

American National Standard for Switchgear— Unit Substations— Requirements

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American National Standards Institute, Inc.

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Foreword

(This Foreword is not part of American National Standard C37.121-1989.)

This new standard has been developed to outline the requirements for unit substations, utilizing other documents such as NEMA 201 covering primary substations, NEMA 210 covering secondary unit substations, and a draft document on articulated unit substations compiled by a working group of the disbanded High Voltage Apparatus Coordinating Committee (HVACC).

This standard was developed by a working group sponsored by the Power Switchgear Assemblies Technical Committee of the Switchgear Section (8SG) of the National Electrical Manufacturers Association (NEMA/SG/5). During the course of the preparation of this standard, coordination was maintained with the Transformer Section (8TR) of the National Electrical Manufacturers Association.

Suggestions for improvements gained in the use of this standard will be welcome. They should be sent to National Electrical Manufacturers Association, 2101 L Street, NW, Washington, DC 20037.

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

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American National Standard for Switchgear—

Unit Substations—Requirements

1. Scope

1.1

This standard covers the requirements for three-phase unit substations for step-down operation in the range of 112.5 kVA through 10 000 kVA at primary voltages of 601 volts through 38 kilovolts.

1.2

The standard is intended for use as the basis for the coordination of equipment by assisting in the selection of components. A variety of designs for unit substations are possible using various combinations of incoming sections, transformer sections, outgoing sections, and transition (throat) sections. Since the transformer section determines the kVA and voltage capabilities of a unit substation, the ratings of the various types of unit substations are described in terms of transformer capability.

1.3

This standard does not cover the following installations:

- 1) Substations in which the transformer section includes load-tap-changing equipment
- 2) Substations in which the transformer section is described and defined as “network,” “subway,” “vault,” or “underground” in American National Standards C57.12.24-1989, C57.12.40-1982, and C57.12.57-1987¹
- 3) Substations in which the transformer section is described and defined as “pad-mounted” in American National Standards C57.12.22-1989, C57.12.26-1987, and C57.12.27¹
- 4) Substations with gas-insulated equipment, such as substations insulated with SF₆, described in ANSI/IEEE C37.122-1989¹

¹The complete titles of these related standards are given in 2.3.

- 5) Rectifier-type substations
- 6) Mobile substations
- 7) Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles
- 8) Installations for mines
- 9) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock, or for installations used exclusively for signaling and railway communication purposes.
- 10) Installations of communication equipment that is under the exclusive control of communication utilities, located outdoors or in building spaces used exclusively for such installations.
- 11) Installations under the exclusive control of electric utilities for the purpose of communication, or metering; or for the generation, control, transformation, transmission, and distribution of electric energy located in buildings used exclusively by utilities for such purposes or located outdoors on property owned or leased by the utility or on public highways, streets, roads, etc; or outdoors by established rights on private property.

1.4

It is intended that the incoming, outgoing, transformer, and transition sections included in a unit substation shall meet the basic requirements of applicable industry standards for those sections. In addition, these sections shall meet any additional requirements imposed by this standard when they are used as part of a unit substation.

2. Referenced and Related Standards

2.1 Referenced American National Standards

This standard is intended for use in conjunction with the following American National Standards. When these referenced standards are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

ANSI C37.55-1989, Switchgear — Metal-Clad Switchgear Assemblies — Conformance Test Procedures

ANSI C57.12.10-1988, Transformers — 230 kVA and below 833/958 through 8333/10,417 kVA, Single-Phase, and 750/862 through 60 000/80 000/100 000 kVA, Three-Phase, without Load-Tap Changing; and 3750/4687 through 60 000/80 000/100 000 kVA with Load-Tap Changing — Safety Requirements

ANSI C57.12.13-1982, Conformance Standard for Liquid-Filled Transformers Used in Unit Substations, Excluding Pad-Mounted Compartmental-Type Transformers

ANSI C57.12.50-1981 (R1989), Ventilated Dry-Type Distribution Transformers, Three-Phase 5—500 kVA

ANSI C57.12.51-1981 (R1989), Ventilated Dry-Type Power Transformers, Three-Phase, 750—5000 kVA

ANSI C57.12.52-1981 (R1989), Sealed Dry-Type Power Transformers, Three-Phase, 750—5000 kVA

