Overhead Conductor Ratings

Document No. MDI 0042

Amendment No. 03

27/05/26

Endeavour Energy

POWER together

Revision History

This amendment replaces the following standard:

MDI 0042 – Overhead Conductor Rating Am.2

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Document Control

Documentation content coordinator: Asset Engineering Manager

Contents

1 Purpose

To set out in detail the continuous, contingency and short circuit ratings of overhead conductors that are commonly used in Endeavour Energy's network.

2 Scope

This document outlines operating conditions for overhead conductors and gives details of the continuous and short circuit ratings for these conditions.

3 References

External Regulations
N/A

External Standards		
Standard No.	Year	Title
IEC 60287-1-1	2023	Electric cables - Calculation of the current rating - Part 1-1: Current rating equations (100 % load factor) and calculation of losses - General
IEC 60865-1	2011	Short-circuit currents – Calculation of effects - Part 1: Definitions and calculation methods
AS/NZS 3675	2002	Conductors - Covered overhead - For working voltages 6.35/11 (12) kV up to and including 19/33 (36) kV
AS/NZS 3599.2	1999	Electric cables - Aerial bundled - Polymeric insulated - Voltages 6.35/11(12) kV and 12.7/22(24) kV
ESAA D(b)5	1988	Current rating of bare overhead line conductors
ENA Doc 01	2019	National Electricity Network Safety Code
CIGRE 207	2002	Thermal behaviour of overhead conductors

Company Policies and Procedures
Company Policy 9.2.1 - Network Planning
Company Policy 9.2.10 - Network Asset Ratings
Electricity Network Safety Management System (as amended)

4 Definitions and Abbreviations

Term	Definition
AAC	All aluminium conductor
AAAC	All aluminium alloy conductor
ACSR/GZ	Aluminium conductor, galvanised steel reinforced
ACCFSC	Aluminium Conductor Carbon Fiber Composite Supported
Albedo	Ground reflectance coefficient
CCT	Covered conductor thick
Contingency Rating	Is defined as the maximum current a line can safely carry for a limited duration as result of a system outage or contingency operation without suffering damage or accelerated ageing.
Continuous Rating	Is defined as the maximum current that can be allowed to flow indefinitely through that asset without suffering damage or accelerated ageing.
HTLS	High Temperature Low sag conductor
LV ABC	Low-voltage aerial bundle cable
NMSHVABC	Non-metallic screened high-voltage aerial bundle cable
OHEW	Overhead earth wire
SC/GZ	Steel conductor, zinc galvanised
T_{init}	Initial conductor temperature

5 Actions

This document is to be used as a reference for the design and management of all overhead conductors specified.

5.1 Overhead conductor rating parameters

This clause defines the reference parameters that are assumed when calculating overhead conductor ratings. If conditions differ from those assumed, relevant details shall be provided to the Asset Engineering Manager for an asset-specific rating to be calculated.

5.1.1 Radiation parameters

Table 1: Radiation parameters.

Parameters	Winter		Summer	
	Night	Noon	Night	Noon
Direct solar radiation intensity (W/m²)	0	1000	0	1000
Indirect solar radiation intensity (W/m²)	0	100	0	100
Albedo	0.2			
Solar absorption coefficient	Bare: 0.8*		Insulated: 0.5	
Conductor emissivity coefficient	Bare: 0.65*		Insulated: 0.9	
* These parameters are based on the assumption that the conductors have been erected for sufficient time for the characteristic bright appearance to have diminished.				

5.1.2 Weather parameters

For the purpose of calculating overhead conductor ratings, Endeavour Energy's network is divided into three geographic regions: *inland; coastal; and mountainous*.

The *coastal* region describes the region within Endeavour Energy's supply area between the sea and the escarpment from Stanwell Park to Ulladulla. *Mountainous* refers to the Blue Mountains and the Southern Highlands areas. *Inland* refers to the remainder of Endeavour Energy's supply area. Refer to KMZ file in standards portal.

Table 2: Inland region weather parameters.

Parameters	Winter		Summer	
	Night	Noon	Night	Noon
Ambient temperature (°C)	5	20	30	40
Transverse wind speed (m/s)	0.5			
Altitude (m)	0			

Table 3: Coastal region weather parameters.

Parameters	Winter		Summer	
	Night	Noon	Night	Noon
Ambient temperature (°C)	10	25	20	30
Transverse wind speed (m/s)	1.0			
Altitude (m)	0			

Table 4: Mountainous region weather parameters.

Parameters	Winter		Summer	
	Night	Noon	Night	Noon
Ambient temperature (°C)	5	20	20	30
Transverse wind speed (m/s)	1.0			
Altitude (m)	1,000			

5.1.3 Maximum permissible conductor temperature during a short circuit

The maximum permissible conductor temperatures during a short circuit are specified in the following table.

