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Category
Electrical

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Transmission Line Current Ratings & Standard Conductors

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The technical content of this document has been approved by the relevant ARTC engineering authority and has also been endorsed by the ARTC Safety Committee.

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About This Standard

This standard sets out the maximum continuous current ratings of preferred standard conductors based on thermal conditions for ARTC transmission lines. Other factors such as voltage drop, protection relay settings and economic operating current are not considered.

This publication supersedes SRA publication “Transmission Line Current Ratings” dated 20th August 1992.

Document History

Primary Source – RIC Standard EP 10 00 00 05 SP Version 2.0

List of Amendments –

ISSUE	DATE	CLAUSE	DESCRIPTION
1.1	11/03/2005	Disclaimer	Minor editorial change

Contents

1 References

[1] Morgan, V.T. - “The Current Carrying Capacity of Overhead Line Conductors”. IE (Aust.) Elec. Eng. Transactions, March 1968.

[2] Sydney County Council Plant Rating Manual.

2 Introduction

Prior to 1970, SRA transmission lines were designed to give statutory clearances at a conductor temperature of 50 degrees Celsius. However conductors in sunlight can attain almost 50 degrees Celsius when carrying no current. Designers normally added "a couple of feet" to required clearances on an ad hoc basis to ensure that they adequately complied with statutory clearances. The fact that there are many such transmission lines in operation verifies that this approach was, in general, satisfactory. Thus it is reasonable to accept that these old transmission lines are actually capable of operating safely at conductor temperatures greater than 50 degrees Celsius.

Raising the temperature to 60 degrees Celsius on typical designs/bay lengths etc. gives (very approximately) an additional sag of 150-200mm which is well within the "couple of feet" mentioned above. As the majority of ARTC transmission lines are on Authority property and because of the statistical nature of ambient temperatures, loads, etc. it is safe and economic to assume that transmission lines designed for the "old" 50 degrees Celsius can safely operate at 60 degrees Celsius conductor temperature.

Since 1970 SRA transmission lines have been designed using 70 degrees Celsius conductor temperature.

3 Probability and Ambient Conditions

In order to assign a current rating to a feeder, it is necessary to decide on the “design” case ambient conditions to be expected in the geographic area. While it is possible to build a transmission line to operate under the absolute worst case of high temperature and low wind, it is not economic to do so. It was decided to use a statistical approach to determine the “design case” ambient conditions. This approach also takes into account the risk associated with operating in ambients exceeding the “worst case” condition.

Data from the Sydney County Council Plant Rating Manual, Appendix 1, Section 10 was used to establish a criteria for determining the current ratings of transmission lines taking into account the effects of ambient temperatures, wind and solar radiation. The plant Rating Manual shows that the SCC adopted a wind speed of 1 mile per hour = 0.44 metres/second and later changed to 0.5 metres/second.

To determine the ambient temperatures and wind speeds applicable to the ARTC transmission line infrastructure a detailed analysis of weather data from the Bankstown, Seven Hills, Richmond, Liverpool and Campbelltown weather stations was used.

From the analysis it has been determined that a weather probability combination of a 40 degrees Celsius ambient temperature and 0.5 metre/second wind or the equivalent occurs approximately once every 5 years.

In other words, SCC has accepted a probability that on 1 day in 5 years, ambient conditions will be such as to cause a transmission line to sag to its minimum design level when carrying rated current. At less frequent intervals, the line will sag below its minimum design level when carrying rated current

The SRA therefore used "once in 5 year" summer day ambients as shown in table 1.

Zone	Area	Ambient Temp.	Wind Speed m/s	Solar Radiation Midday W/m
1	East of Granville incl. Newcastle / Wollongong	39°	0.4	1000
2	Granville to Glenbrook, Glenee and Richmond	42°	0.25	1000
3	Glenbrook to Faulconbridge	39°	0.4	1000
4	Faulconbridge to Wallerawang	35°	0.3	1100

Table 1 - Summer Day Ambients

The ambient conditions for zones 1, 3 and 4 result in virtually identical conductor temperatures, therefore only two different sets of ambients need to be considered. The areas have been combined to form an Eastern Region comprising zones 1, 3 and 4 and a Western Region comprising zone 2.

4 Ambient Conditions

4.1 Summer Days

Ambient conditions used to determine current ratings are conditions that will occur on average one day every five years. These values were determined in detail for summer days from data from a number of weather stations (see table 1).

4.2 Ratings for Other Times

Ratings are also given for summer nights, winter days and winter nights. The “design case” ambient conditions for these times were determined by a similar process to the summer day case and are shown in table 2.

Table 2 summarises the ambient conditions used to determine current ratings.

	EASTERN ZONE **East of Granville and Glenbrook to Wallerawang**			**WESTERN ZONE** **Granville to Glenbrook, Richmond & Campbelltown**		
	Ambient Temp. Deg. C	**Wind Speed m/s**	**Solar Radiation Midday W/m**	**Ambient Temp. Deg. C**	**Wind Speed m/s**	**Solar Radiation Midday W/m**
Summer day	39	0.4	1000	42	0.25	1000
Summer night	34	0.4	0	37	0.25	0
Winter day	20	0.2	300	20	0.2	300
Winter night	15	0.2	0	15	0.2	0

Table 2

4.3 Risk

Using a once in 5-year ambient case does mean that on rare occasions the conductor temperature will exceed the design value and therefore the conductor sag will also exceed the design value.

Therefore there will be very rare instances where the conductor height may be lower than the statutory limits eg. once in ten years an ambient of 40 degrees Celsius and 0.3 metres/second wind can be expected at the rated current for a 70 degree Celsius design. This condition will give a conductor temperature of approximately 75 degrees Celsius with an additional conductor sag of approximately 150mm for a 100 metre span.

