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Power Switchgear Assemblies

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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Scope

POWER SWITCHGEAR ASSEMBLIES VOTING CLASSIFICATION OF THE SWITCHGEAR SECTION

Power switchgear assemblies including, but not specifically limited to, equipment for the control and protection of apparatus used for power generation, conversion, transmission, and distribution.

A. METAL ENCLOSED LOW VOLTAGE AIR CURCUIT BREAKER SWITCHGEAR ASSEMBLIES

Low voltage metal enclosed air circuit breaker switchgear assemblies, indoor and outdoor, 600 volts a-c or less, either drawout or stationary.

Renewal and spare parts when furnished with this item are included in the scope of this item.

B. METAL-CLAD SWITCHGEAR ASSEMBLIES

Metal-clad switchgear assemblies, indoor and outdoor, including power circuit breakers 4.16 to 13.8 kV and 75 to 1000 mva interrupting capacity.

Renewal and spare parts when furnished with this item are included in the scope of this item.

C. STATION-TYPE CUBICLES

Station-type cubicle switchgear, indoor and outdoor, including stationary power circuit breakers 14.4 kV and above, 1000 mva interrupting capacity and above.

Renewal and spare parts when furnished with this item are included in the scope of this item.

D. METAL ENCLOSED POWER BUSES

Metal enclosed bus structures and connections, when furnished separate from switchgear assemblies, and not composing a part of metal enclosed switchgear assemblies as tie circuits.

Renewal and spare parts when furnished with this item are included in the scope of this item.

F. SWITCHBOARD ASSEMBLIES (ALL TYPES)

Switchboard assemblies for centralized manual or automatic secondary control and protection of stations; generation, transmission, conversion and distribution, including the following:

1. Vertical, enclosed and duplex swtichboards.
2. Control desks and benchboards.
3. Battery charging equipment for power station and substation control circuits.
4. Switchboards with knife switches or stationary mounted low voltage power circuit breakers.
5. Switchboards with power circuit breakers, panel or remote mounted.
6. Open or enclosed type d-c switchboard assemblies, either drawout or stationary, including anode equipment.

Renewal and spare parts when furnished with this item are included within the scope of this item.

G. METAL ENCLOSED LOAD INTERRUPTER SWITCHGEAR ASSEMBLIES*

Metal enclosed assemblies, indoor and outdoor, having load interruptor switches, together with any or all of the following: power fuses, buses, connections, instrument transformers, metering and indicating devices.

* See note on page ii.

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Foreword

This is one* of six NEMA Standards Publications covering the range of low- to high-voltage switchgear products. Such products are generally applied to utility and industrial use with a portion going to commercial applications. User and general interest input played a significant part in the development of the product requirements carried by this publication. It, as well as the other NEMA Standards Publications, is not intended to stand alone, for without exception:

1. It adopts by reference the appropriate American National Standards (approved by American National Standards Committee C37) as the main body of this NEMA publication.
2. It offers a vehicle for getting into print the proposed NEMA revisions of the pertinent C37 Standards, until such time as those revisions can be evaluated, approved and published as a revision of the particular American National Standard.
3. It covers additional information about a product of specific interest to the manufacturing community, which the ANSI Standards Committee does not include in its scope.

Within this NEMA publication, therefore, the main focus is on American National Standards and the consensus method of standards approval used by ANSI.

Switchgear standards are, for the most part, developed through the combined and separate efforts of IEEE, AEIC and NEMA. ANSI Standards Committee C37 serves as the administrator through which are channeled all switchgear proposals intended for eventual publication as American National Standards. It is within these organizations that the principal manufacturer-user exchange is accomplished. This exposes product requirements to those people having the direct responsibility for the use, design, application, maintenance and acceptance of the products and thus assures a most objective and critical review within the voluntary standards program.

SG 2	High-voltage Fuses
SG 3	Low-voltage Power Circuit Breakers
SG 4	High-voltage Power Circuit Breakers
*SG 5	Power Switchgear Assemblies
SG 6	Power Switching Equipment
SG 13	Automatic Circuit Reclosers, Automatic Line Sectionalizers and Oil-filled Capacitor Switches for Alternating-current Systems

The standards in this publication are periodically reviewed by the Power Switchgear Assemblies Voting Classification of the Switchgear Section of NEMA for any revisions necessary to keep them up to date with advancing technology. Proposed or recommended revisions should be submitted to:

Manager, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

* These are free standing units or assemblies and do not cover the primary equipment associated with and considered part of unit equipment transformers. Such equipment is to be included and reported as part of the transformer.