Table 5: Short circuit permissible conductor temperatures

Conductor Type	Maximum conductor temperature
Bare copper, aluminium, aluminium alloy, and steel-cored conductor	200°C[1]
Bare steel conductor	300°C[1]
CCT	210°C[2]
NMSHVABC	250°C[3]
HTLS ACCFCS	330°C

[1] IEC 60865-1, 2011
[2] AS/NZS 3675, 2002
[3] AS/NZS 3599.2, 1999

Variation of maximum conductor temperature may be given by formal application to the Asset Engineering Manager.

5.1.4 Initial conductor temperature for short circuit analysis

Calculations for short circuit ratings require an initial conductor temperature. This clause specifies the temperature, and therefore rating, that shall be selected when applying a short circuit rating to a particular network element.

Table 6: Initial conductor temperature for SC analysis

Network Element		T_{init}
Overhead earthwire – any type		40°C
Phase conductor	all except HTSL ACCFCS	50°C
	HTLS ACCFCS	100°C

5.1.5 Metric equivalent of imperial conductors

For historical reasons conductors are sometimes referred to by imperial sizes. The following table shows the closest metric and imperial strand diameters for common sizes.

Example of usage: 19/0.183 AAC would be deemed equivalent to 19/4.75 AAC.

Note that the sizes in the table reflect those commonly encountered and may not match exactly, for instance 0.183inch × 25.4mm/inch = 4.65mm which is slightly less than 4.75mm given in the table. The differences are within approximately 5% and considered a reasonable approximation.

In instances where no metric equivalent is listed, the rating may be requested from Asset Engineering.

Table 7: Imperial to metric conversion table.

Equivalent strand diameters	
mm	Inches
1.75	0.064
2.00	0.080
2.25	0.087
2.50	0.101
2.75	0.104
3.00	0.118
3.25	0.128
3.75	0.144
4.50	0.173
4.75	0.183

5.2 Overhead current ratings

Continuous ratings for bare conductors have been determined in accordance with ESAA D(b)5:1988, with an adjustment for altitude as described in Annexure 1: Effect of altitude on continuous current ratings.

Continuous ratings for insulated conductors have been determined in accordance with IEC 60287.

Ratings in the following tables apply to individual conductors. Where there are multiple conductors on each phase, the rating of the feeder is multiplied accordingly, for example, for two (2) conductors on each phase, the rating of the feeder is doubled.

Ratings are provided for a range of maximum operating temperatures commonly found on the Endeavour Energy network.

Feeders are typically designed based on their continuous rating, while contingency ratings permit operation up to the maximum design temperature under abnormal conditions.

The maximum conductor temperature for which a line is designed shall be determined, and shall not be exceeded, when choosing the rating to apply to that line (whether for continuous, or contingency operation). This includes considering the thermal limits (grease drop off point of legacy conductors[1]) of fittings and other components. Where the design temperature is not known, it may be determined by line survey.

CAUTION: If a line is operated at a higher temperature than that for which it was designed, the additional sag may lead to minimum clearances being breached. This can cause clashing with other lines or vegetation and poses a risk to vehicles passing underneath. Operating staff should be aware of these factors, and a rating study including a line survey could help clarify them.

The conductors listed in the tables correspond to sizes and types commonly found on Endeavour Energy's network, including conductors that are no longer approved for use in new constructions.

To determine the continuous or contingency rating of a conductor please refer to table 8 below and tables found in clauses 5.2.1 to 5.2.20:

Approval for operation above the designed standard temperature limits specified below Table 8 may be considered using a risk-based approach.

Table 8: Reference temperature for overhead lines

Network	Type	Maximum conductor temperature	
		Continuous	Contingency
Distribution	Bare conductor	75°C[1]	N/A
	LV ABC	80°C[1]	
	HV ABC	90°C[2]	
	CCT	80°C[3]	
Transmission	Bare conductor	75°C	100°C
	HTLS ACCFCS	180°C	200°C

[1] Drop point of bituminous compound in ACSR installed prior to circa 1970 was 67°C. Modern specifications require a drop point of at least 160°C. Therefore, this is only applicable for a limited number of conductors in Endeavour Energy's Network.

5.2.1 AAC ampacity at a conductor temperature of 50°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Jupiter	7/2.25	*	115	111	169	102	161	121	185	98	157	132	191
Libra	7/3.00	*	168	156	247	141	234	169	269	134	229	187	278
Mars	7/3.75	*	224	200	329	178	311	218	357	170	304	242	369
Mercury	7/4.50	*	283	244	415	214	392	266	449	203	383	298	464
Moon	7/4.75	*	304	258	444	226	420	282	481	214	410	316	497
Neptune	19/3.25	*	355	293	520	253	490	321	562	239	479	362	581
Pluto	19/3.75	*	429	341	626	290	590	374	676	272	577	425	699
Taurus	19/4.75	*	583	432	848	353	798	477	913	327	780	549	944
Uranus	61/3.25	*	761	524	1105	406	1037	581	1187	368	1015	681	1227
Venus	61/3.75	*	919	595	1333	437	1249	664	1429	385	1223	790	1477

