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Discipline
Engineering Standard - NSW

Category
Electrical

Title
**Electrical Power Equipment - Design Ranges
of Ambient Conditions**

Reference Number
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Document Control

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About This Standard

This document sets out the ranges of ambient conditions within which electrical equipment used on the ARTC high voltage and traction networks shall be designed to operate. It is recognised that extreme weather events may result in conditions outside the ranges set out in this document. Designing for extreme excursions is not economically viable and under such conditions degraded performance may result or it may be necessary to limit the load on the equipment or shut the equipment down in order to protect it from damage. Such occurrences should not be seen as failures of the equipment.

The release of this document does not affect the operation or maintenance of existing electrical equipment in the ARTC high voltage or traction network. Where existing equipment is modified, re-located or re-housed the requirements of this standard shall be applied.

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1.2	11/03/2005	Disclaimer	Minor editorial change

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1 Scope and Application

This document sets out the ranges of ambient conditions within which electrical equipment used on the ARTC high voltage and traction networks shall be designed to operate. It is recognised that extreme weather events may result in conditions outside the ranges set out in this document. Designing for extreme excursions is not economically viable and under such conditions degraded performance may result or it may be necessary to limit the load on the equipment or shut the equipment down in order to protect it from damage. Such occurrences should not be seen as failures of the equipment.

The release of this document does not affect the operation or maintenance of existing electrical equipment in the ARTC high voltage or traction network. Where existing equipment is modified, re-located or re-housed the requirements of this standard shall be applied.

2 References

The following documents are either referenced in this standard or can provide further information.

2.1 ARTC Engineering Standards

EP 03 01 40 00 SP	Rectifier Transformer (RailCorp publication)
EP 20 10 00 01 SP	1500 Volt DC Cable Ratings (RailCorp publication)
EP 08 00 00 01 SP	Overhead Wiring Standards for the Electrification of New Routes (RailCorp publication)
PDS 19	Transmission Line Current Ratings & Standard Conductors
PDS 20	Transmission Line Standard for Design and Construction

2.2 Australian Standards

AS1939	1990	Degrees of protection provided by enclosures for electrical equipment (IP Code).
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2.3 Definitions

Nil

3 Design Ranges of Ambient Conditions for Outdoor Equipment

3.1 Auxiliary equipment located near heat emitting equipment.

The following design conditions are appropriate for instrumentation, monitoring and control equipment located where the ambient temperature will be elevated due to heat emitted by major plant such as power transformers. Examples of equipment to which these conditions apply include tap changer controllers, cooling fans and controllers, and buchholz relays.

Ambient Air Temperature:	-5 ⁰ C ^[1] to 50 ⁰ C ^[1]
Humidity:	<i>Not yet determined to 95%</i> ^[1]
Solar radiation:	1000W/m ²
Wind speed:	For maximum temperature condition assume 0km/h
IP rating	IP65

3.2 Oil Cooled equipment

The following design conditions are appropriate for transformers, reactors and other equipment, either ONAN or ONAF.

Ambient Air Temperature for equipment rating:	-5 ⁰ C ^[1] to 40 ⁰ C ^[1]
Ambient Temperature for conservator sizing:	-5 ⁰ C ^[1] to 40 ⁰ C ^[1]
Humidity:	Not applicable
Solar radiation:	1000W/m ²
Wind speed:	For maximum temperature condition assume 0 km/h

3.3 Overhead Lines

The following design conditions are appropriate for overhead lines.

Note that the maximum ambient temperatures stated are likely to be exceeded once in a 5 year period.

3.3.1 General

The following conditions relate to both the Eastern and Western Zones.

Humidity:	Not Applicable
Wind pressure for determining horizontal clearance (blow out):	500Pa ^[5]
Wind pressure for determining vertical (ground) clearance:	0Pa
Concurrent conditions for determining conductor temperature	Maximum temperature, maximum solar radiation, and minimum wind speed.

3.3.2 Eastern Zone

East of Granville and Glenbrook to Wallerawang

Ambient Air Temperature for determining sag:	-5 ⁰ C to 39 ⁰ C ^[4]
Solar radiation:	1000W/m ² ^[4]
Wind speed for determining conductor temperature:	0.4m/s ^[4]

3.3.3 Western Zone

Granville to Glenbrook, Richmond & Campbelltown

Ambient Air Temperature for determining sag:	-5 ⁰ C to 42 ⁰ C ^[4]
Solar radiation:	1000W/m ² ^[4]
Wind speed for determining conductor temperature:	0.25m/s ^[4]

3.4 OHW

The following design conditions are applicable for overhead wiring installed in the open and also in tunnels. Due to local variations the conditions for overhead wiring installed in the open have been determined separately for five defined areas.

Note that the maximum ambient temperatures stated are likely to be exceeded once in a 5 year period.

3.4.1 General

Humidity:	Not Applicable
Wind speed for determining sag at design temperature:	0km/h
Wind speed for determining blow out:	130km/h (regulated OHW) 80km/h (fixed anchored OHW)
Concurrent conditions for determining conductor temperature	Maximum temperature, maximum solar radiation, and minimum wind speed.

3.4.2 Area 1

The following design conditions are applicable for overhead wiring installed in all areas east of Lidcombe, Sefton, East Hills, including to Newcastle & Wollongong.

Minimum ambient air temperature:	-5°C ^[3]
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Morning

Maximum ambient air temperature:	28°C
Solar radiation:	580W/m ²
Minimum wind speed for determining conductor temperature when calculating sag:	0ms ⁻¹

Midday and afternoon

Maximum ambient air temperature:	39°C	
Solar radiation - midday:	1000W/m ²	
Solar radiation - afternoon:	650W/m ²	
Minimum wind speed for determining conductor temperature:	Fixed anchored OHW	Regulated OHW
	3.2ms ⁻¹	2.7ms ⁻¹

3.4.3 Area 2

The following design conditions are applicable for overhead wiring installed Lidcombe to Blacktown, Granville to Campbelltown, East Hills to Glenfield, Sefton to Cabramatta (inclusive).

