so marked.

Table 3.10.2.6(B)(16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C, Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C*

Conductor Size mm²	Temperature Rating of Conductor [See Table 3.10.3.1(A)]					
	60°C	75°C	90°C	60°C	75°C	90°C
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM		
2.0(1.6)*	15	20	25	—	—	—
3.5(2.0)*	20	25	30	15	20	25
5.5(2.6)*	30	35	40	25	30	35
8.0(3.2)	40	50	55	30	40	45
14	55	65	75	40	50	65
22	70	85	95	55	65	80
30	85	100	115	65	80	90
38	100	115	130	75	90	105
50	115	140	150	90	110	125
60	130	155	170	100	120	135
80	155	190	205	120	145	165
100	185	220	240	140	170	190
125	210	255	285	165	200	225
150	240	285	320	190	230	255
175	260	305	345	205	245	275
200	275	325	360	220	265	300
250	315	375	425	255	305	345
325	370	435	490	300	355	405
375	395	470	530	315	380	430
400	400	480	535	320	385	440
500	445	530	595	365	435	485

*Refer to 3.10.2.6(B)(2)(a) for the ampacity correction factors where the ambient temperature is other than 30°C. Refer to 3.10.2.6(B)(3)(a) for more than three current-carrying conductors.

**Refer to 2.40.1.4(D) for conductor overcurrent protection limitations.

Table 3.10.2.6(B)(17) Allowable Ampacities of Single-Insulated Conductors Rated Up to and Including 2000 Volts in Free Air, Based on Ambient Temperature of 30°C*

Conductor Size mm²	Temperature Rating of Conductor [See Table 3.10.3.1(A)]					
	60°C	75°C	90°C	60°C	75°C	90°C
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM		
2.0(1.6)*	25	30	35	—	—	—
3.5(2.0)*	30	35	40	25	30	35
5.5(2.6)*	40	50	55	35	40	40
8.0(3.2)	55	65	75	45	50	55
14	80	100	110	65	80	85
22	105	130	145	85	105	115
30	125	150	165	95	115	130
38	145	175	195	115	135	155
50	180	210	235	135	165	185
60	200	235	265	155	185	210
80	245	290	325	185	225	255
100	285	340	380	220	265	295
125	335	400	445	260	310	350
150	375	445	505	295	355	400
175	410	495	560	325	390	440
200	440	530	590	345	410	465
250	510	620	685	405	485	545
325	600	720	800	475	560	640
375	645	775	875	510	615	690
400	660	795	890	520	630	705
500	755	905	1020	605	730	820

*Refer to 3.10.2.6(B)(2)(a) for the ampacity correction factors where the ambient temperature is other than 30°C.

**Refer to 2.40.1.4(D) for conductor overcurrent protection limitations.

Table 2.50.6.13 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size mm² (mm dia.)	
	Copper	Copper Aluminum or Copper-Clad Aluminum*
15	2.0(1.6)	3.5(2.0)
20	3.5(2.0)	5.5(2.6)
30	5.5(2.6)	8.0(3.2)
40	5.5(2.6)	8.0(3.2)
60	5.5(2.6)	8.0(3.2)
100	8.0(3.2)	14
200	14	22
300	22	30
400	30	38
500	30	50
600	38	60
800	50	80
1000	60	100
1200	80	125
1600	100	175
2000	125	200
2500	175	325
3000	200	325
4000	250	375
5000	375	600
6000	400	600

Note: Where necessary to comply with 2.50.1.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 2.50.6.11

Table 2.50.3.17 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] mm^2		Size of Grounding Electrode Conductor mm^2	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
30 or smaller	50 or smaller	8.0(3.2)	14
38 or 50	60 or 80	14	22
60 or 80	100 or 125	22	30
Over 80 through 175	Over 125 through 250	30	50
Over 175 through 325	Over 250 through 400	50	80
Over 325 through 500	Over 400 through 850	60	100
Over 500	Over 850	80	125

Table 4.30.14.2 Full-Load Currents in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
1/6	4.4	2.5	2.4	2.2	1 1/2	20	11.5	11.0	10
1/4	5.8	3.3	3.2	2.9	2	24	13.8	13.2	12
1/3	7.2	4.1	4.0	3.6	3	34	19.6	18.7	17
1/2	9.8	5.6	5.4	4.9	5	56	32.2	30.8	28
3/4	13.8	7.9	7.6	6.9	7 1/2	80	46.0	44.0	40
1	16	9.2	8.8	8.0	10	100	57.5	55.0	50

Table 4.30.14.4 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics.

The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)								Synchronous-Type Unity Power Factor[1] (Amperes)			
	115 Volts	200 Volts	208 Volts	230 Volts	400 Volts	460 Volts	575 Volts	2300 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
1/2	4.4	2.5	2.4	2.2	1.3	1.1	0.9	-	-	-	-	-
3/4	6.4	3.7	3.5	3.2	1.8	1.6	1.3	-	-	-	-	-
1	8.4	4.8	4.6	4.2	2.3	2.1	1.7	-	-	-	-	-
1 1/2	12.0	6.9	6.6	6.0	3.3	3.0	2.4	-	-	-	-	-
2	13.6	7.8	7.5	6.8	4.3	3.4	2.7	-	-	-	-	-
3	19.2*	11.0	10.6	9.6	6.1	4.8	3.9	-	-	-	-	-
5	30.4*	17.5	16.7	15.2	9.7	7.6	6.1	-	-	-	-	-
7 1/2	44.0*	25.3	24.2	22	14	11	9	-	-	-	-	-
10	56.0*	32.2	30.8	28	18	14	11	-	-	-	-	-
15	84.0*	48.3	46.2	42	27	21	17	-	-	-	-	-
20	108.0*	62.1	59.4	54	34	27	22	-	-	-	-	-
25	136.0*	78.2	74.8	68	44	34	27	-	53	26	21	-
30	160.0*	92	88	80	51	40	32	-	63	32	26	-
40	208.0*	120	114	104	66	52	41	-	83	41	33	-
50	260.0*	150	143	130	83	65	52	-	104	52	42	-
60	-	177	169	154	103	77	62	16	123	61	49	12
75	-	221	211	192	128	96	77	20	155	78	62	15
100	-	285	273	248	165	124	99	26	202	101	81	20
125	-	359	343	312	208	156	125	31	253	126	101	25
150	-	414	396	360	240	180	144	37	302	151	121	30
200	-	552	528	480	320	240	192	49	400	201	161	40
250	-	-	-	604*	403	302	242	60	-	-	-	-
300	-	-	-	722*	482	361	289	72	-	-	-	-
350	-	-	-	828*	560	414	336	83	-	-	-	-
400	-	-	-	954*	636	477	382	95	-	-	-	-
450	-	-	-	1030*	-	515	412	103	-	-	-	-
500	-	-	-	1180*	786	590	472	118	-	-	-	-