* Ratings cannot be provided for a conductor temperature of 50°C when ambient temperature is 40°C

5.2.2 AAC ampacity at a conductor temperature of 75°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Jupiter	7/2.25	121	165	162	203	171	209	182	226	166	204	187	229
Libra	7/3.00	171	240	233	296	245	304	261	329	238	297	269	333
Mars	7/3.75	222	321	306	395	322	404	343	438	312	395	353	443
Mercury	7/4.50	273	404	380	497	400	508	427	550	388	497	440	557
Moon	7/4.75	291	434	406	533	426	545	456	589	413	532	470	597
Neptune	19/3.25	333	507	470	624	493	636	528	688	478	622	544	697
Pluto	19/3.75	392	612	559	752	586	765	629	828	568	748	649	838
Taurus	19/4.75	509	831	742	1019	776	1035	834	1119	752	1013	862	1133
Uranus	61/3.25	634	1085	947	1328	988	1346	1065	1455	956	1318	1103	1473
Venus	61/3.75	738	1310	1125	1603	1171	1621	1265	1752	1133	1588	1311	1774

5.2.3 AAC ampacity at a conductor temperature of 100°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Jupiter	7/2.25	167	198	197	229	214	243	223	257	209	237	224	258
Libra	7/3.00	240	290	284	334	309	354	321	374	301	346	324	375
Mars	7/3.75	317	387	376	446	409	471	425	498	398	461	428	499
Mercury	7/4.50	396	488	470	562	511	593	531	627	497	580	536	628
Moon	7/4.75	423	524	503	603	546	636	568	671	531	621	573	673
Neptune	19/3.25	491	613	585	705	634	742	660	784	617	726	666	786
Pluto	19/3.75	586	740	700	850	759	894	789	944	738	874	797	946
Taurus	19/4.75	783	1006	939	1154	1015	1210	1057	1277	988	1184	1068	1281
Uranus	61/3.25	1005	1314	1211	1506	1306	1574	1361	1661	1272	1542	1377	1666
Venus	61/3.75	1199	1587	1450	1818	1561	1897	1628	2001	1520	1858	1647	2008

5.2.4 AAAC ampacity at a conductor temperature of 50°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Chlorine	7/2.50	*	131	125	193	113	183	135	210	109	178	149	217
Fluorine	7/3.00	*	165	153	243	138	230	167	265	132	225	184	273
Helium	7/3.75	*	221	197	324	175	307	215	352	167	300	239	364
Hydrogen	7/4.50	*	279	240	409	211	386	262	443	200	378	294	458
Krypton	19/3.25	*	350	289	512	250	483	316	554	235	472	357	573
Neon	19/3.75	*	422	336	616	285	580	368	665	267	567	418	687
Oxygen	19/4.75	*	575	426	837	348	787	470	901	322	770	542	931
Selenium	61/3.25	*	749	516	1088	400	1021	572	1169	362	1000	670	1208

* Ratings cannot be provided for a conductor temperature of 50°C when ambient temperature is 40°C

5.2.5 AAAC ampacity at a conductor temperature of 75°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Chlorine	7/2.50	136	187	183	231	194	237	206	257	188	232	212	260
Fluorine	7/3.00	169	237	229	292	242	299	258	324	235	292	265	328
Helium	7/3.75	219	316	301	389	317	398	338	431	308	389	348	436
Hydrogen	7/4.50	270	399	375	491	395	502	422	543	383	491	435	550
Krypton	19/3.25	329	501	463	616	486	628	521	679	472	614	537	687
Neon	19/3.75	386	603	551	740	577	754	619	816	560	737	639	826
Oxygen	19/4.75	502	821	733	1006	766	1022	824	1105	742	1000	851	1119
Selenium	61/3.25	625	1069	934	1310	974	1327	1050	1434	943	1299	1087	1452

5.2.6 AAAC ampacity at a conductor temperature of 100°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Chlorine	7/2.50	189	226	223	261	243	277	253	293	237	270	255	293
Fluorine	7/3.00	237	286	280	330	305	349	317	369	297	341	320	370
Helium	7/3.75	313	382	371	440	403	465	419	492	392	454	423	493
Hydrogen	7/4.50	391	483	465	556	505	586	525	620	491	573	530	621
Krypton	19/3.25	485	606	578	697	627	733	652	775	610	717	658	777
Neon	19/3.75	578	730	690	838	748	881	778	931	728	862	786	933
Oxygen	19/4.75	774	994	928	1141	1003	1196	1045	1262	977	1170	1056	1266
Selenium	61/3.25	992	1296	1195	1486	1289	1553	1343	1639	1255	1521	1359	1644