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POWER SWITCHGEAR ASSEMBLIES

Sections 1 through 10

APPLICABLE AMERICAN NATIONAL STANDARD (WITH NEMA REVISIONS AND ADDITIONS)

The American National Standard for Switchgear Assemblies Including Metal-enclosed Bus, C37.20-1969*, and supplements C37.20a-1970, C37.20b-1972 and C37.20c-1974, (with the exception of par. 6.1.4.1 Finish Color and the first paragraph of par. 8.3.1 Finish) have been approved by NEMA and constitute Sections 1 through 10 of this NEMA Publication No. SG 5-1981. The following revisions to C37.20 have also been approved by NEMA and will be referred to the American National Standards Institute for its consideration.

NEMA Standard 11-14-1974; revised 9-17-1981.

5.3.4.2 Control Wiring Insulation Test

Add the following two sentences to this paragraph:

The duration of the test may be 1 second if a voltage of 1800 volts is applied. At the option of the manufacturer, switchgear mounted devices which have been individually tested may be disconnected during the test.

6.1.1.4 Terminal (Terminal Connectors)

Revise this section to read:

6.1.1.4 Cable Terminations. The design of the switchgear shall provide space for the devices used for making electrical and mechanical connections to the cables. Each cable terminal connection point shall have a unit rating (see par. 4.3.2 Continuous Current Ratings in the 1974 Consolidated Edition of C37.20) and shall meet the bolt hole requirements of par. CC 1-4.05 of the NEMA Standards Publication for Electric Power Connectors, Publication No. CC 1-1972.

6.1.3.1 Control and Secondary Wiring

Delete the fourth paragraph which reads:

Type TA—American National Standard Requirements for Asbestos, Asbestos-Varnished-Cloth and Asbestos-Thermoplastic Insulated Wires and Cables, C8.36-1962 (R 1970) (ICEA Publication No. S-28-357, Second Edition, NEMA Publication No. WC 1-1963).

6.1.3.3 Terminal Blocks

Terminal blocks incorporating screw or stud-and-nut type terminals shall accommodate wire lugs or similar devices affixed to stranded wire. Screw or stud-and-nut type terminals intended for use with stranded wire shall be such that all strands of the conductor are confined. Terminal blocks incorporating pressure connectors shall not damage† the wire and, when terminating stranded conductors, all strands shall be clamped within the connector.

NEMA Standard 9-17-1981.

6.2.1 Material and Finish

Revise the first paragraph to read:

The materials for metal-clad switchgear shall be sheet metal suitably supported. Barriers between the primary sections of adjacent units and between the primary major sections of each circuit shall not be less than No. 11 MSG (Manufacturer's Standard Gage) (nominal thickness 0.30 cm or 0.1196 in.). All other covers, barriers, panels, and doors shall be not less than No. 14 MSG (nominal thickness 0.19 cm or 0.0747 in.). Minimum thicknesses are based on the use of steel. Where other metals are used, the thickness shall be modified to provide equivalent strength and deflection. Doors or panels used to support devices shall be increased in thickness or otherwise strengthened as necessary to support the devices.

6.3.1 Material and Finish

Revise the first paragraph to read:

The materials for station-type cubicle switchgear shall be sheet metal suitably supported. Barriers between the primary sections of adjacent units and between the primary major sections of each circuit shall not be less than No. 11 MSG (Manufacturer's Standard Gage) (nominal thickness 0.30 cm or 0.1196 in.). All other covers, barriers, panels, and doors shall not be less than No. 14

*C37.20-1969 and supplements C37.20a, C37.20b and C37.20c have been combined and are available as a "1974 Consolidated Edition" from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

† In the absence within this standard of definitive performance requirements, compliance with this clause can be assessed by referencing ANSI/UL 486-1975.

NEMA Standard 9-17-1981.

It should be noted that, for many applications, only crimp-on terminals are permitted by user's specifications.

Authorized Engineering Information 9-17-1981.

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MSG (nominal thickness 0.19 cm or 0.0747 in.). Minimum thicknesses are based on the use of steel. Where other metals are used, the thickness shall be modified to provide equivalent strength and deflection. Doors or panels used to support devices shall be increased in thickness or otherwise strengthened as necessary to support the devices.

6.4.1 Material and Finish

Revise the first paragraph to read:

The material for metal-enclosed interrupter switchgear shall be sheet metal, suitably supported. Barriers used between units shall not be less than No. 11 MSG (nominal thickness 0.30 cm or 0.1196 in.). All external covers, panels, and doors shall not be less than No. 14 MSG (nominal thickness 0.19 cm or 0.0747 in.). Minimum thicknesses are based on the use of steel. Where other metals are used, the thickness shall be modified to provide equivalent strength and deflection. Doors or panels used to support devices shall be increased in thickness or otherwise strengthened as necessary to support the devices.

