AMERICAN NATIONAL STANDARD

American National Standard

ANSI C37.16-2000

American National Standard

Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors— Preferred Ratings, Related Requirements, and Application Recommendations

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
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Secretariat

National Electrical Manufacturers Association

Approved 05/19/00

American National Standards Institute, Inc.

American National Standard

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FOREWORD (This foreword is not part of American National Standard C37.16-2000.)

This standard has been revised to include a 5000 Ampere frame size in tables 1 through 5 and tables 22A and 22B for low-voltage AC power circuit breakers. In addition, both 1000 volt and 1200 volt ratings for DC breakers in tables 11, 11a, and 12 are now included, since both ratings of breakers are now available. The titles of tables 11 and 12 have been clarified to differentiate between "heavy duty" and "light duty" applications.

The 1997 version was revised to reflect industry trends such as deleting the 225 ampere frame size throughout since it is not utilized any longer; adding a 2000 ampere frame size fused circuit breaker (Tables 17 and 19, Line 4) which is now available; incorporating the C37.16a-1994 DC circuit breaker Tables 8, 9, 10, 11, 11A and 12, which correlated with C37.14-1992; and incorporating the electronic trip device ratings.

This standard was first published by the American Standards Association (now the American National Standards Institute) in 1956, using material developed by the National Electrical Manufacturers Association (NEMA).

Reference should be made to the appropriate American National Standards for service conditions, definitions, ratings, temperature limitations, classes of insulating material, nameplate markings, dielectric-withstand requirements, test requirements, and application standards.

American National Standards are subject to periodic review. Users are cautioned to secure the latest edition. Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Power Switchgear, C37. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time this standard was approved, the C37 Committee had the following members:

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A.K. McCabe, Executive Vice-Chairman, HV Standards
J. Scott, Executive Vice-Chairman, LV Standards
D.L. Swindler, Executive Vice-Chairman, IEC Activities
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TABLES

AMERICAN NATIONAL STANDARD **C37.16-2000**

Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors—Preferred Ratings, Related Requirements, and Application Recommendations

1 Scope

This standard applies to all low-voltage power circuit breakers and AC power circuit protectors as covered in the following American National Standards (see Section 4):

ANSI/IEEE C37.13-1990 (R1995), *American National Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures*

ANSI/IEEE C37.14-1999, *American National Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures.*

ANSI C37.17-1997, *American National Standard for Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers*

ANSI/IEEE C37.18-1979 (R1997), *American National Standard Requirements for Field Discharge Circuit Breakers for Rotating Electric Machinery*

ANSI/IEEE C37.29-1981 (R1990), *American National Standard for Low-Voltage AC Power Circuit Protectors Used in Enclosures*

ANSI C37.50-1989 (R2000), *American National Standard Test Procedures for Low-Voltage AC Power Circuit Breakers Used in Enclosures*

ANSI C37.52-1974 (R2000), *American National Standard Test Procedures for Low-Voltage AC Power Circuit Protectors Used in Enclosures*

2 Referenced standards

In addition to the standards listed in Section 1, this standard is intended for use in conjunction with American National Standard National Electrical Code, ANSI/NFPA 70-1999.

3 Requirements

Preferred ratings, related requirements, and application recommendations for low-voltage power circuit breakers and AC power circuit protectors shall be as given in tables 1 through 23.

4 Revision of American National Standards referred to in this document

When the American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply.

Table 1 – Preferred Ratings for low-voltage AC power circuit breakers with instantaneous direct-acting phase trip elements (See ANSI/IEEE C37.13)

Line No.	Rated maximum-voltage volts Col 1	Dielectric withstand volts Col 2	Short-circuit current rating, symmetrical amperes[1] Col 3	Frame-size amperes Col 4	Range of trip-device current ratings amperes[2] Electro-mechanical Col 5	 Electronic Col 6
1	635	2200	22000	600	40-600	60-600
2	635	2200	22000	800	100-800	150-800
3	635	2200	42000	1600	200-1600	300-1600
4	635	2200	42000	2000	200-2000	500-2000
5	635	2200	65000	3000	2000-3000	800-3000
6	635	2200	65000	3200	2000-3200	800-3200
7	635	2200	85000	4000	4000	1000-4000
8	635	2200	85000	5000	5000	2000-5000
9	508	2200	30000	600	100-600	60-600
10	508	2200	30000	800	100-800	150-800
11	508	2200	50000	1600	400-1600	300-1600
12	508	2200	50000	2000	400-2000	500-2000
13	508	2200	65000	3000	2000-3000	800-3000
14	508	2200	65000	3200	2000-3200	800-3200
15	508	2200	85000	4000	4000	1000-4000
16	508	2200	85000	5000	5000	2000-5000
17	254	2200	42000	600	150-600	60-600
18	254	2200	42000	800	150-800	150-800
19	254	2200	65000	1600	600-1600	300-1600
20	254	2200	65000	2000	600-2000	500-2000
21	254	2200	85000	3000	2000-3000	800-3000
22	254	2200	85000	3200	2000-3200	800-3200
23	254	2200	130000	4000	4000	1000-4000
24	254	2200	130000	5000	5000	2000-5000

NOTES

1 Ratings in this column are rms symmetrical values for single-phase (2-pole) circuit breakers and three-phase average rms symmetrical values of three-phase (3-pole) circuit breakers. When applied on systems where rated maximum voltage may appear across a single pole, the short-circuit current ratings are 87% of these values. See 5.6 of ANSI/IEEE C37.13.

2 For preferred trip-device current ratings, see table 22. Note that the continuous-current-carrying capability of some circuit-breaker-trip-device combinations may be higher than the trip-device current rating. See 10.1.3 of ANSI/IEEE C37.13.