[1]For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

*Based on UL 508

Table 4.30.14.5(A) Conversion Table of Single-Phase Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating

For use only with 4.30.9.10, 4.40.1.2, 4.40.5.1, and 4.55.1.8(C).

Rated Horsepower	Maximum Locked-Rotor Current in Amperes, Single Phase			Rated Horsepower	Maximum Locked-Rotor Current in Amperes, Single Phase		
	115 Volts	208 Volts	230 Volts		115 Volts	208 Volts	230 Volts
1/2	58.8	32.5	29.4	3	204	113	102
3/4	82.8	45.8	41.4	5	336	186	168
1	96	53	48	7 1/2	480	265	240
1 1/2	120	66	60	10	1000	332	300
2	144	80	72				

Table 4.30.14.5(B) Conversion Table of Polyphase Design B, C, and D Maximum Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating and Design Letter

For use only with 4.30.9.10, 4.40.1.2, 4.40.5.1 and 4.55.1.8(C).

Rated Horsepower	Maximum Motor Locked-Rotor Current in Amperes, Two- and Three-Phase, Design B, C, and D*						
	115 Volts	200 Volts	208 Volts	230 Volts	400 Volts	460 Volts	575 Volts
	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D
1/2	40	23	22.1	20	20	10	8
3/4	50	28.8	27.6	25	20	12.5	10
1	60	34.5	33	30	20	15	12
1 1/2	80	46	44	40	27	20	16
2	100	57.5	55	50	34	25	20
3	128	73.6	71	64	43	32	25.6
5	184	105.8	102	92	61	46	36.8
7 1/2	254	146	140	127	84	63.5	50.8
10	324	186.3	179	162	107	81	64.8
15	464	267	257	232	154	116	93
20	580	334	321	290	194	145	116
25	730	420	404	365	243	183	146
30	870	500	481	435	289	218	174
40	1160	667	641	580	387	290	232
50	1450	834	802	725	482	363	290
60	-	1001	962	870	578	435	348
75	-	1248	1200	1085	722	543	434
100	-	1668	1603	1450	965	725	580
125	-	2087	2007	1815	1207	908	726
150	-	2496	2400	2170	1441	1085	868
200	-	3335	3207	2900	1927	1450	1160
250	-	-	-	3650	-	1825	1460
300	-	-	-	4400	-	2200	1760
350	-	-	-	5100	-	2550	2040
400	-	-	-	5800	-	2900	2320
450	-	-	-	6500	-	3250	2600
500	-	-	-	7250	-	3625	2900

*Design A motors are not limited to a maximum starting current or locked rotor current.

Table C.10 Maximum Number of Conductors or Fixture Wires in Rigid PVC Conduit, Schedule 80 (Based on Chapter 10: Table 10.1.1.1, Table 10.1.1.4, and Table 10.1.1.5)

Type	Conductor Size (AWG/kcmil)	Trade Size (Metric Designator)											
		1/2 (16)	3/4 (21)	1 (27)	1 1/4 (35)	1 1/2 (41)	2 (53)	2 1/2 (63)	3 (78)	3 1/2 (91)	4 (103)	5 (129)	6 (155)
		CONDUCTORS											
RHH, RHW, RHW-2	14	3	5	9	17	23	39	56	88	118	153	243	349
	12	2	4	7	14	19	32	46	73	98	127	202	290
	10	1	3	6	11	15	26	37	59	79	103	163	234
	8	1	1	3	6	8	13	19	31	41	54	85	122
	6	1	1	2	4	6	11	16	24	33	43	68	98
	4	1	1	1	3	5	8	12	19	26	33	53	77
	3	0	1	1	3	4	7	11	17	23	29	47	67
	2	0	1	1	3	4	6	9	14	20	25	41	58
	1	0	1	1	1	2	4	6	9	13	17	27	38
	1/0	0	0	1	1	1	3	5	8	11	15	23	33
	2/0	0	0	1	1	1	3	4	7	10	13	20	29
	3/0	0	0	1	1	1	3	4	6	8	11	17	25
	4/0	0	0	0	1	1	2	3	5	7	9	15	21
	250	0	0	0	1	1	1	2	4	5	7	11	16
	300	0	0	0	1	1	1	2	3	5	6	10	14
	350	0	0	0	1	1	1	1	3	4	5	9	13
	400	0	0	0	0	1	1	1	3	4	5	8	12
	500	0	0	0	0	1	1	1	2	3	4	7	10
	600	0	0	0	0	0	1	1	1	3	3	6	8
	700	0	0	0	0	0	1	1	1	2	3	5	7
	750	0	0	0	0	0	1	1	1	2	3	5	7
	800	0	0	0	0	0	1	1	1	2	3	4	7
	900	0	0	0	0	0	1	1	1	1	2	4	6
	1000	0	0	0	0	0	1	1	1	1	2	4	5
	1250	0	0	0	0	0	0	1	1	1	1	3	4
	1500	0	0	0	0	0	0	1	1	1	1	2	4
	1750	0	0	0	0	0	0	0	1	1	1	2	3
	2000	0	0	0	0	0	0	0	1	1	1	1	3
TW, THHW, THW, THW-2	14	6	11	19	35	49	82	118	185	250	324	514	736
	12	4	9	15	27	38	63	91	142	192	248	394	565
	10	3	6	11	20	28	47	68	106	143	185	294	421
	8	1	3	6	11	15	26	37	59	79	103	163	234
RHH*, RHW*, RHW-2*	14	4	8	13	23	32	55	79	123	166	215	341	490
	12	3	6	10	19	26	44	63	99	133	173	274	394
	10	2	5	8	15	20	34	49	77	104	135	214	307
	8	1	3	5	9	12	20	29	46	62	81	128	184
TW, THW, THHW, THW-2, RHH*, RHW*, RHW-2*	6	1	1	3	7	9	16	22	35	48	62	98	141
	4	1	1	3	5	7	12	17	26	35	46	73	105
	3	1	1	2	4	6	10	14	22	30	39	63	90
	2	1	1	1	3	5	8	12	19	26	33	53	77
	1	0	1	1	2	3	6	8	13	18	23	37	54
	1/0	0	1	1	1	3	5	7	11	15	20	32	46
	2/0	0	1	1	1	2	4	6	10	13	17	27	39
	3/0	0	0	1	1	1	3	5	8	11	14	23	33
	4/0	0	0	1	1	1	3	4	7	9	12	19	27

