

C37.20.1™

IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

IEEE Power Engineering Society

Sponsored by the
Switchgear Committee



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IEEE Power Engineering Society

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Abstract: Low-voltage metal-enclosed switchgear—which contains either stationary or drawout, manually or electrically operated low-voltage ac or dc power circuit breakers in individual grounded metal compartments, in three-pole, two-pole, or single-pole construction—is covered. Rated maximum voltage levels are 254V, 508V, or 635V (ac) and 300/325V, 800V, 1000V, 1200V, 1600V, or 3200V (dc). The preferred continuous current ratings of the main bus in ac designs are 1600A, 2000A, 3000A, 3200A, 4000A, or 5000A. For dc designs, the preferred ratings are 1600A, 2000A, 2500A, 3000A, 4000A, 5000A, 6000A, 8000A, 10000A, or 12000A. The switchgear may also contain associated control, instruments, metering, protective, and regulating devices as necessary. The standard deals with service conditions, ratings, temperature limitations, and classification of insulating materials, insulation (dielectric) withstand voltage requirements, test procedures, and application.

Keywords: circuit breaker, control, cumulative loading, current transformers, drawout, indoor, instrumentation, load current-carrying, metering, outdoor, protection, stationary

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Introduction

(This Introduction is not a part of IEEE Std C37.20.1-2002, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.)

This standard has been revised to reflect needed technical changes that have been suggested since the last revision to IEEE Std C37.20.1 that was published in 1993. Major editorial and technical changes have been incorporated. The more significant changes include the following:

- a) Major expansion of text describing the design testing requirements in order to more fully delineate objective test criteria and performance evaluation guidelines. In most cases, it is felt that the text elaboration captures test requirements that were previously understood by test laboratories and designers, but not adequately delineated in the document.
- b) Addition of new definitions for mechanism-operated contact (MOC) and truck-operated contact (TOC) switches, previously contained in IEEE Std C37.2-1996, but necessary to a full understanding of metal-enclosed low-voltage power circuit breaker switchgear.
- c) Expansion of discussion of the requirements for LV dc switchgear, including devices commonly used in such switchgear, and coordination with on-going changes to related standards, including IEEE Std C37.14TM-1999.^a
- d) Changes to coordinate with other documents in the IEEE Std C37.20.X series of documents, particularly with IEEE Std C37.20.2TM-1999 for metal-clad switchgear. This coordination is maintained on an ongoing basis so as to treat common subjects in an equivalent manner.
- e) Addition of explanatory text related to short-circuit current ratings in 5.4.4.
- f) Updating and expansion of requirements for control wiring in 7.1.3.
- g) Conversion to the International System of Units (SI), the modernized metric system.

It is also noted that the altitude correction factors listed in Table 11 of this standard are under review by an IEEE Switchgear Committee Working Group, PC37.100.1, on Common Requirements for Power Switchgear. The old values are included in this document for reference until the Working Group releases the new values, at which time the new values will supersede those in the current Table 11.

This standard includes only the requirements for metal-enclosed low-voltage power circuit breaker switchgear. These requirements were previously a part of IEEE Std C37.20TM-1969 (Reaff 1981), IEEE Standard for Switchgear Assemblies Including Metal-Enclosed Bus (1974 consolidated edition). Other types of equipment previously included in IEEE Std C37.20-1969 are incorporated in separate publications.

The IEEE Switchgear Assemblies Committee was responsible for this revision.

This publication is one of a series covering switchgear assemblies as follows:

- 1) IEEE Std C37.20.1-2002, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
- 2) IEEE Std C37.20.2-1999, IEEE Standard for Metal-Clad Switchgear.
- 3) IEEE Std C37.20.3TM-2001, IEEE Standard for Metal-Enclosed Interrupter Switchgear.
- 4) IEEE Std C37.20.7TM-2001, IEEE Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults.

^aInformation on references can be found in Clause 2.

- 5) IEEE Std C37.21™-1985, IEEE Standard for Control Switchboards.
- 6) IEEE Std C37.23™-1987, IEEE Standard for Metal-Enclosed Bus and Calculating Losses in Isolated Phase Bus.

Figure A depicts types of switchgear assemblies.

