CEL North Neerabup-Wangara

Neerabup EMF Studies

Western Power

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→ **The Power of Commitment**

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1. Introduction

Western Power's Clean Energy Link - North program involves the expansion of the northern transmission network to support decarbonisation. As part of this program, Western Power will undertake expansions at several sites, along with the construction and reconfiguration of sections of the transmission network.

To support community engagement activities and environmental and planning approvals, Western Power requires EMF modelling studies for the proposed Neerabup–Wangara 132 kV transmission line.

1.1 Purpose of this report

The purpose of this report is to document the EMF study undertaken for the proposed 132 kV Neerabup - Wangara transmission line, extending from Neerabup Terminal (Ziatis Rd, Pinjar) to corner of Ocean Reef Rd & Wanneroo Rd, Woodvale.

1.2 Scope and limitations

1.2.1 Scope

The scope of this report is limited to the EMF studies conducted which includes:

- Modelling of the future double circuit 132 kV transmission line to simulate magnetic and electric fields associated with transmission line operation.
- Comparison with ARPANSA and international standards & guidelines to demonstrate compliance.
- Reference points that include electric and magnetic field levels at standard locations beneath the transmission line,
  - Directly below the lowest point of the conductor, at a nominal height of a person (1.8m)
  - At lateral distances of 5m, 10m, 50m, and 100m from the lowest point of the conductor.

1.2.2 Limitations

This report: has been prepared by GHD for Western Power and may only be used and relied on by Western Power for the purpose agreed between GHD and Western Power as set out in section 1.1 and 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Western Power arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

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If the GHD document containing the disclaimer is to be included in another document (for example, if GHD has prepared an expert report to be included in a prospectus or sale of business documentation), the following additional paragraph should be added to the generic disclaimer detailed above:

GHD has not been involved in the preparation of the [insert name of the other document] and has had no contribution to, or review of the [name of other document] other than in the [name of other document prepared by GHD]. GHD shall not be liable *to any person for any error in, omission from, or false or misleading statement in, any other part of the [name of other document].*

GHD has prepared the CDEGS model ("Model") for, and for the benefit and sole use of, Western Power to support the Neerabup–Wangara 132 kV transmission line EMF Study and must not be used for any other purpose or by any other person.

The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the Western Power, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs becomes available.

The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.

The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.

GHD has prepared this report on the basis of information provided by Western Power and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.3 Assumptions

The following assumptions apply to this report:

– Load data supplied by Western Power is suitable for the operation of the transmission life during the lifetime of the asset
– The EMF assessment was conducted for structures with a height of 20 m only.
– The extent of the new 132 kV transmission line works is from structures 1 to 169, in accordance with the staking table data supplied by WP (beyond structure 169 the transmission line is existing).

1.4 References

The following documents are referenced in this document:

1. ENA EMF Management Handbook, 2016
2. ICNIRP Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 HZ – 100 kHz); Published in Health Physics 99(6):818-836; 2010
3. WHO Environmental Health Criteria 238: Extremely Low Frequency Fields, 2007
4. Radiation: Electromagnetic Fields Questions and Answers (**https://www.who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields**, accessed 22/12/25)
5. Staking Table_132kV DC_20251121_P146-155 Profile.xlsx
6. T5003/6/8/9/1: Structure – Details D/C Strain/Terminal Metro 150m Span Pole Top Geometry
7. T5003/6/8/8/1: Structure – Details D/C Suspension Metro 150m Span Pole Top Geometry
8. Nexans Olex Aerial Catalogue (https://www.nexans.com.au/en/products/Aerial-and-Overhead.html)

1.5 Abbreviations

Table 1 Abbreviations

Abbreviation	Definition
AAC	All Aluminium Conductor
ACSR/GZ	Aluminium Conductor Steel Reinforced / Galvanised Zinc
Al	Aluminium
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
CDEGS	Current Distribution, Electromagnetic fields, Grounding and Soil structure analysis
Cu	Copper
EMF	Electric and magnetic fields
ENA	Energy Networks Association
HV	High Voltage
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
LV	Low voltage
OHEW	Overhead Earth Wire
TL	Transmission line
WHO	World Health Organisation

2. Electric and magnetic fields

2.1 Overview

Electric and magnetic fields exist naturally and around electrical equipment. In nature, the earth has a constant magnetic field generated by its core. Electric fields also exist naturally in the earth's atmosphere.

Electric and magnetic fields are also created when electricity flows to, from, or through electrical equipment. Electric fields depend on voltage. Voltage usually stays fairly steady, so electric fields are also fairly steady. When voltage increases, the electric field becomes stronger.

Most solid objects reduce electric fields. Buildings, hills, trees and even human skin block them. Because of this, strong electric fields are usually only found close to the source (such as a power line). As you move away, the same amount of electrical energy is spread over a much larger area. This makes the field weaker with distance. Inside the human body, electric fields are much weaker than outside the body.

Magnetic fields depend on electrical current. Current can change as equipment turns on and off or as electricity or as electricity demand changes. When current increases, the magnetic field becomes stronger.

Magnetic fields are harder to block. Only electrically conductive materials, such as metal enclosures, steel reinforcement in concrete, provide significant shielding.

2.2 Reference levels

With respect to the need for exposure limits to protect against acute effects to humans associated with ELF EMF, the WHO advise (refer 1):

"Health effects related to short-term, high-level exposure have been established and form the basis of two international exposure limit guidelines (ICNIRP, 1998; IEEE, 2002). At present, these bodies consider the scientific evidence related to possible health effects from long-term, low-level exposure to ELF fields insufficient to justify lowering these quantitative exposure limits".

Similarly, ARPANSA advise (refer 1):

"The ICNIRP ELF guidelines are consistent with ARPANSA's understanding of the scientific basis for the protection of people from exposure to ELF EMF".

Consequently, ICNIRP ELF guidelines are used for this assessment, in line with ARPANSA advice and its role as the Australian government's primary authority on radiation protection and nuclear safety.

ICNIRP guidelines specify reference levels applicable to the general public and for the occupational environment. The reference levels are based on mathematical modelling and are calculated with consideration of the condition of maximum coupling of the field to the exposed individual to provide maximum protection to the individual.

The following advice from WHO (refer [4]) is important to consider with respect to reference levels and guidelines:

"A guideline limit is not a precise delineation between safety and hazard. There is no one level above which exposures become hazardous to health; instead, the potential risk to human health gradually increases with higher exposure levels. Guidelines indicate that, below a given threshold, electromagnetic field exposure is safe according to scientific knowledge. However, it does not automatically follow that, above the given limit, exposure is harmful."

And:

"This threshold level for behaviour is not equal to the guideline limit. ICNIRP applies a safety factor of 10 to derive occupational exposure limits, and a factor of 50 to obtain the guideline value for the general public."

Therefore, the reference levels used for this study are:

– In accordance with ARPANSA, ICNIRP and WHO recommendations, and

– Incorporate a safety factor of 10 for occupational exposure reference levels and 50 for public exposure reference levels to prevent adverse human health outcomes due to electric and magnetic fields

ICNIRP ELF EMF reference levels are included in Table 2.

Table 2 ICNIRP reference levels – electric and magnetic fields

Exposure Group	Magnetic flux density (μT rms)	Electric field strength (V/m rms)
Public	200	5,000
Occupational	1,000	10,000

All values in Table 2 are unperturbed rms values.

3. System Definition

3.1 Overview

The alignment for the proposed 132 kV transmission line between Neerabup and Wangara is included in Figure 1.

