

An American National Standard

IEEE Standard for Metal-Enclosed Interrupter Switchgear

Sponsor
**Switchgear Committee
of the
IEEE Power Engineering Society**

Secretariat

**Institute of Electrical and Electronics Engineers
National Electrical Manufacturers Association**

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Corrected Edition

July, 1987

Foreword

(This Foreword is not a part of ANSI/IEEE C37.20.3-1987, IEEE Standard for Metal-Enclosed Interrupter Switchgear.)

This standard includes only the requirements for metal-enclosed interrupter switchgear. These requirements were previously a part of ANSI/IEEE C37.20-1969 (R 1981), IEEE Standard for Switchgear Assemblies Including Metal-Enclosed Bus (1974 Consolidated Edition). Other types of equipment previously included in ANSI/IEEE C37.20-1969 (R 1981), will now be incorporated in separate publications.

ANSI/IEEE C37.20 has for many years covered all switchgear assemblies including metal-enclosed bus. Standards committees of IEEE Switchgear Assemblies Subcommittee and NEMA Power Switchgear Assemblies Technical Committee recommended that the document be further developed and, where appropriate, the various sections be identified with their own standards. This approach also identifies with the Conformance Test Procedure Standards.

This edition was prepared by the Power Switchgear Assemblies Technical Committee, National Electrical Manufacturers Association (NEMA). NEMA is responsible for Section 4, Ratings and Section 6, Construction.

The Switchgear Assemblies Subcommittee of the IEEE Switchgear Committee is responsible for Section 2, Definitions; Section 3, Service Conditions; Section 5, Tests; Section 7, General Application Conditions; and Section 8, Handling, Storage, and Installation.

A working group of the NEMA Power Switchgear Assemblies Technical Committee revised ANSI/IEEE C37.23-1970, IEEE Guide for Calculating Losses in Isolated-Phase Bus, to include Section 8 of ANSI/IEEE C37.20, Metal-Enclosed Bus. The document updates the material for metal-enclosed conductors including cable bus. The IEEE Switchgear Assemblies Subcommittee refined and expanded the document.

The following documents were developed for each product type based on ANSI/IEEE C37.20 (see Fig A).

C37.20.1	Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear (1000 V and Below)
C37.20.2	Metal-Clad and Station-Type Cubicle Switchgear (Above 1000 V)
C37.20.3	Metal-Enclosed Interrupter Switchgear (Above 1000 V)
C37.21	Control Switchboards
C37.23	Metal-Enclosed Bus and Guide for Calculating Losses in Isolated Phase Bus

Through this joint effort over the many years, the switchgear assemblies standards have been of extreme value to the industry and further suggestions for improvement gained in the use of this standard will be welcomed.

The Standards Committee on Power Switchgear, C37, which reviewed and approved this standard had the following personnel at the time of approval:

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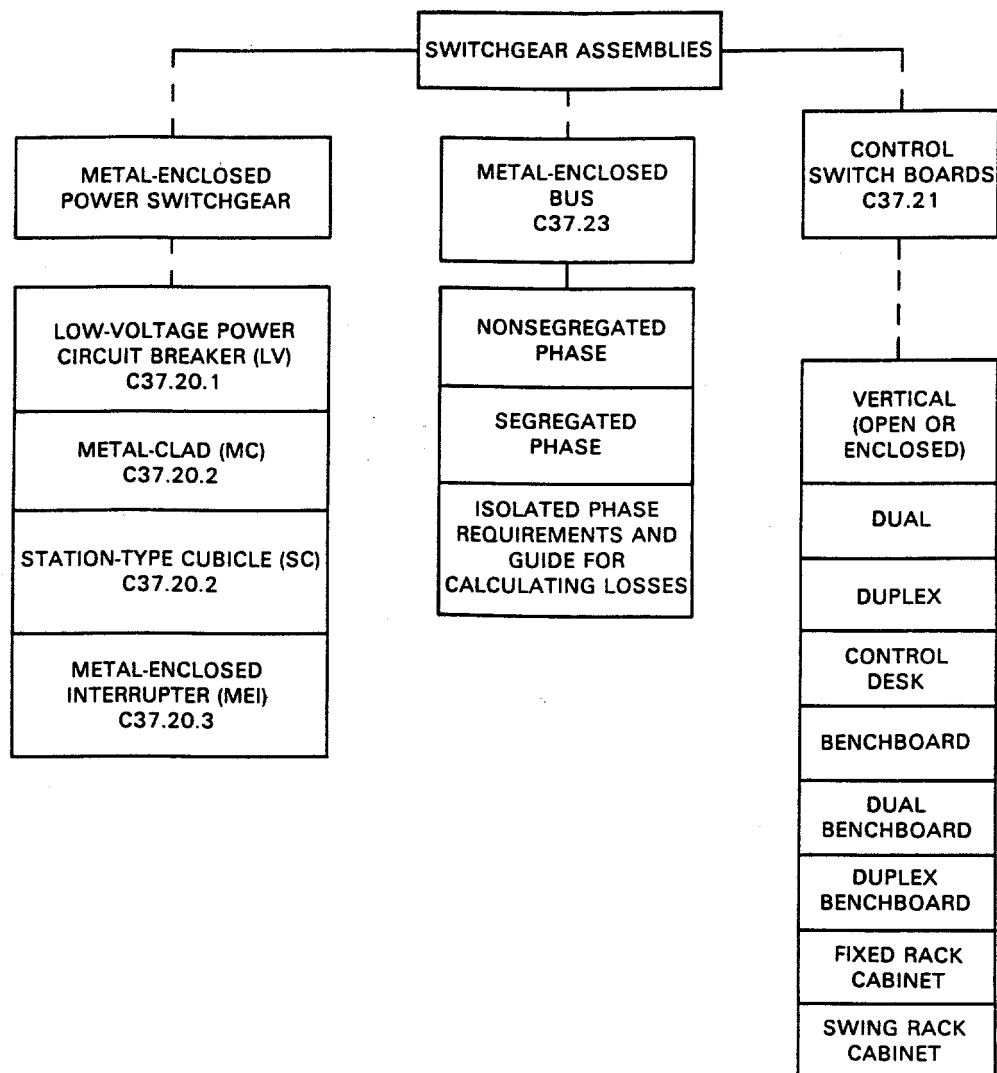