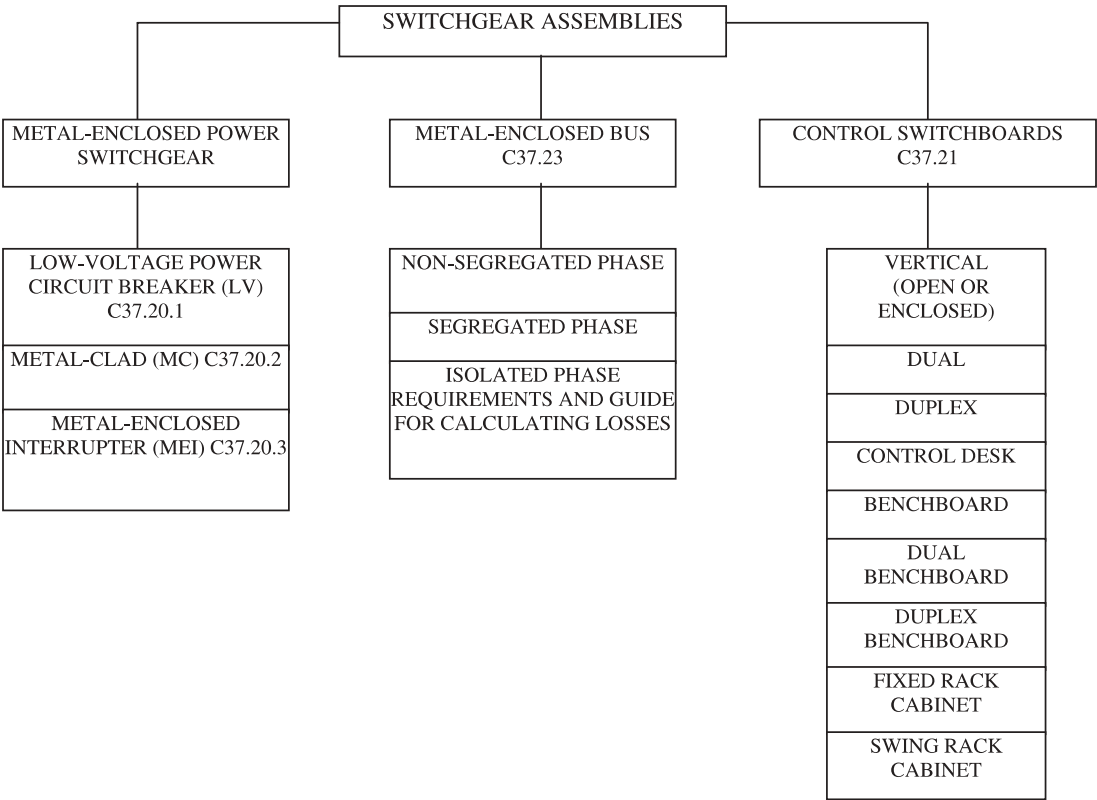


Figure A—Types of switchgear assemblies

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Contents

1. Scope	1
2. References	1
3. Definitions	4
3.1 General.....	4
4. Service conditions.....	6
5. Ratings	6
5.1 General.....	6
5.2 Voltage and insulation levels	6
5.3 Rated power frequency	7
5.4 Rated current	8
5.5 Temperature limitations	9
5.6 Current transformer ratings (LV ac switchgear)	11
5.7 Phase current transformer accuracies	12
5.8 Shunts for use in LV dc switchgear	12
6. Tests	12
6.1 General.....	12
6.2 Design tests	13
6.3 Production tests	26
6.4 Conformance tests.....	28
6.5 Field dielectric tests.....	28
7. Construction.....	28
7.1 General requirements	28
7.2 Materials and finish	34
7.3 Barriers.....	35
7.4 Buses and connections	35
7.5 Access doors and covers	35
7.6 Closing and tripping	36
7.7 Indoor LV switchgear	36
7.8 Outdoor LV switchgear	36
7.9 Pull box.....	37
7.10 Arrangements with stationary circuit breakers.....	37