Table 2 – Preferred ratings for low-voltage AC power circuit breakers without instantaneous direct-acting phase trip elements (Short-time-delay element or remote relay) (See ANSI/IEEE C37.13)

					Range of trip-device current ratings amperes[2]			
					Setting of short-time-delay trip element			
					Electro-mechanical			
	Rated maximum voltage volts	Dielectric withstand volts	Short-circuit current rating / short-time current rating symmetrical amperes[1]	Frame size amperes	Minimum time band	Intermediate time band	Maximum time band	Electronic any time band
Line No.	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
1	635	2200	22000	600	175-600	200-600	250-600	60-600
2	635	2200	22000	800	175-800	200-800	250-800	150-800
3	635	2200	42000	1600	350-1600	400-1600	500-1600	300-1600
4	635	2200	42000	2000	350-2000	400-2000	500-2000	500-2000
5	635	2200	65000	3000	2000-3000	2000-3000	2000-3000	800-3000
6	635	2200	65000	3200	2000-3200	2000-3200	2000-3200	800-3200
7	635	2200	85000	4000	4000	4000	4000	1000-4000
8	635	2200	85000	5000	5000	5000	5000	2000-5000
9	508	2200	22000	600	175-600	200-600	250-600	60-600
10	508	2200	22000	800	175-800	200-800	250-800	150-800
11	508	2200	42000	1600	350-1600	400-1600	500-1600	300-1600
12	508	2200	50000	2000	350-2000	400-2000	500-2000	500-2000
13	508	2200	65000	3000	2000-3000	2000-3000	2000-3000	600-3000
14	508	2200	65000	3200	2000-3200	2000-3200	2000-3200	800-3200
15	508	2200	85000	4000	4000	4000	4000	1000-4000
16	508	2200	85000	5000	5000	5000	5000	2000-5000
17	254	2200	22000	600	175-600	200-600	250-600	60-600
18	254	2200	22000	800	175-800	200-800	250-800	150-800
19	254	2200	42000	1600	350-1600	400-1600	500-1600	300-1600
20	254	2200	50000	2000	350-2000	400-2000	500-2000	500-2000
21	254	2200	65000	3000	2000-3000	2000-3000	2000-3000	800-3000
22	254	2200	65000	3200	2000-3200	2000-3200	2000-3200	800-3200
23	254	2200	85000	4000	4000	4000	4000	1000-4000
24	254	2200	85000	5000	5000	5000	5000	2000-5000

NOTES

1 Ratings in this column are rms symmetrical values for single-phase (2-pole) circuit breakers and three-phase average rms symmetrical values of three-phase (3-pole) circuit breakers. When applied on systems where rated maximum voltage may appear across a single pole, the short-circuit current ratings are 87% of these values. See 5.6 of ANSI/IEEE C37.13.

2 For preferred trip-device current ratings, see table 22. Note that the continuous-current-carrying capability of some circuit-breaker-trip-device combinations may be higher than the trip-device current rating. See 10.1.3 of ANSI/IEEE C37.13.

Table 3 – Overload switching requirements for low-voltage AC power circuit breakers (See ANSI C37.50)

Line No.	Circuit-breaker frame size amperes Col 1	Number of make-break operations Col 2
1	600	50
2	800	50
3	1600	38
4	2000	38
5	3000	*
6	3200	*
7	4000	*
8	5000	*

*Not applicable.

Table 4 – Endurance requirements for low-voltage AC power circuit breakers (See ANSI C37.50)

Line No.	Circuit-breaker frame size amperes Col 1	Number of make-break or close-open operations Between servicing[1] Col 2	Electrical endurance Col 3	Mechanical endurance Col 4	Total Col 5
1	600	1750	2800	9700	12500
2	800	1750	2800	9700	12500
3	1600	500	800	3200	4000
4	2000	500	800	3200	4000
5	3000	250	400	1100	1500
6	3200	250	400	1100	1500
7	4000	250	400	1100	1500
8	5000	250	400	1100	1500

NOTE
1 Servicing shall consist of adjusting, cleaning, lubricating, and tightening.

Table 5 – Application limitations relating to repetitive duty and normal maintenance of low-voltage AC power circuit breakers (See ANSI/IEEE C37.13)

Line No.	Circuit-breaker frame size amperes Col 1	Number of make-break or close-open operations Between servicing[1] Col 2	No-load mechanical[2] Col 3	Rated continuous-current switching[3] Col 4	Inrush-current switching[4] Col 5
1	600	1750	9700	2800	1400
2	800	1750	9700	2800	1400
3	1600	500	3200	800	400
4	2000	500	3200	800	400
5	3000	250	1100	400	-
6	3200	250	1100	400	-
7	4000	250	1100	400	-
8	5000	250	1100	400	-

NOTES
1 See Annex A, item A.
2 See Annex A, items A through G.
3 See Annex A, items A, C, D, G, F, G, H, and J.
4 See Annex A, items C, D, E, F, G, I, and J.

Table 6 – Application of low-voltage AC power circuit breakers to full-voltage motor starting and running duty of three-phase, 60-Hz, 40°C-rise motors (See ANSI/IEEE C37.13)

	Horsepower rating of three-phase AC motors*									Trip-device current rating	Motor full-load current amperes	
	Induction motors			100% power-factor synchronous motors			80% power-factor synchronous motors					
Line	230 V	460 V	575 V	220 V	440 V	550 V	220 V	440 V	550 V	amperes**	Min	Max
No.	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
1	10	25	30	-	30	40	-	25	25;30	40	26	35
2	15	30	40	-	40	50	-	30	40	50	32	44
3	20	40	50;60	25	50	60	-	40	50	70	45	61
4	25;30	50;60	75	30	60	75	25	50	60	90	58	78
5	-	-	-	40	75	100	30	60	80	100	64	87
6	40	75	100	50	100	125	40	75	100	125	80	109
7	50	100	125	60	-	150	-	-	-	150	96	131
8	-	-	150	-	125	-	50	100	125	175	112	152
9	60	125	-	75	150	200	60	125	150	200	128	174
10	75	150	200	-	-	-	-	-	-	225	144	196
11	-	-	-	100	200	-	75	150	200	250	160	218
12	100	200	250*	-	-	-	-	-	-	300	192	261
13	-	250*	300	125	-	-	100	200	-	350	224	304
14	125	-	350	-	-	-	125	-	-	400	256	348
15	150	300;350	400;450	-	-	-	-	-	-	500	320	435
16	200	400	500	-	-	-	-	-	-	600	384	522
17	250*	450;500	-	-	-	-	-	-	-	800	512	696
18	300;350	-	-	-	-	-	-	-	-	1000	640	870
19	400	-	-	-	-	-	-	-	-	1200	768	1044
20	450;500	-	-	-	-	-	-	-	-	1600	1023	1392

* Characteristics of motors of more than 200 hp vary widely, and the manufacturer of the motor should be consulted for specific details in these cases.