5.2.7 ACSR/GZ ampacity at a conductor temperature of 50°C

Conductor			Inland			Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Almond	6/1/2.50	*	119	113	175	103	166	123	191	99	162	135	197
Apple	6/1/3.00	*	148	137	218	124	206	149	237	119	202	165	245
Banana	6/1/3.75	*	198	176	290	157	274	192	315	150	268	214	326
Cherry	6/4.75 + 7/1.60	*	264	225	387	197	365	245	419	186	357	275	433
Coyote	26/2.54 + 7/1.91	*	322	268	471	232	445	293	510	219	435	330	527
Goat	30/7/3.71	*	587	423	854	339	803	467	919	311	785	542	950
Grape	30/7/2.50	*	351	284	512	244	483	312	554	229	472	353	572
Lemon	30/7/3.00	*	445	343	649	287	611	377	700	267	598	431	723
Lime	30/7/3.50	*	544	400	792	325	745	441	853	300	729	509	881
Mango	54/7/3.00	*	626	444	910	353	854	492	978	322	836	572	1011
Moose	54/7/3.53	*	769	511	1115	385	1046	569	1196	344	1024	672	1237
Olive	54/7/3.50	*	766	512	1112	387	1043	569	1193	346	1021	672	1233
Quince	3/4/1.75	*	59	59	88	55	83	64	96	52	81	70	99
Raisin	3/4/2.50	*	93	89	138	81	131	97	150	78	128	106	155
Sultana	4/3/3.00	*	131	122	193	110	183	132	210	105	178	146	217
Walnut	4/3/3.75	*	172	153	252	136	239	167	274	130	233	186	283

* Ratings cannot be provided for a conductor temperature of 50°C when ambient temperature is 40°C

5.2.8 ACSR/GZ ampacity at a conductor temperature of 75°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Almond	6/1/2.50	124	170	166	210	176	215	187	233	171	210	192	236
Apple	6/1/3.00	151	212	205	261	216	268	230	290	210	261	237	293
Banana	6/1/3.75	196	283	269	348	283	356	303	386	275	348	311	390
Cherry	6/4.75 + 7/1.60	253	377	353	464	371	474	397	513	360	463	409	519
Coyote	26/2.54 + 7/1.91	304	460	427	566	448	577	480	625	435	564	495	632
Goat	30/7/3.71	503	837	741	1026	774	1041	833	1126	749	1019	862	1140
Grape	30/7/2.50	325	501	460	615	483	627	518	678	468	613	534	687
Lemon	30/7/3.00	399	635	574	779	601	793	646	857	583	775	666	868
Lime	30/7/3.50	472	776	691	952	722	966	777	1045	700	946	803	1058
Mango	54/7/3.00	532	892	786	1093	821	1109	884	1199	795	1085	914	1214
Moose	54/7/3.53	627	1095	947	1341	987	1357	1066	1467	955	1329	1104	1485
Olive	54/7/3.50	627	1092	945	1337	986	1353	1064	1462	954	1325	1102	1481
Quince	3/4/1.75	64	85	85	105	90	108	95	117	87	106	98	119
Raisin	3/4/2.50	97	134	131	165	138	169	147	184	134	165	151	186
Sultana	4/3/3.00	134	187	181	231	191	237	204	257	186	231	210	260
Walnut	4/3/3.75	170	246	234	303	246	310	263	335	239	302	271	339

5.2.9 ACSR/GZ ampacity at a conductor temperature of 100°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Almond	6/1/2.50	172	205	202	237	221	251	229	265	215	245	231	266
Apple	6/1/3.00	212	256	250	295	273	312	283	330	265	305	286	331
Banana	6/1/3.75	279	341	331	393	360	415	374	439	351	406	378	440
Cherry	6/4.75 + 7/1.60	368	456	438	525	475	553	494	584	463	541	499	586
Coyote	26/2.54 + 7/1.91	446	556	531	640	576	674	599	712	561	659	605	713
Goat	30/7/3.71	783	1014	941	1163	1017	1217	1059	1285	990	1192	1071	1289
Grape	30/7/2.50	482	605	575	696	623	732	648	773	607	716	655	775
Lemon	30/7/3.00	604	768	722	882	782	926	814	978	761	906	822	980
Lime	30/7/3.50	729	939	876	1078	946	1129	985	1192	921	1106	996	1196
Mango	54/7/3.00	832	1080	1001	1239	1081	1296	1126	1368	1052	1269	1138	1372
Moose	54/7/3.53	1008	1327	1217	1520	1312	1588	1367	1675	1277	1555	1383	1681
Olive	54/7/3.50	1006	1323	1214	1516	1309	1583	1364	1670	1274	1551	1380	1676
Quince	3/4/1.75	87	102	102	118	112	126	116	133	109	123	117	133
Raisin	3/4/2.50	135	161	159	186	174	197	180	209	169	193	182	209
Sultana	4/3/3.00	188	226	222	261	241	276	251	292	235	270	253	293
Walnut	4/3/3.75	243	297	288	342	313	361	325	382	305	353	328	382