7.11	Arrangements with drawout circuit breakers	37
7.12	Primary cable space	39
7.13	Precautionary labels	39
7.14	Lifting devices	39
8.	Application guide for LV switchgear.....	39
8.1	Unusual service conditions	39
8.2	System characteristics—voltage and frequency.....	42
8.3	Overvoltage considerations—insulation levels	43
8.4	Continuous current rating and overload capability.....	43
8.5	Short-circuit considerations	48
8.6	Nuclear power plant application	49
8.7	Associated devices often used in LV switchgear.....	49
8.8	Protection and isolation of switchgear connected to other circuit protective equipment.....	51
8.9	Overcurrent protection.....	52
9.	Guide for handling, storage, and installation	52
9.1	General.....	52
9.2	Handling	52
9.3	Preoperation check.....	54
9.4	Removable elements.....	55
9.5	Interlocks	55
9.6	Energizing	55

IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1. Scope

This standard covers metal-enclosed low-voltage power circuit breaker switchgear assemblies containing, but not limited to, such devices as low-voltage power circuit breakers (fused or unfused); other interrupting devices; switches, control, instrumentation, and metering; and protective and regulating equipment.

This standard is concerned with enclosed, rather than open, indoor and outdoor switchgear assemblies. It includes types of equipment that are part of secondary unit substations. It does not apply to equipment covered by industrial control standards, communication switchboards, communication switching equipment, switchboards for use on board ships, or dead-front distribution switchboards.

In this standard, metal-enclosed low-voltage power circuit breaker switchgear shall be called *LV switchgear*. For LV ac switchgear, the voltage shall be 1000 V or below; for LV dc switchgear, the voltage shall be 3200 V or below.

2. References

This standard shall be used in conjunction with the following publications. When the publications referenced in this standard are superseded by an approved revision, the revision shall apply.

ANSI C2-2002, National Electrical Safety Code[®] (NESC[®]), American National Standards Institute.^{1,2}

ANSI C37.16-2000, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors: Preferred Ratings, Related Requirements, and Application Recommendations.

¹ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org>).

²The NESC is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA. (<http://standards.ieee.org>). National Electrical Safety Code and NESC are both registered trademarks and service marks of the Institute of Electrical and Electronic Engineers, Inc.

ANSI C37.50-1989, Low-Voltage AC Power Circuit Breakers Used in Enclosures—Test Procedures.

ANSI C37.51-1989 (Reaff 1995), Metal-Enclosed Low-Voltage AC Power-Circuit-Breaker Switchgear Assemblies—Conformance Test Procedures.

ANSI Z535.4-1998, Product Safety Signs and Labels.

ASTM B117-1997, Standard Practice for Operating Salt Spray (Fog) Apparatus.³

ASTM D229-2001, Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation.

ASTM D412-1998A, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.

ASTM D714-1987 (Reaff 1994), Standard Test Method for Evaluating Degree of Blistering of Paints.

ASTM D1535-2001, Standard Practice for Specifying Color by the Munsell System.

ASTM D1654-1992, Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

ASTM G21-1996, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

IEEE Std 1TM-2001, General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation.^{4,5}

IEEE Std 4TM-1995, IEEE Standard Techniques for High-Voltage Testing.

IEEE Std 100TM, *The Authoritative Dictionary of IEEE Standard Terms*, Seventh Edition.

IEEE Std 120TM-1989 (Reaff 1997), IEEE Master Test Guide for Electrical Measurements in Power Circuits.

IEEE Std 141TM-1993 (Reaff 1999), IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (*IEEE Red Book*).

IEEE Std 142TM-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (*IEEE Green Book*).

IEEE Std 241TM-1990 (Reaff 1997), IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (*IEEE Gray Book*).

³ASTM publications are available from American Society for Testing and Materials, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (<http://www.astm.org/>).

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IEEE Std 242TM-2001, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (*IEEE Buff Book*).

IEEE Std 316TM-1971, IEEE Standard Requirements for Direct Current Instrument Shunts.⁶ (Note: this document has been withdrawn by IEEE, but the requirements for dc instrument shunts have not been adequately reflected in other standards. Therefore, IEEE Std 316-1971 continues as the relevant reference).

IEEE Std 446TM-1995 (Reaff 2000), IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (*IEEE Orange Book*).