** Selection of trip-device current rating and circuit-breaker frame size. The trip device rating listed is a preferred rating from table 22. In accordance with ANSI/NFPA 70 *National Electrical Code*, section 430-110, this rating is at least 115% of the maximum motor full-load current (column 12). With trip devices having the lowest calibration point at 80% of the trip-device rating, the requirement of section 430-34 can be met for the minimum full-load current (column 11). Section 430-34 requires that the trip device be set at a calibration point which does not exceed the following:

(1) 140% of motor full-load current for motors with a marked service factor not less than 1.15 and for motors with a marked temperature rise not over 40°C.

(2) 130% of motor full-load current for all other motors.

Any value listed in Column 10 may also be a trip-device setting if this current can be carried continuously and if additional adjustments allow compliance with section 430-34.

Trip devices having a higher current rating may be used provided that they have a suitable calibration point below 80% of the trip-device rating. The circuit-breaker frame size should be selected based on the applicable trip-device rating as well as the short-circuit current available. See Tables 1 and 2 for guidance.

NOTES

1 Locked-rotor current and instantaneous trip setting—Circuit breakers selected from this table are suitable for all motors having locked-rotor kilovolt-ampere per horsepower, indicated by code letters A through J, inclusive, as listed in ANSI/NFPA 70, section 430-7. For motors with higher locked-rotor currents, care must be taken to ensure that an instantaneous trip setting high enough to permit motor starting is available. It may be necessary to choose the circuit breaker with the next higher continuous current rating, provided that the calibration limitations given in the footnote to column 10 are not exceeded.

If motor locked-rotor current exceeds 600% of the circuit-breaker frame size, a shorter service life than that shown in Table 5, Column 5, can be expected.

2 Applications to motors other than those listed—For motors with horsepower ratings not listed in this table or for motors with other than normal speed or torque characteristics, it will be necessary to determine the full-load current and locked-rotor current as specified by the motor manufacturer. Find the current range in columns 11 and 12 which matches the full-load current to determine the circuit breaker with the proper continuous rating. Check locked-rotor current according to Note 1.

Table 7 – Preferred ratings and related requirements of field-discharge circuit breakers(See ANSI/IEEE C37.18)

	Main contacts									Discharge contacts		
Line No.	Rated nominal voltage volts, DC	Dielectric test voltage rms 60 Hz for 1 min[1]	Rated continuous current amperes, DC	Rated short-time voltage volts, DC	Rated interrupting current at rated short-time voltage amperes, DC	Rated maximum interrupting voltage volts, DC	Rated interrupting current at rated maximum interrupting voltage amperes, DC	Rated 1/2-s short-time current amperes, DC	Rated making current peak amperes	Rated 15-s short-time current amperes, DC[3]	Rated 1/2-s short-time current amperes, DC	Rated interrupting current at rated nominal voltage amperes, DC
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
1	250	2500	600	350	6000	1000	2700	3300	3300	1200	2700	600
2	375	3750	600	500	6000	1500	3000	3300	3300	1200	2700	600
3	375	3750	1600	500	16000	2200	7200	9600	9600	3200	7200	1600
4	500	5000	4000	700	24000	2000	14000	18600	18600	-	14000	4000
5	500	5000	6000	700	24000	2000	14000	18600	18600	-	14000	6000
6	700[2]	5400	6000	700	48000	2450	21000	30000	21000	-	12000	6000
7	750[2]	5500	8000	750	64000	2625	28000	40000	28000	-	16000	8000
8	1000[2]	6000	10000	1000	80000	3500	35000	60000	35000	-	20000	10000
9	750[2]	5500	12000	750	96000	2625	42000	60000	42000	-	24000	12000

NOTES
1 The test voltage for field windings rated up to and including 500 volts shall be an AC voltage whose effective value is 10 times the rated excitation voltage but not less than 1500 volts.
2 It is suggested that the test voltage greater than 500 volts be an AC voltage whose effective value is 4000 volts plus twice the rated excitation voltage.
3 See 9.4.5.2 of ANSI/IEEE C37.18.

NOTE: For mechanical endurance requirements see Table 14.

Table 8 – Preferred ratings for general-purpose DC power circuit breakers with or without instantaneous direct-acting trip elements (See ANSI/IEEE C37.14 for basis of ratings)

Line No.	Circuit-breaker frame size amperes	System nominal voltage volts	Rated maximum voltage volts	Rated peak current amperes[1]	Rated maximum short-circuit current or rated short-time current amperes[2,3]	Maximum inductance for full interrupting rating microhenries[4]	Load circuit stored-energy factor W kilowatt seconds[4]	Range of trip-device current ratings amperes[5]
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
1	600/800	250	300	41000	25000	160	50	40-800
2	1600	250	300	83000	50000	80	100	200-1600
3	2000	250	300	83000	50000	80	100	200-2000
4	3000	250	300	124000	75000	50	140	2000-3000
5	4000	250	300	165000	100000	32	160	4000
6	5000	250	300	165000	100000	32	160	5000
7	6000	250	300	165000	100000	32	160	6000

NOTES

1 The peak current rating is only applicable for circuit breakers for use on solid-state rectifier applications.

2 A circuit breaker with coils that have a continuous-current rating lower than those listed for the breakers under a particular interrupting rating shall be given an interrupting rating corresponding to the greatest interrupting rating under which the coil rating is listed.

