Ausconnex

Roberts Road Substation Augmentation Project

EMF Assessment Report

Document Record

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Issue Date	1 May 2026
Document Number	ZSE26272-01 R1

Revision History

Revision	Issue Date	Description
Revision 0	1 May 2026	Preliminary Issue
Revision 1	4 May 2026	Revised Station Loading

EXECUTIVE SUMMARY

Ausconnex have asked Zero Sequence Earthing (ZSE) to undertake electromagnetic field (EMF) assessment in relation to augmentation works at the Roberts Road Substation.

With consideration of the proposed augmentation works, this assessment has evaluated the prospective EMF levels in the area directly outside the south-west corner of the substation boundary. This area is directly above existing 132kV cables that are expected to experience an increase in load current and is considered representative of a 'worst-case' scenario for public exposure to EMF.

This study does not cover any equipment inside the substation or the proposed new data centre as these are not publicly accessible areas. Only electrical assets reasonably impacted by the proposed augmentation project have been included.

This study has computed Magnetic Flux Density (MFD) and Electrical Field Strength (EFS) levels and found them to be well below industry standard zoning EMF limits for public exposure.

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1 INTRODUCTION

Ausconnex have asked Zero Sequence Earthing (ZSE) to undertake electromagnetic fields (EMF) assessment of the proposed augmentation of the Roberts Road Substation as part of a DA approval.

The proposed augmentation project includes the installation of a new 132/11kV transformer and the upgrade of several others. There will be new 11kv circuits installed as part of the project, however ZSE has been advised that these new cables will transition directly to an adjacent data centre and will not be traversing publicly accessible areas.

The Roberts Road Substation is supplied via two 132kV circuits. It is expected that the proposed upgrade project will increase the loading on these circuits. Hence, this study will focus on the two 132kV circuits as they exit the substation and traverse publicly accessible land.

The EMF assessment has focussed on the following:

- Modelling of the key voltage sources (chiefly; 132 kV cables) creating Electric Fields, and plotting the Electric Field Strength (EFS) at 1 m above surface level, relevant to human exposure.
- Modelling of the key current sources (chiefly; 132 kV cables) creating Magnetic Fields, and plotting the Magnetic Flux Density (MFD) at 1 m above surface level, relevant to human exposure.
- Assessment of EMF (EFS and MFD) outcomes against ICNIRP (International Commission on Non-Ionizing Radiation Protection) guideline [9] for reference levels as they are consistent with ARPANSA's (Australian Radiation Protection and Nuclear Safety Agency) understanding of the scientific basis for the protection of people from exposure to EMF.

This study does not model any plant and equipment internal to the Roberts Road Substation or any aspect of the augmentation project aside from the two 132kV circuits supplying the substation as the focus is on areas of public exposure. It should be noted that the clearance distances of the high voltage equipment within the substation provide confidence that modelling of the cables only will yield the highest level of both EFS and MFD.

2 METHODOLOGY AND MODEL

This following sub-sections outline the overall methodology used to approach the analysis of Roberts Road Substation EFS and MFD.

2.1 CDEGS Software and Modelled Fields

The HIFREQ module of CDEGS [11] is used to model and analyse the fields.

In this document, EFS is discussed and reported as RMS and total resultant value in kV/m, and MFD is discussed and reported as the RMS and total resultant value in μT. As the magnetic fields are computed as a complete model, magnetic field strength itself is not discussed in this document; only the resultant magnetic flux densities are considered.

The fields calculated in this model are hypothetical, based on maximum load ratings of the 132 kV cables. Both voltage levels are modelled at over-voltage of maximum continuous 1.1 p.u.

Simplifications and approximations are made in the creation of the model where appropriate as a best endeavour approach to maintain computational efficiency and relevance to the result.

Computational profiles are established at a 1.0 m height about surface level, to provide for various analysis scenarios.

Results of the computed profiles are presented in Section 4 'Results' and compared to the limits presented in Section 3 'Zoning EMF Limits'.

2.2 Assessment Input Data

The following sub-sections outline the key details used in the analysis of the EFS and MFD.

2.2.1 11kV Cables

Ausconnex have advised that all new 11kV cables installed as part of this proposed project will remain within the Roberts Road Substation or transition directly to the adjacent Data Centre and will not transverse publicly accessible areas. Therefore, this EMF assessment does not need to extend to any 11kV cables.

2.2.2 132kV Cable Details

This study will focus on the two existing 132kV circuits supplying the Roberts Road Substation. These circuits are each comprised of three single phase 630mm^2 Cu single phase XLPE cables [1].

The EMF study be conducted on the south-west corner of the substation where the two x 132kV circuits leave the boundary of the substation and enter publicly accessible space as this is considered representative of the public exposure scenario.

The study will not cover assets within the boundary of the substation as these are not publicly accessible.