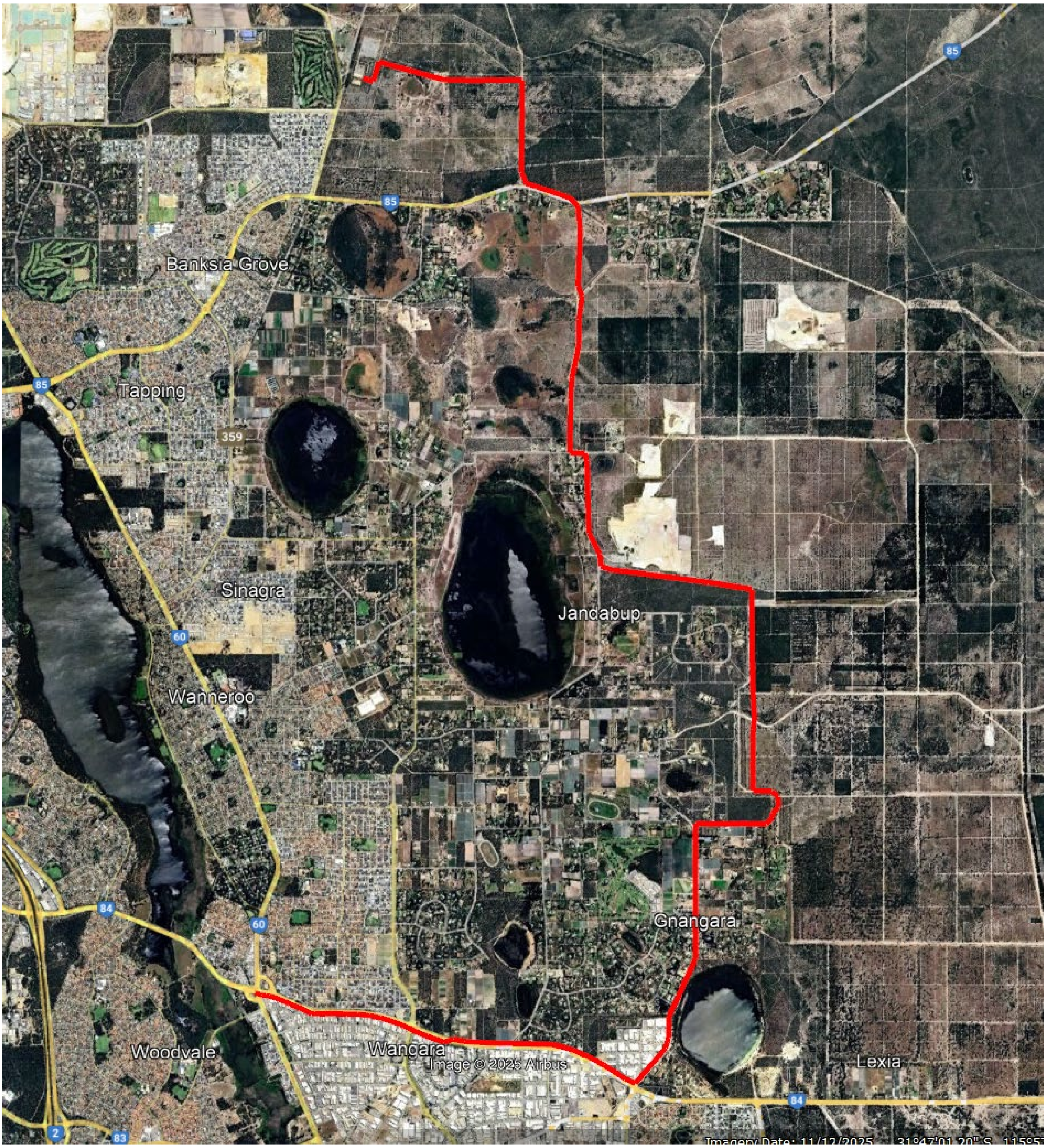


Figure 1 132 kV Transmission Line Alignment – Neerabup to Wangara

Note that the southern end of the alignment interfaces with existing 132 kV transmission line which has not been assessed as part of this report.

3.2 Transmission line configuration

The transmission line conductor details are included in Table 3.

Table 3 132 kV Western Power transmission line – conductor specification

Conductor Type	Conductor Specification	Load (A)	Reference
Phase	Venus AAC	1400 (per phase)	In accordance with WP advice (refer Appendix A)
OHEW	Triton AAC	N/A	In accordance with WP advice (refer Appendix A)

Transmission line pole top arrangements were modelled in accordance with the following standard WP drawings included in Appendix A:

- T5003/6/8/9/1: Structure – Details D/C Strain/Terminal Metro 150m Span Pole Top Geometry (refer [6])
- T5003/6/8/8/1: Structure – Details D/C Suspension Metro 150m Span Pole Top Geometry (refer [7])

3.3 Sensitive receivers

The following sensitive receiver locations were identified after a survey of the proposed transmission line route:

- Lakelands Lifestyle Village: 289 Sydney Rd, Gnangara. The residential boundary of the village is approximately 13 m from the proposed transmission line.
- Wanneroo BMX Club: 276 Shiraz Blvd, Pearsall. The residential boundary of the bike track where children may frequent is approximately 62 m from the proposed transmission line.
- Residential properties: At multiple locations along the route, no closer than 10 m from the proposed transmission line.

4. Modelling

4.1 Methodology

To complete the EMF assessment of the transmission line, the following approach was taken:

– The proposed transmission line was modelled in PLS-CADD using WP supplied staking table data.
  - Conductor blowout was calculated as part of the PLS-CADD modelling process.
  - Conductor sag was modelled at maximum operating temperature of 100°C in accordance with drawings T5003/6/8/9/1 and T5003/6/8/8/1 (which equated to an average sag of approximately 2.5%.and a maximum sag of 3.4%)

– SESEnviroPlus was used to determine electric and magnetic field levels associated with transmission line operation, noting the following:
  - One circuit in the twin circuit arrangement was modelled in a transposed arrangement – a reversed circuit order to the other circuit – in accordance with the principle of prudent avoidance, and methodology described in [1].
  - Locations for lowest conductor point along each span were determined using the PLS-CADD model, and formed the basis for the calculation in SESEnviro
  - Conductor positions relative to the centreline of the transmission line alignment accounted for conductor blowout to ensure that field levels calculated represented worst-case conditions, with respect to 'spread' of electric and magnetic fields.

– Simulation output from SESEnviroPlus was used to determine electric and magnetic field strengths directly below transmission line conductors at the lowest point of conductors along each span, and at distances of 5m, 10m, 50m and 100 m laterally along each span.

– Review of sensitive receivers along the proposed transmission line was completed using Google Earth, and field levels at these locations were evaluated in accordance with ICNIRP reference levels.

Each circuit modelled was energised using the nominal operating voltage assuming a balanced load across phases and calibrated to simulate designated current loads.

It is noted that modelling is conservative considering energisation of the circuits at the rated feeder value, which does not account for decreases in load during typical cyclical loading conditions, which when applying a time-weighted approach to the assessment will likely decrease the magnitude of simulated electric and magnetic field levels.

4.2 Software

The following software was used to complete the EMF study:

– CDEGS Professional Version 19.0.18976.3
  - SESEnviroPlus: To calculate electric and magnetic field levels at standard lateral offsets from the centreline of the transmission line.

– PLS-CADD 21.00
  - Used to determine transmission line conductor sag and blowout information

5. Assessment

5.1 Simulation Output

Output from modelling and simulation described in Section 4 is included in Table 5.

Field levels are colour coded to indicate the margin available between the simulated value and the reference level, as defined in Table 4.

Table 4 Electric and magnetic field reference level indication system

Field range	Colour indicator
0 – 10 % of reference level	
10 - 20 % of reference level	
20 – 50 % of reference level	
50 – 80 % of reference level	
80 – 100 % of reference level	
Exceeding 100 % of reference level	

Table 5 132 kV Transmission Line – Structures 1 – 37 - Simulated Electric and Magnetic Fields

Transmission Line Span	Simulated Electric Field (V/m)					Simulated Magnetic Flux Density (µT)				
	0 m	5 m	10 m	50 m	100 m	0 m	5 m	10 m	50 m	100 m
Structure 1 - 2	400	780	540	10	3	23	21	19	4.2	2
Structure 2 - 3	380	590	380	9	2	23	20.8	16.1	4	2
Structure 3 - 4	380	590	380	8	2	22.5	19.3	15.7	4	2
Structure 4 - 5	390	600	390	8	2	23.9	20.6	16.7	4.2	2.1
Structure 5 - 6	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 6 - 7	380	640	420	9	2	22.5	19.3	15.8	4.1	2
Structure 7 - 8	420	740	450	8	2	23	20	16.3	4	2
Structure 8 - 9	350	540	360	9	2	21.4	18.8	15.4	4	2
Structure 9 - 10	430	750	440	9	2	23.2	20.2	16.4	4.1	2
Structure 10 - 11	370	580	390	8	2	22.8	20	16.4	4.2	2.1
Structure 11 - 12	390	640	410	8	2	22.4	19.5	15.9	4	2
Structure 12 - 13	390	640	420	9	2	22.4	19.6	16	4.1	2
Structure 13 - 14	370	590	370	8	2	21.7	19	15.6	4	2
Structure 14 - 15	390	640	410	8	2	22.4	19.5	15.9	4	2
Structure 15 - 16	410	700	440	9	2	23.9	19.9	16.2	4.1	2
Structure 16 - 17	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 17 - 18	490	760	420	8	2	26.8	22.8	17.9	4.2	2
Structure 18 - 19	440	770	460	8	2	23.4	20.3	16.5	4.1	2
Structure 19- 20	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 20 - 21	390	680	450	9	2	22.1	19.4	16	4.1	2
Structure 21 - 22	400	680	430	9	2	23.1	19.7	16.1	4.1	2
Structure 22 - 23	370	580	390	9	2	21.8	19.1	15.6	4.1	2
Structure 23 - 24	390	650	420	9	2	22.2	19.4	15.9	4.1	2
Structure 24 - 25	390	660	430	9	2	22.1	19.3	15.9	4.1	2
Structure 25 - 26	430	900	590	10	2	23.1	20.9	17.7	4.3	2.1
Structure 26 - 27	430	800	500	10	2	24.1	21.2	17.5	4.3	2.1
Structure 27 - 28	390	680	440	9	2	22.2	19.5	16	4.1	2
Structure 28 - 29	410	710	450	9	2	22.6	19.8	16.2	4.1	2
Structure 29 - 30	410	720	440	10	2	22.4	19.7	16.2	4.2	2
Structure 30 - 31	400	760	460	10	2	23.1	20.5	17.1	4.2	2.1
Structure 31 - 32	420	790	510	10	2	23.6	20.9	17.4	4.3	2.1
Structure 32 - 33	410	770	500	9	2	23.3	20.6	17.1	4.2	2.1
Structure 33 - 34	410	820	560	10	2	22.7	20.4	17.3	4.3	2.1
Structure 34 - 35	410	740	470	10	2	23.7	20.9	17.2	4.2	2.1
Structure 35 - 36	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 36 - 37	390	650	420	9	2	22.2	19.4	15.9	4.1	2
Structure 37 - 38	390	680	450	9	2	22.1	19.4	16	4.1	2