6.5.1 Material and Finish

Revise the first paragraph to read:

The material for metal-enclosed low-voltage power circuit breaker switchgear shall be sheet metal, suitably supported. Barriers between compartments as listed in Section 6.5.2 shall not be less than No. 11 MSG (nominal thickness 0.30 cm or 0.1196 in.). All other covers, barriers, panels, and doors shall not be less than No. 14 MSG (nominal thickness 0.19 cm or 0.0747 in.). Minimum thicknesses are based on the use of steel. Where other metals are used, the thickness shall be modified to provide equivalent strength and deflection. Doors or panels used to support devices shall be increased in thickness or otherwise strengthened as necessary to support the devices.

6.6.1 Material and Finish

Revise the first paragraph to read:

The materials and finishes for switchboard panels shall be:

Thickness not less than No. 14 MSG (nominal thickness 0.19 cm or 0.0747 in.). This minimum thickness is based on the use of steel. Where other materials are used, the thickness shall be modified to provide equivalent strength and deflection. Doors or panels used to support devices shall be increased in thickness or otherwise strengthened as necessary to support the devices.

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Section 11
SWITCHGEAR ASSEMBLIES AND COMPONENTS

11.1 GENERAL

The equipment described in Section 11 for factory-built alternating-current switchgear is considered minimum for typical 3-phase 3-wire circuits.

For other system requirements, additional equipment should be added, in which case the manufacturer should be consulted.

NEMA Standard 9-25-1939, revised 9-17-1941; 6-11-1946; 7-15-1948; 6-3-1956; Authorized Engineering Information 11-17-1966.

11.2 METAL-ENCLOSED LOW-VOLTAGE POWER-CIRCUIT-BREAKER SWITCHGEAR

(Indoor and outdoor types, with low-voltage power circuit breakers with ratings up to 600 volts and 4000 amperes alternating current and 14,000 to 200,000 amperes interrupting capacity and having standard NEMA ratings.)

The following covers metal-enclosed units and the devices associated with them for use on 3-phase circuits. Removable drawout breakers are included.

One or more units, as determined by size and ratings, are built in common vertical structures approximately 90 inches high and of suitable width. These are combined to house the required total number of units with the minumum number of empty or unused spaces. Adequate surface area and mounting facilities should be provided for all standard panel-mounted items. Space should be provided in auxiliary compartments, when required, in addition to that available in the standard unit assemblies to house buses, connections, operating transformers, instrument transformers, rheostats, field control equipment and other devices.

Breaker housings for future use should be fully equipped to receive removable units. Filler compartments purely incidental to the unit arrangement need not be so equipped.

Standard low-voltage power circuit breaker functional components are available.

When the switchgear is intended for outdoor use, the equipment should be located within a weatherproof housing, with each housing having:

1. Suitable weatherproof access door or doors with provision for locking.
2. Protected openings for ventilation, as required.
3. Interior lighting and utility outlets with protective devices.
4. Heaters with protective devices.

A. Basic Unit

A basic unit should consist of one metal-enclosed unit, complete, including:

1 Door.
1 Low-voltage power circuit breaker (drawout type), three pole, single throw, with three inverse-time-delay and instantaneous trips, and operated manually or electrically. See par. 9.1.4.4 of American National Standard C37.13.
1 Mechanical trip device.
1 Breaker, open-close indicating target.
1 Position-changing mechanism for removable element, when required.
1 Mechanical interlock to prevent the removable element from being inserted or withdrawn when the breaker is closed.
1 Set of primary disconnecting devices.
1 Set of secondary disconnecting contacts for electrically-operated breakers or, when required, for manually-operated breakers.
1 Set of three-phase bare buses adequate for total load in that bus section.
1 Set of three-phase bare connections of the same ampere rating as the breaker.
1 Set of cable terminals, cable clamps, ground bus, small wiring, control bus and terminal blocks, as required.

B. Auxiliary Compartments

Auxiliary compartments should consist of:

1 Metal enclosure to house auxiliary equipment.
1 Front panel.
1 Set of three-phase bare buses, if required.

NOTE—Auxiliary compartments are provided to supply space for potential transformers, surge protective equipment, control power transformers, extra current transformers, trip batteries and other auxiliary equipment. The front panel may be used for panel-mounted devices. These compartments are also used to provide for transition of buses or the formation of bus-tie connections.

C. Feeder, Incoming-line or Transformer Equipment

Feeder, incoming-line or transformer equipment should consist of:

1 Metal-enclosed basic unit as covered by par. A.

NOTE—Current transformers may be supplied for use with instruments, meters, relays or other devices mounted apart from and not included with the standard unit.