Figure A —Types of Switchgear Assemblies

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IEEE Standard for Metal-Enclosed Interrupter Switchgear

Corrections are indicated by vertical bars in the margins opposite the areas of change.

1. Scope and References

1.1 Scope

This standard covers metal-enclosed interrupter switchgear assemblies containing but not limited to such devices as interrupter/switches, selector switches, power fuses, control, instrumentation and metering, and protective equipment. It includes, but is not specifically limited to, equipment for the control and protection of apparatus used for distribution of electrical power.

This standard is concerned with enclosed, rather than open, switchgear assemblies rated above 1000 V. It includes equipments that are part of primary and secondary unit substations. It does not include gas insulated substation equipments, nor switching devices mounted integrally within a transformer enclosure.

In this standard the metal-enclosed interrupter switchgear shall be called MEI switchgear.

1.2 References

[1] ANSI C2-1987, American National Standard National Electrical Safety Code.¹

[2] ANSI C37.47-1981, American National Standard Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses.

[3] ANSI Z35.1-1972, American National Standard Specifications for Accident Prevention Signs.

[4] ANSI Z55.1-1967 (R 1973), American National Standard Gray Finishes for Industrial Apparatus and Equipment.

[5] ANSI/IEEE C37.2-1979, IEEE Standard Electrical Power System Device Function Numbers.²

¹ ANSI publications are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

² ANSI/IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331. Copies are also available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

- [6] ANSI/IEEE C37.24-1971 (R 1984), IEEE Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear.
- [7] ANSI/IEEE C37.100-1981, IEEE Standard Definitions for Power Switchgear.
- [8] ANSI/IEEE C57.13-1978 (R 1986), IEEE Standard Requirements for Instrument Transformers.
- [9] ANSI/IEEE Std 1-1986, IEEE Standard General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation.
- [10] ANSI/IEEE Std 4-1978, IEEE Standard Techniques for High-Voltage Testing.
- [11] ANSI/IEEE Std 100-1984, IEEE Standard Dictionary of Electrical and Electronics Terms.
- [12] ANSI/IEEE Std 141-1986, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
- [13] ANSI/IEEE Std 142-1982, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- [14] ANSI/IEEE Std 241-1983, IEEE Recommended Practice for Electric Power Systems in Commercial Buildings.
- [15] ANSI/IEEE Std 242-1986, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- [16] ANSI/IEEE Std 344-1975, IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.
- [17] ANSI/IEEE Std 446-1987, IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
- [18] ANSI/NFPA 70-1987, National Electrical Code.³
- [19] ANSI/UL 486A-1982, Wire Connectors and Soldering Lugs for Use With Copper Conductors.⁴
- [20] ASTM B117-85, Standard Method of Salt Spray (Fog) Testing.⁵
- [21] ASTM D229-82, Standard Method of Testing Rigid Sheet and Plate Materials Used for Electrical Insulation.
- [22] ASTM D714-56 (R 1981), Standard Method of Evaluating Degree of Blistering of Paints.
- [23] ASTM D1535-80, Standard Method of Specifying Color by The Munsell System.
- [24] ASTM D1654-79 (R 1984), Standard Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- [25] ASTM D2303-85, Standard Test Method for Liquid-Contaminant, Inclined-Plane Tracking of Erosion of Insulating Materials.
- [26] ASTM G21-70 (R 1980), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

³ The National Electrical Code is published by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269. Copies are also available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

⁴ ANSI/UL publications are available from Underwriters Laboratories Inc, Publication Stock, 333 Pfingsten Road, Northbrook, IL 60062.