ANSI C57.12.70-1978 (R1986), Terminal Markings and Connections for Distribution and Power Transformers

ANSI C84.1-1989, Electric Power Systems and Equipment — Voltage Ratings (60 Hz)

ANSI Y14.15-1966, Y14.15a-1988, and Y14.15b-1988, Electrical and Electronics Diagrams

ANSI/IEEE 4-1978, Standard Techniques for High Voltage Testing

ANSI/IEEE 100-1988, Standard Dictionary for Electrical and Electronic Terms

ANSI/IEEE 141-1986, Recommended Practice for Electrical Power Distribution for Industrial Plants

ANSI/IEEE 142-1982, Recommended Practice for Grounding of Industrial and Commercial Power Systems

ANSI/IEEE 241-1983, Recommended Practice for Electric Power Systems in Commercial Buildings

ANSI/IEEE C37.010-1979 (R1989), Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

ANSI/IEEE C37.20.1-1987, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear

ANSI/IEEE C37.20.2-1987, Metal-Clad and Station-Cubicle Type Switchgear

ANSI/IEEE C37.20.3-1987, Metal-Enclosed Interrupter Switchgear

ANSI/IEEE C37.24-1971 (R1986), Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Enclosed Switchgear

ANSI/IEEE C37.40-1981 (R1988), and C37.40a-1988 Service Conditions and Definitions for Distribution Cutouts and Fuse Links, Secondary Fuses, Distribution Enclosed Single-Pole Air Switches, Power Fuses, Fuse Disconnecting Switches and Accessories

ANSI/IEEE C37.90-1978 (R1983), Relays and Relay Systems Associated with Electrical Power Apparatus

ANSI/IEEE C37.91-1985 (R1989) and C37.91b-1985 (R1989), Guide for Protective Relay Applications to Power Transformers

ANSI/IEEE C37.100-1981 (R1989) and C37.100b-1985, Definitions for Power Switchgear

ANSI/IEEE C57.12.00-1987, General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

ANSI/IEEE C57.12.01, General Requirements for Dry-Type Distribution, Power, and Regulating Transformers²

ANSI/IEEE C57.12.80-1978 (R1986), Terminology for Power and Distribution Transformers

ANSI/IEEE C57.13-1978 (R1987), Requirements for Instrument Transformers

ANSI/IEEE C57.91-1981, Guide for Loading Mineral Oil-Immersed Overhead and Pad-Mounted Distribution Transformers Rated 500 kVA and Less with 65°C or 55°C Average Winding Rise

ANSI/IEEE C57.92-1981, Guide for Loading Mineral Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Winding Rise

ANSI/IEEE C57.94-1982, Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General-Purpose Power and Distribution Transformers

ANSI C57.96-1989, Guide for Loading Dry-Type Distribution and Power Transformers (Appendix to ANSI C57.12 Standards)

²Withdrawn pending approval of a proposed revision. Consult the secretariat for recent information regarding its status.

ANSI/IEEE C62.1-1984, Surge Arrestors for Alternating-Current Power Circuits

ANSI/IEEE C62.2-1987, Guide for the Application of Gapped Silicon Carbide Surge Arresters for AC Systems

ANSI/NEMA ICS-2-1983, Standards for Industrial Control Devices, Controllers, and Assemblies

ANSI/NFPA 70-1987, National Electrical Code

ANSI/NFPA 70B-1987, Electrical Equipment Maintenance

2.2 Other Referenced Standards

This standard is also intended for use in conjunction with the following standards:

IEEE C57.104-1978, Guide for the Detection and Determination of Generated Gases in Oil-Immersed Transformers and Their Relation to the Serviceability of the Equipment³

IEEE C57.106-1977, Guide for Acceptance and Maintenance of Insulating Oil in Equipment

NEMA SG2-1986, High-Voltage Fuses⁴

NEMA SG5-1981, Power Switchgear Assemblies

2.3 Related Standards

The following standards are listed for information only, and are not essential for the completion of the requirements of this standard.