5.2.10 ACSR/GZ ampacity at a conductor temperature of 120°C

Conductor		Inland				Coastal				Mountainous			
Name	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Almond	6/1/2.50	200	227	225	255	248	274	255	286	242	268	255	286
Apple	6/1/3.00	247	284	279	317	307	341	316	356	300	333	317	355
Banana	6/1/3.75	328	379	370	423	407	454	419	474	397	444	419	473
Cherry	6/4.75 + 7/1.60	434	507	491	566	539	605	554	632	525	592	555	630
Coyote	26/2.54 + 7/1.91	527	618	597	690	654	737	674	770	638	721	675	768
Goat	30/7/3.71	940	1129	1068	1257	1165	1334	1200	1392	1136	1306	1203	1390
Grape	30/7/2.50	572	673	647	751	709	801	730	836	691	784	731	835
Lemon	30/7/3.00	719	854	816	952	892	1014	918	1058	870	992	921	1057
Lime	30/7/3.50	874	1046	992	1165	1083	1237	1115	1291	1056	1211	1118	1289
Mango	54/7/3.00	1000	1203	1136	1339	1239	1420	1276	1482	1208	1391	1280	1480
Moose	54/7/3.53	1218	1478	1386	1644	1508	1740	1554	1816	1472	1705	1559	1814
Olive	54/7/3.50	1215	1474	1383	1639	1504	1735	1550	1810	1468	1700	1555	1809
Quince	3/4/1.75	101	114	113	127	125	137	129	144	122	134	129	143
Raisin	3/4/2.50	157	179	177	200	195	216	201	225	190	211	201	225
Sultana	4/3/3.00	219	251	247	281	272	302	280	315	265	295	280	314
Walnut	4/3/3.75	285	329	322	368	354	395	364	412	345	386	365	411

5.2.11 Hard drawn copper ampacity at a conductor temperature of 50°C

Conductor	Inland				Coastal				Mountainous			
Stranding (inches)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
7/.064	*	98	98	144	91	137	106	158	87	134	116	163
7/.080	*	130	127	192	117	182	138	209	112	178	151	216
7/.104	*	182	172	267	156	254	187	291	149	248	206	301
19/.083	*	259	234	381	209	360	255	413	200	352	283	427
19/.101	*	334	291	489	256	463	317	531	244	452	354	548
19/.116	*	399	338	585	294	552	369	633	279	540	414	654
37/.083	*	399	337	584	294	551	368	632	278	539	414	654

* Ratings cannot be provided for a conductor temperature of 50°C when ambient temperature is 40°C

5.2.12 Hard drawn copper ampacity at a conductor temperature of 75°C

Conductor	Inland				Coastal				Mountainous			
Stranding (inches)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
7/.064	106	140	141	173	149	178	158	193	144	174	162	196
7/.080	138	186	185	230	195	237	207	256	189	231	213	259
7/.104	188	260	254	321	268	330	286	357	260	322	293	361
19/.083	260	371	355	457	374	468	399	507	363	457	411	513
19/.101	326	478	451	588	475	601	507	651	460	588	522	659
19/.116	381	572	534	703	561	718	600	777	544	702	618	786
37/.083	381	571	533	702	560	717	599	776	543	701	617	785

5.2.13 Hard drawn copper ampacity at a conductor temperature of 100°C

Conductor	Inland				Coastal				Mountainous			
Stranding (inches)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
7/.064	144	169	169	196	185	208	192	220	180	203	194	220
7/.080	190	225	224	260	244	276	253	292	238	269	255	292
7/.104	263	315	310	363	338	385	351	407	329	376	354	408
19/.083	369	449	437	517	475	547	494	578	463	534	498	579
19/.101	470	578	558	666	606	703	630	743	590	687	636	744
19/.116	558	692	663	796	720	839	748	886	701	820	756	888
37/.083	557	691	662	795	719	838	748	886	700	820	755	888

5.2.14 SC/GZ ampacity at a conductor temperature of 50°C

Conductor	Inland				Coastal				Mountainous			
Stranding (inches)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
3/2.75	*	34	34	50	31	48	36	55	30	47	40	57
7/3.25	*	72	66	105	59	100	71	114	56	97	79	118
19/2.75	*	110	95	162	83	153	103	175	79	149	116	181

* Ratings cannot be provided for a conductor temperature of 50°C when ambient temperature is 40°C

5.2.15 SC/GZ ampacity at a conductor temperature of 75°C

Conductor	Inland				Coastal				Mountainous			
Stranding (inches)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
3/2.75	36	49	48	60	51	62	54	67	50	60	56	68
7/3.25	72	102	98	126	104	129	110	140	101	126	114	141
19/2.75	106	157	148	193	155	198	166	214	150	193	171	216

5.2.16 CCT ampacity at a conductor temperature of 80°C

Conductor			Inland				Coastal				Mountainous			
Voltage	Area (mm²)	Stranding (mm)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
11kV	80	7/3.75	261	331	331	387	333	393	351	423	333	393	368	437
11kV	120	7/4.75	348	445	442	520	446	529	470	569	446	529	493	588
11kV	180	19/3.50	442	569	563	665	568	677	599	728	568	677	628	752
22kV	120	7/4.75	337	435	429	509	427	510	451	549	427	510	473	567