Figure 2-1 shows the area of study [2].

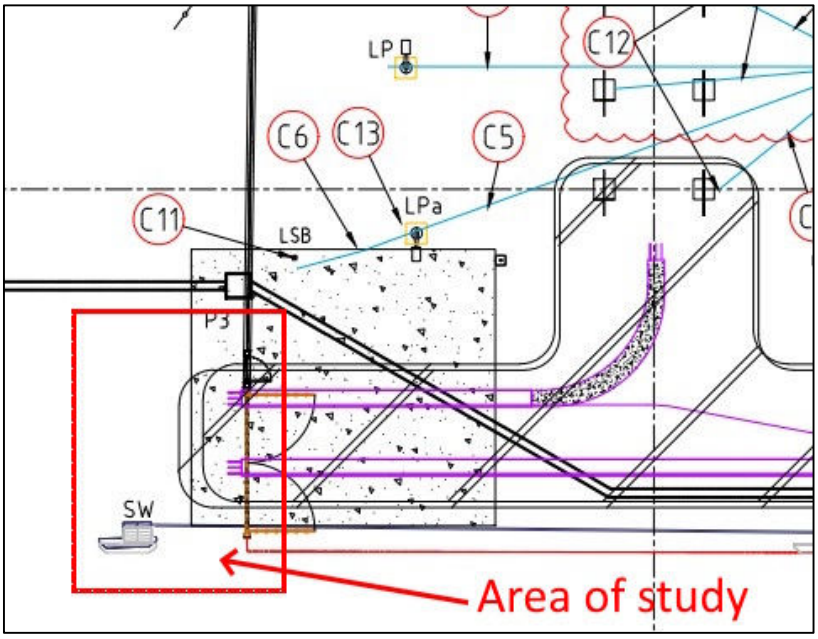

Figure 2-1 Area of EMF Study

As advised by Ausconnex the trenching profile and cable arrangement is taken as item 'T7' in [3]. Figure 2-2 shows the trenching model used in this assessment. Note, for conservatism a cable depth of 1200mm has been used.

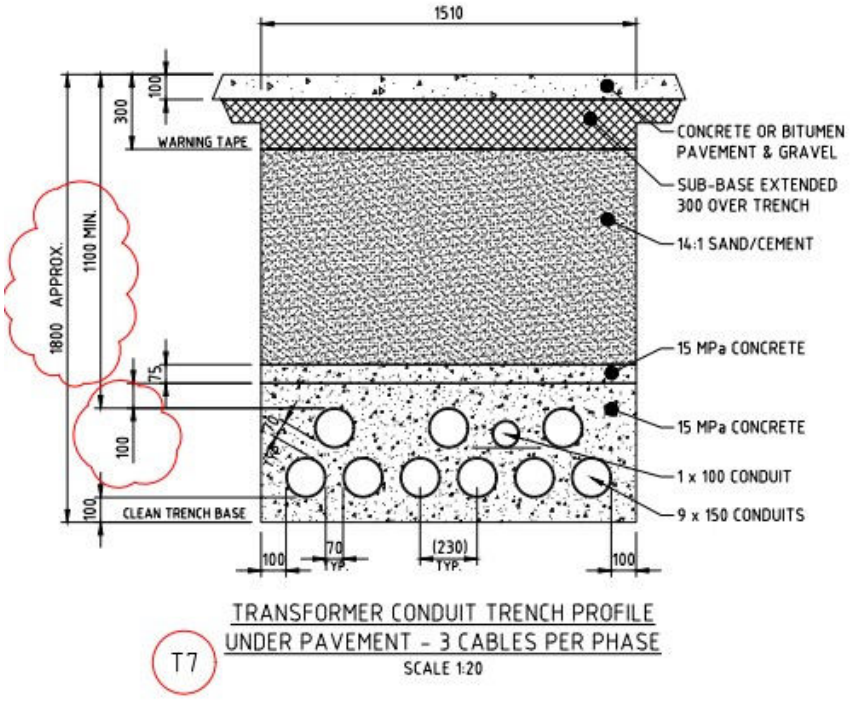

Figure 2-2 132kV Cable Trenching Arrangement Used In Model

2.2.3 132kV Cable Load Values – Steady State

Expected steady state load values for the 2 x 132kV circuits were not provided to ZSE. In consultation with Ausconnex, ZSE has considered loading based on the provided transformer ratings [1]. At the conclusion of the augmentation works the substation will house five 132/11kV power transformers totalling 300MVA of installed load capacity. This is calculated based on five 60MVA transformers.

Assuming each of the two 132kV circuits supplies 50% of the above total load the each circuit will carry 150MVA.

The single line diagram provided by Ausconnex [1] indicates a 132kV circuit summer rating of 160 MVA. For conservatism the greater value of 160MVA for each 132kV circuit is applied in this study. This equates to approximately 404A per cable.

