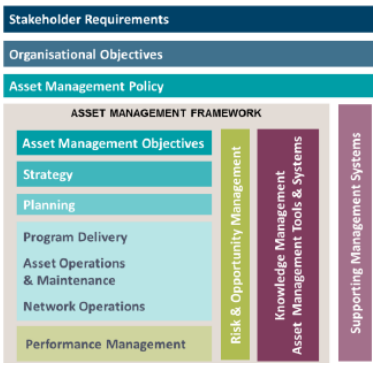
Transmission Line Easement and Clearance Requirements

Design Standard



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Record of endorsement, approval, stakeholders, and notification list is provided in EDM# 34333251 appendix

RESPONSIBILITIES

Western Power's Engineering and Design Function is responsible for this document

CONTACT

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Contents

Revision Details

Version	Date	Summary of change
0	02/03/2017	Initial release
1	14/05/2021	New template and updated standard
2	30/10/2023	Change to AMS format

1. Introduction

Easements on transmission lines are required for the purpose of managing activities that may lead to a contravening of safety standards and allows protection and safe access to the network.

Easements registered on a property acts as an early warning system to landowners and developers to engage with Western Power to ensure no public or asset safety is compromised.

In the absence of a registered easement, Western Power uses the term “safety clearance zone”. The safety clearance zone is a distance defined by the line voltage, current rating, distance between poles, pole height and deflection and is calculated on a case-by-case basis in line with AS/NZS 7000.

Easements and clearances on all transmission lines shall be verified by means of calculations.

1.1 Purpose and scope

This standard specifies the factors affecting easement widths and its calculation.

1.2 Acronyms

Acronym	Definition
Pa	Pascal (unit)
kV	Kilovolt (unit)

1.3 Definitions

Term	Definition
Easement	A type of interest that has been registered over a parcel of land. It provides the holder of the easement the right to use the land for a particular purpose even though they do not own the land. It provides a ‘right of way’, allowing Western Power workers to access, maintain and refurbish electrical infrastructure on private property.
Electrical clearance	A safe distance from electrical equipment/infrastructure.
Support Structure	General term for different structure types that support the conductors of the overhead electrical line.
Safety clearance zone	Used in the absence of a registered easement to describe the area adjacent to a power line within which AS/NZS 7000 clearance restrictions must be observed.

1.4 References

References which support implementation of this document

Table 1.1 References

Reference No.	Title
AS/NZS 1170.2:2011	Structural Design Actions – Wind Actions
AS 3818.1-2009	Timber – Heavy structural products – Visually graded. Part 1: General Requirements

AS/NZS 7000:2016	Overhead Line Design-Detailed Procedures
	Work Health and Safety (General) Regulations 2022

2. Safety in Design

The transmission line easement and clearance requirements must consider all safety aspects that can arise from the construction, operation, maintenance and decommissioning of the transmission line and other activities within the line corridor.

The Transmission Line Easement and Clearance Requirement Hazard Management Register (HMR)[1] captures and document what risks have been controlled by this standard, and what residual risks may remain that should be considered at the project design stages and construction.

3. Transmission Line Easement

An easement width is calculated as a distance measured both side from the centre line of the overhead power line. It is always parallel sided and should be at least equal to:

2 x (support structure deflection + blowout + safety clearance) + distance between outer conductors

Where:

Support Structure deflection: greatest horizontal distance at tip of structure to the undeformed position of the tip of the structure which shall include lateral movement for short duration at serviceable wind and sustained deflection such as creep and foundation rotation.

Blowout: greatest horizontal distance the conductor of the longest span in the section moves under wind conditions. Insulator swing needs to be included when there are insulator strings used on suspension structures.

Safety Clearance: minimum clearance from electrical conductors to any non-electrical infrastructure such as structures and buildings as stipulated in AS/NZS 7000.

Distance between outer conductors: greatest horizontal separation between outer conductors on the support structure in still air.