5.2.17 NMSHVABC ampacity at a conductor temperature of 90°C

Conductor	Inland				Coastal				Mountainous			
Area (mm²)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
50	173	220	211	250	215	255	225	272	215	255	234	280
150	341	438	416	497	434	518	455	552	434	518	474	568

5.2.18 LV ABC ampacity at a conductor temperature of 80°C

Conductor		Inland				Coastal				Mountainous			
No. of Cores	Area (mm²)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
2	25	95	122	121	147	124	148	131	159	121	144	133	159
4	25	85	108	108	129	111	131	117	140	108	127	119	141
4	95	195	252	247	302	253	303	266	325	245	294	271	325
4	150	257	335	327	401	333	401	351	430	323	389	357	431

5.2.19 HTLS ACCFCS ampacity at a conductor temperature of 180°C

Conductor		Inland				Coastal				Mountainous			
Name	Area (mm²)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Brussels	421.4	1436	1546	1525	1647	1679	1785	1705	1832	1642	1748	1691	1815
Milan	567.7	1742	1879	1849	2000	2031	2162	2061	2219	1986	2118	2046	2200
Paris	813.7	2181	2357	2314	2507	2533	2702	2571	2772	2479	2648	2553	2750
Athens	1409.7	3076	3338	3262	3546	3561	3813	3616	3913	3481	3730	3583	3872

5.2.20 HTLS ACCFCS ampacity at a conductor temperature of 200°C

Conductor		Inland				Coastal				Mountainous			
Name	Area (mm²)	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night	Summer noon	Summer night	Winter noon	Winter night
Brussels	421.4	1533	1632	1613	1723	1774	1870	1798	1913	1736	1832	1781	1894
Milan	567.7	1862	1985	1958	2094	2148	2267	2176	2319	2103	2222	2157	2296
Paris	813.7	2335	2492	2453	2628	2683	2863	2718	2900	2629	2782	2695	2874
Athens	1409.7	3305	3540	3471	3728	3780	4009	3830	4100	3703	3929	3796	4056

5.3 Short circuit ratings

Short circuit ratings for bare conductors have been determined in accordance with Cigre 207: 2002. Where calculation variables are not defined by this MDI, defaults from Cigre 207 have been applied.

Short circuit ratings supplied by this MDI are in the units of kA for 1.0s and 1.5s. In addition, the $kA^2.s$ short circuit rating is also provided. This can be used to determine the permissible combination of fault duration and magnitude. Guidance on the use of the $kA^2.s$ unit is provided at Annexure 2: Guide to the application of the kA2.s fault rating.

The application of all short circuit ratings shall be in accordance with the requirements set by Company Policy 9.2.10: Network Asset Ratings.

The $kA^2.s$ fault rating shall only be applied for fault durations less than five (5) seconds.

5.3.1 AAC short circuit ratings

Conductor		T_{init} = 40°C (Earthwire)			T_{init} = 50°C (Phase conductor)		
Name	Stranding (mm)	kA².s	kA for 1.0s	kA for 1.5s	kA².s	kA for 1.0s	kA for 1.5s
Jupiter	7/2.25	7.72	2.78	2.27	7.11	2.67	2.18
Libra	7/3.00	24.39	4.94	4.03	22.48	4.74	3.87
Mars	7/3.75	59.54	7.72	6.30	54.88	7.41	6.05
Mercury	7/4.50	123.46	11.11	9.07	113.79	10.67	8.71
Moon	7/4.75	153.27	12.38	10.11	141.27	11.89	9.70
Neptune	19/3.25	247.46	15.73	12.84	228.11	15.10	12.33
Pluto	19/3.75	438.64	20.94	17.10	404.33	20.11	16.42
Taurus	19/4.75	1,129.21	33.60	27.44	1,040.77	32.26	26.34
Uranus	61/3.25	2,550.81	50.51	41.24	2,351.25	48.49	39.59
Venus	61/3.75	4,521.04	67.24	54.90	4,167.57	64.56	52.71

5.3.2 AAAC short circuit ratings

Conductor		T_{init} = 40°C (Earthwire)			T_{init} = 50°C (Phase conductor)		
Name	Stranding (mm)	kA².s	kA for 1.0s	kA for 1.5s	kA².s	kA for 1.0s	kA for 1.5s
Chlorine	7/2.50	10.60	3.26	2.66	9.78	3.13	2.55
Fluorine	7/3.00	21.97	4.69	3.83	20.29	4.50	3.68
Helium	7/3.75	53.65	7.32	5.98	49.53	7.04	5.75
Hydrogen	7/4.50	111.25	10.55	8.61	102.70	10.13	8.27
Krypton	19/3.25	222.99	14.93	12.19	205.87	14.35	11.72
Neon	19/3.75	395.26	19.88	16.23	364.88	19.10	15.60
Oxygen	19/4.75	1,017.46	31.90	26.04	939.28	30.65	25.02
Selenium	61/3.25	2,298.52	47.94	39.15	2,122.00	46.07	37.61