⁵ ASTM publications are available from American Society for Testing and Materials, 1916 Race St, Philadelphia, PA 19103.

[27] NEMA CC1-1975, Electric Power Connectors for Substations.⁶

[28] NEMA WC5-1973, Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-61-402).

[29] NEMA WC7-1971 (R 1976), Cross-Linked-Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-66-524).

[30] NEMA Bulletin No 77-1973 (R 1975), Guide Lines for Warning Labels.

[31] NEMA LI1-1983, Industrial Laminated Thermosetting Products.

[32] Federal Specification PPP-T-45B.⁷

2. 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 ANSI/IEEE C37.100.1981 [7]⁸ applies. An asterisk (*) following a definition indicates that the definition in this standard is not contained in ANSI/IEEE C37.100-1981 [7] while a dagger (†) indicates the definition differs from that in ANSI/IEEE C37.100-1981 [7].

2.1 switchgear: A general term covering switching and interrupting devices and their combination with associated control, instrumentation, 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.†

2.1.1 switchgear assembly (see Fig A): An assembled equipment (indoor or outdoor) including, but not limited to, one or more of switching, interrupting, control, instrumentation, metering, protective and regulating devices, together with their supporting structures, enclosures, conductors, electric interconnections, and accessories.†

2.1.2 metal-enclosed power switchgear: 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 and may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors or removable covers.†

metal-enclosed interrupter switchgear. Metal-enclosed power switchgear including the following equipment as required:

- 1) Interrupter switches
- 2) Power fuses (current limiting or noncurrent limiting)
- 3) Bare bus and connections
- 4) Instrument transformers
- 5) Control wiring and accessory devices

The interrupter switches and power fuses may be stationary or removable (drawout) type. When removable type, automatic shutters that cover primary circuit elements when the removable element is in the disconnected, test, or removed position, and mechanical interlocks are to be provided for proper operating sequence.

2.2 qualifying terms: (Relating to types of enclosures, ventilation methods, etc).

⁶ NEMA publications are available from the National Electrical Manufacturers Association, 2101 L Street, NW, Washington, DC 20037.

⁷ This publication is available from the Director, US Navy Publications and Printing Service, Eastern Division, 700 Robbins Ave, Philadelphia, PA 19111.

⁸ The numbers in brackets correspond to those of the references in 1.2.

- 1) The following qualifying terms are defined in ANSI/IEEE Std 100-1984 [11] and the user is referred to the definitions given therein:
 - accessible**
 - enclosed**
 - isolated**
 - ventilated**
- 2) The following qualifying terms are defined in ANSI/IEEE C37.100-1981 [7] and the user is referred to the definitions given therein:
 - enclosure**
 - flame-resistant (retardant)**
 - indoor**
 - metal-enclosed**
 - outdoor**
 - resistant (suffix)**
 - secondary**
 - ventilated enclosure**

2.3 common or related terms: The following common or related terms are defined in ANSI/IEEE C37.100-1981 [7] and the user is referred to the definitions given therein:

- asymmetrical**
- auxiliary switch**
- bus**
- connected position**
- continuous current tests**
- disconnected position**
- drawout-mounted device**
- ground bus**
- main (primary switchgear connections)**
- primary disconnecting devices**
- removable element**
- secondary and control wiring**
- silver surfaced**
- stationary mounted device**
- symmetrical**
- terminal**
- terminal block**
- test position**

2.4 ambient air temperature: The temperature of the surrounding air that comes in contact with equipment.*

NOTE — Ambient air temperature, as applied to enclosed switchgear assemblies, is the average temperature of the surrounding air that comes in contact with the enclosure. See 5.2.2.3 for method of measurement.

2.5 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 apparatus or prototypes to verify the validity of design analysis and calculation methods and to substantiate the ratings assigned to all other apparatus 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. These 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*.

2.6 production tests: Tests made for quality control by the manufacturer on every device or representative samples, or on parts or materials 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*.

2.7 conformance tests: Conformance tests demonstrate compliance with the applicable standards. The test specimen is normally subjected to all planned production tests prior to initiation of the conformance test program.†

NOTE — The conformance tests may, or may not, be similar to certain design tests. Demonstration of margin (capabilities) beyond the standards is not required.

2.8 field tests: (for switchgear). Tests made after the assembly has been installed at its place of utilization.†

2.9 switch compartment: That portion of the switchgear assembly that contains one switching device, such as an interrupter switch, power fuse interrupter switch combination, etc, and the associated primary conductors.*

2.10 vertical section: That portion of the switchgear assembly between two successive vertical delineations and may contain one or more switch compartments and associated primary conductors.*

3. Service Conditions

American National Standards for the design and performance of MEI switchgear as 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 these usual service conditions exist.