Table 6 132 kV Transmission Line – Structures 38 - 74 - Simulated Electric and Magnetic Fields

Transmission Line Span	Simulated Electric Field (V/m)					Simulated Magnetic Flux Density (µT)				
	0 m	5 m	10 m	50 m	100 m	0 m	5 m	10 m	50 m	100 m
Structure 38 - 39	410	810	490	10	2	23.5	20.6	17.3	4.3	2.1
Structure 39 - 40	410	750	500	10	2	23.3	20.6	17.2	4.3	2.1
Structure 40 - 41	420	820	530	9	2	22.3	19.7	16.4	4.1	2
Structure 41 - 42	430	840	540	10	2	23.5	21	17.5	4.3	2.1
Structure 42 - 43	420	820	530	9	2	22.3	19.7	16.4	4.1	2
Structure 43 - 44	420	870	590	10	2	23	20.7	17.6	4.3	2.1
Structure 44 - 45	400	760	510	10	2	23	20.5	17.2	4.3	2.1
Structure 45 - 46	410	770	500	9	2	23.3	20.6	17.1	4.2	2.1
Structure 46 - 47	390	690	450	9	2	23.6	20.5	16.9	4.2	2.1
Structure 47 - 48	380	680	460	9	2	21.7	19.1	15.9	4.1	2
Structure 48 - 49	420	730	460	10	2	23.9	21	17.2	4.2	2.1
Structure 49 - 50	360	550	370	9	2	21.6	18.9	15.5	4	2
Structure 50 - 51	360	570	380	9	2	21.6	19	15.6	4.1	2
Structure 51 - 52	380	640	420	9	2	22.5	19.3	15.8	4.1	2
Structure 52 - 53	430	490	280	7	2	24.7	20.9	16.2	4	2
Structure 53 - 54	330	480	340	9	2	21.6	19.2	15.9	4.2	2.1
Structure 54 - 55	320	420	290	7	2	20.7	18.2	14.9	4	2
Structure 55 - 56	340	490	320	7	2	22.7	19.4	15.6	4.1	2
Structure 56 - 57	430	780	500	9	2	23.9	21.1	17.4	4.2	2.1
Structure 57 - 58	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 58 - 59	430	790	500	9	2	23	20.1	16.5	4.1	2
Structure 59 - 60	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 60 - 61	390	650	420	9	2	22.2	19.4	15.9	4.1	2
Structure 61 - 62	470	830	490	9	2	25.2	22	17.8	4.2	2.1
Structure 62 - 63	430	840	540	10	2	23.5	21	17.5	4.3	2.1
Structure 63 - 64	410	770	500	9	2	23.3	20.6	17.1	4.2	2.1
Structure 64 - 65	470	890	530	10	2	25.3	22.2	18.2	4.3	2.1
Structure 65 - 66	390	740	500	10	2	22.5	20.1	16.9	4.3	2.1
Structure 66 - 67	440	820	520	10	2	24	21.3	17.6	4.3	2.1
Structure 67 - 68	400	680	430	9	2	23.1	19.7	16.1	4.1	2
Structure 68 - 69	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 69 - 70	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 70 - 71	390	650	420	9	2	22.2	19.4	15.9	4.1	2
Structure 71 - 72	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 72 - 73	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 73 - 74	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 74 - 75	410	710	450	9	2	22.6	19.8	16.2	4.1	2

Table 7 132 kV Transmission Line – Structures 75 – 117 - Simulated Electric and Magnetic Fields

Transmission Line Span	Simulated Electric Field (V/m)					Simulated Magnetic Flux Density (µT)				
	0 m	5 m	10 m	50 m	100 m	0 m	5 m	10 m	50 m	100 m
Structure 75 - 76	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 76 - 78	410	710	450	9	2	22.6	19.8	16.2	4.1	2
Structure 78 - 79	450	650	370	7	1	24.6	20.9	16.4	4	2
Structure 79 - 81	400	670	440	9	2	23.5	20.7	17	4.2	2.1
Structure 81 - 82	390	630	410	8	2	22.1	19.4	15.8	4	2
Structure 82 - 83	390	650	420	9	2	22.2	19.4	15.9	4.1	2
Structure 83 - 84	440	780	480	8	2	23.2	20.2	16.5	4.1	2
Structure 84 - 85	400	670	430	9	2	22.4	19.6	16	4.1	2
Structure 85 - 86	400	680	430	9	2	23.1	19.7	16.1	4.1	2
Structure 86 - 87	410	710	450	9	2	22.6	19.8	16.2	4.1	2
Structure 87 - 88	420	760	480	9	2	22.6	22.6	16.3	4.1	2
Structure 88 - 89	430	830	530	10	2	24.4	21.1	17.6	4.3	2.1
Structure 89 - 90	380	640	420	9	2	22.5	19.3	15.8	4.1	2
Structure 90 - 91	410	750	490	9	2	22.2	19.6	16.2	4.1	2
Structure 91 - 92	430	910	620	10	2	22.9	20.9	17.9	4.3	2.1
Structure 92 - 93	430	830	520	9	2	22.7	20	16.6	4.1	2
Structure 93 - 94	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 94 - 95	390	680	450	9	2	22.1	19.4	16	4.1	2
Structure 95 - 96	410	730	470	9	2	22.6	19.8	16.2	4.1	2
Structure 96 - 98	450	820	490	9	2	23.6	20.5	16.7	4.1	2
Structure 98 - 99	370	560	370	9	2	23.1	20.3	16.5	4.2	2.1
Structure 99 - 100	350	550	380	9	2	21.3	18.7	15.4	4	2
Structure 100 - 101	370	570	380	9	2	22.9	20.2	16.5	4.2	2.1
Structure 101 - 103	400	760	510	10	2	23	20.5	17.2	4.3	2.1
Structure 103 - 104	340	540	380	9	2	22.5	19.6	16.2	4.2	2.1
Structure 104 - 105	300	390	290	9	2	20.8	18.6	15.4	4.2	2.1
Structure 105 - 106	350	580	400	9	2	22.2	19.7	16.4	4.2	2.1
Structure 106 - 107	470	820	480	9	2	25.2	22.1	17.8	4.2	2.1
Structure 107 - 108	400	680	430	9	2	23.1	19.7	16.1	4.1	2
Structure 108 - 109	370	590	360	8	2	22.1	19.2	15.6	4	2
Structure 109 - 110	440	810	500	9	2	23.2	20.3	16.6	4.2	2
Structure 110 - 111	400	680	430	9	2	23.1	19.7	16.1	4.1	2
Structure 111 - 113	390	680	450	9	2	22	19.4	16	4.1	2
Structure 113 - 115	420	500	280	8	2	25.8	22	17.2	4.2	2.1
Structure 115 - 116	390	630	410	8	2	22.1	19.4	15.8	4	2
Structure 116 - 117	430	760	480	9	2	23	20	16.4	4.1	2
Structure 117 - 118	420	740	450	8	2	23	20	16.3	4	2

Table 8 132 kV Transmission Line – Structures 118 – 153 - Simulated Electric and Magnetic Fields