[1] Refer to Western Power's internal document

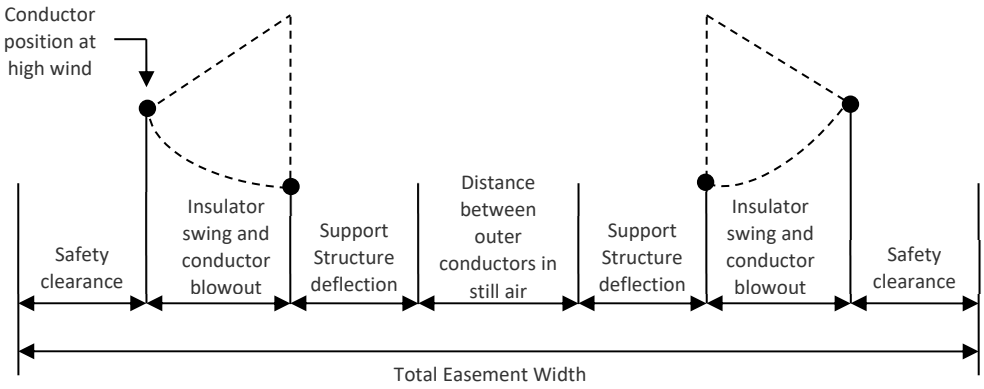


Figure 3.1: Components of Easement Width

3.1 Support Structure Deflection

Support structure deflection is taken as the lateral movement of the support structure under serviceable wind pressure of 500 Pa[2].

It is measured from the tip of the structure to the undeformed position of the tip of the structure.

3.1.1 Timber, Steel and Concrete Pole Deflection

The total deflection of a pole is a combination of both:

- Elastic - wind loading on structure
- Non-elastic deflection - foundation rotation (Appendix A.2) and creep/warping/shrinkage of timber poles.

Table 3.1: Timber Pole (Overall Height up to 21.5m) Deflection

Timber Pole[3]	Soil Condition[4]		
	Soft/Loose	Firm/Medium	Stiff/Dense
Total deflection[5]	1.8 m	1.4 m	1.2 m

[2] The serviceable wind pressure of 500 Pa only applies to areas in region A (all terrain categories) and region B (terrain categories 1 and 2 only) as defined in AS/NZS 1170.2. For other regions and terrain categories, the serviceable wind pressure shall be derived from a 50 year return period and an averaging time of 5 minutes.

[3] Pole degradation factor of 0.9 has been applied based on the pole diameter at the ground line. The pole shall be strength group S3 (according to AS 3818.1) or better as per T5000 standard requirement.

[4] Soil properties as defined in Table L1 and L2 of AS/NZS 7000 for cohesive and non-cohesive soils.

[5] Total deflection is based on the maximum allowable non-elastic deflection of 0.55 m. Timber poles with non-elastic deflection greater than 0.55 shall be considered as operating beyond its serviceability limit state and shall be rectified. For steel/concrete poles, the serviceability limit is 2 % of its effective pole length.

Table 3.2: Steel/Concrete Pole Deflection

Steel/Concrete Pole	Soil Condition[3]		
	Soft/Loose	Firm/Medium	Stiff/Dense
Fixity Point	½	⅓	200 mm [6]
Non-elastic deflection (*Degree of foundation rotation*	1 º	0.5 º	0.5 º
Elastic deflection (*wind*)	3 % of pole effective length (Appendix A.3)		
Total deflection	**Non-elastic plus elastic deflection**		

[6] For steel/concrete poles in good soil, the point of foundation rotation shall be taken as 200 mm below ground level. This shall also apply to all caisson foundation, irrespective of soil condition.

3.1.2 Soil Condition

The firm/medium soil condition is a good representation of the typical soil encountered in Western Australia.

When determining the pole deflection, the criteria in Table 3.3 shall apply.

Table 3.3:Criteria for Determining Pole Deflection

Calculation Type	Soil Condition
Easement	Firm/Medium
Clearance	Actual Soil Condition

For clearance calculation, actual soil condition shall be considered. Where soil condition is identified to be soft/loose and the easement/clearance calculation is still within the allowable limit, then no further works is required. However, if it fails, then calculation based on improved soil condition shall be conducted with remedial works to improve the soil (should it satisfy the electrical clearance requirement) to occur prior to construction of the structure proposed to be located within the easement.

