MUSCO ENGINEERING ASSOCIATES
Consulting Engineers www.muscoengineering.com

375 Morgan Lane, Unit 307
West Haven, CT 06516
Telephone #: (203) 932-1901
Fax #: (203) 931-1550

Electrical Charts, Tables and Formulas

Minimum Size Grounding Conductors for Grounding Raceways and Equipment (From NEC Table 250-122)

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size	
	Copper Wire Number	Aluminum or Copper Clad Aluminum Wire Number
15 20 30 40 50	14 12 10 10 10	12 10 8 8 8
100 200 300 400 500 600 800	8 6 4 3 2 1 1/0	6 4 2 1 1/0 2/0 3/0
1000 1200 1600 2000 2500	2/0 3/0 4/0 250 kcmil 350 kcmil	4/0 250 kcmil 350 kcmil 400 kcmil 600 kcmil
3000 4000 5000 6000	400 kcmil 500 kcmil 700 kcmil 800 kcmil	600 kcmil 800 kcmil 1200 kcmil 1200 kcmil

Ampere Ratings – Three Phase

KW	KVA	208V	240V	480V	600V
20	25	69	60	30	24
25	31	87	75	38	30
30	37	104	90	45	36
35	44	121	105	53	42
40	50	139	120	60	48
45	56	156	135	68	54
50	62	174	`50	75	61
60	75	208	180	90	72
80	100	278	241	120	96
100	125	347	301	150	120
125	156	433	376	188	150
150	187	519	450	225	180
180	225	625	542	271	217
200	250	694	601	301	241
225	281	781	677	339	272
250	312	866	751	375	300
300	375	1040	902	450	361
350	438	1216	1054	527	422
400	500	1388	1203	601	481
450	562	1562	1355	677	545
500	625	1735	1504	752	601
600	750	2082	1804	902	722
700	875	2429	2105	1053	842
750	938	2602	2255	1128	902
800	1000	2775	2406	1203	962
900	1125	3123	2706	1353	1083
1000	1250	3470	3007	1504	1203
1250	1563	4337	3759	1879	1504
1350	1688	-	-	2029	1624
1500	1875	-	-	2255	1804
1750	2188	-	-	2631	2105
1820	2275	-	-	2736	2189
2000	2500	-	-	3007	2406
2250	2813	-	-	-	-
2500	3125	-	-	3759	3007
2800	3500	-	-	4210	3368

To Find	Single Phase	Alternating Current Two Phase, Four Wire	Three Phase	Direct Current
Kilowatts	$\frac{I \times E \times pf}{1000}$	$\frac{I \times E \times 2 \times pf}{1000}$	$\frac{I \times E \times 1.73 \times pf}{1000}$	$\frac{I \times E}{1000}$
kVA	$\frac{I \times E}{1000}$	$\frac{I \times E \times 2}{1000}$	$\frac{I \times E \times 1.73}{1000}$	———
Horsepower (Output)	$\frac{I \times E \times \% EFF \times pf}{746}$	$\frac{I \times E \times 2 \times \% EFF \times pf}{746}$	$\frac{I \times E \times 1.73 \times \% EFF \times pf}{746}$	$\frac{I \times E \times \% EFF}{746}$
Amperes when Horsepower is Known	$\frac{HP \times 746}{E \times \% EFF \times pf}$	$\frac{HP \times 746}{2 \times E \times \% EFF \times pf}$	$\frac{HP \times 746}{1.73 \times E \times \% EFF \times pf}$	$\frac{HP \times 746}{E \times \% EFF}$
Amperes when Kilowatts is Known	$\frac{KW \times 1000}{E \times pf}$	$\frac{KW \times 1000}{2 \times E \times pf}$	$\frac{KW \times 1000}{1.73 \times E \times pf}$	$\frac{KW \times 1000}{E}$
Amperes when kVA is Known	$\frac{kVA \times 1000}{E}$	$\frac{kVA \times 1000}{2 \times E}$	$\frac{kVA \times 1000}{1.73 \times E}$	———

NEC CODE RULES	
Breaker/Fuse Ratings	240.6(A)
Conductor Ampacity	310.15 and Table 310.16
Equipment Grounding Conductor	250.122
Grounding Electrode Conductor	250.66
Motor Conductor Size	430.22 (Single) 430.24 (Multiple)
Motor Short-Circuit Protection	430.52
Transformer Overcurrent Protection	450.3