IEEE Std C37.09TM-1999, IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

IEEE Std C37.2TM-1996 (Reaff 2001), IEEE Standard Electrical Power System Device Function Numbers and Contact Designations.

IEEE Std C37.13TM-1990 (Reaff 1995), IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.

IEEE Std C37.14TM-1999, IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures.

IEEE Std C37.24TM-1986 (Reaff 1998), IEEE Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Enclosed Switchgear.

IEEE Std C37.26TM-1972 (Reaff 1996), IEEE Standard Guide for Methods of Power-Factor Measurement for Low-Voltage Inductive Test Circuits.

IEEE Std C37.81TM-1989 (Reaff 1999), IEEE Guide for Seismic Qualification of Class 1E Metal-Enclosed Power Switchgear Assemblies.

IEEE Std C37.100TM-1992 (Reaff 2001), IEEE Standard Definitions for Power Switchgear.

IEEE Std C57.13TM-1993, IEEE Standard Requirements for Instrument Transformers.

NEMA CC1-1993, Electric Power Connectors for Substations.⁷

NEMA WC70-1999/ICEA S-95-658, Non-Shielded Power Cables Rated 2000 V or Less.

NFPA 70-2002, *National Electrical Code*[®] (NEC[®]).⁸

UL 486A-1997, Wire Connectors and Soldering Lugs for Use With Copper Conductors.⁹

⁶IEEE Std 310-1971 has been withdrawn; however, copies can be obtained from Global Engineering, 15 Inverness Way East, Englewood, CO 80112-5704, USA, tel. + 1-303-792-2181 (<http://global.ihs.com/>).

⁷NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA. (<http://global.ihs.com>)

⁸The National Electrical Code is published by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, USA. Copies are also available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org>). National Electrical Code and NEC are registered trademarks of the National Fire Protection Association, Inc.

⁹UL Standards are available from Comm-2000, 1414 Brook Drive, Downers Grove, IL 60515, USA (<http://www.comm-2000.com>).

3. Definitions

The definitions of terms contained in this standard, or in other standards referred to in this standard, are not intended to embrace all legitimate meanings of the terms. They are applicable only to the subject treated in this standard.

If a term is not defined in this standard, the definition in IEEE Std C37.100-1992¹⁰ applies. An asterisk (*) following a definition indicates that the definition in this standard is not contained in IEEE Std C37.100-1992 while a dagger (†) indicates that the definition differs from that in IEEE Std C37.100-1992.

3.1 General

3.1.1 auxiliary compartment: That portion of the switchgear assembly that is assigned to the housing of auxiliary equipment, such as voltage transformers, control power transformers, or other miscellaneous devices.*

3.1.2 circuit breaker compartment: That portion of a switchgear assembly that contains one circuit breaker and the associated primary conductors and secondary control connection devices, including current transformers.*

3.1.3 design tests: Tests made by the manufacturer to determine the adequacy of the design of a particular type, style, or model of equipment or its component parts to meet its assigned ratings and to operate satisfactorily under normal service conditions or under special conditions if specified, and may be used to demonstrate compliance with applicable standards of the industry.†

NOTES

1—Design tests are made on representative apparatuses or prototypes to verify the validity of design analyses and calculation methods and to substantiate the ratings assigned to all other apparatuses of basically the same design. These tests are not intended to be made on every design variation or to be used as part of normal production. The applicable portion of these design tests may also be used to evaluate modifications of a previous design and to ensure that performance has not been adversely affected. Test data from previous similar designs may also be used for current designs, where appropriate. Once made, the tests need not be repeated unless the design is changed so as to modify performance.

2—Design tests are sometimes called *type tests*.

3.1.4 field tests: Tests made after the switchgear assembly has been installed at its place of utilization.