3.1.3 Steel Tower Deflection

For steel towers, the total maximum horizontal deflection shall be in accordance with Table 3.4.

Table 3.4: Steel Tower Deflection

Steel Tower Height	Total Deflection
Less than 35 m	0.5 m
Between 35 - 70 m	1.0 m

3.1.4 Stayed Support Structure

For any stayed support structure, the total maximum horizontal deflection shall be half the value of the un-stayed support structure. This is only applicable to stays under tension in the opposite direction (up to 15°) and attached to at least half the structure's height above ground.

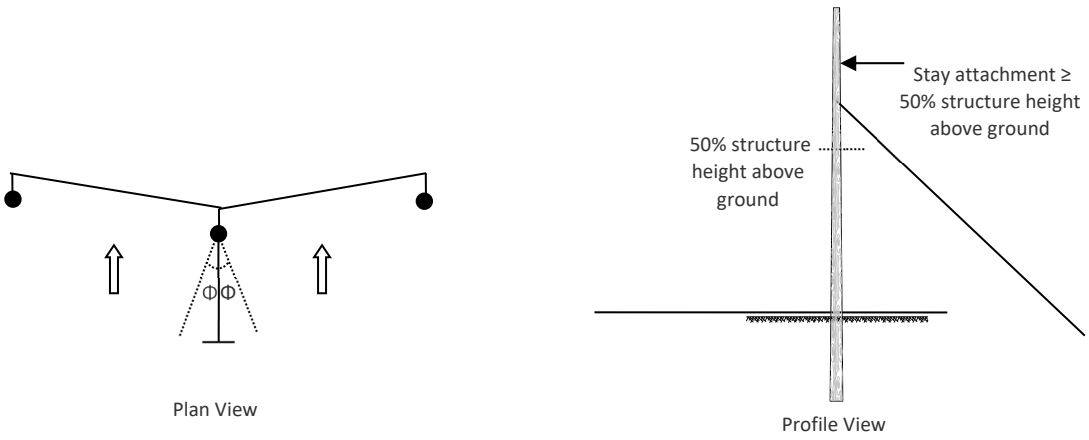


Figure 3.2: Effective Stay Configuration (Φ ≤ 15°)

3.2 Blowout

Blowout calculations for conductor (and insulator where required) shall be based on the following:

1) Conductor temperature 40 °C
2) Sag (including elongation due to wind)
3) Serviceable wind pressure of 500 Pa[7]

The method to determine the conductor blowout and insulator swing shall be in accordance with Appendix Q of AS/NZS 7000 or by using numerical analysis.

3.3 Safety Clearance

The safety clearance is taken as the horizontal electrical clearance required for the nominal voltage of the circuit according to AS/NZS 7000, Table 3.7.

Table 3.5: Horizontal Safety Clearances

33 kV < U ≤ 132 kV	3.0 m
132 kV < U ≤ 275 kV	4.5 m
275 kV < U ≤ 330 kV	5.0 m
330 kV < U ≤ 500 kV	6.0 m

3.4 Typical Transmission Line Easement Width

Registered easement shall be based on the calculated easement width.

[7] The serviceable wind pressure of 500 Pa only applies to areas in region A (all terrain categories) and region B (terrain categories 1 and 2 only) as defined in AS/NZS 1170.2. For other regions and terrain categories, the serviceable wind pressure shall be derived from a 50 year return period and an averaging time of 5 minutes.

For information on a range of typical easement width, refer to Western Power's internal document (reproduced in Appendix A.1 for ease of reference).

4. Clearances from Non-electrical Structures

The minimum electrical clearances from non-electrical structures set by AS/NZS 7000 (Figure 3.10 and table 3.7) is calculated from the point of the worst conductor swing or the maximum conductor sag, whichever governs. It shall be measured to the actual non-electrical structure's location within the span/s.