3 Rated short-time current is applicable only to circuit breakers without instantaneous direct-acting trip elements (short-time-delay element or remote relay).

4 If the expected inductance to the point of fault exceeds the value given in column 6, obtain the reduced interrupting rating from the formula:

$$I = 10^4 \sqrt{20 \frac{W}{L}}$$

Where:

W is the value in column 7
L is the actual inductance in microhenries

5 For preferred trip-device current ratings, see table 22. Note that the continuous-current-carrying capability of some circuit-breaker-trip-device combinations may be higher than the trip-device current rating. See 10.1.3 of ANSI/IEEE C37.13.

NOTE: The above values apply to one pole of the circuit breaker, except where specifically required for use on insulated systems, battery installations, etc., where the tests apply to two poles.

Table 9 – Test circuit values for general-purpose low voltage DC power circuit breakers (See ANSI/IEEE C37.14 for basis of ratings)

Line No.	Circuit-breaker frame size amperes	Test	Rated maximum voltage volts	Rated peak current amperes[1]	Test circuit			Load circuit stored-energy factor W kilowatt seconds
					Current amperes	Resistance ohms	Inductance microhenries	
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
1	600/800	a	300	41000	25000	0.012	160	50
2		b	300	-	9000	0.033	1200	50
3	1600 & 2000	a	300	83000	50000	0.006	80	100
4		b	300	-	13000	0.023	1200	100
5	3000	a	300	124000	75000	0.004	50	140
6		b	300	-	15000	0.020	1200	140
7	4000	a	300	165000	100000	0.003	32	160
8		b	300	-	17000	0.018	1200	160
9	5000	a	300	165000	100000	0.003	32	160
10		b	300	-	17000	0.018	1200	160
11	6000	a	300	165000	100000	0.003	32	160
12		b	300	-	17000	0.018	1200	160

NOTE
1 The peak current rating is only applicable for circuit breakers for use on solid-state rectifier applications.

Table 10 – Preferred ratings and test-circuit values for general-purpose low voltage DC power circuit breakers for mining applications (See ANSI/IEEE C37.14 for basis of ratings)

Line No.	Circuit-breaker frame size amperes	Test	System nominal voltage volts	Rated maximum voltage volts	Rated peak current amperes[4]	Rated maximum short-circuit current amperes	Test circuit			Load circuit stored-energy factor W kilowatt seconds
							Current amperes	Resistance ohms	Inductance microhenries	
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
1	600-2000	a	275	325	41000	25000	25000	0.013	400	125
2		b					9000	0.036	3090	125
3	800-4000	a	275	325	83000	50000	50000	0.007	200	250
4		b					13000	0.025	2950	250

NOTES

1 The above values apply to one pole of the circuit breaker.
2 For the basis of short-circuit current ratings, see ANSI/IEEE C37.14.
3 If the expected inductance to the point of fault exceeds the value given in column 9, line 2 or 4, obtain the reduced interrupting rating from the formula:

$$I = 10^4 \sqrt{20 \frac{W}{L}}$$

Where:

W is the value in column 10
L is the actual inductance in microhenries

4 The peak current rating is only applicable for circuit breakers for use on solid-state rectifier applications.

Table 11 – Preferred ratings and test circuit values for "heavy duty" (8) high-speed, semi-high-speed, and rectifier low-voltage DC power circuit breakers (Based on transit systems with high frequency impedance bonds) (See ANSI/IEEE C37.14 for basis of ratings)

Line No.	Circuit-breaker frame size amperes	Test	Rated maximum voltage volts	Semi-high-speed breaker rated peak or high-speed breaker short-circuit current amperes	Sustained current and semi-high-speed breaker rated short-circuit current avg. amperes	Rectifier or other breaker-ratings with delayed trip or in non-trip direction		Add to load circuit inductance microhenries	Approximate load circuit time constant seconds
						Rated peak current amperes	Rated short-circuit or short-time current amperes		
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9
1	1200-10000	a	300	125,000	85,000	70,000	42,500	Note 1	-
2		b	300	-	46,200	-	-	500	0.053
3		c	300	-	13,300	-	-	1000	0.053
4		d	300	-	7,300	-	-	2000	0.053
5	1200-12000	a	800	200,000	120,000	149,000	90,000	Note 1	-
6		b	800	-	52,600	-	-	450	0.053
7		c	800	-	31,200	-	-	1000	0.053
8		d	800	-	17,900	-	-	2000	0.053
9	1200-8000	a	1000	158,000	96,000	119,000	72,000	Note 1	-
10		b	1000	-	50,250	-	-	500	0.053
11		c	1000	-	34,000	-	-	1000	0.053
12		d	1000	-	20,700	-	-	2000	0.053
13	1200-8000	a	1200	132,000	80,000	100,000	60,000	Note 1	-
14		b	1200	-	49,000	-	-	500	0.053
15		c	1200	-	35,300	-	-	1000	0.053
16		d	1200	-	22,600	-	-	2000	0.053
17	1200-6000	a	1600	100,000	60,000	74,000	45,000	Note 1	-
18		b	1600	-	44,300	-	-	600	0.066
19		c	1600	-	35,000	-	-	1200	0.066
20		d	1600	-	25,000	-	-	2500	0.066
21	1200-4000	a	3200	50,000	30,000	37,000	22,500	Note 1	-
22		b	3200	-	27,700	-	-	600	0.066
23		c	3200	-	25,600	-	-	1200	0.066
24		d	3200	-	22,300	-	-	2500	0.066

NOTES

1 No intentional inductance or resistance is to be added on the load side.

2 Columns 4, 5, 6, and 7 headings delineate specific ratings for breaker types noted.

3 The instantaneous trip element shall be set at not more than four times the circuit breaker continuous current rating or the maximum setting below 63.2% of the available sustained current (column 5). See 9.2.7.3 a) 1) ii) and 10.2.3.7 of ANSI/IEEE C37.14.