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D. Generator Equipment

Generator equipment should consist of:

1 Metal-enclosed basic unit as covered by par. A. Breaker to have three inverse-time-delay and instantaneous trips and one shunt trip. Electrically-operated breakers are recommended where the generator is to be synchronized.
1 Ammeter and three-phase transfer switch.
1 Indicating wattmeter.
1 Indicating power factor meter or indicating varmeter.
1 Three-phase potential switch.
1 Governor motor control switch, if required.
1 Rheostat operating mechanism or control switch, as required.
1 Synchronizing switch, if required.
1 Potential transformer with current-limiting fuses. (Space for switchboard-type generator-voltage regulator, instrument transformers and regulator accessories should be provided.)
3 Current transformers, single secondary.
1 Auxiliary compartment, if required, as covered by par. B.

E. Synchronous Motor Equipment

Synchronous motor equipment for full-voltage starting or the main unit in other starting methods should consist of:

1 Metal-enclosed basic unit as covered by par. A. Breaker to have three long-time-delay trips suitable for motor protection and three instantaneous trips.
1 Rheostat operating mechanism or control switch, if required.
1 Field ammeter and shunt.
1 Field application and protective equipment.

F. Induction Motor Equipment

Induction motor equipment for full-voltage starting or the main unit in other starting methods should consist of:

1 Metal-enclosed basic unit as covered by par. A. Breaker to have three long-time-delay and three instantaneous trips.

G. Starting Methods Other Than Full Voltage

For starting methods other than full-voltage starting, the equipment should consist of:

Neutral or line reactor starting consisting of:

1 Motor-control unit as covered by par. E or F with electrically-operated breaker.
1 Auxiliary starting unit with electrically-operated breaker as covered by par. A.

Necessary time-delay or auxiliary relays as determined by the starting method.

1 Compartment with provision for installation of starting reactor.

Autotransfer starting consisting of:

1 Motor-control unit as covered by par. E or F with electrically-operated breaker.
1 Auxiliary starting unit with electrically-operated breakers as covered by par. A.

Necessary time-delay or auxiliary relays as determined by the starting method.

1 Compartment with provision for installation of starting autotransformer.

NOTE—Other methods of starting may be obtained by a proper selection of a main motor control unit and the necessary auxiliary starting units.

H. Bus-sectionalizing Unit

A bus-sectionalizing unit should consist of:

1 Metal-enclosed basic unit as covered by par. A.

Auxiliary compartment, if required, as covered by par. B.

I. General Requirements

Accessories such as maintenance closing handles, position-changing devices, and lifting yokes should be included as required for each installation.

NEMA Standard 9-25-1939, revised 9-17-1941; 6-11-1946; 7-15-1948; 3-17-1949; 3-13-1952; 1-16-1957; 3-19-1958; 3-21-1962; Authorized Engineering Information 11-17-1966.

11.3 METAL-CLAD SWITCHGEAR

(Indoor and outdoor types, with power circuit breakers rated 4.16 to 13.8 kV, 1200 to 3000 amperes, 75 to 1000 mva interrupting capacity, and fused interrupter switches.)

The following covers standard metal-clad units and the devices associated with them. Metal-clad switchgear for outdoor apparatus applications should be enclosed in a weatherproof enclosure (ventilated) and should include the following items:

1. Suitable weatherproof access door or doors with provision for locking.
2. Protected openings for ventilation, as required.
3. Interior lighting and utility outlets with protective devices.
4. Heaters with protective devices.

SINGLE-BUS ARRANGEMENT

A. Basic Breaker Unit

A basic breaker unit should consist of one metal-clad unit, complete, including:

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1 Front panel.
1 Power circuit breaker, three pole, single throw, electrically-operated with closing relays.
1 Circuit breaker position-changing mechanism (for vertical lift units rated 100 mva and above, a built-in position-changing mechanism with provision for operation by an electric motor should be included).
1 Set of primary disconnecting devices.
1 Set of secondary disconnecting contact devices.
1 Control switch with indicating lamps.
1 Control circuit cutout device.
1 Set of three-phase insulated buses having a continuous current rating adequate for the service involved.
1 Set of three-phase insulated connections, current-carrying capacity equal to that of power circuit breaker.
1 Set of terminal blocks, small wiring, ground bus and control buses, where required.
1 Set of automatic shutters.

Provision for terminating cables.

B. Basic Interrupter Switch and Fuse Unit

A basic interrupter switch and fuse unit should consist of one metal-clad unit, complete, including:

1 Front panel.
1 Interrupter switch, three pole, single throw, with three power fuses.
1 Mechanical interlock between the swtich and access door to the fuses.
1 Set of three-phase insulated buses having a continuous current rating adequate for the service involved.
1 Set of three-phase insulated connections, current-carrying capacity equal to the fuses.
1 Set of terminal blocks, small wiring and ground bus, where required.