In addition to the minimum safe distances, consideration to allow for the encroachment shall also consider issues arising from induced voltages, electromagnetic fields and access for maintenance and construction.

5. Work Health and Safety Regulations

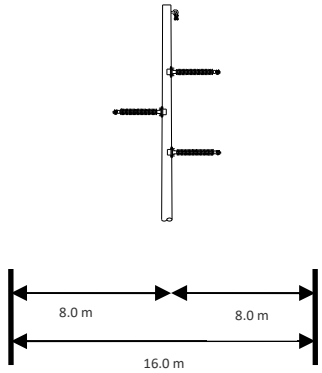
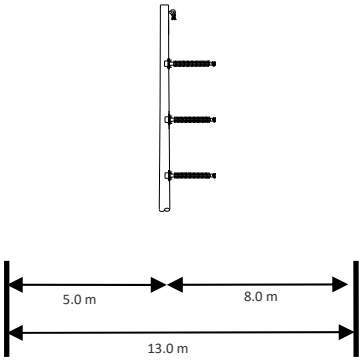
The minimum clearance requirements set by AS/NZS 7000 is the minimum electrical clearances to non-electrical structures. It does not apply to people, plant or materials used or working near the vicinity of overhead power lines. For this, section 166a of the Western Australian Work Health and Safety (General) Regulations 2022 stipulates a 6.0 m danger zone from the live overhead power line of a voltage exceeding 33 000 volts which must be kept clear.

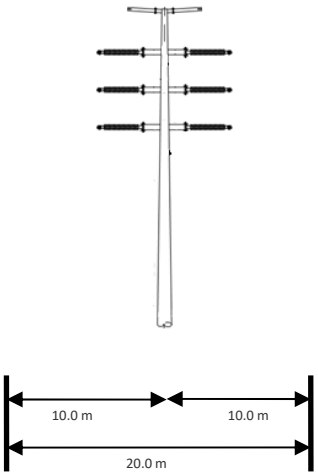
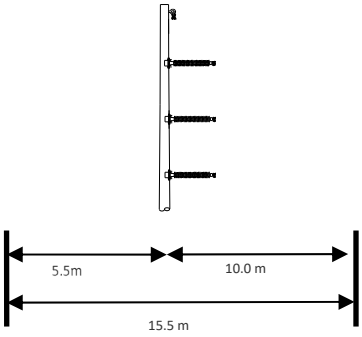
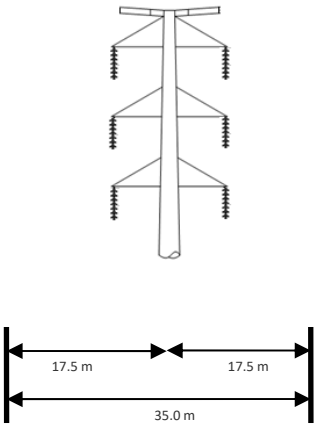
6. Transmission Power Cable Easement

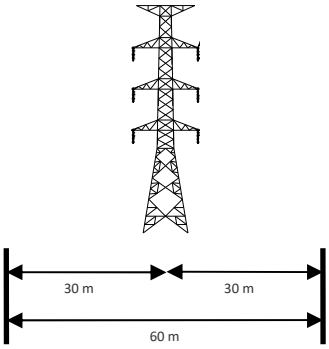
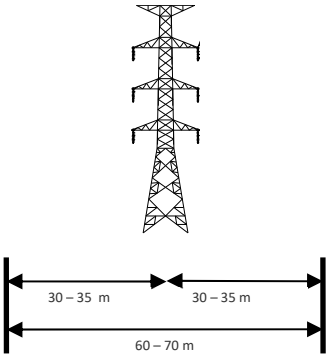
Easements for transmission power cable shall be a minimum width of 3 m from the outermost cables of the circuit or circuits.