4 Tests a, b, c, and d represent simulated close-in, intermediate and distant faults.

5 The circuit breaker must handle all interrupting stored energy of the circuit based on the inherent speed of operation and let-through of current interrupted.

6 For total performance at other parameters, consult the manufacturer.

7 Frame sizes are 1200, 1600, 2000, 2500, 4000, 5000, 6000, 8000, 10000, and 12000 amperes.

8 "Heavy duty" transit system applications are based upon a maximum of 8000 kW source interruption capacity.

Table 11A – Preferred ratings and test circuit values for "heavy duty" (8) high-speed, semi-high-speed, and rectifier low-voltage DC power circuit breakers (Based on transit systems with low frequency impedance bonds) (See ANSI/IEEE C37.14 for basis of ratings)

Line No.	Circuit breaker frame size, amperes	Test	Rated maximum voltage volts	Semi-high-speed breaker rated peak or high-speed breaker short-circuit current amperes	Sustained current and semi-high-speed breaker rated short-circuit current avg. amperes	Rectifier or other breaker-ratings with delayed trip or in non-trip direction		Add to load circuit inductance microhenries	Approximate load circuit time constant seconds
						Rated peak current amperes	Rated short-circuit or short-time current amperes		
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9
1	1200-10000	a	300	125000	85000	70000	42500	Note 1	-
2		b	300	-	46200	-	-	2000	0.21
3		c	300	-	13300	-	-	4000	0.21
4		d	300	-	7300	-	-	8000	0.21
5	1200-12000	a	800	200000	120000	149000	90000	Note 1	-
6		b	800	-	52600	-	-	1800	0.21
7		c	800	-	31200	-	-	4000	0.21
8		d	800	-	17900	-	-	8000	0.21
9	1200-8000	a	1000	158,000	96,000	119,000	72,000	Note 1	-
10		b	1000	-	50,250	-	-	2000	0.21
11		c	1000	-	34,000	-	-	4000	0.21
12		d	1000	-	20,700	-	-	8000	0.21
13	1200-8000	a	1200	132000	80000	100000	60000	Note 1	-
14		b	1200	-	49000	-	-	2000	0.21
15		c	1200	-	35300	-	-	4000	0.21
16		d	1200	-	22600	-	-	8000	0.21
17	1200-6000	a	1600	100000	60000	74000	45000	Note 1	-
18		b	1600	-	44300	-	-	3250	0.34
19		c	1600	-	35000	-	-	6400	0.34
20		d	1600	-	25000	-	-	12800	0.34
21	1200-4000	a	3200	50000	30000	37000	22500	Note 1	-
22		b	3200	-	27700	-	-	3250	0.34
23		c	3200	-	25600	-	-	6400	0.34
24		d	3200	-	22300	-	-	12800	0.34

NOTES
1 No intentional inductance or resistance is to be added on the load side.
2 Columns 4, 5, 6, and 7 headings delineate specific ratings for breaker types noted.
3 The instantaneous trip element shall be set at not more than four times the circuit breaker continuous current rating or the maximum setting below 63.2% of the available sustained current (column 5). See 9.2.7.3 a) 1) ii) and 10.2.3.7 of ANSI/IEEE C37.14.
4 Tests a, b, c, and d represent simulated close-in, intermediate, and distant faults.
5 The circuit breaker must handle all interrupting stored energy of the circuit based on the inherent speed of operation and let-through of current interrupted.
6 For total performance at other parameters, consult the manufacturer.
7 Frame sizes are 1200, 1600, 2000, 2500, 4000, 5000, 6000, 8000, 10000, and 12000 amperes
8 "Heavy duty" transit system applications are based upon a maximum of 8000 kW source interruption capacity.

Table 12 – Preferred ratings and test circuit values for "light duty" (8) high-speed, semi-high-speed, and rectifier low-voltage DC power circuit breakers (Based on transit systems with high frequency impedance bonds) (See ANSI/IEEE C37.14 for basis of ratings)

Line No.	Circuit-breaker frame size amperes	Test	Rated maximum voltage volts	Semi-high-speed breaker rated peak or high-speed breaker short-circuit current amperes	Sustained current and semi-high-speed breaker rated short-circuit current avg. amperes	Rectifier or other breaker-ratings with delayed trip or in non-trip direction		Add to load circuit inductance microhenries	Approximate load circuit time constant seconds
						Rated peak current amperes	Rated short-circuit or short-time current amperes		
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9
1	1200-6000	a	800	100000	60000	74000	45000	Note 1	-
2		b	800	-	35100	-	-	600	0.066
3		c	800	-	24800	-	-	1250	0.066
4		d	800	-	15700	-	-	2500	0.066
5	1200-6000	a	1200	66000	40000	50000	30000	Note 1	-
6		b	1200	-	30700	-	-	600	0.066
7		c	1200	-	24500	-	-	1250	0.066
8		d	1200	-	17600	-	-	2500	0.066

NOTES

1 No intentional inductance or resistance is to be added on the load side.
2 Columns 4, 5, 6, and 7 headings delineate specific ratings for breaker types noted.
3 The instantaneous trip element shall be set at not more than four times the circuit breaker continuous current rating or the maximum setting below 63.2% of the available sustained current (column 5). See 9.2.7.3 (1) (b) and 10.2.3.7 of ANSI/IEEE C37.14.
4 Tests a, b, c, and d represent simulated close-in, intermediate, and distant faults.
5 The circuit breaker must handle all interrupting stored energy of the circuit based on the inherent speed of operation and let-through of current interrupted.
6 For total performance at other parameters, consult the manufacturer.
7 Frame sizes are 1200, 1600, 2000, 2500, 4000, 5000, and 6000.
8 "Light duty" transit system applications are based upon a maximum of 4000 kW source interruption capacity.