Provision for terminating cables.

C. Auxiliary Compartments

Auxiliary compartments should consist of:

1 Metal enclosure of the same height and depth as the metal-clad structure of which it is a part.
1 Front panel.
1 Set of three-phase insulated buses, if required, having a continuous current rating adequate for the service involved.

NOTE—Auxiliary compartments are provided to supply space for potential transformers, surge protective equipment, control power transformers, extra current transformers, trip batteries and other auxiliary equipment. These compartments are also used to provide for transition of buses or the formation of bus-tie connections.

D. Feeder, Incoming-line or Transformer Equipment

Feeder, incoming-line or transformer equipment should consist of a metal-clad basic unit as covered by par. A or B. When the basic unit is in accordance with par. A, the following is recommended:

1 Ammeter and three-phase transfer switch.
3 Single-phase overcurrent relays, direct-current trip, complete with test facilities.
3 Current transformers, single secondary.

E. Generator Equipment

Generator equipment should consist of:

1 Metal-clad basic unit as covered by par. A.
1 Ammeter and three-phase transfer switch.
1 Three-phase indicating wattmeter.
1 Indicating power factor meter or varmeter.
1 Field ammeter with shunt.
3 Relays, time-overcurrent voltage restraint.
1 Three-phase potential switch.
1 Synchronizing switch.
1 Governor motor control switch.

Rheostat operating mechanisms or control switches as required.

1 Suitable field switch.
2 Potential transformers with disconnecting features and current-limiting fuses.
3 Current transformers, single secondary. (Space for switchboard-type generator voltage regulator, instrument transformers and regulator accessories should be provided.)
1 Auxiliary compartment as covered by par. C.

F. Synchronous Motor Equipment

Synchronous motor equipment for full-voltage starting or the main unit in other starting methods should consist of:

1 Metal-clad basic unit as covered by par. A.
1 Ammeter, single phase.
1 Indicating wattmeter or varmeter.
1 Field ammeter with shunt.
1 Rheostat operating mechanism or control switch.
1 Field application and field protective equipment in a suitable compartment.
1 Single-phase time-delay undervoltage protective equipment.
3 Single-phase overcurrent relays, complete with test facilities.

Necessary thermal relays as required for overload protection.

3 Current transformers, single secondary.

Damper winding protection as required.

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G. Induction Motor Equipment

Induction motor equipment for full-voltage starting or the main unit of other starting methods should consist of:

1 Metal-clad basic unit as covered by par. A.
1 Ammeter, single phase.
1 Single-phase time-delay undervoltage protective equipment as required.
3 Single-phase overcurrent relays, complete with test facilities.

Necessary thermal relays as required for overload protection.

3 Current transformers, single secondary.

Damper winding protection as required.

H. Starting Methods Other Than Full Voltage

For starting methods other than full-voltage starting, the equipment should consist of:

Neutral or line-reactor starting consisting of:

1 Motor-control unit as covered by par. F or G.
1 Auxiliary starting unit as covered by par. A.

Necessary time-delay or auxiliary relays as determined by the starting method.

1 Compartment with provision for installation of starting reactor.

Autotransformer starting consisting of:

1 Motor-control unit as covered by par. F or G.
2 Starting units as covered by par. A.

Necessary time-delay or auxiliary relays as determined by the starting method.

1 Compartment with provision for installation of starting autotransformer.

NOTE—Other methods of starting may be obtained by a proper selection of a main motor-control unit and the necessary auxiliary starting units.

I. Bus-sectionalizing Unit

A bus-sectionalizing unit should consist of:

1 Metal-clad basic unit as covered by par. A.

Necessary auxiliary compartments as covered by par. C to provide for bus transition connections and current transformers, when required.

MULTIPLE-BUS ARRANGEMENT

J. Double-bus Back-to-back Breakers

Double-bus back-to-back breakers (each side) should consist of:

1 Metal-clad unit as covered by par. D, E, F, or G.
1 Metal-clad unit as covered by par. A.

K. Main and Auxiliary Bus-tie Unit

Main and auxiliary bus-tie unit should consist of:

1 Metal-clad unit as covered by par. D.
1 Auxiliary compartment as covered by par. C.

L. Main and Transfer Bus

The main and transfer bus (one structure) should consist of:

1 Metal-clad unit as covered by par. D, E, F or G.
1 Superstructure with insulated three-phase transfer bus and interconnections, as required.
1 Group-operated three-pole single-throw disconnect switch with interlock.

M. Main and Transfer Bus Tie Feeder

Main and transfer bus tie feeder (one structure) should consist of:

1 Metal-clad unit as covered by par. D.
1 Superstructure with insulated three-phase transfer bus and interconnections, as required.