Appendices

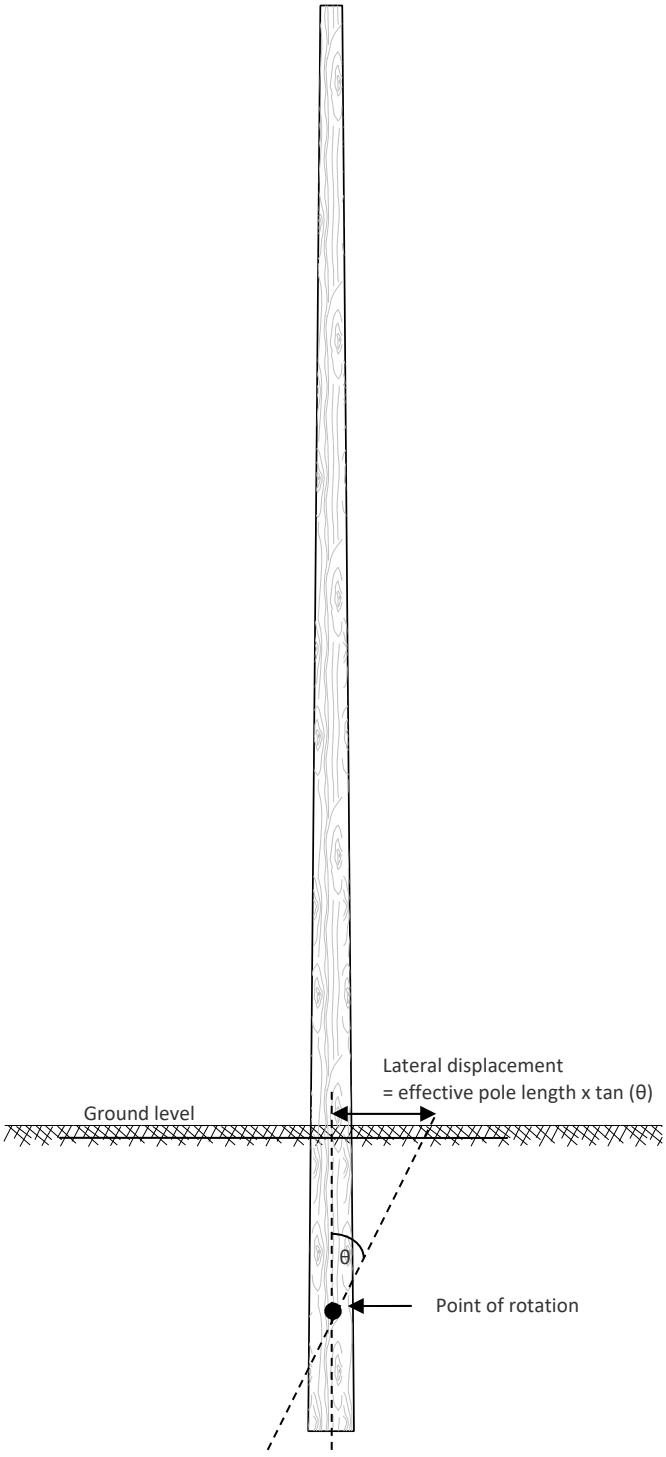
A.1 Typical Overhead Transmission Line Easement Width

Circuit Type	Typical Easement Width	Illustration
Metropolitan 66 kV and 132 kV wood pole line	16.0 m (based on T5000 standard firtree wood pole configuration)	
	13.0 m (based on T5000 standard running post wood pole configuration)	

Circuit Type	Typical Easement Width	Illustration
Metropolitan 66 kV and 132 kV steel/concrete pole line	20.0 m (based on T5003 standard double circuit steel pole configuration)	
	15.5 m (based on T5003 standard running post steel pole configuration)	
Country 66 kV and 132 kV steel/concrete pole line	35.0 m (based on T5003 double circuit steel pole configuration)	

Circuit Type	Typical Easement Width	Illustration
220 kV line	60 m	
330 kV line	500 m span – 60 m 600 m span – 70 m	

A.2 Foundation Rotation



A.3 Pole Effective Length

A pole's effective length is determined by:

$$Pole\ Effective\ Length(m) = L + F \times embedment\ depth$$

where *L* is the pole height above ground

F is the % embedment depth to the point of rotation (fixity point).