

1947
NATIONAL ELECTRICAL CODE

STANDARD

OF THE
National Board of Fire Underwriters
FOR
ELECTRIC WIRING
AND
APPARATUS

AS RECOMMENDED BY THE
NATIONAL FIRE PROTECTION ASSOCIATION

AMERICAN STANDARD
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**PLAINTIFF'S
EXHIBIT**

474

CHAPTER 1. GENERAL

ARTICLE 100—DEFINITIONS

Definitions which duplicate those in the American Standard Definitions of Electrical Terms, C42, are marked with an asterisk (*). Those not so marked either differ from the American Standard or are not found in the 1941 edition.

***Accessible:** (As applied to wiring methods). Not permanently closed in by the structure or finish of the building; capable of being removed without disturbing the building structure or finish.

***Accessible:** (As applied to equipment). Admitting close approach because not guarded by locked doors, elevation or other effective means. (See also "Readily Accessible.")

Appliance: Appliances are current-consuming equipment, fixed or portable; for example heating, cooking and small motor-operated equipment.

Approved: Acceptable to the authority enforcing this code.

Askarel: A synthetic non-flammable insulating liquid which, when decomposed by the electric arc, evolves only non-explosive gases.

Branch Circuit: That portion of a wiring system extending beyond the final overcurrent device protecting the circuit.

A device not approved for branch circuit protection, such as a thermal cutout or motor overload protective device, is not considered as the overcurrent device protecting the circuit.

Building: A structure which stands alone or which is cut off from adjoining structures by unpierced fire walls.

***Cabinet:** An enclosure designed either for surface or flush mounting, and provided with a frame, matt or trim in which swinging doors are hung. (See cutout box.)

Communication Circuit: A circuit which is part of a so-called "central station system."

Such circuits include telephone, telegraph, district messenger, fire and burglar alarms, watchmen, and sprinkler supervisory circuits.

Circuit-Breaker: A device designed to open under abnormal conditions a current-carrying circuit without injury to itself. The term as used in this code applies

they shall not be larger than No. 10, and shall comply with other requirements of the code for conductors to be used in raceways.

ARTICLE 445—GENERATORS

4451. Location. Generators shall be located in dry places, and also so as to meet the requirements for motors in section 4310. Generators installed in hazardous locations as described in Article 500, or in other locations as described in Articles 510, 520, and 530, shall also comply with the provisions of those articles.

It is recommended that waterproof covers be provided for use in emergency.

4452. Identification. Each generator shall be provided with a name-plate giving the maker's name, the rating in kilowatts or kilo-volt-amperes, the normal volts and amperes corresponding to the rating, and the revolutions per minute.

4453. Drip Pans. Generators shall be provided with suitable drip pans if required by the authority enforcing this code.

4454. Overcurrent Protection. Constant-potential generators, except alternating-current generators and their exciters, shall be protected from excessive current by circuit-breakers or fuses.

a. Two-Wire Generators. Two-wire, direct-current generators may have overcurrent protection in one conductor only if the overcurrent device is actuated by the entire current generated, except that in the shunt field. The overcurrent device shall not open the shunt field.

b. 65 Volts or Less. Generators operating at 65 volts or less and driven by individual motors shall be considered as protected by the overcurrent device protecting the motor if these devices will operate when the generators are delivering not more than 150 per cent of their full-load rated current.

c. Balancer Sets. Two-wire, direct-current generators used in conjunction with balancer sets to obtain neutrals for 3-wire systems shall be equipped with overcurrent devices which will disconnect the 3-wire

system in the case of excessive unbalancing of voltages or currents.

d. 3-Wire, Direct-Current Generators. Three-wire, direct-current generators, whether compound or shunt wound, shall be equipped with overcurrent devices one in each armature lead, and so connected as to be actuated by the entire current from the armature. Such overcurrent devices shall consist either of a double-pole, double-coil circuit-breaker, or of a 4-pole circuit-breaker connected in the main and equalizer leads and tripped by two overcurrent devices, one in each armature lead. Such protective devices shall be so interlocked that no one pole can be opened without simultaneously disconnecting both leads of the armature from the system.

