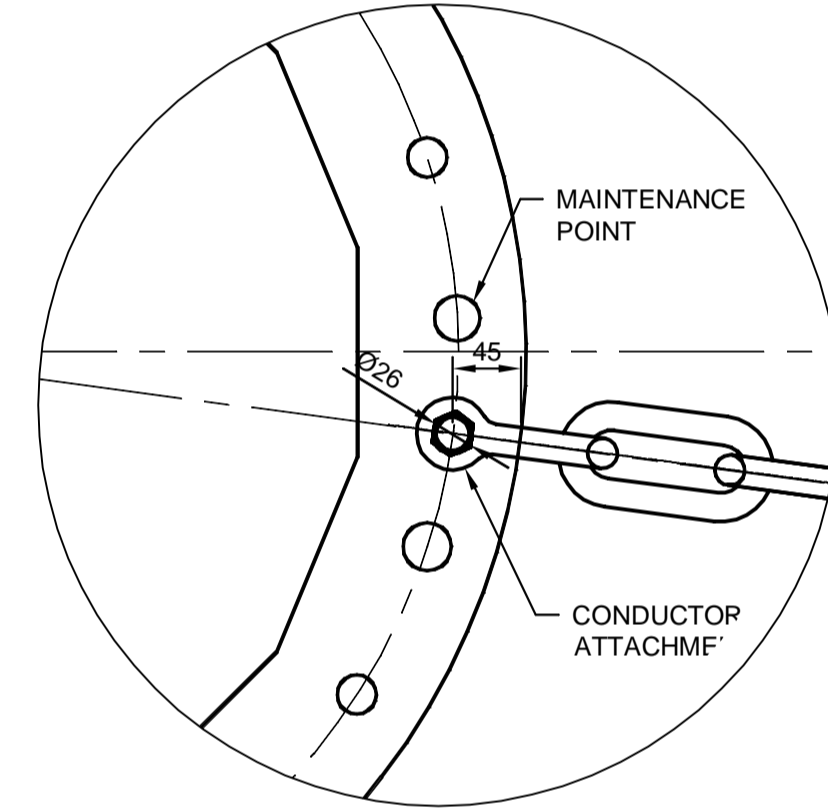
ELEVATION VIEW
Scale 1:50



1 | DETAIL
Scale 1:5



A | VIEW
Scale 1:5



2 | DETAIL
Scale 1:5

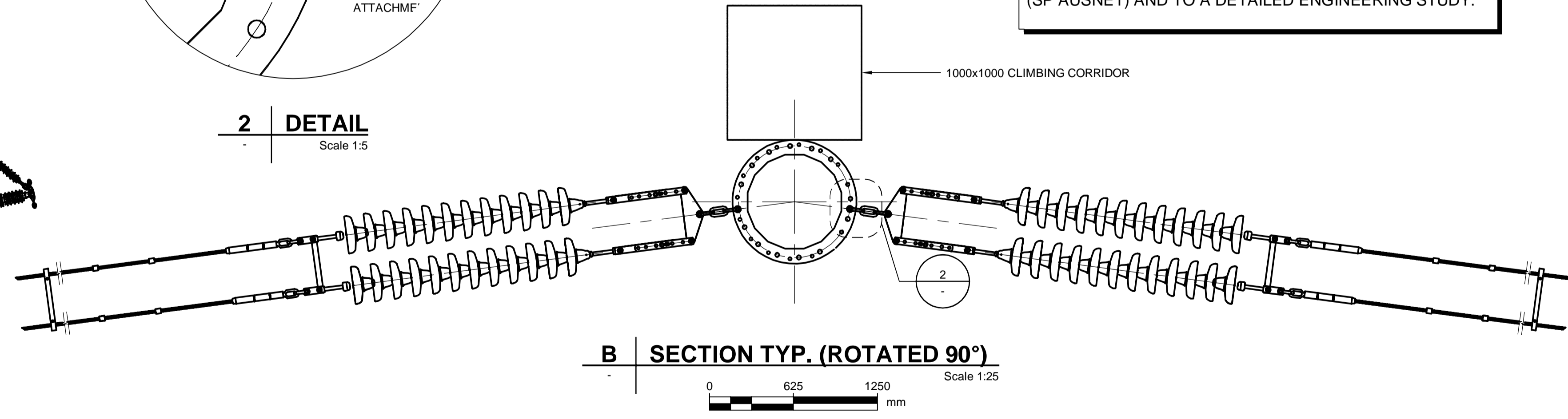
NOTES:

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- ALL OPGW STRAIN ATTACHMENT POINTS TO BE RATED TO BREAKING STRENGTH OF STRAIN OPGW ASSEMBLY.
- FOR POLE DETAIL REFER TO VALMONT CONCEPT DRAWING E14190A 48m 160kNU.

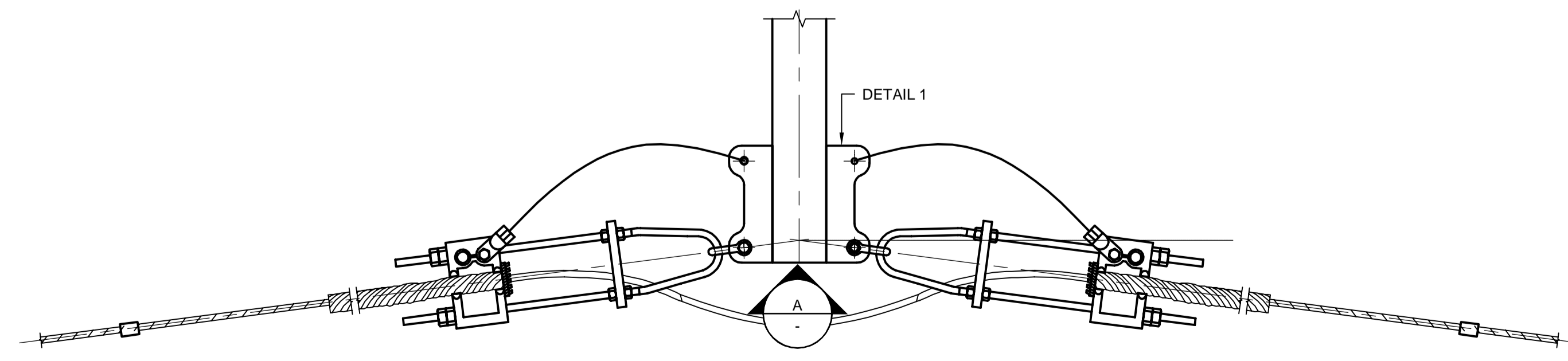
POLE No.	DIM 'X'	DIM 'Y'
12A	48000	26600

NOTES:

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B | SECTION TYP. (ROTATED 90°)
Scale 1:25



A | SECTION (ROTATED 90°)
Scale 1:10

SAFETY IN DESIGN INFORMATION
ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?
 NO
 YES

REGISTRATION

CHECK PRINT	BACKDRAFT	READY TO
	REQUIRED	ISSUE
INITIAL	DATE	
SELF CHECK		
DRAFTING		
DESIGN ENGINEER		
LEAD DESIGN		
VERIFIER		
BACKDRAFTED/CORRECTED		
CONFIRMED		

FOR INFORMATION ONLY
PROJECT MANAGEMENT INITIALS

BM	SB	SB
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
A	11.07.14	FOR INFORMATION ONLY

KEY PLAN