N. Main and Transfer Bus With Regulator By-pass

Main and transfer bus with regulator by-pass (separate structure) should consist of:

1 Metal-clad unit as covered by par. D.
1 Auxiliary compartment as covered by par. C.
1 Group-operated three-pole transfer switch with electrical interlock between switch and regulator.

Provision for terminating cables.

O. Main and Transfer Bus-tie

Main and transfer bus-tie should consist of:

1 Metal-clad unit in one structure as covered by par. D.
1 Auxiliary compartment in separate structure as covered by par. C.

Provision for terminating cables.

P. General Requirements

Accessories such as inspection rack (or cabinet), transfer trucks, maintenance closing lever for electrically-operated circuit breakers, crank for elevating mechanism and control jumpers should be included as required for each installation.

The equipment listed do not include potential transformers (except for generators). Additional potential transformers and compartments should be added as required.

The equipments listed in par. A to O are typical factory-built and shipped-assembled units having the standard control, meter and protective equipment integral with the structure units. It may be desired under various conditions to provide additional devices for other functions or to mount and wire the control, meter and protective devices on separate structures or vertical panels.

NEMA Standard 9-25-1939, revised 9-17-1941; 6-11-1946; 7-15-1948; 3-17-1949; 3-13-1952; 7-21-1954; 1-16-1957; 3-19-1958; 5-24-1960; 11-9-1961; 5-16-1963; Authorized Engineering Information 11-17-1966.

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11.4 STATION-TYPE CUBICLE SWITCHGEAR

(Indoor and outdoor with power circuit breakers rated 14.4 to 34.5 kV, 1200 to 5000 amperes, 1500 and 2500 mva interrupting ratings.)

The following covers standard station-type cubicle switchgear. When the equipment is intended for outdoor applications, it should be enclosed in a weatherproof enclosure (ventilated) and should include the following items:

1. Suitable weatherproof access door or doors with provision for locking.
2. Protected openings for ventilation, as required.
3. Interior lighting and utility outlets with protective devices.
4. Heaters with protective devices.
5. Provision for mounting air compressor equipment for oilless power circuit breakers, when required.

SINGLE-BUS ARRANGEMENT

A. Basic Unit

A basic unit should consist of:

1 Metal-enclosed cubicle with hinged front doors giving access to the power circuit breaker and with bolted-on rear cover plates.
1 Power circuit breaker, three pole, single throw, power operated, with closing relay.
1 Control circuit cutout device.
2 Sets of group-operated disconnecting switches, three pole, single throw.

Interlocks between power circuit breaker, disconnecting switches and front doors giving access to primary compartments.

1 Set of three-phase bare buses having continuous current rating adequate for the service involved.
1 Set of three-phase bare connections, current-carrying capacity equal to that of power circuit breaker.
1 Set of terminal blocks, small wiring, ground bus and control buses, as required.
6 Bushing-type current transformers.

B. Auxiliary Compartment

Auxiliary compartments should consist of:

1 Metal enclosure with bolted-on cover plates. Doors are provided on enclosures for draw-out potential transformers.
1 Set of three-phase bare buses, if required, rated not less than the buses in adjacent cubicles.

NOTE—Auxiliary compartments are provided for potential transformers and fuses, transition of buses, or for the formation of bus tap connections, disconnecting switches and current transformers, where required.

C. Bus-sectionalizing Unit

A bus-sectionalizing unit should consist of:

1 Basic unit as covered by par. A.
1 Auxiliary compartments as covered by par. B.
1 Metal-enclosed bus, three phase, current-carrying capacity equal to that of the basic unit for connecting it to the auxiliary compartment.

D. Reactor Unit

A reactor unit should consist of:

1 Metal enclosure with bolted-on cover plates.
3 Air core reactors, single phase, supported on porcelain insulators and separated by interphase barriers.
1 Metal-enclosed bus, three phase, of proper current-carrying capacity, for connecting the basic unit to the reactor unit. These connections should be made through suitable seal-off bushings.

E. Cable Disconnecting and Grounding Unit

The cable disconnecting and grounding unit for the reactor should consist of:

1 Metal enclosure with bolted-on front cover plated.
1 Set of group-operated disconnecting switches, three pole, with interlock between these switches and the disconnecting switches of the associated basic unit for disconnecting outgoing cable.
3 Grounding switches, single pole, with individual operating mechanism and with mechanical interlocks to the cable disconnecting switch mechanism.
1 Set of three-phase bare connections, current-carrying capacity equal to that of the cable disconnecting switch.
1 Metal-enclosed bus, three phase, current-carrying capacity equal to that of the cable disconnecting switch for connecting cable disconnecting and grounding unit to reactor unit.