(continues)

Table C.10 *Continued*

Type	Conductor Size (AWG/kcmil)	Trade Size (Metric Designator)											
		1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6
		(16)	(21)	(27)	(35)	(41)	(53)	(63)	(78)	(91)	(103)	(129)	(155)
TW, THW, THHW, THW-2, RHH*, RHW*, RHW-2*	250	0	0	0	1	1	2	3	5	7	9	15	22
	300	0	0	0	1	1	1	3	5	6	8	13	19
	350	0	0	0	1	1	1	2	4	6	7	12	17
	400	0	0	0	1	1	1	2	4	5	7	10	15
	500	0	0	0	1	1	1	1	3	4	5	9	13
	600	0	0	0	0	1	1	1	2	3	4	7	10
	700	0	0	0	0	1	1	1	2	3	4	6	9
	750	0	0	0	0	0	1	1	1	3	4	6	8
	800	0	0	0	0	0	1	1	1	3	3	6	8
	900	0	0	0	0	0	1	1	1	2	3	5	7
	1000	0	0	0	0	0	1	1	1	2	3	5	7
	1250	0	0	0	0	0	1	1	1	1	2	4	5
	1500	0	0	0	0	0	0	1	1	1	1	3	4
	1750	0	0	0	0	0	0	1	1	1	1	3	4
	2000	0	0	0	0	0	0	0	1	1	1	2	3
THHN, THWN, THWN-2	14	9	17	28	51	70	118	170	265	358	464	736	1055
	12	6	12	20	37	51	86	124	193	261	338	537	770
	10	4	7	13	23	32	54	78	122	164	213	338	485
	8	2	4	7	13	18	31	45	70	95	123	195	279
	6	1	3	5	9	13	22	32	51	68	89	141	202
	4	1	1	3	6	8	14	20	31	42	54	86	124
	3	1	1	3	5	7	12	17	26	35	46	73	105
	2	1	1	2	4	6	10	14	22	30	39	61	88
	1	0	1	1	3	4	7	10	16	22	29	45	65
	1/0	0	1	1	2	3	6	9	14	18	24	38	55
	2/0	0	1	1	1	3	5	7	11	15	20	32	46
	3/0	0	1	1	1	2	4	6	9	13	17	26	38
	4/0	0	0	1	1	1	3	5	8	10	14	22	31
	250	0	0	1	1	1	3	4	6	8	11	18	25
	300	0	0	0	1	1	2	3	5	7	9	15	22
	350	0	0	0	1	1	1	3	5	6	8	13	19
	400	0	0	0	1	1	1	3	4	6	7	12	17
	500	0	0	0	1	1	1	2	3	5	6	10	14
	600	0	0	0	0	1	1	1	3	4	5	8	12
	700	0	0	0	0	1	1	1	2	3	4	7	10
	750	0	0	0	0	1	1	1	2	3	4	7	9
	800	0	0	0	0	1	1	1	2	3	4	6	9
	900	0	0	0	0	0	1	1	1	3	3	6	8
	1000	0	0	0	0	0	1	1	1	2	3	5	7
FEP, FEPB, PFA, PFAH, TFE	14	8	16	27	49	68	115	164	257	347	450	714	1024
	12	6	12	20	36	50	84	120	188	253	328	521	747
	10	4	8	14	26	36	60	86	135	182	235	374	536
	8	2	5	8	15	20	34	49	77	104	135	214	307
	6	1	3	6	10	14	24	35	55	74	96	152	218
	4	1	2	4	7	10	17	24	38	52	67	106	153
	3	1	1	3	6	8	14	20	32	43	56	89	127
	2	1	1	3	5	7	12	17	26	35	46	73	105

(continues)

Table C.4 Maximum Number of Conductors or Fixture Wires in Intermediate Metal Conduit (IMC) (Based on Chapter 10: Table 10.1.1.1, Table 10.1.1.4, and Table 10.1.1.5)

