

GROUNDING SYSTEM – CONDUCTORS AND CONNECTORS

The grounding conductor size is based on the maximum magnitude and duration of available fault current, and on the type of connections being used in the grounding system.

IEEE Std. 80-2000, Guide for Safety in Substation Grounding, the accepted industry standard, uses a fusing formula as the basis for selecting minimum conductor size to avoid fusing (melting) under fault conditions.

This formula can be simplified to the following:

$$A = K \cdot I \sqrt{S}$$

Where: A = Conductor size in circular mils
 K = Constant from the following table
 I = RMS fault current in amperes
 S = Fault time in seconds

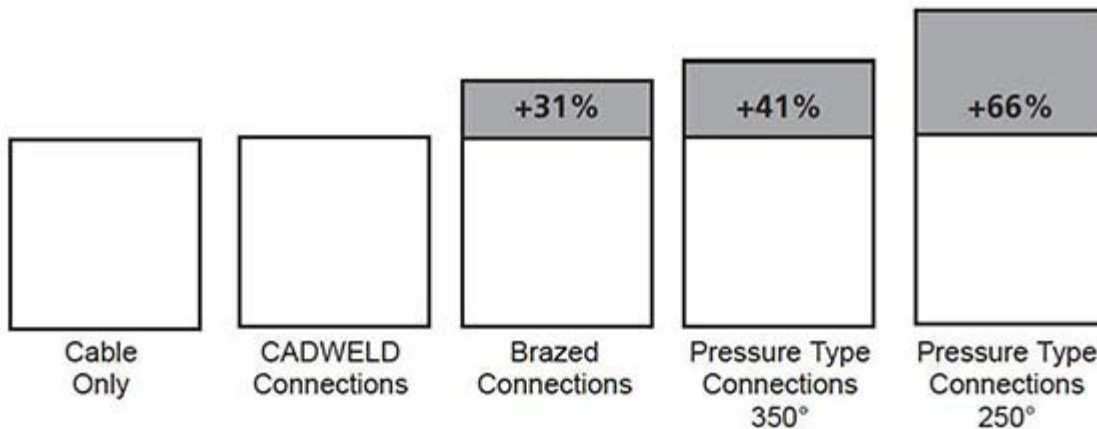
Based on the standard ambient temperature of 40°C.

MAX TEMP	CONSTANT K FOR ABOVE FORMULA		
	COPPER S.D.	COPPERWELD DSA 40%	COPPERWELD DSA 30%
1083 C	7.01	10.46	12.04
450 C	9.18	13.74	15.87
350 C	10.10	15.13	17.46
250 C	11.65	17.47	20.17

The temperatures listed above for each material are specified in IEEE Std. 80-2000 to be used for different types of connecting means;

Pressure type connectors	250° to 350°C*
Brazed connections	450°C
Exothermic welded connections	1083°C

*except those which have been tested to and passed the requirements of IEEE Std. 837-1989.



EXAMPLE – 25,000 Ampere, 2 second fault:

CONNECTION TYPE	CONDUCTOR SIZE
CADWELD	.246 kcmil – use 250 kcmil
Brazed	.322 kcmil – use 350 kcmil
Pressure Type (at 350 C)	.357 kcmil – use 350 kcmil
Pressure Type (at 250 C)	.408 kcmil – use 400 kcmil

BARE CLASS A, B, AND C CONCENTRIC STRANDED CONDUCTOR

Based on A.S.T.M. Standard Specifications.

Size in Circular mils	Size A.W.G.	Conductor Dia. In.	NUMBER OF WIRES					CADWELD Cable code	
			7	19	37	61	91		
1,000,000		1.152			.1644*	.1280	.1048	4Y	
800,000		1.031			.1470*	.1145	.0938	4Q	
750,000		.998			.1424*	.1109	.0908	4L	
700,000		.964			.1375*	.1071	.0877	4G	
600,000		.893				.1273	.0992	.0812	3X
500,000		.813		.1622*	.1162	.0905			3Q
400,000		.728		.1451	.1040	.0810			3H
350,000		.681		.1357	.0973	.0757			3D
300,000		.630		.1257	.0900	.0701			3A
250,000		.575		.1147	.0822	.0640			2V
211,600	4/0	.528	.1739	.1055	.0756				2Q
167,800	3/0	.470	.1548	.0940	.0673				2L
133,100	2/0	.419	.1379	.0837	.0600				2G
105,500	1/0	.373	.1228	.0745	.0534				2C
83,690	1	.332	.1093	.0664	.0476				1Y
66,370	2	.292	.0974	.0591					1V
52,630	3	.260	.0867	.0526					1Q
41,740	4	.232	.0772	.0469					1L
26,240	6	.184	.0612	.0372					1H
16,510	8	.146	.0486	.0295					1E
10,380	10	.116	.0385	.0234					1B
6,530	12	.0915	.0305	.0185					
4,110	14	.0726	.0242	.0147					

*Class AA



BARE SOLID COPPER WIRE

DSA COPPERWELD CONDUCTOR

Based on A.S.T.M. Standard Specifications

Size A.W.G.	Cross Sectional Area Circular Mills	Wire Dia. In.	CADWELD Cable code
4/0	211,600	.4600	2P
3/0	167,800	.4096	2K
2/0	133,100	.3648	2F
1/0	105,500	.3249	2B
1	83,690	.2893	1X
2	66,370	.2576	1T
3	52,630	.2294	1P
4	41,740	.2043	1K
6	26,250	.1620	1G
8	16,510	.1285	1D
10	10,380	.1019	1A
12	6,530	.0808	
14	4,110	.0664	

Cable Stranding	Nominal Diameter	kcmil	Equivalent Copper Size*	CADWELD Cable code
7/#10	.306	72.7	3AWG	9A
7/#8	.385	115.6	1	9B
7/#7	.433	145.7	1/0	9C
7/#6	.486	183.8	2/0	9D
7/#5	.546	231.7	3/0	9E
19/#9	.572	248.8	3/0	9F
7/#4	.613	292.2	4/0	9L
19/#8	.642	313.7	4/0	9G
19/#7	.721	395.5	250 Kcmil	9H
37/#9	.801	484.4	300	7W
19/#6	.810	498.8	350	9J
37/#8	.899	610.9	400	7V
19/#5	.910	628.9	450	9K
37/#7	1.01	770.3	500	9M

*Approximate based on Fusing Current calculations and tests by Copperweld Co.