The following inputs have been applied:

- A voltage energisation of 1.1 p.u
- Maximum voltage unbalance in the 132 kV system is conservatively modelled at 2% for no contingency event (Table S5.1a.1 of *National Electricity Rules*)
- Phases modelled as 0°, ±120°
- Maximum current unbalance in this 132 kV system is modelled at 2% (Section S5.3.6 of *National Electricity Rules*), resulting in slight deviations in phase current magnitudes around the nominal 404A and has been used to model MFD.

3 ZONING EMF LIMITS

ARPANSA advice the ICNIRP guideline [9] for reference levels as they are consistent with ARPANSA's understanding of the scientific basis for the protection of people from exposure to EMF. These reference levels are as presented in Table 3-1, for design compliance.

Table 3-1: Zoning EMF Limits

Exposure characteristic	Electric Field Strength	Magnetic Flux Density
Occupational exposure	10 kV/m	1,000 μT
Public exposure	5 kV/m	200 μT

Only public exposure limits are considered in this report as the site cannot be defined under occupational exposure.

4 RESULTS

Results of the computed profiles are presented in the following Section 4.1 'Electric Field Strength' and Section 4.2 'Magnetic Flux Density' and compared to the limits presented in Section 3 'Zoning EMF Limits'. A summary of the results is presented in Section 4.3 'Results Summary'.

4.1 Electric Field Strength

This section presents analysis of the EFS at 1.1 p.u. voltage.

Figure 4-1 plots the EFS at the plane 1 m above surface level, in a two-dimensional plot. The electric fields above the 132kV cables in the area of study are well within the public exposure limit of 5 kV/m, with values well below 1 kV/m.

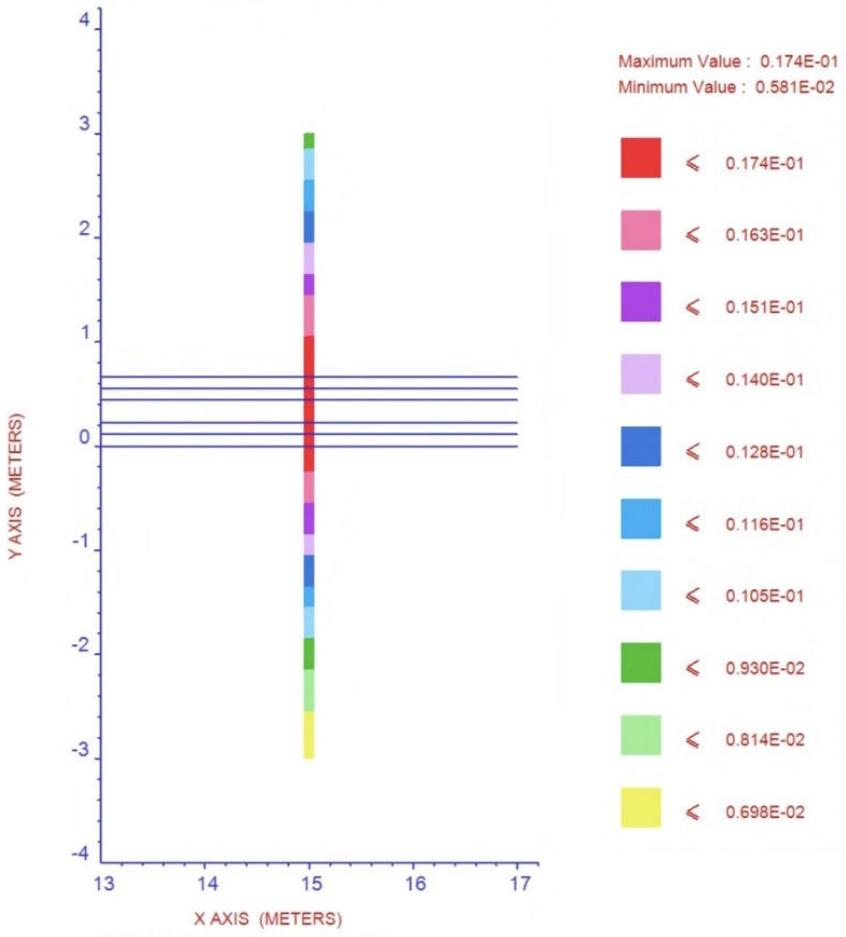

Figure 4-1: Two-dimensional plot of EFS (V/m)

4.2 Magnetic Flux Density

This section presents analysis of the MFD at maximum current ratings. Figure 4-2 presents the MFD as a two-dimensional plot. The MFD in the area of study is well within the normal operating reference level of 1,000 μT, with values well below 100 μT.