Table 13 – Preferred ratings for anode circuit breakers

(DELETED FROM THIS EDITION)

Table 14 – Endurance requirements for low-voltage DC power circuit breakers and field discharge circuit breakers (See ANSI/IEEE C37.14 and ANSI/IEEE C37.18)

Line No.	Circuit breaker frame size amperes	Number of make-break or close-open operations			Total
		Electrical endurance	Mechanical endurance	Between Servicing[1]	
	Col 1	Col 2	Col 3	Col 4	Col 5
1	600/800	1750	9700	1750	11450
2	1200	500	3200	500	3700
3	1600	500	3200	500	3700
4	2000-12000	250	1100	250	1350

NOTE
1 Servicing shall consist of adjusting, cleaning, lubricating, tightening, etc.

Table 15 – Application limitations relating to repetitive duty and normal maintenance of low-voltage DC power circuit breakers (See ANSI/IEEE C37.14)

Line No.	Circuit breaker frame size amperes	Number of make-break or close-open operations		
		Between servicing[1]	No-load mechanical[2]	Rated continuous current switching[3]
	Col 1	Col 2	Col 3	Col 4
1	600/800	1750	9700	1750
2	1200	500	3200	500
3	1600	500	3200	500
4	2000-12000	250	1100	250

NOTES
1 See Annex A, item A.
2 See Annex A, items A through G.
3 See Annex A, items A, C, D, E, F, G, H, and J.

Table 16 – Application of general-purpose low-voltage DC power circuit breakers to motor starting and running duty (See ANSI/IEEE C37.14)

Line No.	Horsepower ratings of DC motors		Trip-device current rating amperes[1]	Motor full-load current amperes[2]	
	120 V	240 V		Min	Max
	Col 1	Col 2	Col 3	Col 4	Col 5
1	-	7.5	40	26	35
2	5	10	50	32	44
3	7.5	15	70	45	61
4	10	20	90	58	78
5	-	-	100	64	87
6	-	25	125	80	109
7	15	30	150	96	131
8	20	40	175	112	152
9	-	-	200	128	174
10	25	50	225	144	196
11	-	60	250	160	218
12	30	-	300	192	261
13	40	75	350	224	304
14	-	-	400	256	348
15	50	100	500	320	435
16	60	125;150	600	384	522
17	75	200	800	512	696
18	-	250	1000	640	870
19	-	300	1200	768	1044
20	-	350	1600	1023	1392
21	-	400;500	2000	1280	1740
22	-	600	2500	1600	2180
23	-	750	3000	1920	2610
24	-	1000	4000	2560	3480

NOTES

1 Selection of trip-device current rating and circuit-breaker frame size. The trip device rating listed is a preferred rating from table 22. In accordance with ANSI/NFPA 70, Section 430-110, this rating is at least 115% of the maximum motor full-load current (column 5). With trip devices having the lowest calibration point at 80% of the trip-device rating, the requirement of Section 430-34 can be met for the minimum full-load current (column 4). Section 430-34 requires that the trip device be set at a calibration point which does not exceed the following:

(1) 140% of motor full-load current for motors with a marked service factor not less than 1.15 and for motors with a marked temperature rise not over 40°C.

(2) 130% of motor full-load current for all other motors.

Any value listed in column 3 may also be a trip-device setting if this current can be carried continuously and if additional adjustments allow compliance with section 430-34.

Trip devices having a higher current rating may be used provided that they have suitable calibration points below 80% of the trip-device rating. The circuit-breaker frame size should be selected based on the applicable trip-device rating as well as the short-circuit current available. See table 8 for guidance.

2 Applications to motors other than those listed. For motors with horsepower ratings not listed in this table or for motors with other than normal speed or torque characteristics, it will be necessary to determine the full-load current as specified by the motor manufacturer. Find the current range in columns 4 and 5 which matches the full-load current to determine the circuit breaker with the proper continuous-current rating.

Table 17 – Preferred ratings for integrally fused low-voltage AC power circuit breakers with instantaneous direct-acting phase trip elements (See ANSI/IEEE C37.13)

Line No.	Circuit-breaker frame size amperes[1]	Rated maximum voltage volts[2]	Dielectric withstand volts	Short-circuit current rating symmetrical amperes[3]	Range of continuous-current rating amperes	
					Range of trip-device current ratings amperes[4]	Maximum fuse rating[5]
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
1	600	600	2200	200000	125-600	††
2	800	600	2200	200000	125-800	††
3	1600	600	2200	200000	200-1600	††
4	2000	600	2200	200000	500-2000	††

NOTES

1 Two circuit-breaker frame ratings are used for integrally fused circuit breakers. The continuous-current rating of the integrally fused circuit breaker is determined by the rating of either the direct-acting trip device or the current-limiting fuse applied to a particular circuit-breaker frame rating, whichever is smaller.

2 Listed values are limited by the standard voltage rating of the fuse.

3 Ratings in this column are rms symmetrical values for single-phase (2-pole) circuit breakers and three-phase average rms symmetrical values of three-phase (3-pole) circuit breakers. When applied on systems where rated maximum voltage may appear across a single pole, the short circuit current ratings are 87% of these values. See 5.6 of ANSI/IEEE C37.13.

4 For preferred trip-device current ratings, see table 22. Note that the continuous-current-carrying capability of some circuit-breaker-trip-device combinations may be higher than the trip-device current rating. See 10.1.3 of ANSI/IEEE C37.13. Lower rated trip-device current ratings may be used when the fuse size is small or the available current is low, or both. Consult the manufacturer.

5 Fuse current ratings may be 300, 400, 600, 800, 1000, 1200, 1600, 2000, 2500, 3000, and 4000 amperes. Fuses are of the current-limiting type.

†† Values have not yet been determined; consult the manufacturer.

