

IEEE Standard for Shunt Power Capacitors

Sponsor

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of the
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Abstract: Capacitors rated 216 V or higher, 2.5 kvar or more, and designed for shunt connection to alternating-current transmission and distribution systems operating at a nominal frequency of 50 or 60 Hz are considered. Service conditions, ratings, manufacturing, and testing are covered. A guide to the application and operation of power capacitors is included.

Keywords: capacitors, shunt connection, transmission and distribution systems

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Introduction

(This introduction is not a part of IEEE Std 18-1992, IEEE Standard for Shunt Power Capacitors.)

This standard was revised in response to a need created by the continuous changes in capacitor technology. Its principal objects are to provide a basis for uniformity in design and testing, and to assist users in the application of shunt capacitors.

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IEEE Standard for Shunt Power Capacitors

1. Scope

This standard applies to capacitors rated 216 V or higher, 2.5 kvar or more, and designed for shunt connection to alternating current transmission and distribution systems operating at a nominal frequency of 50 or 60 Hz.

2. References

This standard shall be used in conjunction with the following publications:

ANSI Z55.1-1967 (withdrawn 1987), Gray Finishes for Industrial Apparatus and Equipment.¹

ANSI/NFPA 70-1990, National Electrical Code.²

IEEE Std 21-1976, General Requirements and Test Procedures for Outdoor Apparatus Bushings.³

IEEE Std 100-1992, The New IEEE Standard Dictionary of Electrical and Electronics Terms.

IEEE Std 1036-1992, IEEE Guide for Application of Shunt Power Capacitors.

IEEE C37.99-1990, IEEE Standard Guide for Protection of Shunt Capacitor Banks (ANSI).

NEMA 107-1987, Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus.⁴

NEMA CP1-1988, Shunt Capacitors.

3. Definitions

3.1 ambient temperature: The temperature of the medium, such as air, water, or earth, into which the heat of the equipment is dissipated.

NOTES

1—For self-ventilated equipment, the ambient temperature is the average temperature of the air in the immediate neighborhood of the equipment.

2—For air- or gas-cooled equipment with forced ventilation or secondary water cooling, the ambient temperature is taken as that of the ingoing air or cooling gas.

3—For self-ventilated enclosed (including oil-immersed) equipment considered as a complete unit, the ambient temperature is the average temperature of the air outside of the enclosure in the immediate neighborhood of the equipment. See 5.7 and table 2.

¹ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA. ANSI Z55.1-1967 (w1987) is available as an archival document through the same address.

²NFPA publications are available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

³IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁴NEMA publications are available from the National Electrical Manufacturers Association, 2101 L Street NW, Washington, DC 20037, USA.

3.2 capacitor bank: An assembly at one location of capacitors and all necessary accessories, such as switching equipment, protective equipment, controls, etc., required for a complete operating installation. It may be a collection of components assembled at the operating site or may include one or more piece(s) of factory-assembled equipment.

3.3 capacitor equipment: An assembly of capacitors with associated accessories, such as fuses, switches, etc., all mounted on a common frame for handling, transportation, and operation as a single unit.

3.4 discharge device: An internal or external device intentionally connected in shunt with the terminals of a capacitor for the purpose of reducing the residual voltage after the capacitor is disconnected from an energized line.

3.5 enclosed capacitor: A capacitor having enclosed terminals. The enclosure is provided with means for connection to a rigid or flexible conduit.

3.6 fused capacitor: A capacitor having fuses mounted on its terminals, or inside a terminal enclosure, or inside the capacitor case, for the purpose of interrupting a failed capacitor.

3.7 indoor (prefix): Not suitable for exposure to the weather.

NOTE—For example, an indoor capacitor unit is designed for indoor service or for use in a weatherproof housing. (See also: **outdoor**.)

3.8 kilovar (1000 vars): The practical unit of reactive power, equal to the product of the rms voltage in kilovolts (kV), the rms current in amperes (A), and the sine of the angle between them.

3.9 metal-enclosed equipment: A capacitor equipment assembly enclosed in a metal enclosure or metal house, usually grounded, to prevent accidental contact with live parts. *Syn:* **metal-housed equipment**.

3.10 metal-housed equipment: *See:* **metal-enclosed equipment**.

3.11 outdoor (prefix): Designed for use outside buildings and to withstand exposure to the weather.

3.12 power capacitor: An assembly of dielectric and electrodes in a container (case), with terminals brought out, that is intended to introduce capacitance into an electric power circuit.