3.1.5 metal-enclosed low-voltage power circuit breaker switchgear (LV): LV switchgear of multiple or individual enclosures, including the following equipment as required:

- a) Low-voltage power circuit breakers (fused or unfused) in accordance with IEEE Std C37.13-1990 or IEEE Std C37.14-1999.†
- b) Bare bus and connections
- c) Instrument and control power transformers
- d) Instruments, meters, and relays
- e) Control wiring and accessory devices

The low-voltage power circuit breakers are contained in individual grounded metal compartments and controlled either remotely or from the front of the enclosure. The circuit breakers may be stationary or

¹⁰Information on references can be found in Clause 2.

removable (drawout) type; when of removable type, mechanical interlocks are provided for proper operating sequence.[†]

NOTE—Bare bus and connections meet the requirements of this standard. However, the manufacturer may provide insulated bus and/or connections when required to meet dielectric requirements or as an option.

3.1.6 metal-enclosed power switchgear (ME): A switchgear assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows) containing primary power circuit switching or interrupting devices, or both, with buses and connections. The assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors or removable covers, or both.[†]

3.1.7 mechanism-operated cell switch. *See:* **mechanism-operated contact (MOC).**

3.1.8 mechanism-operated contact (MOC): A circuit breaker mechanism-operated auxiliary switch which is mounted in the stationary housing and is operated by linkage which cooperates with the circuit breaker mechanism. *Syn:* **mechanism-operated cell switch.***

3.1.9 production tests: Tests made for quality control by the manufacturer on every device or representative samples, or on parts or materials as required to verify during production that the product meets the design specifications and applicable standards.[†]

NOTES

1—Certain quality assurance tests on identified critical parts of repetitive high-production devices may be tested on a planned statistical sampling basis.

2—Production tests are sometimes called *routine tests*.

3.1.10 switchgear: A general term covering switching and interrupting devices and their combination with associated control, instruments, metering, protective, and regulating devices; also assemblies of these devices with associated interconnections, accessories, and supporting structures used primarily in connection with the generation, transmission, distribution, and conversion of electric power.[†]

3.1.11 switchgear assembly: An assembled equipment (indoor or outdoor) including, but not limited to, one or more of the following categories: switching, interrupting, control, instrumentation, metering, protective, and regulating devices; together with their supporting structures, enclosures, conductors, electrical interconnections, and accessories. *See:* Figure A in the Introduction.[†]

3.1.12 tin-surfaced or equivalent: Metallic materials having satisfactory long-term performance that operate within the limits established for tin-surfaced electrical contact parts and conduction mechanical joints.*

3.1.13 truck-operated cell switch: *See:* **truck-operated contact (TOC).**

3.1.14 truck-operated contact (TOC): A circuit breaker truck-operated auxiliary switch which is mounted in the compartment of a removable circuit breaker and is operated by the circuit breaker frame. *Syn:* **truck-operated cell switch.***

3.1.15 vertical section: That portion of the switchgear assembly between two successive vertical delineations, and may contain one or more circuit breakers, auxiliary compartments, and associated primary conductors.[†]

4. Service conditions

Standards for the design and performance of LV switchgear are based on usual service conditions as described below. The selection of equipment for a particular application can be based on the construction and ratings as defined in this standard provided that the following usual service conditions exist:

- a) The temperature of the cooling air (ambient air temperature) surrounding the enclosure of the LV switchgear is within the limits of -30°C and $+40^{\circ}\text{C}$.
- b) The altitude of the installation does not exceed 2000 m.
- c) The effect of solar radiation is not significant. (The principles stated in IEEE Std C37.24-1986 may be used for guidance.)
- d) Unusual service conditions, such as those outlined in 8.1, do not prevail.

The user should review 8.1 for unusual service conditions and other considerations when preparing specifications for LV switchgear because those unusual conditions impact the equipment design.

5. Ratings

5.1 General

The ratings of a switchgear assembly are designations of operating limits under specified conditions of ambient temperature, temperature rise, etc. Where the switchgear assembly comprises a combination of primary and secondary circuits, each may be given ratings.

Low-voltage switchgear shall have the following ratings:

- a) Rated maximum voltage
- b) Rated power frequency
- c) Rated insulation level
- d) Rated continuous current
- e) Rated short-time withstand current
- f) Rated short-circuit withstand current

The designated ratings in this standard are preferred, but are not to be considered restrictive. In addition to these ratings, a switchgear assembly may have interrupting or switching capabilities, which are determined by the ratings of the particular interrupting and switching devices that are integral parts of the switchgear assembly. Refer to specific standards for the ratings of these devices.