4455. Size of Conductors. The conductors from the generator terminals to supplied equipment shall have a carrying capacity not less than 115 per cent of the name plate current rating. Neutral conductors shall be the same size as the conductors of the outside legs.

4456. Protection of Live Parts. Live parts of generators of more than 150 volts to ground shall not be exposed to accidental contact if accessible to unqualified persons.

4457. Guards for Attendants. Where necessary for the safety of attendants the provisions of section 4433 shall be complied with.

4458. Grounding. If a generator operates at a terminal voltage in excess of 150 volts to ground, the frame shall be grounded in the manner specified in Article 250. If the frame is not grounded, it shall be permanently and effectively insulated from the ground.

ARTICLE 450—TRANSFORMERS AND TRANSFORMER VAULTS (Including Secondary Ties)

4501. Application. This article applies to the installation of all transformers except: (1) current transformers; (2) dry-type transformers which constitute a component part of other apparatus and which conform to the requirements for such apparatus; (3) transformers for use with X-ray and high-frequency; (4) transformers used with Class 2 remote-control.

low energy power and signal circuits which shall conform to Article 725; (5) transformers for sign and outline lighting which shall conform to Article 600; and (6) transformers for electric discharge lighting which shall conform to Article 410.

This article applies to the installation of transformers in hazardous locations except as modified by Article 500.

See also Article 710, Circuits and Equipment Operating at More than 600 Volts Between Conductors, and Service Installations Over 600 Volts as referred to in Article 230.

General Provisions

4511. Location. They shall be located and arranged to minimize possible life and fire hazards. The location of transformer vaults as affected by ventilating requirements is covered elsewhere in this article.

4512. Overcurrent Protection. Overcurrent protection shall conform to the following. As used in this section, the word "transformer" means a transformer or a bank of transformers operating as a unit.

a. Primary Side. Each transformer shall be protected by an overcurrent device in the primary connection, rated or set at not more than 250 per cent of the rated primary current of the transformer, except that an individual overcurrent device is not required if the primary circuit overcurrent device provides the protection specified in this paragraph, and except as provided in paragraph b of this section.

b. Primary and Secondary Side. A transformer having an overcurrent device in the secondary connection, rated or set at not more than 250 per cent of the rated secondary current of the transformer, or a transformer equipped with a coordinated thermal overload protection by the manufacturer, is not required to have an individual overcurrent device in the primary connection provided the primary feeder overcurrent device is rated or set to open at a current value not more than six times the rated current of the transformer for transformers having not more than six per cent impedance, and not more than four times rated current of the transformer for transformers having more than six but not more than ten per cent impedance.

c. Potential (Voltage) Transformers. Potential transformers should have primary fuses. The fuse

rating should not exceed 10 amperes for circuits of 600 volts or less, and 3 amperes for circuits of more than 600 volts. A resistor should be connected in series with high tension fuses if necessary to limit the possible short-circuit current to a value within the interrupting capacity of the fuse.

4513. Secondary Ties. As used in this section the word "transformer" means a transformer or a bank of transformers operating as a unit. A secondary tie is a circuit operating at 600 volts or less between phases which connects two power sources or power supply points, such as the secondaries of two transformers. The tie may consist of one or more conductors per phase.

a. Tie Circuits. Tie circuits shall be provided at each end with overcurrent protection as required in Article 240 of this code, except under the conditions described in sub-paragraphs 1 and 2 of this section, in which cases, the overcurrent protection may be in accordance with sub-paragraph 3 of this section.

1. Loads at Transformer Supply Points Only. If all loads are connected at the transformer supply points at each end of the tie and overcurrent protection is not provided in accordance with Article 240, the rated current-carrying capacity of the tie shall be not less than 67 per cent of the rated secondary current of the largest transformer connected to the secondary tie system.

2. Loads Connected Between Transformer Supply Points. If load is connected to the tie at any point between transformer supply points and overcurrent protection is not provided in accordance with Article 240, the rated current-carrying capacity of the tie shall be not less than 100 per cent of the rated secondary current of the largest transformer connected to the secondary tie system except as otherwise provided in sub-paragraph 4.