RULE OF THUMB FOR QUICK AMP CALCULATIONS		
480 Volt 3ph kW x 1.5	=	Amps
240 Volt 3ph kW x 3	=	Amps
208 Volt 3ph kW x 3.5	=	Amps
240 Volt 1ph (kW x 4) + 4%	=	Amps

FUEL CONSUMPTION			
Diesel	0.085 x kW	=	gal/hr
Gas	17,000 x kW	=	Btu/hr

POWER FORMULAS FOR 3 PHASE APPLICATIONS		
rKVA	Volts, Amps, Power Factor	$\frac{V \times A \times 1.73}{1000} \times \frac{1}{1-(PF)^2}$
HP – Engine Output	Generator, kW, Generator Eff., Radiator Fan Horsepower	$\left(\frac{KW}{Efficiency \times 0.746}\right) + FanHP$
kW – Required Motor	Motor HP, Eff.	$\frac{HP \times 0.746}{Efficiency}$
kVA – Required Motor	Motor HP, Eff., Power Factor	$\frac{HP \times 0.746}{Efficiency \times PF}$
Frequency	rpm, Poles	$\frac{rpm \times Poles}{2 \times 60}$
Poles	Frequency, rpm	$\frac{2 \times 60 \times Frequency}{rpm}$
rpm	Frequency, Poles	$\frac{2 \times 60 \times Frequency}{Poles}$
Diesel Fuel	7.38#/gal	Heat Value – 19,350 Btu/lb
Therm. Nat. Gas	100,000 Btu	Heat Value NG – 950 Btu/lb

FULL-LOAD CURRENT IN AMPERES FOR DC AND SINGLE PHASE AC MOTORS

HP	DC MOTORS			SINGLE PHASE AC MOTORS		
	120V	240V	550V	115V	208V	230V
1/6	--	--	--	4.4	2.4	2.2
1/4	3.1	1.6	--	5.8	3.2	2.9
1/3	4.1	2.0	--	7.2	4.0	3.6
1/2	5.4	2.7	--	9.8	5.4	4.9
3/4	7.6	3.8	--	13.8	7.6	6.9
1	9.5	4.7	--	16	8.8	8
1 ½	13.2	6.6	--	20	11	10
2	17	8.5	--	24	13.2	12
3	25	12.2	--	34	18.7	17
5	40	20	--	56	30.8	28
7 ½	58	29	12.2	80	44	40
10	76	38	16	100	55	50
15	--	55	24	--	--	--
20	--	72	31	--	--	--
25	--	89	38	--	--	--
30	--	106	46	--	--	--
40	--	140	61	--	--	--
50	--	173	75	--	--	--
60	--	206	90	--	--	--
75	--	255	111	--	--	--
100	--	341	148	--	--	--
125	--	425	185	--	--	--
150	--	506	222	--	--	--
200	--	675	294	--	--	--

MOTOR FULL-LOAD CURRENTS OF THREE PHASE AC INDUCTION TYPE MOTORS

Motor Rating Horsepower	CURRENT (AMPERES)			
	208V	230V	460V	575V
1/4	1.11	.96	.48	.38
1/3	1.34	1.18	.59	.47
1/2	2.4	2.2	1.1	.9
3/4	3.5	3.2	1.6	1.3
1	4.6	4.2	2.1	1.7
1 ½	6.6	6	3	2.4
2	7.5	6.8	3.4	2.7
3	10.6	9.6	4.8	3.9
5	16.7	15.2	7.6	6.1
7 ½	24.2	22.0	11.0	9.0
10	30.8	28.0	14.0	11.0
15	46.2	42.0	21.0	17.0
20	59.4	54	27	22
25	74.8	68	34	27
30	88	80	40	32
40	114	104	52	41
50	143	130	65	52
60	169	154	77	62
75	211	192	96	77
100	273	248	124	99
125	343	312	156	125
150	396	360	180	144
200	528	480	240	192
250	--	--	302	242
300	--	--	361	289
350	--	--	414	336
400	--	--	477	382
450	--	--	515	412
500	--	--	590	472

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250