Transmission Line Span	Simulated Electric Field (V/m)					Simulated Magnetic Flux Density (µT)				
	0 m	5 m	10 m	50 m	100 m	0 m	5 m	10 m	50 m	100 m
Structure 118 - 119	420	740	450	8	2	23	20	16.3	4	2
Structure 119 - 120	420	720	450	9	2	22.8	19.9	16.3	4.1	2
Structure 120 - 121	360	550	370	9	2	21.6	18.9	15.5	4	2
Structure 121 - 122	380	590	390	9	2	22	19.2	15.7	4.1	2
Structure 122 - 123	370	560	370	9	2	17.3	15.2	12.4	3.2	1.6
Structure 123 - 124	330	460	320	9	2	20.9	18.4	15.1	4	2
Structure 124 - 125	370	560	370	9	2	17.3	15.2	12.4	3.2	1.6
Structure 125 - 126	430	790	500	9	2	23	20.1	16.5	4.1	2
Structure 126 - 127	390	640	430	9	2	23.1	20.4	16.8	4.2	2.1
Structure 127 - 128	370	590	360	8	2	22.1	19.2	15.6	4	2
Structure 128 - 129	380	590	390	8	2	22	19.2	15.7	4	2
Structure 129 - 130	370	580	390	9	2	21.8	19.1	15.6	4.1	2
Structure 130 - 131	380	590	390	9	2	22	19.2	15.7	4.1	2
Structure 131 - 132	420	720	450	9	2	22.8	19.9	16.3	4.1	2
Structure 132 - 133	390	690	460	9	2	23.6	20.5	16.9	4.2	2.1
Structure 133 - 134	380	640	430	9	2	22.8	20	16.7	4.2	2.1
Structure 134 - 135	390	740	500	10	2	22.5	20.1	16.9	4.3	2.1
Structure 135 - 136	440	820	520	9	2	24.7	21.3	17.6	4.2	2.1
Structure 136 - 137	380	640	420	9	2	22.5	19.3	15.8	4.1	2
Structure 137 - 138	400	690	440	9	2	22.4	19.6	16.1	4.1	2
Structure 138 - 139	430	660	390	7	1	24	20.6	16.3	4	2
Structure 139 - 140	420	860	580	10	2	22.8	20.6	17.5	4.3	2.1
Structure 140 - 141	420	820	540	10	2	23.4	20.8	17.4	4.3	2.1
Structure 141 - 142	420	820	530	9	2	22.3	19.7	16.4	4.1	2
Structure 142 - 143	450	870	540	9	2	24.2	21.5	17.8	4.2	2.1
Structure 143 - 144	380	620	420	9	2	21.9	19.2	15.8	4.1	2
Structure 144 - 145	390	680	450	9	2	22.1	19.4	16	4.1	2
Structure 145 - 146	410	820	560	10	2	22.7	20.4	17.3	4.3	2.1
Structure 146 - 147	410	820	560	10	2	22.7	20.4	17.3	4.3	2.1
Structure 147–147A	390	700	470	10	2	22.9	20.3	16.9	4.2	2.1
Structure 147A-148	390	700	480	9	2	21.8	19.3	16	4.1	2
Structure 148 - 149	400	780	540	10	3	23	21	19	4.2	2
Structure 149 - 150	410	740	470	10	2	23.7	20.9	17.2	4.2	2.1
Structure 150 - 151	390	650	420	9	2	22.2	19.4	15.9	4.1	2
Structure 151 - 152	360	570	380	9	2	21.6	19	15.6	4.1	2
Structure 152 - 153	360	570	380	9	2	21.6	19	15.6	4.1	2
Structure 153 - 154	410	700	460	9	2	22.9	19.6	16.1	4.1	2

Table 9 132 kV Transmission Line – Structures 154 – 174 - Simulated Electric and Magnetic Fields

Transmission Line Span	Simulated Electric Field (V/m)					Simulated Magnetic Flux Density (μT)				
	0 m	5 m	10 m	50 m	100 m	0 m	5 m	10 m	50 m	100 m
Structure 154 - 155	400	790	540	10	2	22.8	20.4	17.2	4.3	2.1
Structure 155 - 156	390	720	480	9	2	22.9	20.4	17	4.2	2.1
Structure 156 - 157	410	720	470	9	2	24	20.8	17.1	4.2	2.1
Structure 157 - 158	410	750	500	10	2	23.3	20.6	17.2	4.3	2.1
Structure 158 - 159	410	820	560	10	2	22.7	20.4	17.3	4.3	2.1
Structure 159 - 160	390	740	500	10	2	22.5	20.1	16.9	4.3	2.1
Structure 160 - 161	430	910	590	10	2	22.9	20.7	17.7	4.3	2.1
Structure 161 - 162	420	860	580	10	2	22.8	20.6	17.5	4.3	2.1
Structure 162 - 163	390	740	500	10	2	22.5	20.1	16.9	4.3	2.1
Structure 163 - 164	430	910	620	10	2	22.9	20.9	17.9	4.3	2.1
Structure 164 - 165	440	850	530	10	2	24	21.3	17.7	4.3	2.1
Structure 165 - 166	390	660	430	9	2	22.1	19.3	15.9	4.1	2
Structure 166 - 167	380	620	410	9	2	22	19.3	15.8	4.1	2
Structure 167 - 168	380	670	450	9	2	21.9	19.2	15.9	4.1	2
Structure 168 - 169	420	870	590	10	2	23	20.7	17.6	4.3	2.1
Structure 169 - 170	400	710	470	10	2	23.1	20.5	17	4.2	2.1
Structure 170 - 171	410	750	500	10	2	23.3	20.6	17.2	4.3	2.1
Structure 171 - 172	410	840	560	10	2	22.9	20.6	17.4	4.3	2.1
Structure 172 - 173	340	510	360	9	2	22	19.5	16.1	4.2	2.1
Structure 173 - 174	300	410	300	9	2	19.8	17.6	14.6	4	2

5.2 Evaluation

All field values in Table 5 to Table 9 are within allowable limits specified in Table 2.

Further, all simulated values are no greater than 20% of the associated reference level, indicating a significant margin of safety between predicted EMF levels, and EMF levels where adverse health effects may occur.

With respect to sensitive receivers identified in Section 3.3, the maximum simulated levels at 10 m from the line (closest location of any sensitive receiver) are:

– Electric field = 770 V/m (15.4% of public reference level), and
– Magnetic flux density = 19 μT (9.5% of public reference level).

The maximum field plots simulated are included in Figure 2 and Figure 3.

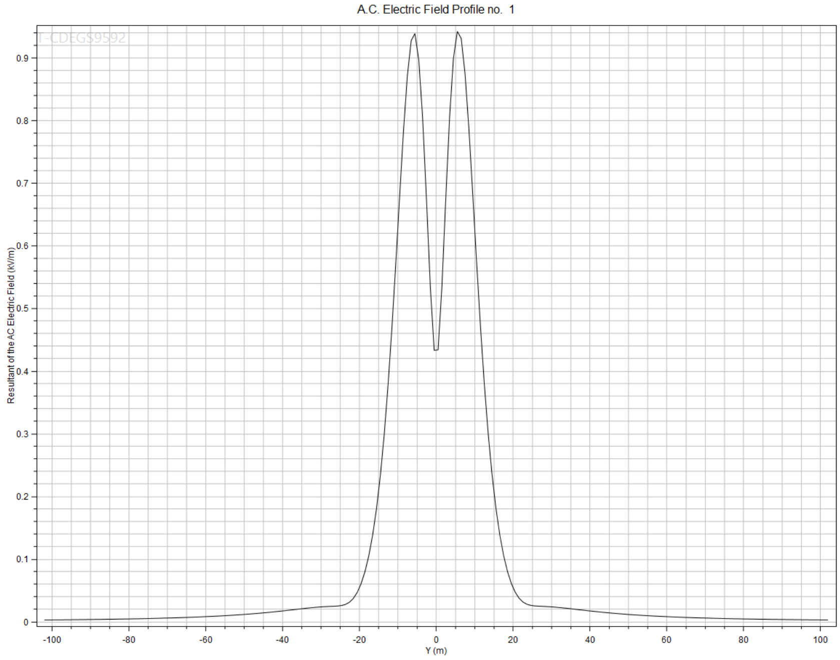


Figure 2 Maximum electric field at Structure 91 – 92, Structure 160 – 161 and Structure 163 – 164

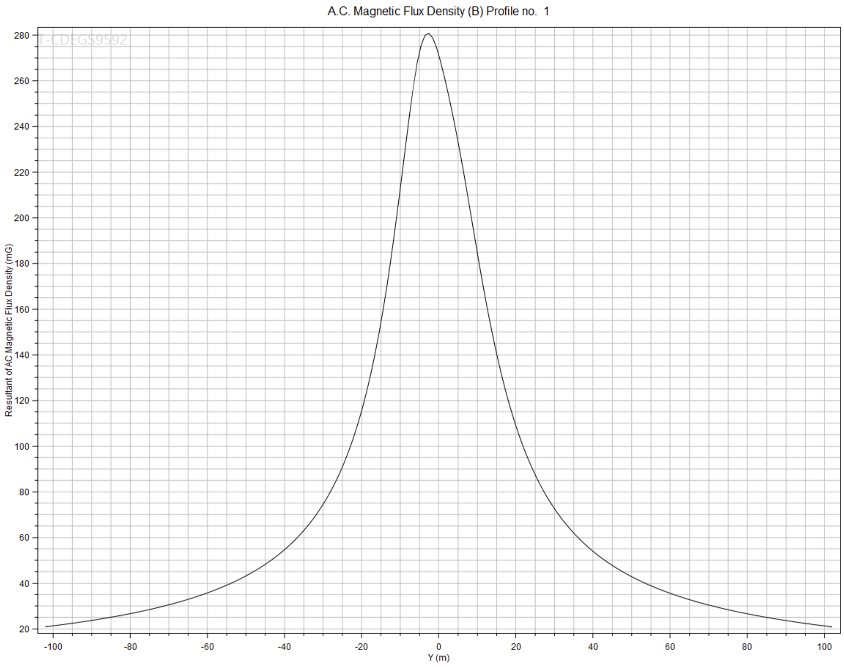


Figure 3 Maximum magnetic field at Structure 17-18

6. Prudent Avoidance

The transmission line design has followed the principle of prudent avoidance to minimise the impacts of electric and magnetic fields to workers and the public.