3. Tie Circuit Protection. Under the conditions described in sub-paragraphs 1 and 2 of this section, both ends of each tie conductor shall be equipped with a protective device which will open at a predetermined temperature of the tie conductor under short circuit conditions. This protection shall consist of the following: (1) a fusible link cable connector, terminal or lug, commonly known as a limiter, each

being of a size corresponding with that of the conductor and of approved construction and characteristics according to the operating voltage and the type of insulation on the tie conductors, or (2) automatic circuit-breakers actuated by devices having comparable current-time characteristics.

4. Interconnection of Phase Conductors Between Transformer Supply Points. If the tie consists of more than one conductor per phase, the conductors of each phase shall be interconnected in order to establish a load supply point, and the protection specified in sub-paragraph 3 shall be provided in each tie conductor at this point, except as follows:

Loads may be connected to the individual conductors of a multiple-conductor tie without interconnecting the conductors of each phase and without the protection specified in sub-paragraph 3 at load connection points provided: the tie conductors of each phase have a combined capacity not less than 133 per cent of the rated secondary current of the largest transformer connected to the secondary tie system; the total load of such taps does not exceed the rated secondary current of the largest transformer; the loads are equally divided on each phase and on the individual conductors of each phase as far as practicable.

5. Tie Circuit Control. If the operating voltage exceeds 150 volts to ground, secondary ties provided with limiters shall have a switch at each end which when open will de-energize the associated tie conductors and limiters. The current rating of the switch shall be not less than the rated current of the conductors connected to the switch. It shall be capable of opening its rated current, and it shall be constructed so that it will not open under the magnetic forces resulting from short-circuit current.

b. Overcurrent Protection for Secondary Connections. When secondary ties are used an overcurrent device rated or set at not more than 250 per cent of the rated secondary current of the transformers shall be provided in the secondary connections of each transformer, and in addition an automatic circuit-breaker actuated by a reverse-current relay set to open the circuit at not more than the rated secondary current of the transformer shall be provided in the secondary connection of each transformer.

4514. Parallel Operation. Transformers may be operated in parallel and protected as a unit if their electrical characteristics are such that they will divide the load in proportion to their rating.

4515. Guarding. Transformers shall be guarded as follows:

a. **Mechanical Protection.** Appropriate provisions shall be made to minimize the possibility of damage to transformers from external causes if the transformers are located where they are exposed to mechanical injury.

b. **Exposed Live Parts.** The transformer installation shall conform with the provisions for guarding of live parts in section 1113.

c. **Voltage Warning.** The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structures.

4516. Grounding. Exposed non-current carrying metal parts of transformer installations including fences shall be grounded under the conditions and in the manner prescribed for electrical equipment and other exposed metal parts in Article 250.

4517. Name-plate. Each transformer shall be provided with a name-plate giving the name of the manufacturer; rated kilovolt-amperes, frequency, primary and secondary voltage; and the amount and kind of insulating liquid, if any, if the transformer rating exceeds 25 kva. If Class B insulation as defined in American Standard for Transformers C 57.1 is used in the construction of dry-type transformers of more than 100 kva, the name-plate shall so indicate.

Specific Provisions Applicable to Different Types of Transformers

4521. Dry-Type Transformers Installed Indoors. Transformers rated 100 kva or less shall have a separation of at least 12 inches from combustible material unless separated therefrom by a fire-resistant heat-insulating barrier, or unless of a rating not exceeding 600 volts and completely enclosed except for ventilating openings.

Transformers of more than 100 kva rating shall be installed in a transformer room of fire-resistant construction unless they are constructed with Class B

insulation, as defined in American Standard for Transformers C 57.1, and are separated from combustible material not less than 6 feet horizontally and 12 feet vertically or are separated therefrom by a fire-resistant heat-insulating barrier.

Transformers rated more than 15,000 volts shall be installed in a vault.

4522. Askarel-Insulated Transformers Installed Indoors. Askarel-insulated transformers rated in excess of 25 kva shall be furnished with a pressure-relief vent. If installed in a poorly ventilated place they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure relief vent shall be connected to a chimney or flue which will carry such gases outside the building. Askarel-insulated transformers rated more than 15,000 volts shall be installed in a vault.