From the following it is considered that the once in 10 year ambient condition is an acceptable risk.

(i) Most transmission line span lengths are not designed to give minimum statutory clearances but are actually higher.

(ii) ARTC transmission lines are predominantly located on State Rail Authority property.

(iii) The probability of rated current being carried on the hottest day is low for the ARTC system as the loads are not temperature dependant.

(iv) Transmission line construction tolerances are less than the likely increased sag due to the once in ten year ambients.

5 Current Ratings and Standard Conductors

Current ratings are based on the condition that conductors must not infringe the design statutory height limits in ambient conditions that occur, on average, once every 5 years.

The ratings were calculated using a spreadsheet based on theoretical conductor temperature calculation, see reference 1.

The current ratings of conductors for summer day/night and winter day/night are shown in Tables 3 and 4 for all conductors used by the Australian Rail Track Corporation.

The standard conductors used by the ARTC are shown in tables 3 and 4.

TRANSMISSION LINES - 50 DEG. CURRENT RATINGS								
	EASTERN REGION				WESTERN REGION			
	Current Rating for 50 deg. Design				Current Rating for 50 deg. Design			
PHASE CONDUCTOR DESCRIPTION	Summer Daytime amps	Summer Night amps	Winter Daytime amps	Winter Night amps	Summer Daytime amps	Summer Night amps	Winter Daytime amps	Winter Night amps
COPPER								
Preferred								
7/2.00 mm.	**100**	**140**	**130**	**160**	**80**	**120**	**130**	**160**
7/2.75 mm.	**150**	**200**	**190**	**230**	**110**	**180**	**190**	**230**
19/2.00 mm.	**180**	**260**	**240**	**300**	**140**	**220**	**240**	**300**
37/1.75 mm.	**230**	**330**	**310**	**380**	**170**	**290**	**310**	**380**
19/3.00 mm.	**290**	**430**	**390**	**500**	**210**	**380**	**390**	**500**
Non-Preferred								
7/.064 in.	90	120	110	130	70	100	110	130
7/.080 in.	100	140	130	160	80	120	130	160
7/.104 in.	140	190	180	220	110	170	180	220
19/.083 in.	190	270	260	320	140	240	260	320
Twin 19/.083 in.	380	540	520	640	280	480	520	640
19/.092 in.	220	310	290	360	160	270	290	360
37/.083 in.	290	430	390	490	210	370	390	490
ALUMINIUM								
Preferred								
7/3.75 mm. AAC	**170**	**240**	**220**	**280**	**120**	**210**	**220**	**280**
Twin 7/3.75 mm.	**340**	**480**	**440**	**560**	**240**	**420**	**440**	**560**
7/4.5mm AAC	**210**	**300**	**280**	**350**	**150**	**260**	**280**	**350**
Twin 7/4.45 mm.	**420**	**600**	**560**	**700**	**300**	**520**	**560**	**700**
19/3.75 mm. AAC	**290**	**450**	**410**	**530**	**200**	**400**	**410**	**530**
Twin 19/3.75 mm.	**580**	**900**	**820**	**1060**	**400**	**800**	**820**	**1060**
Non-Preferred								
1/6/.144 in. SCA	140	200	190	230	110	170	190	230

Table 3

Note: The current ratings specified as "50 deg. Design" are actually calculated at 60 deg.

TRANSMISSION LINES - 70 DEG. CURRENT RATINGS								
	EASTERN REGION				WESTERN REGION			
	Current Rating for 70 deg. Design				Current Rating for 70 deg. Design			
PHASE CONDUCTOR DESCRIPTION	Summer Daytime amps	Summer Night amps	Winter Daytime amps	Winter Night amps	Summer Daytime amps	Summer Night amps	Winter Daytime amps	Winter Night amps
COPPER								
Preferred								
7/2.00 mm.	**130**	**160**	**150**	**170**	**110**	**140**	**150**	**170**
7/2.75 mm.	**190**	**240**	**220**	**260**	**160**	**210**	**220**	**260**
19/2.00 mm.	**240**	**300**	**280**	**320**	**200**	**260**	**280**	**320**
37/1.75 mm.	**300**	**390**	**350**	**420**	**250**	**340**	**350**	**420**
19/3.00 mm.	**390**	**500**	**460**	**550**	**320**	**440**	**460**	**550**
Non-Preferred								
7/.064 in.	110	130	130	140	90	120	130	140
7/.080 in.	130	160	150	170	110	140	150	170
7/.104 in.	180	220	210	240	150	200	210	240
19/.083 in.	260	320	290	350	210	280	290	350
Twin 19/.083 in.	520	640	580	700	420	560	580	700
19/.092 in.	290	360	330	390	240	320	330	390
37/.083 in.	390	500	450	540	320	440	450	540
ALUMINIUM								
Preferred								
7/3.75 mm. AAC	**220**	**280**	**260**	**300**	**180**	**250**	**260**	**300**
Twin 7/3.75 mm.	**440**	**560**	**520**	**600**	**360**	**500**	**520**	**600**
7/4.5mm AAC	**270**	**350**	**320**	**380**	**230**	**310**	**320**	**380**
Twin 7/4.45 mm.	**540**	**700**	**640**	**760**	**460**	**620**	**640**	**760**
19/3.75 mm. AAC	**400**	**530**	**470**	**580**	**330**	**470**	**470**	**580**
Twin 19/3.75 mm.	**800**	**1060**	**940**	**1160**	**660**	**940**	**940**	**1160**
Non-Preferred								
1/6/.144 in. ACSR	190	230	210	250	160	200	210	250

Table 4