Appendix G. Electric and Magnetic Fields Assessment

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Subject	**EMF Assessment for the 33kV Grid Connection OHL**		
Client	Vales Point Solar Farm	**Date**	18 October 2017
Project	Vales Point Solar PV - EIS		
Project No.	IA155900	**File**	IA155900_06_MEMO-EMF assessment_Final
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1. Summary

The assessment of the exposure to any person to electromagnetic fields (EMF) associated with the 33kV connection feeder (overhead line) from the Vales Point Solar PV to Ausgrid's Vales Point Zone Substation show that the exposure will be well below the ICNIRP 2010 reference levels for occupational category for both electrical and magnetic fields.

2. Scope and context for assessment

Item	Description
Task Summary	Qualitative assessment of the electromagnetic fields (EMF) associated with the 33kV connection feeder (overhead) from the Vales Point Solar PV to Ausgrid's Vales Point Zone Substation.
Assumptions	The following have been assumed as basis to undertake the work: · The desktop assessment is made in accordance with the ENA EMF Management Handbook dated January 2016; (http://www.ena.asn.au/sites/default/files/emf_handbook_2016_02.pdf) · Exposure limits identified by ICNIRP (2010) are used as reference; · EMF fields associated with the solar farm or Ausgrid substation are not considered as it is expected that the EMF fields will be managed using standard designs that result in very low fields at the boundary/fence-line of the farm / substation (public only has access up to the fence-line); and · The assessment considers the 50Hz voltage and current. Consideration of Radio Frequency Interference (RFI) and Audible Noise (AN), or any high-frequency noise associated with AC/DC converters has not been considered.

3. Design information

Item	Description
Input(s)	1. Relevant engineering details (e.g. site layout, operating voltage and maximum operating current etc.) 2. Connection feeder design properties – Jacobs has assumed a 33kV feeder design in accordance with Ausgrid's design standards.

3.1 Engineering details

The following information was obtained from the client:

· Solar farm maximum export to grid: 55MW

- Feeder voltage: 33kV
- Feeder design: single circuit overhead line
- Feeder route: refer figure below