Type	Conductor Size (AWG/kcmil)	Trade Size (Metric Designator)										
		3/8 (12)	1/2 (16)	3/4 (21)	1 (27)	1 1/4 (35)	1 1/2 (41)	2 (53)	2 1/2 (63)	3 (78)	3 1/2 (91)	4 (103)
		CONDUCTORS										
RHH, RHW, RHW-2	14	-	4	8	13	22	30	49	70	108	144	186
	12	-	4	6	11	18	25	41	58	89	120	154
	10	-	3	5	8	15	20	33	47	72	97	124
	8	-	1	3	4	8	10	17	24	38	50	65
	6	-	1	1	3	6	8	14	19	30	40	52
	4	-	1	1	3	5	6	11	15	23	31	41
	3	-	1	1	2	4	6	9	13	21	28	36
	2	-	1	1	1	3	5	8	11	18	24	31
	1	-	0	1	1	2	3	5	7	12	16	20
	1/0	-	0	1	1	1	3	4	6	10	14	18
	2/0	-	0	1	1	1	2	4	6	9	12	15
	3/0	-	0	0	1	1	1	3	5	7	10	13
	4/0	-	0	0	1	1	1	3	4	6	9	11
	250	-	0	0	1	1	1	1	3	5	6	8
	300	-	0	0	0	1	1	1	3	4	6	7
	350	-	0	0	0	1	1	1	2	4	5	7
	400	-	0	0	0	1	1	1	2	3	5	6
	500	-	0	0	0	1	1	1	1	3	4	5
	600	-	0	0	0	0	1	1	1	2	3	4
	700	-	0	0	0	0	1	1	1	2	3	4
	750	-	0	0	0	0	1	1	1	1	3	4
	800	-	0	0	0	0	0	1	1	1	3	3
	900	-	0	0	0	0	0	1	1	1	2	3
	1000	-	0	0	0	0	0	1	1	1	2	3
	1250	-	0	0	0	0	0	1	1	1	1	1
	1500	-	0	0	0	0	0	0	1	1	1	1
	1750	-	0	0	0	0	0	0	1	1	1	1
	2000	-	0	0	0	0	0	0	1	1	1	1
TW, THHW, THW, THW-2	14	-	10	17	27	47	64	104	147	228	304	392
	12	-	7	13	21	36	49	80	113	175	234	301
	10	-	5	9	15	27	36	59	84	130	174	224
	8	-	3	5	8	15	20	33	47	72	97	124
RHH*, RHW*, RHW-2*	14	-	6	11	18	31	42	69	98	151	202	261
	12	-	5	9	14	25	34	56	79	122	163	209
	10	-	4	7	11	19	26	43	61	95	127	163
	8	-	2	4	7	12	16	26	37	57	76	98
TW, THW, THHW, THW-2, RHH*, RHW*, RHW-2*	6	-	1	3	5	9	12	20	28	43	58	75
	4	-	1	2	4	6	9	15	21	32	43	56
	3	-	1	1	3	6	8	13	18	28	37	48
	2	-	1	1	3	5	6	11	15	23	31	41
	1	-	1	1	1	3	4	7	11	16	22	28
	1/0	-	1	1	1	3	4	6	9	14	19	24
	2/0	-	0	1	1	2	3	5	8	12	16	20
	3/0	-	0	1	1	1	3	4	6	10	13	17
	4/0	-	0	1	1	1	2	4	5	8	11	14

(continues)

Table C.4 *Continued*

Type	Conductor Size (AWG/kcmil)	Trade Size (Metric Designator)										
		3/8 (12)	1/2 (16)	3/4 (21)	1 (27)	1 1/4 (35)	1 1/2 (41)	2 (53)	2 1/2 (63)	3 (78)	3 1/2 (91)	4 (103)
TW, THW, THHW, THW-2, RHH*, RHW*, RHW-2*	250	-	0	0	1	1	1	3	4	7	9	12
	300	-	0	0	1	1	1	2	4	6	8	10
	350	-	0	0	1	1	1	2	3	5	7	9
	400	-	0	0	0	1	1	1	3	4	6	8
	500	-	0	0	0	1	1	1	2	4	5	7
	600	-	0	0	0	1	1	1	1	3	4	5
	700	-	0	0	0	0	1	1	1	3	4	5
	750	-	0	0	0	0	1	1	1	2	3	4
	800	-	0	0	0	0	1	1	1	2	3	4
	900	-	0	0	0	0	1	1	1	2	3	4
	1000	-	0	0	0	0	0	1	1	1	3	3
	1250	-	0	0	0	0	0	1	1	1	1	3
	1500	-	0	0	0	0	0	1	1	1	1	2
	1750	-	0	0	0	0	0	0	1	1	1	1
	2000	-	0	0	0	0	0	0	1	1	1	1
THHN, THWN, THWN-2	14	-	14	24	39	68	91	149	211	326	436	562
	12	-	10	17	29	49	67	109	154	238	318	410
	10	-	6	11	18	31	42	69	97	150	200	258
	8	-	3	6	10	18	24	39	56	86	115	149
	6	-	2	4	7	13	17	28	40	62	83	107
	4	-	1	3	4	8	11	17	25	38	51	66
	3	-	1	2	4	6	9	15	21	32	43	56
	2	-	1	1	3	5	7	12	17	27	36	47
	1	-	1	1	2	4	5	9	13	20	27	35
	1/0	-	1	1	1	3	4	8	11	17	23	29
	2/0	-	1	1	1	3	4	6	9	14	19	24
	3/0	-	0	1	1	2	3	5	7	12	16	20
	4/0	-	0	1	1	1	2	4	6	9	13	17
	250	-	0	0	1	1	1	3	5	8	10	13
	300	-	0	0	1	1	1	3	4	7	9	12
	350	-	0	0	1	1	1	2	4	6	8	10
	400	-	0	0	1	1	1	2	3	5	7	9
	500	-	0	0	0	1	1	1	3	4	6	7
	600	-	0	0	0	1	1	1	2	3	5	6
	700	-	0	0	0	1	1	1	1	3	4	5
	750	-	0	0	0	1	1	1	1	3	4	5
	800	-	0	0	0	0	1	1	1	3	4	5
	900	-	0	0	0	0	1	1	1	2	3	4
	1000	-	0	0	0	0	1	1	1	2	3	4
FEP, FEPB, PFA, PFAH, TFE	14	-	13	23	38	66	89	145	205	317	423	545
	12	-	10	17	28	48	65	106	150	231	309	398
	10	-	7	12	20	34	46	76	107	166	221	285
	8	-	4	7	11	19	26	43	61	95	127	163
	6	-	3	5	8	14	19	31	44	67	90	116
	4	-	1	3	5	10	13	21	30	47	63	81
	3	-	1	3	4	8	11	18	25	39	52	68
	2	-	1	2	4	6	9	15	21	32	43	56

(continues)

Table 10.1.1.9 Alternating-Current Resistance and Reactance for 600-Volt Cables, 3-Phase, 60 Hz, 75°C -Three Single Conductors in Conduit