The philosophy describing this approach is described in the ENA EMF Handbook [1]:

"ENA's policy includes designing and operating electricity generation, transmission and distribution systems in compliance with relevant Australian Guidelines and in an approach consistent with prudent avoidance. No cost and very low cost measures that reduce exposure while not unduly compromising other issues should be adopted."

The following is noted with respect to prudent avoidance for the Neerabup to Wangara transmission line design:

1. The design uses vertical construction arrangements which produce lower electric and magnetic field levels at ground level than alternate arrangements such as delta (refer [1]).
2. The design uses phase transposition for one of the circuits in the twin circuit arrangement. This conductor arrangement has a significant effect on magnetic field reduction due to field cancellation, as shown in Figure 4.

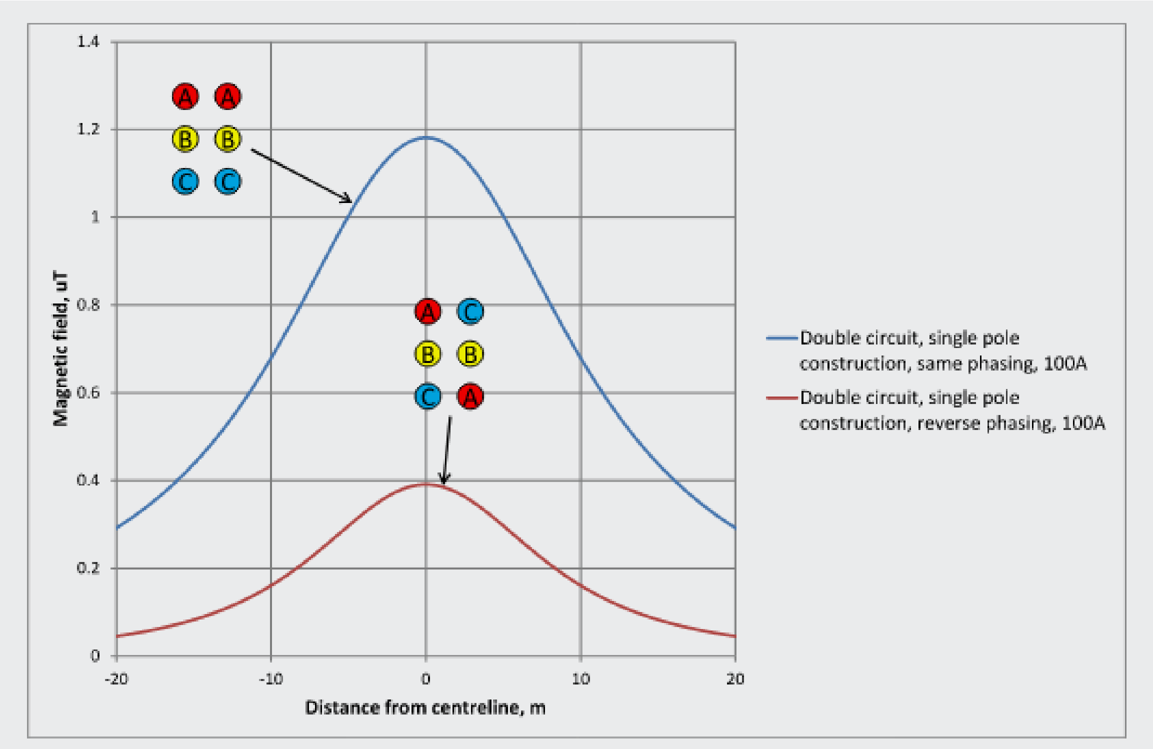


Figure 4 ***Circuit transposition (extract from ENA EMF Handbook)***

The upper curve is the result of magnetic field superposition between adjacent conductors which are 'in-phase', whereas the lower curve shows the effect of partial magnetic field cancellation between adjacent conductors which are 'out-of-phase'. Arranging conductors in this manner is of relatively low cost (poles, insulators and crossarms are the same for transposed and non-transposed circuit arrangements), thereby following the principle of prudent avoidance.

3. The transposed circuit arrangement will be implemented over the full length of the transmission line, ensuring sensitive receiver locations which may be constructed near the line in future (such as schools, aged care facilities or medical facilities) will already benefit from the reduced impact of electric and magnetic fields due to circuit transposition.
4. Further reduction of electric and magnetic fields due to conductor arrangement modifications (such as increasing conductor height or increasing separation between phases) would incur significant cost over the length of the transmission line, and would not be considered prudent avoidance.

7. Conclusions

GHD completed an EMF study for the proposed Western Power 132 kV transmission line between Neerabup Terminal and Wangara.

Software modelling in PLS-CADD and CDEGS to complete the assessment was based on the following design documents:

- Staking Table_132kV DC_20251121_P146-155 Profile.xlsx
- T5003/6/8/9/1: Structure – Details D/C Strain/Terminal Metro 150m Span Pole Top Geometry
- T5003/6/8/8/1: Structure – Details D/C Suspension Metro 150m Span Pole Top Geometry

Data for conductors was sourced from commercially available products (in accordance with [8]).

Results of the simulations showed that:

- All electric and magnetic fields are within ICNIRP (and hence ARPANSA and WHO) reference levels
- The highest simulated electric field at nominal human height near the proposed transmission line is 18.2% of the associated public exposure reference level
- The highest simulated magnetic flux density at nominal human height near the proposed transmission line is 14% of the associated public exposure reference level

Is also noted that the transmission line design follows the principle of prudent avoidance in accordance with the ENA EMF Handbook, as described in Section 6, to minimise the impact of electric and magnetic fields where the cost of doing so is reasonable.

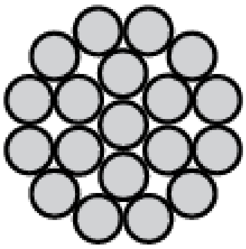
In summary, the transmission line design is compliant with design approach advised in [1], and the reference levels defined in [2].

Appendices

Appendix A

Reference Data

Bare Conductors Type AAC



Aluminium conductors manufactured to AS 1531.

Physical and Mechanical Performance Data

Conductor codename	Stranding and wire diameter no/mm	Nominal overall diameter mm	Cross-sectional area mm²	Approximate mass kg/km	Breaking load kN	Modulus of elasticity GPa	Coefficient of linear expansion × 10⁻⁶/°C	Product code
Leo	7/2.50	7.50	34.4	94.3	5.71	65	23.0	Leo
Leonids	7/2.75	8.25	41.6	113	6.72	65	23.0	Leonids
Libra	7/3.00	9.00	49.5	135	7.98	65	23.0	Libra
Mars	7/3.75	11.3	77.3	211	11.8	65	23.0	Mars
Mercury	7/4.50	13.5	111	304	16.9	65	23.0	Mercury
Moon	7/4.75	14.3	124	339	18.9	65	23.0	Moon
Neptune	19/3.25	16.3	158	433	24.7	65	23.0	Neptune
Orion	19/3.50	17.5	183	503	28.7	65	23.0	Orion
Pluto	19/3.75	18.8	210	576	31.9	65	23.0	Pluto
Saturn	37/3.00	21.0	262	721	42.2	64	23.0	Saturn
Sirius	37/3.25	22.8	307	845	48.2	64	23.0	Sirius
Taurus	19/4.75	23.8	337	924	51.3	65	23.0	Taurus
Triton	37/3.75	26.3	409	1120	62.2	64	23.0	Triton
Uranus	61/3.25	29.3	506	1400	75.2	64	23.0	Uranus
Ursula	61/3.50	31.5	587	1620	87.3	64	23.0	Ursula
Venus	61/3.75	33.8	673	1860	97.2	64	23.0	Venus