5.2 Voltage and insulation levels

5.2.1 Rated maximum voltage and insulation levels for LV ac switchgear

The rated maximum voltage of LV ac switchgear is the highest rms voltage for which the equipment is designed, and is the upper limit for operation. The rated insulation level of LV ac switchgear is equal to the power frequency withstand voltage. The rated maximum voltages and corresponding insulation levels for LV ac switchgear are listed in Table 1.

Table 1—Voltage and insulation levels for LV ac switchgear

Rated maximum voltage (rms)	Insulation levels (kV) ^a	
	Power frequency withstand (rms)	Reference dc withstand ^b
254	2.2	3.1
508	2.2	3.1
635	2.2	3.1

^aFor field test values, see 6.5.

^bThe column headed “dc withstand” is given as a reference only for those using dc tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each voltage class of switchgear. The presence of this column in no way implies any requirement for a dc withstand test on ac equipment, or that a dc withstand test represents an acceptable alternative to the power frequency withstand tests specified in this standard, either for design tests, production tests, conformance tests, or field tests. While power frequency withstand tests are preferred, it is recognized that users may choose to use dc withstand tests for field tests of assembled switchgear for reasons of convenience and availability of test apparatus. When making dc tests, the voltage should be raised to the test value in discrete steps and held for a period of 1 min.

5.2.2 Rated maximum voltage insulation levels for LV dc switchgear

The rated maximum voltage of LV dc switchgear is the highest dc voltage for which the equipment is designed, and is the upper limit for operation. The rated insulation level of LV dc switchgear is equal to the power frequency withstand voltage. The rated maximum voltages and corresponding insulation levels for LV dc switchgear are listed in Table 2.

Table 2—Voltage and insulation levels for LV dc switchgear

Rated maximum voltage (rms)	Insulation levels (kV) ^a	
	Power frequency withstand (rms)	Reference dc withstand ^b
300	2.2	3.1
325	2.2	3.1
800	3.7	5.2
1000	4.6	6.5
1200	4.8	6.8
1600	5.4	7.6
3200	8.8	12.4

^aFor field test values, see 6.5.

^bFor LV dc switchgear rated above 325 V (dc), it is preferred that a dc withstand voltage test be used. For tests conducted with dc voltage, the dc voltage is no less than 1.414 times the ac root-mean-square (rms) listed voltage.

5.3 Rated power frequency

The rated power frequency of a device, or an assembly, is the frequency of the circuit at which it is designed to perform. (Ratings for ac equipment are based on a frequency of 60 Hz.)

5.4 Rated current

5.4.1 Rated continuous current

The rated continuous current of LV switchgear is the maximum current in rms amperes at rated power frequency or direct current that can be carried continuously by the primary circuit components, including buses and connections, without causing temperatures or temperature rises in excess of specified limits for the following:

- a) Any primary or secondary circuit component
- b) Any insulating medium, or structural or enclosing member

The specified temperature and temperature rise limits applicable to switchgear assemblies are given in 5.5.1 through 5.5.6.

5.4.2 Continuous current ratings

The preferred continuous current ratings of the main bus in LV ac switchgear are 1600 A, 2000 A, 3000 A, 3200 A, 4000 A, or 5000 A. In LV dc switchgear, the preferred continuous current ratings are 1600 A, 2000 A, 2500 A, 3000 A, 4000 A, 5000 A, 6000 A, 8000 A, 10 000 A, or 12 000 A.

The continuous current rating of a vertical section bus riser shall be equal to the frame size of the LV power circuit breaker connected to that riser (see ANSI C37.16-2000 or IEEE Std C37.14-1999).

EXCEPTION—The continuous current rating of riser bus may be as modified by the allowable cumulative loading of multiple circuit breakers in the same section (see Table 14), or by lower continuous current ratings for current transformers. In no case does the riser bus rating need to be greater than the rating of the main bus.