Conductor Size [mm2 (mm dia.)]	Ohms to Neutral per 305 m													
	XL (Reactance) for All Wires		Alternating-Current Resistance for Uncoated Copper Wires			Alternating-Current Resistance for Aluminum Wires			Effective Z at 0.85 PF for Uncoated Copper Wires			Effective Z at 0.85 PF for Aluminum Wires		
	PVC, Aluminum Conduits	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit
2.0 (1.6)	0.058	0.073	3.1	3.1	3.1	-	-	-	2.7	2.7	2.7	-	-	-
3.5 (2.0)	0.054	0.068	2.0	2.0	2.0	3.2	3.2	3.2	1.7	1.7	1.7	2.8	2.8	2.8
5.5 (2.6)	0.050	0.063	1.2	1.2	1.2	2.0	2.0	2.0	1.1	1.1	1.1	1.8	1.8	1.8
8.0 (3.2)	0.052	0.065	0.78	0.78	0.78	1.3	1.3	1.3	0.69	0.69	0.70	1.1	1.1	1.1
14	0.051	0.064	0.49	0.49	0.49	0.81	0.81	0.81	0.44	0.45	0.45	0.71	0.72	0.72
22	0.048	0.060	0.31	0.31	0.31	0.51	0.51	0.51	0.29	0.29	0.30	0.46	0.46	0.46
30	0.045	0.057	0.19	0.20	0.20	0.32	0.32	0.32	0.19	0.19	0.20	0.30	0.30	0.30
38	0.046	0.057	0.15	0.16	0.16	0.25	0.26	0.25	0.16	0.16	0.16	0.24	0.24	0.25
50	0.044	0.055	0.12	0.13	0.12	0.20	0.21	0.20	0.13	0.13	0.13	0.19	0.20	0.20
60	0.043	0.054	0.10	0.10	0.10	0.16	0.16	0.16	0.11	0.11	0.11	0.16	0.16	0.16
80	0.042	0.052	0.077	0.082	0.079	0.13	0.13	0.13	0.088	0.092	0.094	0.13	0.13	0.14
100	0.041	0.051	0.062	0.067	0.063	0.10	0.11	0.10	0.074	0.078	0.080	0.11	0.11	0.11
125	0.041	0.052	0.052	0.057	0.054	0.085	0.090	0.086	0.066	0.070	0.073	0.094	0.098	0.10
150	0.041	0.051	0.044	0.049	0.045	0.071	0.076	0.072	0.059	0.063	0.065	0.082	0.086	0.088
175	0.040	0.050	0.038	0.043	0.039	0.061	0.066	0.063	0.053	0.058	0.060	0.073	0.077	0.080
200	0.040	0.049	0.033	0.038	0.035	0.054	0.059	0.055	0.049	0.053	0.056	0.066	0.071	0.073
250	0.039	0.048	0.027	0.032	0.029	0.043	0.048	0.045	0.043	0.048	0.050	0.057	0.061	0.064
325	0.039	0.048	0.023	0.028	0.025	0.036	0.041	0.038	0.040	0.044	0.047	0.051	0.055	0.058
375	0.038	0.048	0.019	0.024	0.021	0.029	0.034	0.031	0.036	0.040	0.043	0.045	0.049	0.052
400	0.038	0.048	0.019	0.024	0.021	0.029	0.034	0.031	0.036	0.040	0.043	0.045	0.049	0.052
500	0.037	0.046	0.015	0.019	0.018	0.023	0.027	0.025	0.032	0.036	0.040	0.039	0.042	0.046

Notes:

(1) These values are based on the following constants: UL-Type RHH wires with Class B stranding, in cradled configuration. Wire conductivities are 100 percent IACS copper and 61 percent IACS aluminum, and aluminum conduit is 45 percent IACS. Capacitive reactance is ignored, since it is negligible at these voltages. These resistance values are valid only at 75°C and for the parameters as given, but are representative for 600-volt wire types operating at 60 Hz.

(2) Effective Z is defined as R cos(θ) + X sin(θ), where θ is the power factor angle of the circuit. Multiplying current by effective impedance gives a good approximation for line-to-neutral voltage drop. Effective impedance values shown in this table are valid only at 0.85 power factor. For another circuit power factor (PF), effective impedance (Ze) can be calculated from R and X L values given in this table as follows: Ze = R × PF + X L sin[arccos(PF)].

Table 10.1.1.8 Conductor Properties

Conductor Size [mm2 (mm dia.)]	Conductors				Direct-Current Resistance at 75°C		
	Stranding		Overall		Copper		Aluminum
	Quantity	Diameter (mm)	Diameter (mm)	Area (mm²)	Uncoated (ohm/305 m)	Coated (ohm/305 m)	(Ohm/305 m)
0.75 (1.0)	1	-	1.02	0.82	7.77	8.08	12.8
0.75 (1.0)	7	0.38	1.17	1.08	7.95	8.45	13.1
1.25 (1.2)	1	-	1.30	1.33	4.89	5.08	8.05
1.25 (1.2)	7	0.48	1.47	1.70	4.99	5.29	8.21
2.0 (1.6)	1	-	1.63	2.09	3.07	3.19	5.06
2.0 (1.6)	7	0.61	1.85	2.69	3.14	3.26	5.17
3.5 (2.0)	1	-	2.06	3.33	1.93	2.01	3.18
3.5 (2.0)	7	0.76	2.34	4.30	1.98	2.05	3.25
5.5 (2.6)	1	-	2.59	5.27	1.21	1.26	2.00
5.5 (2.6)	7	0.97	2.95	6.83	1.24	1.29	2.04
8.0 (3.2)	1	-	3.25	8.30	0.764	0.786	1.26
8.0 (3.2)	7	1.24	3.71	10.81	0.778	0.809	1.28
14	7	1.55	4.67	17.13	0.491	0.510	0.808
22	7	1.96	5.89	27.25	0.308	0.321	0.508
30	7	2.46	7.42	43.24	0.194	0.201	0.319
38	19	1.68	8.43	55.81	0.154	0.160	0.253
50	19	1.88	9.45	70.14	0.122	0.127	0.201
60	19	2.13	10.62	88.58	0.0967	0.101	0.159
80	19	2.39	11.94	111.97	0.0766	0.0797	0.126
100	19	2.69	13.41	141.24	0.0608	0.0626	0.100
125	37	2.08	14.61	167.65	0.0515	0.0535	0.0847
150	37	2.29	16.00	201.06	0.0429	0.0446	0.0707
200	37	2.64	18.49	268.51	0.0321	0.0331	0.0529
250	37	2.95	20.65	334.91	0.0258	0.0265	0.0424
325	61	2.51	22.68	404.00	0.0214	0.0223	0.0353
400	61	2.82	25.35	504.72	0.0171	0.0176	0.0282
500	61	3.25	29.26	672.42	0.0129	0.0132	0.0212
600	91	2.97	32.74	841.88	0.0103	0.0106	0.0169
750	91	3.25	35.86	1009.98	0.00858	0.00883	0.0141
875	127	2.97	38.76	1179.94	0.00735	0.00756	0.0121
1000	127	3.20	41.45	1349.40	0.00643	0.00662	0.0106

Notes:

(1) These resistance values are valid only for the parameters as given. Using conductors having coated strands, different stranding type, and, especially, other temperatures changes the resistance.