5.3.3 ACSR/GZ short circuit ratings

Conductor		T_{init} = 40°C (Earthwire)			T_{init} = 50°C (Phase conductor)		
Name	Stranding (mm)	kA².s	kA for 1.0s	kA for 1.5s	kA².s	kA for 1.0s	kA for 1.5s
Almond	6/1/2.50	10.86	3.30	2.69	10.01	3.16	2.58
Apple	6/1/3.00	22.53	4.75	3.88	20.76	4.56	3.72
Banana	6/1/3.75	55.00	7.42	6.06	50.69	7.12	5.81
Cherry	6/4.75 + 7/1.60	135.60	11.64	9.51	124.99	11.18	9.13
Coyote*	25/2.54 + 7/1.92	199.32	14.12	11.53	183.71	13.55	11.07
Goat	30/7/3.71	1,411.30	37.57	30.67	1,300.86	36.07	29.45
Grape	30/7/2.50	293.79	17.14	14.00	270.82	16.46	13.44
Lemon	30/7/3.00	609.22	24.68	20.15	561.55	23.70	19.35
Lime	30/7/3.50	1,128.73	33.60	27.43	1,040.33	32.25	26.34
Mango	54/7/3.00	1,741.58	41.73	34.07	1,605.43	40.07	32.72
Moose	54/7/3.53	3,338.54	57.78	47.18	3,077.49	55.48	45.30
Olive	54/7/3.50	3,226.51	56.80	46.38	2,974.23	54.54	44.53
Quince	3/4/1.75	1.59	1.26	1.03	1.46	1.21	0.99
Raisin	3/4/2.50	6.61	2.57	2.10	6.09	2.47	2.01
Sultana	4/3/3.00	17.18	4.14	3.38	15.84	3.98	3.25
Walnut	4/3/3.75	41.95	6.48	5.29	38.66	6.22	5.08

* This is an imperial conductor, stranding dimensions have been converted for uniformity with table.

5.3.4 Hard drawn copper short circuit ratings

Conductor	T_{init} = 40°C (Earthwire)			T_{init} = 50°C (Phase conductor)		
Stranding (mm)	kA².s	kA for 1.0s	kA for 1.5s	kA².s	kA for 1.0s	kA for 1.5s
7/.064	4.88	2.21	1.8	4.5	2.12	1.73
7/.080	11.92	3.45	2.82	10.99	3.32	2.71
7/.104	34.04	5.83	4.76	31.39	5.6	4.57
19/.083	101.72	10.09	8.24	93.81	9.69	7.91
19/.101	223.06	14.94	12.19	205.70	14.34	11.71
19/.116	388.11	19.70	16.09	357.89	18.92	15.45
37/.083	385.76	19.64	16.04	355.74	18.86	15.40

5.3.5 CCT short circuit ratings

Voltage	Conductor		T_{init} = 50°C (Phase conductor)		
	Area (mm²)	Stranding (mm)	kA².s	kA for 1.0s	kA for 1.5s
11kV	120	7/4.75	134.44	11.59	9.47
11kV	180	19/3.50	291.96	17.09	13.95
11kV	80	7/3.75	52.22	7.23	5.90
22kV	120	7/4.75	134.44	11.59	9.47

5.3.6 NMSHVABC short circuit ratings

Conductor	T_{init} = 50°C		
Area (mm²)	kA².s	kA for 1.0s	kA for 1.5s
50	28.83	5.37	4.38
150	259.47	16.11	13.15

5.3.7 SC/GZ short circuit ratings

Imperial

Conductor	T_{init} = 40°C (Earthwire)			T_{init} = 50°C (Phase conductor)		
Stranding (inches)	kA².s	kA for 1.0s	kA for 1.5s	kA².s	kA for 1.0s	kA for 1.5s
3/.080	0.30	0.55	0.45	0.29	0.53	0.44
7/.064	0.68	0.82	0.67	0.64	0.80	0.65
7/.080	1.65	1.28	1.05	1.56	1.25	1.02
7/.104	4.78	2.19	1.79	4.52	2.13	1.74

Metric

Conductor	T_{init} = 40°C (Earthwire)			T_{init} = 50°C (Phase conductor)		
Stranding (mm)	kA².s	kA for 1.0s	kA for 1.5s	kA².s	kA for 1.0s	kA for 1.5s
3/2.00	0.28	0.53	0.44	0.27	0.52	0.42
3/2.75	1.02	1.01	0.82	0.96	0.98	0.80
7/3.25	10.79	3.28	2.682	10.19	3.19	2.607
19/2.75	40.75	6.38	5.212	38.49	6.20	5.066

5.3.8 HTLS ACCFCS short circuit ratings

Conductor	T_{init} = 100°C (Phase conductor)		
Stranding	kA².s	kA for 1.0s	kA for 1.5s
Brussels	2154	Isc = 46.42 kA	Isc = 37.90 kA
Milan	3900	Isc = 62.46 kA	Isc = 50.99 kA
Paris	7945	Isc = 89.14 kA	Isc = 72.76 kA
Athens	23193	Isc = 152.30 kA	Isc = 124.32 kA