Electrical Performance Data

Cond. code name	DC resist. at 20°C	AC resist. at 50Hz 75°C	Inductive reactance to 0.3m at 50Hz	Continuous current carrying capacity, A											
				Rural weathered						Industrial weathered					
				Winter night			Summer noon			Winter night			Summer noon		
	Ω/km	Ω/km	Ω/km	Still air	1m/s wind	2m/s wind	Still air	1m/s wind	2m/s wind	Still air	1m/s wind	2m/s wind	Still air	1m/s wind	2m/s wind
Leo	0.833	1.02	0.295	123	211	245	95	190	225	132	216	250	88	186	222
Leonids	0.689	0.842	0.289	140	237	276	107	213	253	150	243	282	99	209	249
Libra	0.579	0.707	0.284	157	265	308	119	237	281	169	272	314	110	232	277
Mars	0.370	0.452	0.270	211	350	408	157	311	369	228	361	417	143	304	364
Mercury	0.258	0.315	0.259	269	440	511	196	388	461	292	454	524	176	378	453
Moon	0.232	0.284	0.255	289	470	546	209	413	492	314	486	560	188	403	483
Neptune	0.183	0.224	0.244	343	548	636	243	479	570	373	568	653	216	465	559
Orion	0.157	0.192	0.240	381	603	699	269	525	625	416	626	719	238	510	612
Pluto	0.137	0.168	0.235	420	657	762	295	570	679	458	683	784	260	553	665
Saturn	0.110	0.135	0.227	490	755	875	341	651	776	536	786	901	299	630	759
Sirius	0.0940	0.116	0.222	547	834	975	379	716	854	599	869	1006	331	692	834
Taurus	0.0857	0.105	0.220	583	883	1039	402	756	902	639	921	1071	350	730	880
Triton	0.0706	0.0872	0.213	668	997	1190	457	849	1028	733	1042	1228	396	818	1002
Uranus	0.0572	0.0710	0.206	773	1137	1377	525	962	1188	850	1191	1422	452	925	1158
Ursula	0.0493	0.0616	0.201	856	1246	1524	578	1049	1314	942	1307	1574	495	1006	1280
Venus	0.0429	0.0539	0.197	941	1356	1674	631	1137	1442	1036	1424	1730	539	1089	1405

Note Current ratings are based on the following conditions:

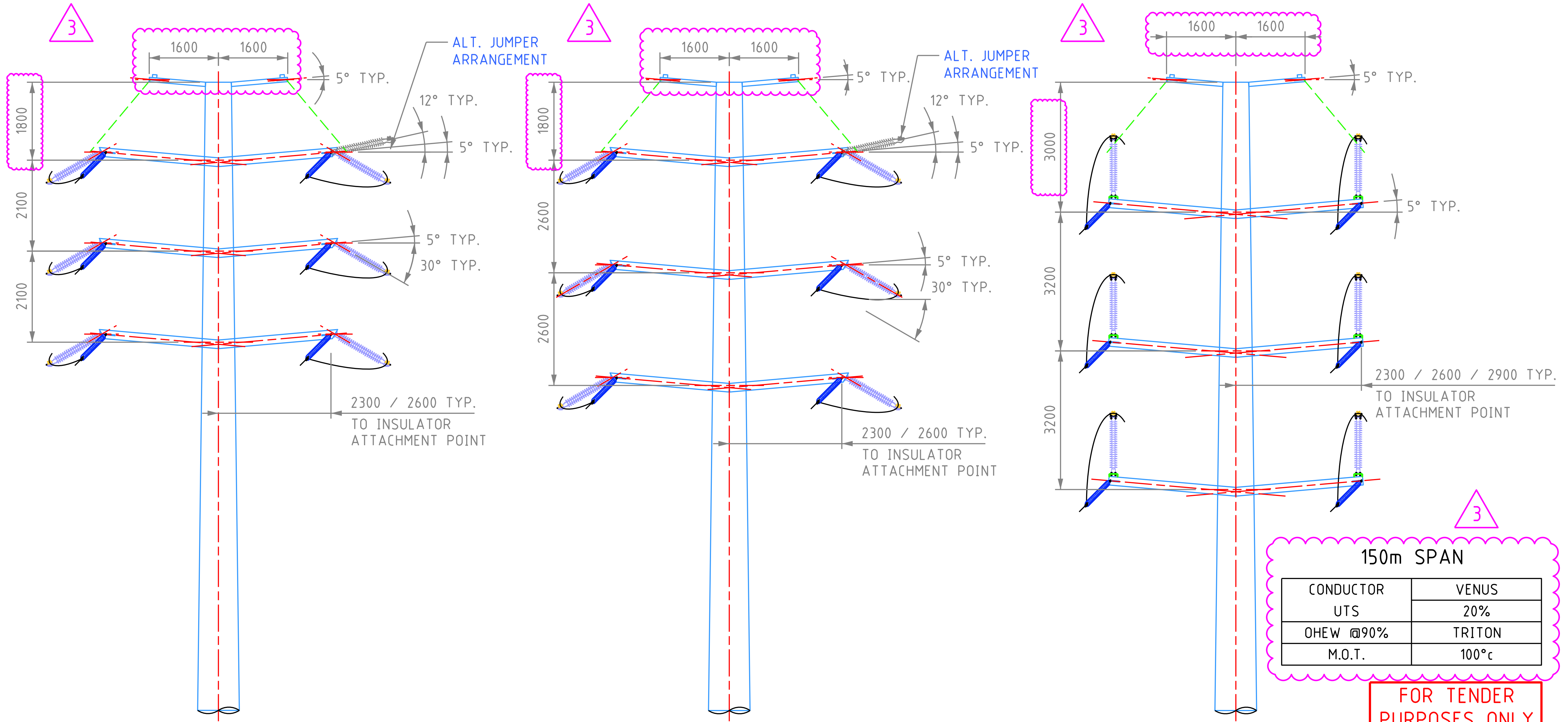
- Conductor temperature rise above ambient of 40°C
- Ambient air temp. of 35°C for summer noon or 10°C for winter night
- Direct solar radiation intensity of 1000W/m² for summer noon or zero for winter night
- Diffuse solar radiation intensity of 100W/m² for summer noon or zero for winter night
- Ground reflectance of 0.2
- Emissivity of 0.5 for rural weathered conductor or 0.85 for industrial weathered conductor
- Solar absorption coefficient of 0.5 for rural weathered conductor or 0.85 for industrial weathered conductor

Cross sections not to scale

Structure Number	X Easting (m)	Y Northing (m)	Centerline Z Elevation (m)	Ahead Span (m)	Line Angle (deg)	Struct. Height (m)	Remarks
1	388390.9	6494176.3	53.8	134.1		20	
2	388519.6	6494138.5	52.6	123.7	-89.9	20	
3	388554.7	6494257.2	56.7	123.5		20	
4	388589.7	6494375.5	60.7	140.3	88.0	20	
5	388725.5	6494340.4	61.4	139.9		20	
6	388860.9	6494305.3	56.3	142.7		20	
7	388999.0	6494269.5	50.3	147.3	1.9	20	
8	389140.3	6494227.9	52.5	130.7	-2.2	20	
9	389267.1	6494195.8	58.2	142.0		20	
10	389404.8	6494161.0	57.0	126.5	-14.7	20	
11	389531.3	6494162.1	56.9	139.4		20	
12	389670.6	6494163.4	55.3	138.3		20	
13	389808.9	6494164.6	56.0	139.3		20	
14	389948.2	6494165.8	55.1	137.4		20	
15	390085.6	6494167.0	55.5	140.8		20	
16	390226.3	6494168.3	55.5	136.0		20	
17	390362.3	6494169.5	56.7	148.8	89.9	20	
18	390363.8	6494020.7	55.9	144.9	0.7	20	
19	390363.4	6493875.8	61.0	147.7	-0.7	20	
20	390364.7	6493728.2	60.2	148.3		20	
21	390366.0	6493579.9	60.2	143.9	0.1	20	
22	390367.0	6493436.0	60.9	136.0	0.6	20	
23	390366.5	6493300.0	55.7	136.5		20	
24	390366.0	6493163.5	54.8	138.0	-0.6	20	
25	390367.0	6493025.5	53.5	145.5	-23.5	20	
26	390426.0	6492892.5	53.3	145.8	-51.4	20	
27	390567.0	6492855.5	53.6	143.9	4.4	20	
28	390703.0	6492808.5	53.6	144.3	-0.4	20	
29	390839.7	6492762.3	54.4	142.8		20	
30	390975.0	6492716.5	55.1	130.1	26.9	20	
31	391066.0	6492623.5	54.6	143.8	38.1	20	
32	391081.6	6492480.5	56.4	143.6		20	
33	391097.2	6492337.8	58.0	136.8	6.3	20	
34	391097.1	6492200.9	55.9	141.6	1.9	20	
35	391092.2	6492059.4	55.2	141.1		20	
36	391087.4	6491918.4	55.3	141.9		20	
37	391082.6	6491776.6	54.5	141.4		20	
38	391077.7	6491635.3	55.5	136.4	-23.6	20	
39	391128.0	6491508.5	58.6	142.6	28.8	20	
40	391110.2	6491367.0	55.2	146.6		20	
41	391092.0	6491221.5	52.8	149.3	-8.3	20	
42	391095.0	6491072.2	53.1	148.8		20	
43	391098.0	6490923.5	55.6	143.7	11.2	20	
44	391072.8	6490782.0	56.6	143.8	2.2	20	
45	391042.2	6490641.5	52.6	142.1		20	
46	391011.9	6490502.6	53.4	133.6	-9.7	20	
47	391005.9	6490369.2	53.6	130.8		20	
48	391000.0	6490238.5	54.8	131.3	-2.7	20	
49	391000.2	6490107.2	54.8	134.4		20	
50	391000.4	6489972.8	52.4	129.9		20	
51	391000.6	6489842.9	54.0	131.3		20	
52	391000.8	6489711.6	51.1	131.1		20	
53	391001.0	6489580.5	55.8	95.0	-89.9	20	
54	391096.0	6489580.5	56.1	89.0		20	
55	391185.0	6489580.5	56.0	94.1	74.7	20	
56	391209.8	6489489.8	53.5	146.9	13.0	20	
57	391215.5	6489343.0	51.2	148.8		20	
58	391221.4	6489194.3	53.8	148.6		20	