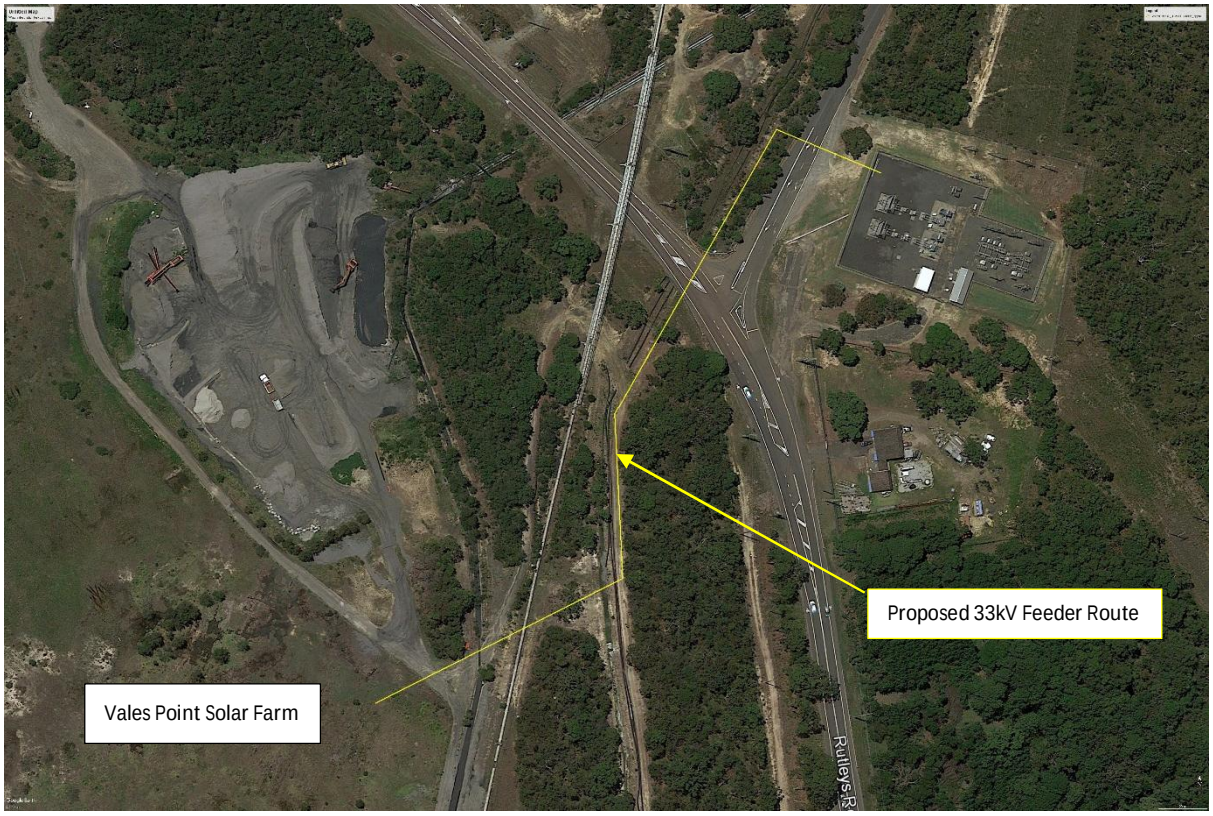

Figure 1 : Proposed 33kV feeder route for the grid connection of Vales Point Solar Farm

The solar farm is expected to be operated at near unity power factor, resulting in a maximum export of 55MVA, or 960A current load at a voltage of 33kV.

3.2 Feeder design properties

It is assumed that the 33kV feeder will be constructed using timber, steel or concrete poles with the phase conductors in a vertical arrangement to reduce the easement width requirement. A 33kV overhead line easement width is typically 10m to 20m wide[1]. An easement width of 15m (+/-7.5m off line centre) has been assumed for the proposed overhead line.

A phase conductor arrangement similar to Ausgrid's standard design drawing No. 185418, with 1.5m vertical separation between phase conductors and a minimum clearance to ground of 7.5m and an average conductor height of the lowest conductor of 8.5m.

[1] AS/NZS 7000 Overhead line design – Detailed procedures

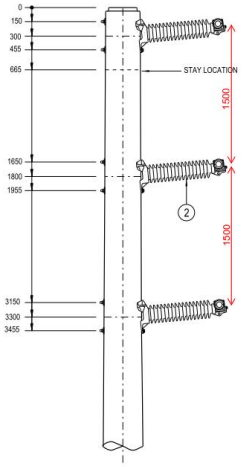

Figure 2 : Typical pole top phase conductor arrangement

4. EMF assessment

4.1 ICNIRP exposure reference levels

The exposure 'limits' commonly referred to with regard to exposure to electric and magnetic fields are formally known as Reference Levels. These Reference Levels have been determined so as to provide a practical tool of assessment whilst maintaining adequate safety margins to potential health effects. Following extract from the ENA handbook describes the relationship between the Reference Levels and the Basic Restriction levels determined based on biological effects:

Basic restrictions are the fundamental limits on exposure and are based on the internal electric currents or fields that cause established biological effects. The basic restrictions are given in terms of the electric fields and currents induced in the body by the external fields. If Basic Restrictions are not exceeded, there will be protection against the established biological effects.

The Basic Restrictions include safety factors to ensure that, even in extreme circumstances, the thresholds for these health effects are not reached. These safety factors also allow for uncertainties as to where these thresholds actually lie. The physical quantity used to specify the Basic Restrictions is the tissue induced electric field.

The Basic Restrictions in the ICNIRP Guidelines are specified through quantities that are often difficult and, in many cases, impractical to measure. Therefore, Reference Levels of exposure to the external fields, which are simpler to measure, are provided as an alternative means of showing compliance with the Basic Restrictions.

The Reference Levels have been conservatively formulated such that compliance with the Reference Levels will ensure compliance with the Basic Restrictions. If measured exposures are higher than Reference Levels then a more detailed analysis would be necessary to demonstrate compliance with the Basic Restrictions.