Table 18 – Application of integrally fused low-voltage AC power circuit breakers to full-voltage motor starting and running duty of three-phase, 60-Hz, 40°C-rise motors maximum short-circuit current rating: 200 000 rms symmetrical current (See ANSI/IEEE C37.13)

	Horsepower rating of three-phase AC motors*									Trip-device current rating amperes**	Typical rating of current-limiting fuse amperes***	Motor full-load current amperes	
	Induction motors			100% power-factor synchronous motors			80% power-factor synchronous motors						
	230 V	460 V	575 V	220 V	440 V	550 V	220 V	440 V	550 V			Min	Max
Line No.	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13
1	40	75	100	50	100	125	40	75	100	125	400	80	109
2	50	100	125	60	-	150	-	-	-	150	600	96	131
3	-	-	150	-	125	-	50	100	125	175	600	112	152
4	60	125	-	75	150	200	60	125	150	200	600	128	174
5	75	150	200	-	-	*	-	-	-	225	800	144	196
6	-	-	*	100	200	-	75	150	200	250	800	160	218
7	100	200	-	-	*	-	-	-	*	300	1000	192	261
8	-	*	-	125	-	-	100	200	-	350	1200	224	304
9	125	-	-	-	-	-	125	*	-	400	1200	256	348
10	150	-	-	-	-	-	-	-	-	500	1600	320	435
11	200	-	-	-	-	-	-	-	-	600	2000	384	522

* Characteristics of motors rated at more than 200 hp vary widely, and the manufacturer of the motor should be consulted for specific details in these cases.

** Selection of trip-device current rating and circuit-breaker frame size. The trip device rating listed is a preferred rating from table 22. In accordance with ANSI/NFPA 70, section 430-110, this rating is at least 115% of the maximum motor full-load current (column 13). With trip devices having the lowest calibration point at 80% of the trip-device rating, the requirement of section 430-34 can be met for the minimum full-load current (column 12). Section 430-34 requires that the trip device be set at a calibration point which does not exceed the following:

(1) 140% of motor full-load current for motors with a marked service factor not less than 1.15 and for motors with a marked temperature rise not over 40°C.
(2) 130% of motor full-load current for all other motors.

Any value listed in column 10 may also be a trip-device setting if this current can be carried continuously and if additional adjustments allow compliance with section 430-34.

Trip devices having a higher current rating may be used provided that they have a suitable calibration point below 80% of the trip-device rating. The circuit-breaker frame size should be selected based on the applicable trip-device rating as well as the short-circuit current available. See table 17 for guidance.

*** These ratings are based on the use of a direct-acting phase trip device with instantaneous trip element. Where information is available, the fuse rating may be selected to suit the particular application based on: (1) motor current, (2) overcurrent trip characteristics, (3) fuse melting time characteristics, and (4) system coordination requirements.

NOTES

1 Locked-rotor current and instantaneous trip setting. Circuit breakers selected from this table are suitable for all motors having locked-rotor kilovolt-ampere per horsepower, indicated by code letters A through J, inclusive, as listed in ANSI/NFPA 70, section 430-7. For motors with higher locked-rotor currents, care must be taken to ensure that an instantaneous trip setting high enough to permit motor starting is available. It may be necessary to choose the circuit breaker with the next higher continuous-current rating, provided the calibration limitations given in the footnote to column 10 are not exceeded.

If motor locked-rotor current exceeds 600% of the circuit-breaker frame size, a shorter service life than that shown in Table 19, column 5, can be expected.

2 Applications to motors other than those listed. For motors with horsepower ratings not listed in this table, or for motors with other than normal speed or torque characteristics, it will be necessary to determine the full-load current and locked-rotor current as specified by the motor manufacturer. Find the current range in columns 12 and 13 that matches the full-load current to determine the circuit breaker with the proper continuous rating. Check locked-rotor current according to Note 1.

Table 19 – Application limitations relating to repetitive duty and normal maintenance of integrally fused low-voltage AC power circuit breakers (See ANSI/IEEE C37.13)

Line No.	Circuit-breaker frame size amperes	Number of make-break or close-open operations			
		Between servicing	No-load mechanical[2]	Rated continuous-current switching[3]	Inrush-current switching[4]
	Col 1	Col 2	Col 3	Col 4	Col 5
1	600	1750	9700	2800	1400
2	800	1750	9700	2800	1400
3	1600	500	3200	800	400
4	2000	500	3200	800	400

NOTES
1 See Annex A.
2 See Annex A, items A through G.
3 See Annex A, items A, C, D, E, F, G, H, and J.
4 See Annex A, items C, D, E, F, G, I, and J.

Table 20 – Preferred ratings for low-voltage AC power circuit protectors (See ANSI/IEEE C37.29)

Line No.	Rated continuous current amperes	System nominal voltage volts	Rated maximum voltage volts	Insulation dielectric withstand volts	Three-phase short-circuit current rating symmetrical amperes[1]	Rated switching current symmetrical amperes	Rated fuse size amperes[2]
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
1	800	240	254	2200	200000	9600	800
		480	508	2200	200000	9600	800
2	1200	240	254	2200	200000	14400	1200
		480	508	2200	200000	14400	1200
3	1600	240	254	2200	200000	19200	1600
		480	508	2200	200000	19200	1600
4	2000	240	254	2200	200000	24000	2000
		480	508	2200	200000	24000	2000
5	3000	240	254	2200	200000	36000	3000
		480	508	2200	200000	36000	3000
6	4000	240	254	2200	200000	48000	4000
		480	508	2200	200000	48000	4000

NOTES
1 Ratings in this column are rms symmetrical values for single-phase (2-pole) circuit breakers and three-phase average rms symmetrical values of three-phase (3-pole) circuit breakers. When applied on systems where rated maximum voltage may appear across a single pole, the short-circuit current ratings are 87% of these values. See 5.6 of ANSI/IEEE C37.13.

2 Fuses are of the current-limiting type.

Table 21 – Endurance requirements for low-voltage AC power circuit protectors (See ANSI/IEEE C37.29)

Line No.	Rated continuous current amperes	Number of make-break or close-open operations		
		Electrical endurance	Mechanical endurance	Between servicing[1]
	Col 1	Col 2	Col 3	Col 4
1	800	100	3500	500
2	1200	100	3000	500
3	1600	50	2500	500
4	2000	50	2500	250
5	3000	50	1250	250
6	4000	50	1250	250

NOTE
1 Servicing shall consist of adjusting, cleaning, lubricating, tightening, etc.