59	391227.2	6489045.8	52.7	148.4	0.4	20	
60	391232.0	6488897.5	52.4	148.5	-0.4	20	
61	391237.7	6488749.1	49.6	148.9		20	
62	391243.5	6488600.3	49.3	149.3	-24.4	20	
63	391310.5	6488466.8	51.3	144.6	-1.9	20	
64	391379.6	6488339.7	51.7	148.2	22.2	20	
65	391396.0	6488192.5	53.5	147.1	-65.8	20	
66	391536.0	6488147.5	56.3	149.1	-12.0	20	
67	391684.3	6488132.3	59.8	144.4	0.9	20	
68	391827.7	6488115.1	59.0	144.5		20	
69	391971.2	6488098.0	63.9	144.3	-0.3	20	
70	392114.5	6488081.6	57.4	143.8		20	
71	392257.3	6488063.9	57.8	144.3		20	
72	392400.4	6488046.1	58.9	143.5		20	
73	392542.9	6488028.4	60.0	144.4	0.7	20	
74	392686.0	6488009.0	63.1	144.9	-0.2	20	
75	392829.6	6487989.8	62.3	143.5		20	
76	392971.9	6487970.9	61.6	145.9		20	
78	393116.5	6487951.6	60.8	142.2		20	
79	393256.8	6487928.1	60.0	137.7	79.6	20	
81	393259.0	6487790.5	60.7	137.9		20	
82	393261.3	6487652.5	61.4	145.0		20	
83	393263.7	6487507.6	62.2	146.6		20	
84	393266.0	6487361.1	63.0	144.5		20	
85	393268.4	6487216.5	63.7	144.5		20	
86	393270.8	6487072.0	64.5	146.6		20	
87	393273.1	6486925.5	65.2	144.5		20	
88	393276.4	6486781.1	66.8	145.7		20	
89	393285.3	6486635.6	78.6	140.7		20	
90	393293.8	6486495.2	75.9	141.2		20	
91	393302.4	6486354.3	74.4	149.1		20	
92	393290.6	6486205.6	71.9	149.2		20	
93	393291.6	6486056.4	72.2	149.8		20	
94	393292.6	6485906.6	72.2	150.1		20	
95	393293.5	6485756.5	71.5	149.7		20	
96	393294.5	6485606.9	70.8	150.0		20	
98	393295.5	6485456.9	70.2	114.8	-89.7	20	
99	393410.3	6485456.9	67.1	113.4		20	
100	393523.8	6485457.0	64.0	106.6	39.9	20	
101	393605.6	6485388.7	56.8	129.7	48.2	20	
103	393610.0	6485259.0	57.7	99.7	51.7	20	
104	393533.9	6485194.6	54.2	64.1	-48.3	20	
105	393532.3	6485130.5	54.7	101.8	43.7	20	
106	393460.1	6485058.7	54.0	148.9		20	
107	393311.2	6485057.4	56.2	144.3		20	
108	393167.0	6485056.2	58.4	144.5		20	
109	393022.5	6485055.0	60.6	147.8		20	
110	392874.7	6485053.8	62.8	141.3		20	
111	392733.5	6485052.6	55.5	139.5		20	
113	392594.0	6485051.5	52.5	127.7	-90.9	20	
115	392597.0	6484923.9	49.1	138.7		20	
116	392598.2	6484785.2	48.2	148.9		20	
117	392599.6	6484636.3	49.0	147.1		20	
118	392600.9	6484489.2	50.7	146.1		20	
119	392602.2	6484343.1	50.3	146.4		20	
120	392603.5	6484196.7	47.5	129.9	-0.2	20	
121	392605.0	6484066.8	48.8	134.5		20	
122	392606.6	6483932.3	47.8	131.8		20	
123	392608.1	6483800.5	46.8	117.8		20	
124	392609.5	6483682.7	47.1	132.2		20	

125	392611.1	6483550.5	47.4	142.7	0.9	20	
126	392610.6	6483407.8	45.9	132.5	22.3	20	
127	392559.8	6483285.4	46.1	132.1	2.0	20	
128	392505.0	6483165.3	46.2	132.8	-0.5	20	
129	392450.9	6483044.0	46.0	132.0	-0.5	20	
130	392398.1	6482923.1	45.9	132.7		20	
131	392345.0	6482801.5	45.5	136.0	1.6	20	
132	392287.1	6482678.4	46.7	129.9	-25.3	20	
133	392287.4	6482548.5	46.2	129.3	0.5	20	
134	392286.6	6482419.3	44.8	126.2	16.9	20	
135	392249.2	6482298.8	44.0	146.4	21.3	20	
136	392157.9	6482184.2	45.6	138.8	3.0	20	
137	392066.0	6482080.3	47.2	142.0		20	
138	391971.9	6481974.0	46.2	139.9	-1.1	20	
139	391881.2	6481867.4	47.2	141.6	73.8	20	
140	391752.0	6481925.5	46.7	148.4	8.4	20	Moved 1.5m to the north
141	391627.0	6482005.5	45.5	147.9	-0.3	20	Moved 5.5m to the north
142	391502.0	6482084.5	46.4	149.6	-5.0	20	Moved 10m to the north
143	391369.0	6482153.0	50.4	137.5	-1.4	23	
144	391245.3	6482212.9	53.1	136.1	-0.8	20	Moved 1m to the north
145	391122.0	6482270.5	53.3	137.1	-9.4	20	Moved 4m to the north
146	390990.0	6482307.5	52.0	136.5	-4.7	20	Moved 5.5m to the north
147	390856.0	6482333.5	53.2	134.1	-9.3	20	Moved 8m to the north
147a	390722.0	6482337.5	55.0	134.0	-0.4	20	Moved to the north side of Ocean Reef Road
148	390588.0	6482340.5	58.4	134.0	-2.1	20	Moved to the north side of Ocean Reef Road
149	390454.0	6482338.5	57.8	141.1	2.9	23	Moved to the north side of Ocean Reef Road
150	390313.0	6482343.5	62.6	139.1	0.0	20	Moved to the north side of Ocean Reef Road
151	390174.0	6482348.5	62.2	131.1	0.1	20	Moved to the north side of Ocean Reef Road
152	390043.0	6482353.5	63.2	131.1	-0.4	20	Moved to the north side of Ocean Reef Road
153	389912.0	6482357.5	61.2	137.3	2.0	20	Moved to the north side of Ocean Reef Road
154	389775.0	6482366.5	61.4	134.2	6.5	20	Moved to the north side of Ocean Reef Road
155	389643.0	6482390.5	63.6	125.2	-28.5	20	Moved to the north side of Ocean Reef Road
156	389524.0	6482351.5	66.7	138.2	38.0	20	Moved 22.5m to the south
157	389394.0	6482398.5	68.2	139.9	0.6	20	Moved 20m to the south
158	389263.0	6482447.5	71.7	137.1	1.9	20	Moved 20m to the south
159	389136.3	6482499.7	72.5	126.3	2.9	20	
160	389022.0	6482553.5	73.1	146.4	-5.7	20	Moved 1.5m to the south
161	388884.0	6482602.5	73.5	142.7	-3.3	20	Moved 4m to the south
162	388747.0	6482642.5	78.2	144.9	-4.7	20	Moved 5m to the south
163	388605.0	6482671.5	79.1	148.9	-5.4	20	Moved 4m to the south
164	388457.0	6482687.5	73.3	149.0	-6.2	20	Moved 3.5m to the south
165	388308.0	6482687.5	71.7	143.0	-1.2	20	Moved 3m to the south
166	388165.0	6482684.5	64.8	138.0	0.4	20	Moved 6m to the south
167	388027.0	6482682.5	56.6	138.0	0.8	20	Moved 7m to the south
168	387889.0	6482682.5	51.1	143.1	24.3	20	Moved 5.5m to the south
169	387758.6	6482741.4	47.6	137.9	-2.1	20	
170	387631.0	6482793.5	42.4	137.9	-0.7	20	Moved 2.5m to the south
171	387502.6	6482844.0	36.3	138.8	-5.8	20	
172	387369.0	6482881.5	32.6	100.2	-3.6	20	Moved 7m to the south
173	387271.0	6482902.5	32.2	85.7	-0.7	23	Moved 7.5m to the south
174	387187.0	6482919.5	30.3	81.6	56.8	30	Moved 5m to the south
175	387156.7	6482995.3	33.7	52.0	-2.7	18.5	
176	387214.0	6482897.5	33.4	32.8	-80.6	20	
177	387211.5	6482864.8	31.3	58.1	-31.1	20	
178	387237.6	6482812.9	32.5	66.4		17	
179	387264.8	6482752.3	31.2			20	
180	387135.1	6483042.6	33.7			20	