(2) Equation for temperature change: $R_2 = R_1 [1 + \alpha (T_2 - 75)]$, where $\alpha_{cu} = 0.00323$, $\alpha_{AL} = 0.00330$ at 75°C.

(3) Conductors with compact and compressed stranding have about 9 percent and 3 percent, respectively, smaller bare conductor diameters than those shown. See Table 5A for actual compact cable dimensions.

(4) The IACS conductivities used: bare copper = 100%, aluminum = 61%.

(5) Class B stranding is listed as well as solid for some sizes. Its overall diameter and area are those of its circumscribing circle.

Table 6.30.3.1(A)(2) Duty Cycle Multiplication Factors for Resistance Welders

Duty Cycle (%)	Multiplier
50	0.71
40	0.63
30	0.55
25	0.50
20	0.45
15	0.39
10	0.32
7.5	0.27
5 or less	0.22

6.30.3.2 Overcurrent Protection. Overcurrent protection for resistance welders shall be as provided in 6.30.3.2(A) and (B). Where the values as determined by this section do not correspond with the standard ampere ratings provided in 2.40.1.6 or where the rating or setting specified results in unnecessary opening of the overcurrent device, a higher rating or setting that does not exceed the next higher standard ampere rating shall be permitted.

(A) For Welders. Each welder shall have an overcurrent device rated or set at not more than 300 percent of the rated primary current of the welder. If the supply conductors for a welder are protected by an overcurrent device rated or set at not more than 200 percent of the rated primary current of the welder, a separate overcurrent device shall not be required.

(B) For Conductors. Conductors that supply one or more welders shall be protected by an overcurrent device rated or set at not more than 300 percent of the conductor ampacity.

Table 4.30.2.2(E) Duty-Cycle Service

Classification of Service	Nameplate Current Rating Percentages			
	5-Minute Rated Motor	15-Minute Rated Motor	30- & 60-Minute Rated Motor	Continuous Rated Motor
Short-time duty operating valves, raising or lowering rolls, etc	110	120	150	-
Intermittent duty freight and passenger elevators, tool heads, pumps, drawbridges, turntables, etc. (for arc welders, see 6.30.2.1)	85	85	90	140
Periodic duty rolls, ore- and coal- handling machines, etc.	85	90	95	140
Varying duty	110	120	150	200

Note: Any motor application shall be considered as continuous duty unless the nature of the apparatus it drives is such that the motor will not operate continuously with load under any condition of use.

Appendix B. Application Information for Ampacity Calculation

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

Relevant section numbering shown can be cross=referenced to PEC1 2017 from the table below. Other section numbering not shown is either unique to this appendix or has already been adapted to PEC1 2017 numbering.

NEC 2017	PEC1 2017
310.15(B)(2)(a)	3.10.2.6(B)(2)(a)
310.15(B)(2)(b)	3.10.2.6(B)(2)(b)
310.15(B)(3)(a)	3.10.2.6(B)(3)(a)
310.15(B)(16)	3.10.2.6(B)(16)
310.15(B)(17)	3.10.2.6(B)(17)
310.15(B)(18)	3.10.2.6(B)(18)
310.15(B)(19)	3.10.2.6(B)(19)
310.15(B)(20)	3.10.2.6(B)(20)
310.15(B)(21)	3.10.2.6(B)(21)

For cross-referencing conductor sizes, refer to the table below.

AWG/(kcmil)	mm^2 (mm dia.)
18	0.75 (1.0)
16	1.25 (1.2)
14	2 (1.6)
12	3.5 (2.0)
10	5.5 (2.6)
8	8 (3.2)
6	14
4	22
3	26
2	30
1	38
1/0	50
2/0	60
3/0	80
4/0	100
(250)	125
(300)	150
(350)	175
(400)	200
(500)	250
(600)	300*
(700)	350
(750)	375
(800)	400
(900)	450
(1000)	500
(1250)	625
(1500)	750
(1750)	875
(2000)	1000

* Size for Appendix B only.

B.1 Equation Application Information. This informative annex provides application information for ampacities calculated under engineering supervision.

B.2 Typical Applications Covered by Tables. Typical ampacities for conductors rated 0 through 2000 volts are shown in Table B.310.15(B)(2)(1) through Table B.310.15(B)(2)(10). Table B.310.15(B)(2)(11) provides the adjustment factors for more than three current-carrying conductors in a raceway or cable with load diversity. Underground electrical duct bank configurations, as detailed in Figure B.310.15(B)(2)(3), Figure B.310.15(B)(2)(4), and Figure B.310.15(B)(2)(5), are utilized for conductors rated 0 through 5000 volts. In Figure B.310.15(B)(2)(2) through Figure B.310.15(B)(2)(5), where adjacent duct banks are used, a separation of 1500 mm between the centerlines of the closest ducts in each bank or 1200 mm between the extremities of the concrete envelopes is sufficient to prevent derating of the conductors due to mutual heating. These ampacities were calculated as detailed in the basic ampacity paper, AIEE Paper 57-660, The Calculation of the Temperature Rise and Load Capability of Cable Systems, by J. H. Neher and M. H. McGrath. For additional information concerning the application of these ampacities, see IEEE STD 835-1994, Standard Power Cable Ampacity Tables.