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F. Cable Grounding Unit

A cable grounding unit should consist of:

1 Metal enclosure with bolted-on front cover plates.
3 Grounding switches, single pole with individual operating mechanisms and with interlocks to the disconnecting switch mechanism in the basic unit.
1 Metal-enclosed bus, three phase, current-carrying capacity equal to the associated basic unit for connecting the grounding unit to the basic unit.

MULTIPLE-BUS ARRANGEMENT

G. Main and Transfer Bus Unit

The main and transfer bus unit should consist of:

1 Basic unit as covered by par. A.
1 Auxiliary compartment as covered by par. B.
1 Set of group-operated disconnecting switches of the same rating as the basic unit with interlock between these switches and the main bus disconnecting switches or the power circuit breaker.
1 Metal-enclosed bus, three phase, current-carrying capacity equal to that of the basic unit, with provision for three current transformers in line tap.

H. Bus-tie Unit

The bus-tie unit should consist of:

1 Basic unit as covered by par. A.
1 Auxiliary compartment as covered by par. B.
1 Metal-enclosed bus, three phase, current-carrying capacity equal to that of the basic unit.

I. Double-bus Double-breaker Equipment

The double-bus double-breaker equipment should consist of:

2 Basic units, each as covered by par. A.
1 Metal-enclosed bus, three phase, current-carrying capacity equal to that of the basic unit.

J. General Requirements

Accessories such as tank lifter, manual maintenance device for power circuit breakers, end covers for bus compartments, and disconnecting switch crank handles to be included where necessary for each installation. The equipments listed do not include potential transformers or potential transformer compartments. These must be added as required.

The equipments listed in par. A to I are typical factory-built and shipped-assembled units.

NEMA Standard 9-25-1939, revised 9-17-1941; 6-11-1946; 7-15-1948; 3-17-1949; 7-21-1954; 1-26-1960; 3-21-1962; 5-16-1963; Authorized Engineering Information 11-17-1966.

11.5 NUMBER OF SPARE AUXILIARY SWITCH CONTACTS

A. Metal-clad Switchgear

1. The number of spare auxiliary switch contacts on metal-clad switchgear for direct-current close direct-current trip should be four extras (two a's and two b's) above those for normal breaker control and lights.

2. The number of spare auxiliary switch contacts on metal-clad switchgear for alternating-current close direct-current trip should be two (one a and one b) above those for normal breaker control and lights.

3. For other than normal control, such as automatic reclosing, the necessary number of contacts should come from the standard number of spares furnished with the metal-clad breaker.

B. Low-voltage Breaker-type Switchgear

1. The number of spare auxiliary switch contacts on low-voltage breaker-type switchgear for manually operated breakers should be zero.

2. The number of spare auxiliary switch contacts on low-voltage breaker-type switchgear for electrically operated breakers (direct or alternating current) should be two (one a and one b).

C. Station-type Cubicle Switchgear

The number of spare auxiliary switch contacts on station-type cubicle switchgear breakers should be four extras (two a's and two b's) above those for normal breaker control and lights.

NEMA Standard 7-21-1954, revised 3-14-1963; Authorized Engineering Information 11-17-1966.

11.6 ISOLATED PHASE BUS

The following covers standard metal-enclosed isolated phase bus:

A. Main Leads

Main leads, such as those running from the generator terminals to the terminals of the main transformer, rated _____ amperes, _____ volts, consist of the following:

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1 Isolated phase bus including conductor and supporting insulators, dusttight and watertight aluminum housings and supports, ground bus and provisions only for attaching to the building.
1 Set of flexible connectors and/or terminals for the generator.
1 Set of isolation barriers, as required, located near the generator terminals for preventing the migration of hydrogen into the main bus.
1 Vibration joint located between the bus supported by the turbine foundation and the bus supported by the building steel.
1 Set of flexible connectors and/or terminals for the main transformer.
Necessary rigid and expansion connectors.
1 Tap to surge protective and potential transformer compartment.
1 Set of isolation barriers located at external building walls to prevent an interchange of air between the indoor and outdoor sections of bus.
1 Set of supporting frames where buses pass through each wall or floor.
1 Tap to the station service (transformer) (compartment).
Set of (indoor) (outdoor) (floor) (entrance) bushings.

B. Current Transformers

Through-type current transformers (ratio) (accuracy) (amperes) for mounting in bus.

C. Disconnecting Switches

Set of (manually) (electrically) group-operated disconnecting switches and compartments, three pole, single throw, including necessary interlocks, auxiliary switches and connections to bus.

D. Potential Transformers

Potential transformers and compartment(s) (indoor) (outdoor) with primary connections, drawout mechanism, primary, secondary and grounding devices with current-limiting fuses. (Line-to-ground) or (phase-to-phase) (ratio) (volt-amperes).