5.3.9 OPGW short circuit ratings

Conductor	T_{init} = 40°C (Earthwire)		
Stranding	kA².s	kA for 1.0s	kA for 1.5s
48 SMF OPGW	250.1	15.81	12.91
144 SMF OPGW	250.1	15.81	12.91

5.3.10 Hardex short circuit ratings at max temperature 160°

Conductor	T_{init} = 40°C (Earthwire)		
Stranding	kA².s	kA for 1.0s	kA for 1.5s
Hardex 5C Pilot	13.82	3.72	3.036

5.3.11 Hardex short circuit ratings at max temperature 300°

Conductor	T_{init} = 40°C (Earthwire)		
Stranding	kA².s	kA for 1.0s	kA for 1.5s
Hardex 5C Pilot	25.04	5.00	4.086

Note: Increased max temperature may be considered where pilots are no longer required due to damage or installation of ADSS.

6 Authorities and Responsibilities

General Manager Future Grid & Asset Management has the authority and responsibility for:

- Approving technical standards, including any variations
- Making all decisions concerning compliance with this standard
- Delegating any of these authorities and responsibilities to the Head of Asset Management & Digital

Head of Asset Management & Digital has the authority and responsibility for:

- Reviewing technical standards and making recommendations to the General Manager Future Grid & Asset Management.
- Making recommendations concerning compliance with this standard.

Head of Future Energy Planning has the authority and responsibility for:

- The conductor ratings of commissioned network assets are appropriately and accurately recorded in Network Characteristics.

Asset Engineering Manager has the authority and responsibility for:

- Periodic review of and any required amendments to this standard.
- Managing dispensation requests for variations to requirements of this standard.

Design Manager – Mains has the authority and responsibility for: Designs comply with this standard for overhead current ratings. Including selection of conductors for new feeders, ensuring that loading requirements are met without exceeding the prescribed operating limits.

ADMS Manager has the authority and responsibility for:

- Ensuring all continuous feeder ratings recorded in Network Characteristics are implemented in ADMS

Network Control Manager has the authority and responsibility for:

- Ensuring all Network Control staff comply with the requirements of this Standard.

Customer Network Engineers are responsible for:

- Reviewing designs from L3 ASPs and communicating with L3 ASPs to ensure compliance with this standard

Project Managers are responsible for

- Providing WAE feeder ratings to the Head of Future Energy Planning at the time of project commissioning for recording in Network Characteristics

Annexure 1: Effect of altitude on continuous current ratings

Company Policy 9.2.10 specifies that an altitude of 1000m should be assumed when calculating ratings for the *mountainous region*. D(b)5-1988 does not factor altitude into the calculation of continuous current ratings, but it is possible to adjust this method to take altitude into account.

As altitude increases, the air density decreases, reducing the ability of air to carry heat away from a conductor. The relative air density at height h above sea level is:

$$\rho_{rel}(h) = \frac{\rho(h)}{\rho(0)} \approx exp(-1.16 \times 10^{-4} \times h)$$

The changing air density can be incorporated into ratings by recognising that the viscosity of the air film varies inversely with density, so:

$$v_f(h) = \frac{v_f(0)}{\rho_{rel}(h)}$$

Where: $\nu_f(0)$ is the viscosity of the air film at sea level, equal to ν_f as defined in D(b)5-1988.

Replacing ν_f with $\nu_f(h)$ in the equation for the Reynolds number gives:

$$R_e(h) = \frac{v \times D}{v_f(h)} \approx exp(-1.16 \times 10^{-4} \times h) \frac{v \times D}{v_f(0)}$$

The remainder of the ratings calculation can then proceed as normal.

As a guide, the air density at an altitude of 1000m is about 11% less than at sea level. This corresponds to approximately a 3% reduction in continuous current ratings, although this varies slightly based on the conductor and other parameters.

Annexure 2: Guide to the application of the kA^2.s fault rating

The kA²·s short circuit rating supplied in Section 5.3 can be used to determine either the maximum permissible fault current, or the required clearance time for a known short circuit current.

The application of this procedure shall be in accordance with the minimum requirements set by Company Policy 9.2.10: Network Asset Ratings.

Where the fault clearance time is known, the maximum permissible fault current for a conductor is calculated using:

$$I_{SC} = \sqrt{\frac{kA^2 \cdot s}{t_{clearance}}}$$

Alternatively, where the short circuit current is known, the maximum time a fault may persist before the conductor temperature is exceeded is given by:

$$t_{clearance} = \frac{kA^2 \cdot s}{{I_{SC}}^2}$$

Where:

I_{SC}	short circuit current in kA
$kA^2 \cdot s$	conductor short circuit rating, specified by this document in kA²·s
$t_{clearance}$	duration to clear short circuit current in seconds

Note: $t_{clearance}$ shall be less than 5 seconds. The result is not valid for values greater than 5 seconds.

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