Typical values of thermal resistivity (Rho) are as follows:

Average soil (90 percent of USA) = 90

Concrete = 55

Damp soil (coastal areas, high water table) = 60

Paper insulation = 550

Example D12
Voltage Regulators, Three-Phase, 60 Hz, 350-530 Volts Input, 230 Volts Output VR

Determine the size of input feeder wires and overcurrent protection for a 30 kVA, 3-phase, 60 hertz, 350-530 volts input, 230 volts output automatic voltage regulator.

$$I_{FL} = \frac{30 \text{ kVA x } 1000}{350 \text{ V x } 1.732}$$

$$= 50 \text{ Amperes}$$

Use 14 mm² THW for feeder wire and 60-ampere fuse or 60-ampere trip molded case circuit breaker.

Example D13
Available Short Circuit Current

Calculate the maximum symmetrical fault current that would be supplied through a single phase distribution transformer rated at 100 kVA, 230 volts if its impedance is 2.5%. Assuming that the primary source is of infinite capacity and neglecting all other impedances.

$$I_{sec} = \frac{\text{transformer volt-amperes}}{\text{secondary voltage}}$$

$$I_{sec} = \frac{100000}{230} = 434.78$$

$$I_{sc(sym)} = \frac{I_{sec}}{Z} \text{ (fault current, symmetrical)}$$

$$= \frac{434.78}{0.025} = 17391 \text{ amperes}$$

Example D14
Simplified Fault Current Calculation

A small factory is to be supplied at 230 volts, 3 ph, 60 hz by a bank of the distribution transformers rated at 100 kVA each with a bank impedance of 5%. This bank is connected to 34.5 kV Meralco line with a short circuit capacity of 1000 MVA. The power system is shown below.

Determine the maximum symmetrical fault currents at points "a", "b" and "c" using the per-unit method. Determine the minimum symmetrical interrupting ratings of molded case circuit breakers A, B, and C.

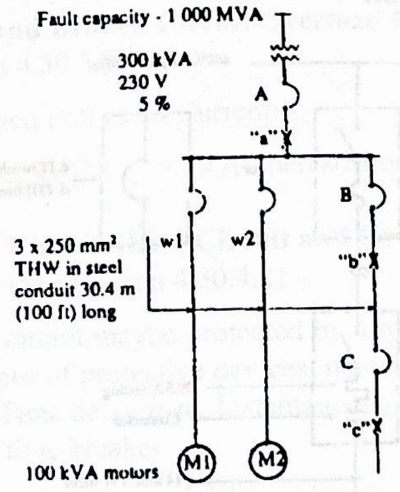
(Note, that for this example other impedance have been neglected. However, for actual design, consider all impedances of lines, busbars and other line devices.)

Procedure using the Per-Unit Method:

1. Draw system diagram

2. Draw impedance diagram

3. Obtain the Source Short Circuit level at the vicinity from the utility company. (1000000 kVA for Metro Manila grid)



4. Select kVA base. (Any convenient value may do but preferably the transformer capacity. Use 300 kVA)

5. Compute PU value of utility source, (pu Zs)

$$\text{pu } Z_s = \frac{\text{kVA base}}{\text{Utility SC kVA}} = \frac{300}{1000000} = 0.0003 \text{ pu}$$

6. Compute PU for transformer, (pu Z_t)

$$\text{pu } Z_t = \frac{\text{Impedance in percent}}{100} = \frac{5 \text{ (given)}}{100} = 0.05 \text{ pu}$$

7. Compute PU value for feeder lines,

a. From Handbooks, obtain impedance of lines corresponding to size, type and number of conductors, in steel conduits or nonferrous conduits, etc.

[For 3 - 250 mm² cable in steel conduit, 100 ft (30.4 m) long, Z = 0.00546 ohm]

b. Convert cable impedance from "ohm" to "pu", (pu Z_w)

$$\text{pu } Z_w = \frac{\text{ohm impedance}}{\text{kV square}} \text{ x } \frac{\text{kVA base}}{1000}$$

$$\frac{0.00546}{0.230 \text{ x } 0.230} \text{ x } \frac{300}{1000} = 0.031 \text{ pu}$$

8. Compute PU value for motor contribution, (pu Z_m)

$$\text{pu } Z_m = \frac{\text{kVA base}}{\text{motor kVA/motor impedance}} = \frac{300}{100/0.25^*} = 0.75 \text{ pu}$$

******Average induction motor impedance per IEEE Std 141*

9. Compute for short circuit currents at designated points.

9.1 Draw impedance diagram.

9.2 Draw simplified diagram with values.

9.3 Combine impedance (pu Zc) up to the fault.

9.4 Compute short circuit current, I_{sc}, (symmetrical)

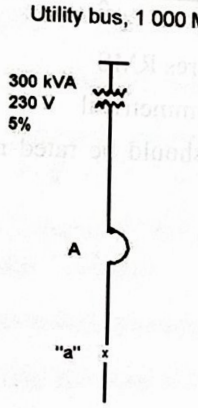
$$I_{sc(sym)} = \frac{\text{pu voltage}}{\text{pu } Z_c} \times \frac{\text{base kVA} \times 1000}{1.732 \times \text{base voltage}}$$

9.5 If asymmetrical values of short circuit currents are needed, multiply the symmetrical values by 1.25.

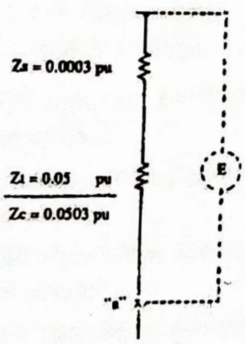
10. Computations at Fault Points:

10.1 Fault at "a" (The fault current to be cleared by Breaker A comes only from the transformer. There are no contributions from the motors.)