ICNIRP identifies two Reference Levels for EMF fields based on whether the exposure is in regard to general public or occupational. Considering the proposed feeder route Jacobs believes it is justified to adopt the occupational Reference Levels.

Table 1 : ICNIRP Reference Levels – Occupational

EMF field	ICNIRP 2010 (Occupational)
Electric field	10 kV/m
Magnetic field	1,000 µT *
* ICNIRP advises that this level may be exceeded under certain conditions.	

4.2 Assessment – magnetic field exposure

The source of magnetic field is the current flowing through a conductor. The magnetic field decreases with the distance from the conductor. In a three phase system the individual phase currents are separated by a phase angle of 120°. This means that in an ideal three-phase system with the three conductors infinitesimally close to each other, the instantaneous sum of the magnetic field arising from the three phase currents is zero. In reality the physical separation of the phase conductors in a three phase overhead line, and small variations in individual phase currents, yields a resulting magnetic field.

The assessment methodology described in the ENA EMF Management Handbook is based on the British Standard BS EN 50499 – Procedures for the assessment of workers due to electromagnetic fields. This methodology derives a minimum compliance distance for people at which the exposure is equal to the ICNIRP reference level, i.e. if people are further away their exposure is below the Reference Levels. The methodology is based on the current flowing in a single conductor but may be conservatively applied also to three-phase conductor arrangements.

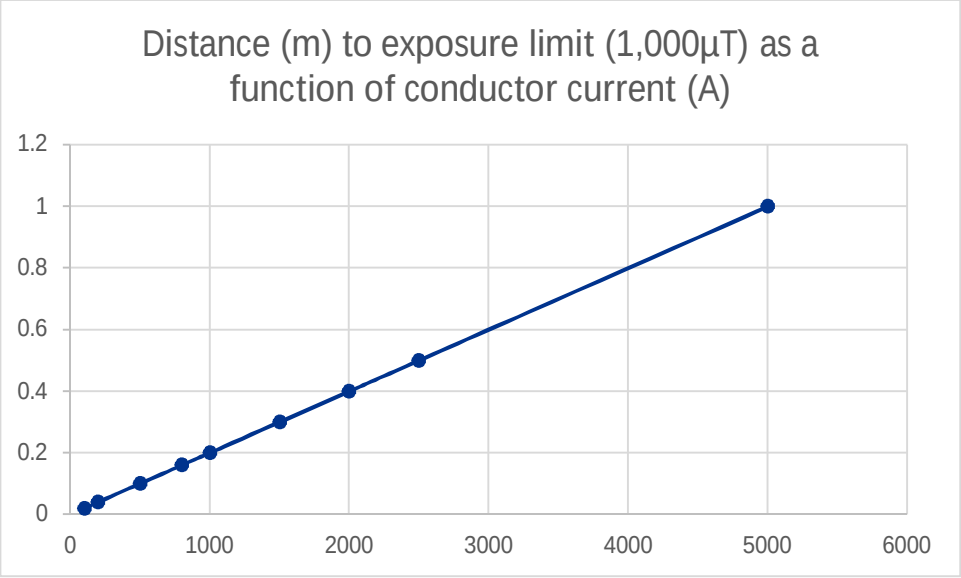

Figure 3 : Minimum compliance distance to the centre of a single conductor (ICNIRP Reference Level – Occupational)[2]

Given the expected current loading of 960A for the 33kV feeder, the resulting compliance distance will be less than 0.2m. The exposure to any people at ground level will thus be below the ICNIRP reference limit for magnetic field.

[2] From ENA EMF Management Handbook

4.3 Assessment – electric field exposure

The electrical field emanating from a power line conductor depends on the operating voltage of the line, and similarly to the magnetic field, deceases with increased distance from the conductor. The individual phase fields will also cancel each other out in an ideal three phase system with the three conductors infinitesimally close to each other. In reality the physical separation of the phase conductors, and small variations in individual phase currents, yields a resulting electric field.

Overhead power lines with voltages above 200kV may under some circumstances result in electrical fields in excess of the reference limits[3]. It is therefore unthat the electrical field arising from the proposed 33kV feeder will not exceed the ICNIRP reference levels.

[3] ENA EMF Management Handbook