OR

Potential transformers and compartments stationary mounted with drawout fuse or fused disconnecting switch.

E. Surge Protective Compartments

3 Single-phase (indoor) (outdoor) compartments with primary connections suitable for mounting.
3 Lightning arresters, station-type.
3 Capacitors, single phase, 0.25 mfd.

F. Generator Neutral

1 Set of generator neutral connections with nonsegregated phase ventilated metal enclosure with provisions for ground connection.

G. Neutral Grounding Compartment

1 Compartment (indoor) (outdoor), suitable for mounting a (potential transformer) (distribution transformer) (secondary resistor) (current transformer) (disconnecting switch) with primary connections.

H. Station Service Transformer Compartments

3 Single-phase (indoor) (outdoor) compartments with primary connections, suitable for mounting (disconnecting switch) (magnetizing current interrupter switch) (current transformers) (potheads).

NEMA Standard 9-29-1954, Authorized Engineering Information 11-17-1966.

11.7 METAL-ENCLOSED INTERRUPTER SWITCHGEAR

(Indoor and outdoor types with interrupter switches and/or power fuses rated 4.16 to 34.5 kV, to 1200 amperes.)

The following covers metal-enclosed interrupter switchgear units and devices associated with them.

When the equipment is intended for outdoor use, each of the following items should be located within a weatherproof housing, with each housing having:

1. Weatherproof doors, with provisions for locking.
2. Protected openings for ventilation, as required.
3. Heaters with protective devices.

A. Basic Interrupter Switch Unit

A basic interrupter switch unit should consist of one metal-enclosed unit, complete, including:

1 Interrupter switch, three pole, single throw, quick make, quick break, manually operated.
1 Set of three-phase buses and necessary connections.
1 Ground bus.
Provision for terminating cables.

B. Basic Fuse Unit

A basic fuse unit should consist of one metal-enclosed unit, complete, including:

3 Power fuses.
1 Interlock to prevent access to fuses unless circuit is de-energized.
1 Set of three-phase buses and necessary connections.
1 Ground bus.
Provision for terminating cables.

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C. Basic Interrupter Switch And Fuse Unit

A basic interrupter switch and fuse unit should consist of one metal-enclosed unit, complete, including:

1 Interrupter switch, three pole, single throw, quick make, quick break, manually operated.
3 Power fuses.
1 Interlock between switch and access to the fuses.
1 Set of three-phase buses and necessary connections.
1 Ground bus.

Provision for terminating cables.

NEMA Standard 1-25-1961, Authorized Engineering Information 11-17-1966.

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status are set forth in certain clauses of the NEMA Bylaws, which are quoted below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for its particular need. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

(Bylaw—Art. V, Sec. 1)

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Bylaw—Art. V, Sec. 2, Subsection A)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the standards publication may be capable of otherwise equivalent performance.

(NEMA Policy Memorandum 84-2, dated June 7, 1984)

Classes of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Bylaw—Art. V, Sec. 2, Subsection B)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design.

(Bylaw—Art. V, Sec. 6, 1st Sentence)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment and/or approval.

(Bylaw—Art. V, Sec. 4, Subsection A)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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POWER SWITCHGEAR ASSEMBLIES VOTING CLASSIFICATION OF THE SWITCHGEAR SECTION OF THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

Abbott Power Corporation
Buena Park, CA 90620

American Switchgear Corporation
North Canton, OH 44720

Brown-Boveri Electric, Inc.
Spring House, PA 19477

Crouse-Hinds Company
Florence, KY 41042

Custom Switchgear and Controls, Inc.
Santa Clara, CA 95051

Electrical Equipment, Inc.
Birmingham, AL 35215

Federal Pacific Electric Company
Newark, NJ 07101

General Electric Company
Philadelphia, PA 19142

Nelson Electric, A Unit of
General Signal Corporation
Tulsa, OK 74101

GTE Products Corporation
Cleveland, OH 44110

Kearney Div., Kearney National, Inc.
Atlanta, GA 30359

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Malton Equipment Company
Brandon, FL 33511

Pedersen Power Products
Omaha, NE 68107

Powercon Corporation
Severn, MD 21144

The Pringle Electrical Mfg. Company
Fort Washington, PA 19034

Siemens-Allis, Inc.
Raleigh, NC 27626

Square D Company
Palatine, IL 60067

Square D Company
Milwaukee, WI 53201

Square D Company
Middletown, OH 45042

Toshiba International Corp.
Houston, TX 77041

Westinghouse Electric Corporation
St. Louis, MO 63141

Westinghouse Electric Corporation
East Pittsburgh, PA 15112

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