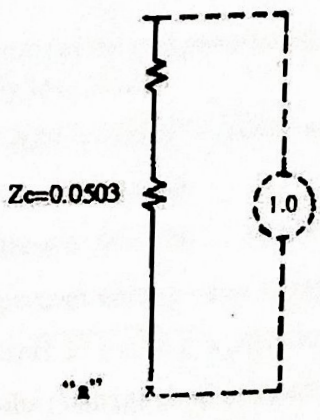
a. Single line diagram



b. Impedance diagram



c. Simplified diagram



d. Fault current at "a"

$$I_{sc(sym)} = \frac{E}{Z_c} \times \frac{\text{base VA}}{1.732 \times \text{base voltage}}$$

$$= \frac{1.0}{0.0503} \times \frac{300000}{1.732 \times 230}$$

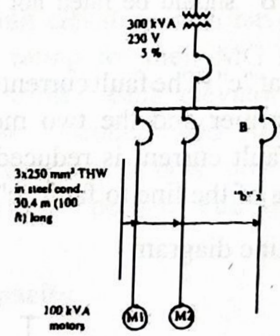
$= 14972$ amperes RMS

Say 15 000 A RMS symmetrical

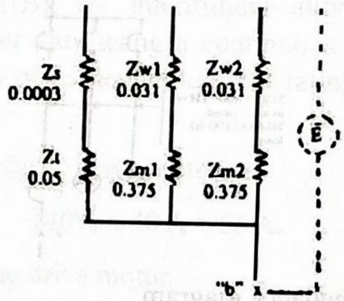
Circuit breaker "A" should be rated not less than 15000 AIC symmetrical

10.2 Fault at "b" (The fault current comes from the transformer plus the contribution from the motors. The total current is to be cleared by Breaker B.)

a. Single line diagram



b. Impedance diagram



Combining parallel impedances:

$$\frac{1}{Z_c} = \frac{1}{Z_s + Z_t} + \frac{1}{Z_{w1} + Z_{m1}} + \frac{1}{Z_{w2} + Z_{m2}}$$

$$= \frac{1}{0.0503} + \frac{1}{0.406} + \frac{1}{0.406}$$

$$= 19.88 + 2.46 + 2.46$$

$$= 24.8$$

$$Z_c = \frac{1}{24.8} = 0.0403$$

Example D15

Voltage Drop Calculation

A 3 ph, 230-volt, 60 Hz electric motor draws a full load current of 20 amperes at 80% load power factor. It is connected to a panelboard 30.5 m away with 3 x 5.5 mm2 THWN copper conductors in steel conduit. The panelboard which draws a total current of 295 amperes from a 3 ph, 460-230-volt transformer bank is 15.2 m away and is supplied by 3 x 250 mm^2 THWN copper conductors in steel conduit.

Calculate: (a) the voltage drop at the panelboard; and (b) the percent voltage drop at the terminals of the motor assuming that the voltage at the transformer bushing is 230 volts and neglecting the effect of voltage phase shift due to load power factor.

Basic Formulas:

(A) Voltage drop (VD) = $kDI \times \sqrt{R^2 + X^2}$ Eq. (1)

where I = line current, amperes

D = Distance of the device from the source

k = Constant (2 for 1-phase and 1.732 for 3-phase)

R = line ac resistance, ohms

X = line reactance at 60 hz, ohms

(B) Percent voltage drop $= \dfrac{(VD_{PB} + VD_M) \times 100\%}{\text{Voltage supply } (V_s)}$ Eq. (2)

From Table 10.1.1.9 Alternating Current Resistance and Reactance For 600V Cables

R (3-ph) = 0.029 ohm/305m (75°C) 250 mm^2 cable in steel conduit

= 1.2 ohms/305m (75°C) 5.5 mm^2 cable in steel conduit

X (3-ph) = 0.048 ohm/305m (60 Hz) 250 mm^2 cable in steel conduit

= 0.063 ohm/305m (60 Hz) 5.5 mm^2 cable in steel conduit

Hence:

Solving for (a) voltage drop at panelboard. Use Equation (1) multiplied by length ratio:

(a) $VD_{PB} = 1.732(295)\sqrt{0.029^2 + 0.048^2} \times 15.2/305$

= 1.428 volt (Answer)

Voltage at panelboard: V = 230 - 1.428 = 228.572 volts

(b) Solving for percent voltage drop at motor terminals:

$VD_M = 1.732(20)\sqrt{1.2^2 + 0.063^2} \times 30.5/305$

= 4.163 volts (Voltage drop at motor terminals)

Add the voltage drops at motor terminals and panel board and divided by 230-volt:

Percent voltage drop $= \dfrac{1.428 + 4.163}{230} \times 100$

= 2.43 % (Answer) - total voltage drop at motor terminals from the voltage supply (transformer secondary) from Eq. (2)

Example D16

Feeder Ampacity Determination for Generator Field Control

[see Sections 2.20.2.1, 4.30.2.4, 4.30.2.4 Exception No. 1, 6.20.2.3, 6.20.2.4, 6.20.7.1, and Tables 4.30.2.2(E) and 6.20.2.4]

Determine the conductor ampacity for a 460-V 3-phase, 60-Hz ac feeder supplying a group of six elevators. The 460-V ac drive motor nameplate rating of the largest MG set for one elevator is 40 hp and 52 A, and the remaining elevators each have a 30-hp, 40-A, ac drive motor rating for their MG sets. In addition to a motor controller, each elevator has a separate motion/operation controller rated 10 A continuous to operate microprocessors, relays, power supplies, and the elevator car door operator. The MG sets are rated continuous.

Conductor Ampacity

Conductor ampacity is determined as follows:

(A) Per Sections 6.20.2.3(D) and 6.20.7.1(B)(1), use Table 4.30.2.2(B), for intermittent duty (elevators). For intermittent duty using a continuous rated motor, the percentage of nameplate current rating to be used is 140%.

(B) For the 30-hp ac drive motor,

140% x 40 A = 56 A.

For the 40-hp ac drive motor,

140% x 52 A = 73 A

(C) The total conductor ampacity is the sum of all the motor currents.

(1 motor x 73 A) + (5 motors x 56 A) = 353 A

(D) Per Section 6.20.2.4 and Table 6.20.2.4, the conductor (feeder) ampacity would be permitted to be reduced by the use of a demand factor. Constant loads are not included (see Section 6.20.2.4, FPN). For six elevators, the demand factor is 0.79.

Therefore, feeder diverse ampacity = 0.79 X 353 A = 279 A.

(E) Per Sections 4.30.2.4 and 2.15.1.3

Controller continuous current = 125% x 10 A = 12.5 A