GROUND RODS

Nominal Size	Material	Type	Thread Size	Body Dia.	CADWELD Ground Rod Code
1/2"	Copperclad Steel*	Sectional	9/16"	.505	14
	Copperclad Steel*	Plain		.500	14
	Copperclad Steel*	Plain		.475	15
	Copperclad Steel*	Sectional	1/2"	.447	13
5/8"	Copperclad Steel*	Sectional	5/8"	.563	16
	Copperclad Steel*	Plain		.625	31
	Copperclad Steel*	Plain		.563	16
3/4"	Copperclad Steel*	Sectional	3/4"	.682	18
	Copperclad Steel*	Plain		.750	33
	Copperclad Steel*	Plain		.682	18
1"	Copperclad Steel*	Sectional	1"	.914	22
	Copperclad Steel*	Plain		1.00	37
	Copperclad Steel*	Plain		.914	22

* Plain steel, stainless steel, stainless clad rods or galvanized steel.

RECTANGULAR COPPER BUSBAR

Thickness Inches	Width Inches	Circular Mil Size	Weight Lbs. per Foot	CADWELD Bus Bar Code
1/8	1	159,200	.484	CE
	1-1/2	238,700	.726	CG
	2	318,300	.969	CH
3/16	1	238,700	.727	DE
	2	477,500	1.45	DH
1/4	1	318,300	.969	EE
	1-1/2	477,500	1.45	EG
	2	636,600	1.94	EH
	3	954,900	2.91	EK
3/8	4	1,273,000	3.88	EM
	1	477,500	1.45	GE
	1-1/2	716,200	2.18	GG
	2	954,900	2.91	GH
1/2	3	1,432,000	4.36	GK
	4	1,910,000	5.81	GM
	2	1,273,000	3.88	JH
	3	1,910,000	5.81	JK
	4	2,546,000	7.75	JM

REINFORCING BARS

USEFUL CONVERSIONS	
Area	
Square Inches x 1273 = kcmil	
Square Millimeters x 1.974 = kcmil	
kcmil x 0.5067 = Square Millimeters	
Density	
Copper:	0.323lb/in ³
Steel:	0.283lb/in ³

Rebar Sizes	NOMINAL DIMENSIONS		Equivalent Copper Sizes*	CADWELD Rebar Code
	Dia. Inches	Cross-Sectional Area - Sq. Inches		
3	.375	.11	9AWG	51
4	.500	.20	7	52
5	.625	.31	5	53
6	.750	.44	3	54
7	.875	.60	2	55
8	1.000	.79	1	56
9	1.128	1.00	1/0	57
10	1.270	1.27	2/0	58
11	1.410	1.56	3/0	59
14	1.693	2.25	250 kcmil	60
18	2.257	4.00	450	61

* Based on 8% IACS, rounded to the next higher commercial copper size.



STANDARD STEEL WIRE GAGE

(WASHBURN MOEN GAGE) SOLID

Gage No.	Dia. Inches	Gage No.	Dia. Inches
7/0	.490	6	.1920
6/0	.4615	7	.1770
5/0	.4305	8	.1620
4/0	.3938	9	.1483
3/0	.3625	10	.1350
2/0	.3310	11	.1205
1/0	.3065	12	.1055
1	.2830	13	.0915
2	.2625	14	.0800
3	.2437	15	.0720
4	.2253	16	.0625
5	.2070	17	.0540

STEEL PIPE SIZES

STANDARD WEIGHT ASTM A53-90-B
(SCHEDULE 40) ANSI/ASME B36.10M-1985

Nominal Size In	O.D. Inches	Wall Thickness Inches	CADWELD Mold Code
1	1.315	.133	1
1-1/4	1.660	.140	1.25
1-1/2	1.900	.145	1.50
2	2.375	.154	2
2-1/2	2.875	.203	2.50
3	3.500	.216	3
3-1/2	4.000	.226	3.50
4	4.500	.237	4
5	5.563	.258	5
6	6.625	.280	6
8	8.625	.322	8
10	10.750	.365	10

CAST IRON PIPE – CLASS A THRU D

AWWA Specification 1908,
ASA A21.2 Class 100-250.

Nominal Size (Inches)	Actual O.D. (Inches)
4	4.80 to 5.00
6	6.90 to 7.10
8	9.05 to 9.30
10	11.10 to 11.40
12	13.20 to 13.50
14	15.30 to 15.70
16	17.40 to 17.80
18	19.50 to 19.90
20	21.60 to 22.1
24	25.80 to 26.30
30	31.70 to 32.70
36	38.00 to 39.20
42	44.20 to 45.60
48	50.50 to 52.00
54	56.70 to 58.40
60	62.80 to 64.80
72	75.30 to 76.90
84	87.50 to 88.50

Other standard sections used for fence posts

Section	CADWELD Mold Code
1-1/2" square	PS15
2" square	PS20
2-1/2" square	PS25
3" square	PS30*
1.875 x 1.625 x .133 "H"	PH1
2.25 x 1.95 x .143 "H"	PH2

* For D or F mold price only