NOTE—The abbreviated term “capacitor” is used interchangeably with “power capacitor” throughout this standard.

3.13 proof (suffix): An apparatus is designated as dustproof, splashproof, etc., when so constructed, protected, or treated that its successful operation is not interfered with when subjected to the specified material or condition.

The meaning of other terms used in this standard shall be as defined in IEEE Std 100-1992, The New IEEE Standard Dictionary of Electrical and Electronics Terms.

4. Service conditions

NOTE—For additional information on service conditions, see clause 8.

4.1 Normal service conditions

Capacitors shall be suitable for operation at their specified rating when

- a) The ambient temperature is within the limits specified in 5.7. (Capacitors may be exposed to the direct rays of the sun.)
- b) The altitude does not exceed 6000 ft (1800 m) above sea level. See 6.6.2 and Table 4.
- c) The voltage applied between terminals does not exceed the rated voltage by more than the tolerance specified in 5.2.3.
- d) The voltage applied between terminals and case does not exceed the insulation class specified in 5.5.
- e) The applied voltage does not contain harmonics in excess of the limits specified in 5.2.3(b).
- f) The nominal operating frequency is equal to the rated frequency.

4.2 Abnormal service conditions

If capacitors are required to operate under abnormal service conditions, such as the following, the application should be brought to the attention of the manufacturer:

- a) Exposure to damaging fumes or vapors
- b) Exposure to conducting or explosive dust
- c) Exposure to abnormal mechanical shock or vibration, including earthquakes
- d) Exposure to radiated heat from surfaces (other than the sun) that are hotter than the ambient temperature limits for capacitors given in 5.7
- e) Mounting and/or arrangement that prevents adequate ventilation
- f) Operation in ambient temperatures outside the range specified in 5.7
- g) Altitude higher than 6000 ft (1800 m) above sea level (see 6.6.2 and Table 4)
- h) Momentary duty exceeding that listed in 8.3.2
- i) Service conditions other than those listed in 4.1

5. Ratings

5.1 Standard ratings

This standard establishes the following ratings:

- a) Voltage, rms (terminal-to-terminal)
- b) Terminal-to-case (or ground) insulation class
- c) Reactive power
- d) Number of phases
- e) Frequency

5.2 Tolerances in ratings

5.2.1

Capacitors shall give not less than the rated reactive power at rated sinusoidal voltage and frequency, and not more than 115% of this value, measured at 25 °C uniform case and internal temperature.

5.2.2

Capacitors shall be suitable for continuous operation at 135% of rated reactive power. This maximum reactive power shall include the following factors, the combined effects of which shall not exceed 135%:

- a) Reactive power due to voltage in excess of nameplate rating at fundamental frequency but within the permissible voltage limitations described in 5.2.3

- b) Reactive power due to harmonic voltages superimposed on the fundamental frequency
- c) Reactive power in excess of nameplate rating due to manufacturing tolerance within the limits specified in 5.2.1

5.2.3

Capacitors shall be capable of continuous operation provided that none of the following limitations are exceeded:

- a) 135% of nameplate kvar (see 5.2.2)
- b) 110% of rated voltage rms, and crest voltage not exceeding $1.2 \cdot \sqrt{2}$ of rated rms voltage, including harmonics but excluding transients (see 8.3.2)
- c) 180% of rated current rms, including fundamental and harmonic currents (see 8.5.1 for guidance)

5.3 Momentary ratings

Capacitors shall be capable of withstanding, with full life expectancy, switching transients having peak voltages up to $2 \cdot \sqrt{2}$ times rated voltage rms and other transient disturbances inherent in the operation of power systems. See 8.3.2 for guidance in operating capacitors at overvoltages and overcurrents.

5.4 Voltage and reactive power ratings

Voltage and reactive power ratings shall conform to table 1.

5.5 Insulation classes

The basic impulse isolation level (BIL) of standard rating capacitors shall be as shown in table 1.

5.6 Frequency

Power capacitors shall be designed for operation at a rated nominal frequency of either 50 or 60 Hz.

5.7 Ambient temperature

Capacitors shall be designed for switched or continuous operation in outdoor locations with unrestricted ventilation and direct sunlight under the ambient temperatures for each mounting arrangement shown in table 2.

5.7.1 Minimum ambient

Capacitors shall be designed for continuous operation at -40 °C.

5.7.2 Exceptions

For operation under conditions other than those listed above, or in indoor locations or locations with restricted ventilation, see 8.4.