Minimum ambient air temperature:	-5°C ^[3]
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Morning

Maximum ambient air temperature:	28°C
Solar radiation:	580W/m ²
Minimum wind speed:	0ms ⁻¹

Midday and afternoon

Maximum ambient air temperature:	42°C	
Solar radiation - midday:	1000W/m ²	
Solar radiation - afternoon:	650W/m ²	
Minimum wind speed for determining conductor temperature:	Fixed anchored OHW	Regulated OHW
	2.3ms ⁻¹	1.7ms ⁻¹

3.4.4 Area 3

The following design conditions are applicable for overhead wiring installed Blacktown to Glenbrook and Richmond.

Minimum ambient air temperature:	-5°C ^[3]
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Morning

Maximum ambient air temperature:	28°C
Solar radiation:	580W/m ²
Minimum wind speed for determining conductor temperature when calculating sag:	0ms ⁻¹

Midday and afternoon

Maximum ambient air temperature:	42°C	
Solar radiation - midday:	1000W/m ²	
Solar radiation - afternoon:	650W/m ²	
Minimum wind speed for determining conductor temperature:	Fixed anchored OHW	Regulated OHW
	2.0ms ⁻¹	1.5ms ⁻¹

3.4.5 Area 4

The following design conditions are applicable for overhead wiring installed Glenbrook to Faulconbridge.

Minimum ambient air temperature:	-5°C ^[3]
----------------------------------	---------------------

Morning

Maximum ambient air temperature:	28°C
Solar radiation:	580W/m ²
Minimum wind speed:	0ms ⁻¹

Midday and afternoon

Maximum ambient air temperature:	39°C	
Solar radiation - midday:	1000W/m ²	
Solar radiation - afternoon:	650W/m ²	
Minimum wind speed for determining conductor temperature:	Fixed anchored OHW	Regulated OHW
	3.2ms ⁻¹	2.7ms ⁻¹

3.4.6 Area 5

The following design conditions are applicable for overhead wiring installed Faulconbridge (446m) to Lithgow.

Minimum ambient air temperature:	-5°C ^[3]
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Morning

Maximum ambient air temperature:	28°C
Solar radiation:	630W/m ²
Minimum wind speed:	0ms ⁻¹

Midday and afternoon

Maximum ambient air temperature:	35°C	
Solar radiation - midday:	1100W/m ²	
Solar radiation - afternoon:	710W/m ²	
Minimum wind speed for determining conductor temperature:	Fixed anchored OHW	Regulated OHW
	To be determined	To be determined

3.4.7 OHW in Tunnels and Less Than 100m From a Portal

The design conditions for the relevant zone as set out above apply except that the solar radiation is 0 W/m². Note that underground station caverns shall be considered as a continuation of the tunnel.

3.4.8 OHW in Tunnels of Greater Than 200m Length

The following design conditions are appropriate for overhead wiring erected in tunnels of greater than 200m length and where the wire is more than 100m from a portal.

Minimum Ambient Air Temperature for determining sag and conductor movement:	5oC[3] below 850m altitude (approx. Wentworth Falls)	
	0oC[3] above 850m altitude	
Maximum ambient air temperature:	30°C	
Solar radiation:	0W/m ²	
Wind speed for determining conductor temperature:	Double Track Tunnels	Single Track Tunnels
	>5 minute headways 0.5m/s	>5 minute headways 0.5m/s
		5 minute headways 0.75m/s
	4 minute headways 0.1 m/s	
	3 minute headways 0.2m/s	3 minute headways 1.25m/s
	2 minute headways 0.25m/s	

	Notes 1. For double track tunnels, “headway” shall be taken to be the interval between trains regardless of direction. 2. Double the above for freight trains.	
Wind speed for determining blow out:	0km/h	

3.5 Cables

Ambient Air Temperature for determining rating:	40 ⁰ C ^[2]
Ambient Soil Temperature for determining rating:	25 ⁰ C ^[2]
Soil Thermal Resistivity	1.2Km/W ^[2]
Humidity:	Not Applicable
Solar radiation:	1000W/m ² ^[2]
Wind speed for determining rating:	0.5m/s ^[2]

4 Indoor Equipment

4.1 Unattended locations - general

The following design conditions are appropriate for equipment installed within substations, sectioning huts and similar locations. Generally such locations are naturally ventilated, free-standing buildings.

Ambient Air Temperature:	-5 ⁰ C to 50 ⁰ C Note: AS/NZS 2650:2000 section 2.1 nominates maximum of 40 ⁰ C and 24 hour average not greater than 35 ⁰ C
Humidity:	See AS/NZS 2650:2000 section 2.1
IP rating	IP21

4.2 Underground locations

The following design conditions are appropriate for equipment installed within substations, switch rooms and similar locations associated with underground railways and constructed adjacent to tunnels, station platforms or similar locations. Such locations are may be naturally or force ventilated.

Ambient Air Temperature:	-5 ⁰ C to 50 ⁰ C
Humidity:	
IP rating	IP21

4.3 Control centres and other environmentally controlled locations

The following design conditions are appropriate for equipment installed within control centres and other air-conditioned locations.

Ambient Air Temperature:	Air conditioning without back-up	Air conditioning with full back-up
	0 ⁰ C to 50 ⁰ C	To be determined
Humidity:	To be determined	
IP rating	IP21	