ANSI/IEEE C37.122-1989, Gas-Insulated Substations, Standards, Recommended Practices and Guides

ANSI C57.12.22-1989, Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage, 34 500 GrdY/19 920 Volts and below; 2500 kVA and Smaller

ANSI C57.12.24-1989, Requirements for Underground-Type Three-Phase Distribution Transformers, 2500 kVA and Smaller; High-Voltage 24,940GrdY/14,400 Volts and below; Low-Voltage 480 Volts and below

ANSI C57.12.26-1987, Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings; High-Voltage, 34 500 GrdY/19 920 Volts and below; 2500 kVA and Smaller

ANSI C57.12.27-1982, Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations

ANSI C57.12.40-1982, Requirements for Secondary Network Transformers, Subway and Vault Types (Liquid Immersed)

ANSI C57.12.57-1989, Transformers — Ventilated Dry-Type Network Transformers 2500 kVA and Below, Three-Phase, with High-Voltage 34 500 Volts and below, Low-Voltage 216Y/125 and 480Y/277 Volts — Requirements

³Available from IEEE Service Center, Publications Sales, 445 Hoes Lane, Piscataway, NJ 08855-1331

⁴Available from National Electrical Manufacturers Association, 2101 L Street, NW, Washington, DC 20037

3. Definitions

The definitions of terms contained in this standard or in other standards referenced in this standard are not intended to embrace all legitimate meanings of the terms, but are applicable only to the subject treated in this standard. For definitions not given in this section, refer to ANSI/IEEE C37.100-1981 and C37.100b-1985, ANSI/IEEE C57.12.80-1978, and ANSI/IEEE 100-1988.

3.1 Substation: An assemblage of equipment for purposes other than generation or utilization, through which electric energy in bulk is passed for the purpose of switching or modifying its characteristics (definition excerpted from ANSI/IEEE 100-1988).

3.2 Unit Substation: A substation consisting primarily of one or more transformers that are mechanically and electrically connected to, and coordinated in design with, incoming and outgoing equipment.

NOTE — For this standard, the term “unit substation” shall be limited to mean “articulated unit substation” only.

3.3 Transformer Section: A three-phase power transformer used for step-down operation, that includes necessary mechanical and electrical connecting parts for coordination in a unit substation. Types of transformer sections are described in Section 5.

3.4 Incoming Section: Equipment that includes necessary mechanical and electrical connecting parts for coordination in a unit substation on the high-voltage (or primary) side of a transformer section. Types of incoming sections are described in Section 6.

3.5 Outgoing Section: Equipment that includes necessary mechanical and electrical connecting parts for coordination into a unit substation on the low-voltage (or secondary) side of a transformer section. Types of outgoing sections are described in Section 7.

3.6 Transition (Throat) Section: A mechanical, electrical, and coordinated connection between a transformer section and an incoming section, or between a transformer section and an outgoing section, or between different types of incoming sections, or between different types of outgoing sections. A transition (throat) section may be (1) integral parts of two adjacent sections, or (2) an integral part of one section, or (3) a separate section.

3.7 Primary Unit Substation: A unit substation in which the low-voltage section is rated above 1000 volts.

3.8 Secondary Unit Substation: A unit substation in which the low-voltage section is rated 1000 volts and below.

3.9 Articulated Unit Substation: A unit substation that is designed, coordinated, and assembled as multiple self-enclosed pieces of equipment intended for connection in the field.

3.10 Preferred Arrangement: A unit substation in which the low-voltage section (or secondary) of the transformer is to the right when one faces the control side of the outgoing section, and where the terminal markings of the transformer are “standard” as in the typical arrangement shown in Figure 7(a) and also in the figures illustrating unit substations in ANSI C57.12.70-1978. Other arrangements may be mutually agreed upon between the manufacturer(s) and the user.

3.11 Reverse Arrangement: A unit substation in which the low-voltage section (or secondary) of the transformer is to the left when one faces the control side of the outgoing section, and where the terminal markings of the transformer are “reversed” as in the typical arrangement shown in Figure 7(b) and in the figures illustrating unit substations in ANSI C57.12.70-1978.

3.12 Design Tests: Tests performed by the manufacturer(s) to determine the adequacy of the design of a particular type, style, or model of any unit of equipment, or its component parts, to meet its assigned ratings and to operate satisfactorily under normal service conditions or under any specified conditions. Such tests may also be used to demonstrate compliance with applicable standards of the industry.

NOTES:

- 1- Design tests are performed 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 similar design. These tests are not intended to be performed on every design or during normal production. The applicable portion of these design tests may also be used