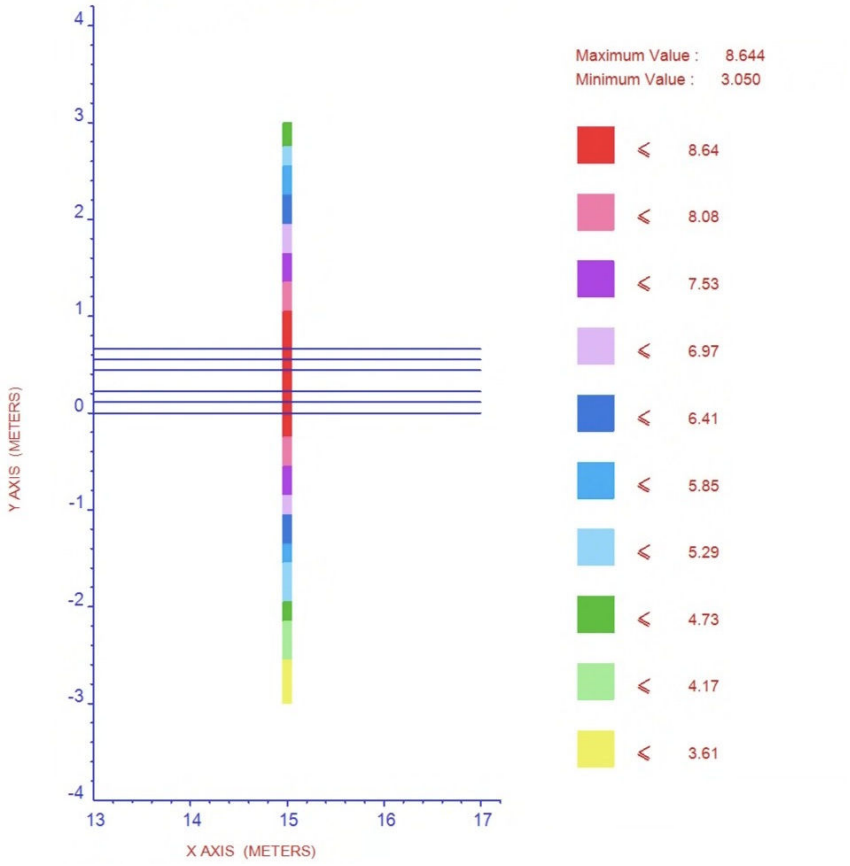

Figure 4-2: Two-dimensional plot of MFD (μT)

4.3 Results Summary

Computed EFS and MFD and the corresponding 'Zoning EMF Limits' in the publicly accessible area outside of the Roberts Road Substation above the 132kV cables are summarised in Table 4-1.

Table 4-1: Results Summary

Exposure characteristic	Magnetic Flux Density Limit	Magnetic Flux Density Computed
Electric Field Strength	5 kV/m	< 1 V/m
Magnetic Flux Density	200 μT	< 10 μT

5 CONCLUSIONS

Results are summarised in Section 4.3 'Results Summary' for EFS and MFD. It was found that EFS and MFD are well below the reference levels in the area directly outside the substation above the two 132kV circuits. This location is the worst-case scenario for public exposure to EMF from substation assets. It should be noted that the clearance distances of the high voltage equipment within the substation provide confidence that modelling of the cables only will yield the highest level of both EFS and MFD.

6 REFERENCES

Project Information

[1] Drawing, SKETCH-STAGE 5, Rev A1, Roberts Road Substation Stage 5-2 (option 2) Proposed Single Line Diagram, 13/01/2026, AUSCONNEX

[2] Drawing, RR-C-SM01, Rev K, Roberts Road Zone Substation Conduit Plan, 10/06/202, AUSCONNEX

[3] Drawing, RR-C-SM02, Rev E, Roberts Road Zone Substation Conduit Trench Profiles and Details, 11/06/2020, AUSCONNEX

[4] Drawing, GA Stage 5, Roberts Road Zone Substation Site Plan Proposed General Arrangement, 5/12/2025, AUSCONNEX

Australian Standards and Guides

[5] Energy Networks Australia EMF Management Handbook, 2016

International Standards and Guides

[6] IEEE 644 2008, Standard Procedures for Measurement and Power Frequency Electric and Magnetic Fields from AC Power Lines

[7] IEEE C95.6 2002, Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz; IEEE International Committee on Electromagnetic Safety on Non-Ionising Radiation

[8] EN 50499 2008, Procedure for the assessment of the exposure of workers to electromagnetic fields; Technical Committee

[9] Published in Health Physics 99(6):818-836; 2010, International Commission on Non-Ionizing Radiation Protection Guidelines, For Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz – 100 kHz), 2010

[10] IEC 62110 2009, Electric and Magnetic Fields generated by AC Power Systems – Measurement Procedures with regards to public exposure

Software

[11] CDEGS, v20.0.22811, SES Technologies