- 1) The temperature of the cooling air (ambient air temperature) surrounding the enclosure of the MEI switchgear is within the limits of -30°C and $+40^{\circ}\text{C}$.
- 2) The altitude of the installation does not exceed 3300 ft (1000 m)
- 3) The effect of solar radiation is not significant. (The principles stated in ANSI/IEEE C37.24-1971 (R 1984) [6] may be used for guidance.)
- 4) Unusual service conditions such as outlined in 7.1 do not prevail.

4. Ratings

4.1 General

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

MEI switchgear having primary circuits shall have the following ratings:

- 1) Rated maximum voltage
- 2) Rated frequency
- 3) Rated insulation levels
- 4) Rated continuous current
- 5) Rated short-time current
- 6) Rated momentary current

The designated ratings in this standard are preferred but are not considered to be restrictive.

In addition to these ratings, MEI switchgear may have interrupting or switching capability, which is determined by the rating of the particular interrupting and switching devices that are integral parts of the switchgear assembly. Refer to specific American National Standards for the ratings of these devices.

For ratings of particular interrupting and switching devices such as interrupter switches and fuses, refer to specific American National Standards for such devices.

Table 1—Voltage and Insulation Levels Rated Insulation Levels (kV)

Rated Maximum Voltage (kV)	Low Frequency Withstand (rms)	Impulse Withstand	Reference * dc Withstand
4.76	19	60	27
8.25	26	75	37
15.0	36	95	50
15.5	50	110	70
25.8	60	125	†
38.0	80	150	†

*The 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 rating 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 low-frequency withstand tests specified in this standard, either for design tests, production tests, conformance tests, or field tests. When making dc tests, the voltage should be raised to the test value in discrete steps and held for a period of 1 min.

† Because of the variable voltage distribution encountered when making dc withstand tests, the manufacturer should be contacted for recommendations before applying dc withstand tests to the switchgear. Potential transformers above 34.5 kV should be disconnected when testing with dc. See ANSI/IEEE C57.13-1978 (R 1986) [8], Section 8 and in particular 8.8.2 which reads "Periodic kenotron tests should not be applied to transformers of higher than 34.5 kV rating."

4.2 Voltage and Insulation Levels (See Table 1)

4.2.1 Rated Maximum Voltage

The rated maximum voltage of MEI switchgear is the highest rms voltage for which the equipment is designed, and is the upper limit for operation.

4.2.2 Rated Insulation Levels

The rated insulation levels of MEI switchgear assembly shall consist of two items

- 1) Low-frequency, one-minute withstand voltage
- 2) Impulse-withstand voltage

4.2.3 Voltage and Insulation Levels

The rated maximum voltages, and corresponding insulation levels for MEI switchgear are listed in Table 1.

4.3 Rated Frequency

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

4.4 Rated Current

4.4.1 Rated Continuous Current

The rated continuous current of MEI switchgear is the maximum current in root-mean-square (rms) amperes at rated frequency, which can be carried continuously by the primary circuit components, including buses and connections, without causing temperature in excess of specified limits for

- 1) Any primary or secondary circuit component
- 2) Any insulating medium, or structural or enclosing member

The specified temperature limits applicable to switchgear assemblies are given in 4.5.1 through 4.5.7.

4.4.2 Continuous Current Ratings

The continuous current ratings of the main bus in MEI switchgear shall be 600 A, 1200 A, and 2000 A.

The continuous current rating of the individual switch compartments shall be equal to the ratings of the switching and interrupting devices used, except as may be modified by lower continuous current ratings for current transformers, power fuses etc.

4.4.3 Rated Momentary Current

The rated momentary current of MEI switchgear is the maximum rms total current which it shall be required to withstand. The current shall be the rms value, including the direct-current component, at the major peak of the maximum cycle as determined from the envelope of the current wave during a test period of at least 10 cycles unless limited to a shorter time by the protective device.

4.4.4 Momentary Current Ratings

The momentary current ratings of the individual switch compartments of MEI switchgear shall be equal to the momentary, fault close, or the total asymmetrical short-circuit current ratings of the switching devices used.

4.4.5 Rated Short-Time Current

The rated short-time current of MEI switchgear is the average rms symmetrical current that it can carry for a period of 2 s unless limited to a shorter time by the protective device or current transformer rating.

4.4.6 Short-Time Current Rating

The short-time current ratings of the individual switch compartments of the MEI switchgear shall be equal to the short-time ratings of the switching and protective devices used or the short-time rating of the current transformer (see ANSI/IEEE C57.13-1978 (R 1986) [8]).