5.4.3 Rated short-time withstand current

The rated short-time withstand current of a LV ac switchgear assembly, or a LV dc switchgear assembly rated 300 V or 325 V (dc), is the designated limit of available (prospective) current at which it shall be required to withstand its short-time current duty cycle (two periods of 0.5 s current flow, separated by a 15 s interval of zero current) at rated maximum voltage under the prescribed test conditions. This current is expressed in rms symmetrical amperes and is measured from the envelope of the available current wave at a time one-half cycle after current is established.

The rated short-time withstand current of a LV dc switchgear assembly for use with solid-state rectifiers (regardless of rated voltage), or rated above 325 V (dc), is the designated limit of available (prospective) sustained rms current it shall be capable of carrying for not less than 250 ms.

Both LV ac and LV dc switchgear assemblies shall have a preferred short-time withstand current rating equal to the short-time current rating of the smallest frame size circuit breaker used in the assembly, as listed in ANSI C37.16-2000.

5.4.4 Rated short-circuit withstand current

The rated short-circuit withstand current of a LV ac assembly, or a LV dc switchgear assembly rated 300 or 325 V (dc), is the designated limit of available (prospective) current at rated maximum voltage

that it shall be required to withstand for a period of no less than four cycles on a 60 Hz basis under the prescribed test conditions. This current is expressed in rms symmetrical amperes and is measured from the envelope of the available current wave at a time 1/2 cycle after current is established.

For a LV dc switchgear assembly, the rated short-circuit withstand current shall be the peak current that it shall be required to withstand when tested using a dc source.

Low-voltage ac switchgear assemblies shall have preferred short-circuit withstand current ratings equal to the short-circuit current rating of the smallest frame size circuit breaker used in the assembly as covered in ANSI C37.16-2000. The power factor (X/R ratio) shall be as required in 6.2.5.1.

Low-voltage dc switchgear assemblies shall meet the ratings and test parameters required for LV dc power circuit breakers as covered in IEEE Std C37.14-1999 and ANSI C37.16-2000.

NOTES

- 1—The rated short-circuit withstand current determines the *bus bracing* which is required of the design.
- 2—For LV ac and dc switchgear assemblies with no fused circuit breakers, the rated short-circuit withstand current is the short-circuit current rating of the circuit breaker with the lowest short-circuit current rating in the assembly.
- 3—For LV ac switchgear assemblies with all fused circuit breakers, the rated short-circuit withstand current is the short-circuit current rating of the fused circuit breakers used in the assembly.
- 4—For LV ac switchgear assemblies with both fused and unfused circuit breakers, the rated short-circuit withstand current is the short-circuit current rating of the unfused circuit breaker with the lowest short-circuit current rating in the assembly.
- 5—The rated short-circuit withstand current (from notes 2, 3, or 4 above), which is expressed in rms symmetrical amperes, times 2.3 (for unfused circuit breaker assemblies) or times 2.16 (for fused circuit breaker assemblies), equals the peak current for which the assembly must be qualified by the short-circuit current withstand tests of 6.2.5. The short-circuit withstand current can also be expressed in rms asymmetrical amperes by multiplying times 1.33 or 1.247 for unfused and fused circuit breaker assemblies, respectively. The rms asymmetrical current values for low-voltage switchgear assemblies are similar in concept to the rms asymmetrical momentary current ratings for medium-voltage switchgear assemblies, except that larger multipliers are required for medium-voltage switchgear assemblies for the higher X/R ratings. The short-circuit withstand current has also sometimes been called *bus bracing*, but continued use of this term is discouraged. If *bus bracing* is used, the specifier must state whether the current is in rms symmetrical or rms asymmetrical amperes. Refer to the column for curve MM in Table 2 of IEEE Std C37.26-1972 for multipliers to convert from rms symmetrical amperes to rms asymmetrical amperes at a specific power factor or X/R ratio.

5.5 Temperature limitations

5.5.1 Limiting temperature

The limiting temperature for LV switchgear is the maximum temperature permitted for the following:

- a) Any component such as insulation, buses, instrument transformers, and switching and interrupting devices
- b) Air in cable termination compartments
- c) Any noncurrent-carrying structural parts
- d) Air surrounding devices

5.5.2 Temperature limits for insulating materials

The total temperature to which insulating materials are subjected shall not exceed the values listed in Table 3 for the various classes of insulating materials.