Table 22A – Preferred trip device current ratings or settings (in amperes) of low-voltage power circuit breakers[1] electro mechanical (AC & DC) (see ANSI C37.17)

Line No.	Amperes Col 1	Amperes Col 2	Amperes Col 3
1	40	200	800
2	50	225	1000
3	70	250	1200
4	90	300	1600
5	100	350	2000
6	125	400	2500
7	150	500	3000
8	175	600	4000
9	-	-	5000
10	-	-	6000[2]

Table 22B – Preferred trip device current ratings or settings (in amperes) of low voltage power circuit breakers[1] electronic (AC only) (see ANSI C37.17)

Line No.	Amperes Col 4	Amperes Col 5
1	150	1200
2	200	1600
3	400	2000
4	600	3000
5	800	3200
6	-	4000
7	-	5000

NOTES
1 See tables 1, 2, 8, and 17 for ranges of trip-device current ratings by circuit-breaker frame size.

2 This value is for DC circuit breakers only.

NOTE: Where these exact ratings or settings are not available in electronic devices, they may be closely approximated by the pickup setting of the long-time-delay element.

Table 23 – Preferred rated control voltages and their ranges

Operating mechanisms are designed for the rated control voltages listed with operational capability throughout the indicated voltage ranges to accommodate variations in source regulation, coupled with low charge levels, as well as high charge levels maintained with floating charges. The maximum voltage is the open circuit voltage measured at the control power terminals of the operating mechanism and the minimum voltage is measured with operating current flowing.

Line No.	Direct current control voltage ranges[1, 2, 3, 6, 9, 10] (Min – Max)			Alternating current control voltage ranges[1, 2, 3, 9] (Min – Max)	
	Rated control voltage (volts, DC)	Functions		Rated control voltage, (volts 60 Hz)	Closing opening & auxiliary functions[4, 5]
		Closing and auxiliary[4]	Opening[5]		
	Col 1	Col 2	Col 3	Col 4	Col 5
1	24	(7)	14-28	Single Phase	Single Phase
2	48 (7)	38-56	28-56	120	104-127 (8)
3				240	208-254 (8)
4	125	100-140	70-140	Polyphase	Polyphase
5	250	200-280	140-280	208Y/120	180Y/104-220Y/127
6	-	-	-	240	208-254

NOTES

1 Electrically operated motors, contactors, solenoids, valves, and the like, need not carry a nameplate voltage rating that corresponds to the nominal voltage rating shown in the table as long as these components perform the intended duty cycle (usually intermittent) in the voltage range specified.

2 Relays, motors, or other auxiliary equipment that function as a part of the control for a device shall be subject to the voltage limits imposed by this standard, whether mounted at the device or at the remote location.

3 Device control components, in some applications, may be exposed to control voltages exceeding those specified here due to abnormal conditions such as abrupt changes in line loading. Such applications require specific study, and the manufacturer should be consulted. Also, application of switchgear control components containing solid-state control, exposed continuously to control voltages approaching the upper limits of ranges specified herein, require specific attention and the manufacturer should be consulted before application is made.

4 Closing functions include (a) the closing power mechanism and (b) the means (coils, contactors, seal-in relays, and the like) to actuate the power mechanisms. Auxiliary functions include all functions except closing and opening.

5 Opening is the release of the holding means that permits stored energy to open the device.

6 It is recommended that the coils of closing, auxiliary, and opening components that are connected continually to one DC potential should be connected to the negative control bus so as to minimize electrolytic deterioration.

7 24-volt or 48-volt control voltages are recommended only when both the control components and devices are located near the battery or where special effort is made to ensure adequate control voltage at the control terminals. The 24-volt closing function is not recommended.

8 Includes heater circuits and supply for pump or compressor motors.

9 The devices utilizing standard auxiliary relays for control may not function at lower extremes of voltage ranges when relay coils are hot, as after repeated or continuous operation.

10 Direct current control voltage sources, such as those derived from rectified alternating current, may contain sufficient inherent ripple to modify the operation of control devices to the extent that they may not function over the entire specified voltage ranges.

Annex A
(Informative)

(This Annex is not part of American National Standard C37.16-2000, but is included for information only.)

Operating Conditions

The various operating conditions are outlined here and should be used with the appropriate tables in the standard. This information is also contained in the basic standards, that is, *American National Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures*, ANSI/IEEE C37.13, *and American National Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures*, ANSI/IEEE C37.14.

(A) Servicing consists of adjusting, cleaning, lubricating, tightening, and the like, as recommended by the manufacturer. When current is interrupted, dressing of contacts may be required as well. The operations listed are on the basis of servicing at intervals of 6 months or less.

(B) When closing and opening no-load.

(C) With rated control voltage applied.

(D) Frequency of operation not to exceed 20 in 10 minutes or 30 in an hour. Rectifiers or other auxiliary devices may further limit the frequency of operation.

(E) Servicing at no greater intervals than shown in column 2 of tables 5, 15, and 19.

(F) No functional parts should have been replaced during the listed operations.

(G) The circuit breaker should be in a condition to carry its rated continuous current at rated maximum voltage and perform at least one opening operation at rated short-circuit current. After completion of this series of operations, functional part replacement and general servicing may be necessary.

(H) When closing and opening current up to the continuous-current rating of the circuit breaker at voltages up to the rated maximum voltage and at 85% power factor or higher for AC circuits, and with L/R ratios between 0.02 and 0.06 seconds for DC circuits.

(I) When closing current up to 600% and opening currents up to 100% (80% power factor or higher) of the continuous-current rating of the circuit breaker at voltages up to the rated maximum voltage.

(J) When closing currents up to 600% and opening currents up to 600% (50% power factor or less) of the continuous-current rating of the circuit breaker at voltages up to rated maximum voltage, the number of operations shown shall be as in Table 3.

(K) If a fault operation occurs before the completion of the listed operations, servicing is recommended and possible functional part replacements may be necessary, depending on previous accumulated duty, fault magnitude, and expected future operations.

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