3

150m SPAN

CONDUCTOR	VENUS
UTS	20%
OHEW @90%	TRITON
M.O.T.	100°c

FOR TENDER PURPOSES ONLY

POLE CONFIG CODE: RUNHI150m#G
SHAFT RATING: 60/80/100/120/150/200/300kN
MODIFICATION: IN LINE OR TRANS. STAY
2.3m OR 2.6m CROSSARM,
TWIN HORIZONTAL JUMPER POST
D/C STRAIN/TERMINAL
WITH CROSSARMS, DOUBLE OHEW & HORIZONTAL JUMPERS
0-90° DEVIATION
3 20m MAX

POLE CONFIG CODE: RUNHI150m#G
SHAFT RATING: 60/80/100/120/150/200/300kN
MODIFICATION: IN LINE OR TRANS. STAY
2.3m OR 2.6m CROSSARM,
TWIN HORIZONTAL JUMPER POST
D/C STRAIN/TERMINAL
WITH CROSSARMS, DOUBLE OHEW & HORIZONTAL JUMPERS
0-90° DEVIATION
3 21.5m MAX

POLE CONFIG CODE: RUNVI150m#G
SHAFT RATING: 60/80/100/120/150/200/250/300/350/400/450/500kN
MODIFICATION: IN LINE OR TRANS. STAY
1.8m OR 2.1m OHEW ARM
2.3m, 2.6m OR 2.9m CROSSARM
D/C STRAIN/TERMINAL
WITH CROSSARMS, DOUBLE OHEW & VERTICAL JUMPERS
0-90° DEVIATION
3 23m MAX

REVISIONS

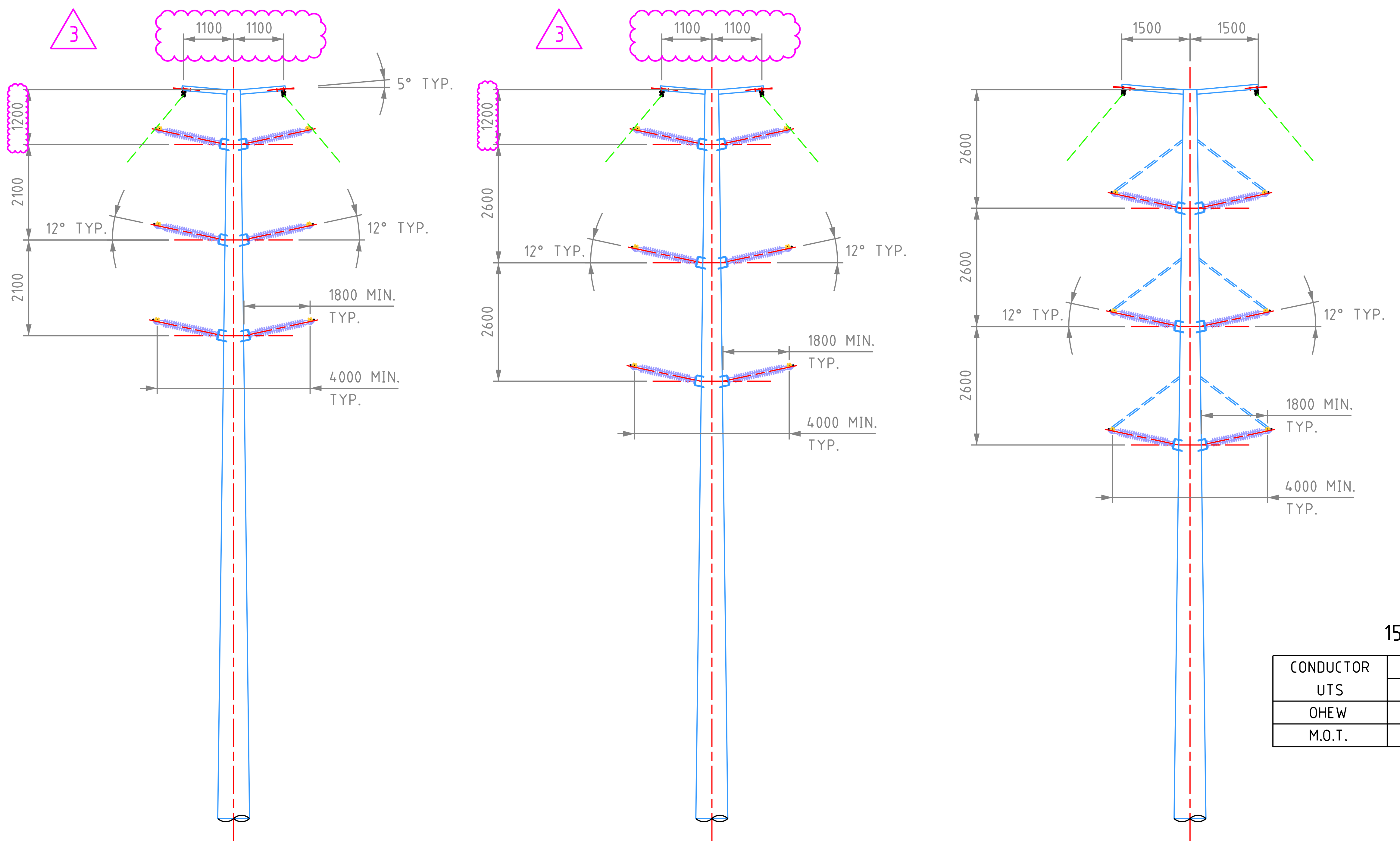
REV	DRN	DATE	CHKD	PROJ No.	DESIGN	EXMD	APPROVED	DESCRIPTION
2	E.D	11/17				S.L	L.B	ALT. JUMPER ARRANGED ADDED: SHAFT RATING & DEV ANGLE UPDATED; ISSUED FOR TENDER
3	H.C	02/22	M.L		J.S	S.L	A.S	CONDUCTOR DETAIL UPDATED: INSULATOR ARM ATTACHMENT HEIGHT UPDATED: OHEW ARM UPDATED: ISSUED FOR TENDER

STANDARD 132kV POLES
STRUCTURE - DETAILS
D/C STRAIN/TERMINAL
METRO 150m SPAN
POLE TOP GEOMETRY

westernpower

DRAWN: E.D	DATE: 10/12	DRG. No.	
CHECKED: S.R	DESIGNED: J.S	T5003/6/8/9/1	
EXAMINED: L.W			
EXAMINED:			
APPROVED: T.KRUGER		SCALE: NTS	NEXT SHT.
			REVISION: 3

A3



150m SPAN

CONDUCTOR	VENUS
UTS	20%
OHEW	TRITON @90% PHASE SAG
M.O.T.	100°c

POLE CONFIG CODE: RUNH150m0G
SHAFT RATING: 30/40/60kN
MODIFICATION: WIDE OR SLIM SHAFT
D/C SUSPENSION WITH DOUBLE OHEW
0-2° DEVIATION
20m MAX
3

POLE CONFIG CODE: RUNH150m0G
SHAFT RATING: 30/40/60kN
MODIFICATION: WIDE OR SLIM SHAFT
D/C SUSPENSION WITH DOUBLE OHEW
0-2° DEVIATION
26m MAX
3

POLE CONFIG CODE: RUN2H150m0G
SHAFT RATING: 30/40/60kN
MODIFICATION: WIDE OR SLIM SHAFT
D/C SUSPENSION WITH DOUBLE OHEW
0-2° DEVIATION
21.5m MAX
3

FOR TENDER PURPOSES ONLY

REVISIONS

REV	DRN	DATE	CHKD	PROJ No.	DESIGN	EXMD	APPROVED	DESCRIPTION
2	E.D	11/17			S.L		L.B	
3	H.C	02/22	M.L		J.S	S.L	A.S	OHEW ARM UPDATED: INSULATOR ARM ATTACHMENT HEIGHT UPDATED: POLE DESCRIPTION UPDATED: ISSUED FOR TENDER

STANDARD 132kV POLES STRUCTURE - DETAILS D/C SUSPENSION METRO 150m SPAN POLE TOP GEOMETRY

westernpower

DRAWN: E.D	DATE: 10/12	DRG. No.	T5003/6/8/8/1
CHECKED: S.R	DESIGNED: S.L		
EXAMINED: L.W			
EXAMINED:		SCALE: NTS	NEXT SHT.
APPROVED: T. KRUGER			REVISION: 3

A3

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The Power of Commitment