4523. Oil-Insulated Transformers Installed Indoors. Oil-insulated transformers shall be installed in a vault constructed as specified in this article except as follows:

a. Not Over 100 kva Total Capacity. The provisions for transformer vaults specified in this article apply except that the vault may be constructed of reinforced concrete not less than 4 inches thick.

b. Not Over 600 Volts. A vault is not required provided suitable arrangements are made where necessary to prevent a transformer oil fire igniting other materials, and the total transformer capacity in one location does not exceed 10 kva in a section of the building classified as combustible, or 75 kva where the surrounding structure is classified as fire-resistant construction.

c. Furnace Transformers. Electric furnace transformers of a total rating not exceeding 75 kva may be installed without a vault in a building or room of fire-resistant construction if arrangements necessary to prevent a transformer oil fire spreading to other combustible material are provided.

d. Detached Buildings. Transformers may be installed in a building which does not conform with the provisions specified in this code for transformer vaults provided neither the building nor its contents presents a fire hazard to any other building or property, and

provided the building is used only in supplying electric service and is accessible only to qualified persons.

4524. Oil-Insulated Transformers Installed Outdoors. Combustible buildings, combustible parts of buildings, fire escapes, door and window openings of buildings, and other combustible material shall be safeguarded from fires originating in oil-insulated transformers installed on, attached to, or adjacent to a building or other property by providing effective space separation or an effective fire-resistant barrier, and by providing means of retaining or safely disposing of the oil from a ruptured transformer tank in cases where the transformer installation would present a fire hazard without such precautionary measures.

Provisions for Transformer Vaults

4541. Location. Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.

4542. Walls, Roof, and Floor. The walls and roof of vaults shall consist of reinforced concrete not less than 6 inches in thickness or of brick not less than 8 inches in thickness, or of load-bearing hollow tile not less than 12 inches in thickness, the inside surface of the wall being coated with cement plaster. The vault shall have a concrete floor at least 4 inches thick. The floor or walls of the building may be used for one or more parts of the vault if they are approved as being equivalent to the foregoing specifications.

4543. Doorways. Any doorway leading from the vault into the building shall be protected as follows:

a. **Type of Door.** Each doorway shall be provided with a tight-fitting door of a type approved for openings in Class A situations as defined in the 1939 edition of the standard of the National Board of Fire Underwriters for Protection of Openings in Walls and Partitions Against Fire. The authority enforcing this code may require such a door on each side of the wall if conditions warrant.

b. **Sills.** A door sill or curb of sufficient height to confine within the vault the oil from the largest transformer shall be provided and in no case shall the height be less than 4 inches.

c. **Locks.** Entrance doors shall be equipped with locks, and doors shall be kept locked, access being

allowed only to qualified persons. Locks and latches shall be so arranged that the door may be readily and quickly opened from the inside.

4544. **Ventilation.** The ventilation shall be adequate to prevent a transformer temperature in excess of the values prescribed in American Standard for Transformers publication C 57.1.

4545. **Ventilation Openings.** Openings for ventilation shall be provided in accordance with the following:

a. **Location.** Ventilation openings shall be located as far away as possible from doors, windows, fire escapes, and combustible material.

b. **Arrangement.** Vaults ventilated by natural circulation of air may have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof; or all of the area required for ventilation may be provided in one or more openings in or near the roof.

c. **Size.** In the case of vaults ventilated to an outdoor area without using ducts or flues the combined net area of all ventilating openings after deducting the area occupied by screens, gratings, or louvers, shall be not less than 3 square inches per kva of transformer capacity in service except that the net area shall be not less than 1 square foot for any capacity under 50 kva.

d. **Covering.** Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.

e. **Dampers.** If automatic dampers are used in the ventilation openings of vaults containing oil-insulated transformers, the actuating device should be made to function at a temperature resulting from fire and not at a temperature which might prevail as a result of an overheated transformer or bank of transformers. Care should be taken to avoid unintentional closing of automatic dampers.

f. **Ducts.** Ventilating ducts shall be constructed of fire-resistant material.

4546. **Drainage.** If practicable, vaults containing more than 100 kva transformer capacity shall be provided with a drain which will carry off any accumulation of oil or water that may collect in the vault. The floor shall be pitched to the drain opening.

4547. **Water Pipes and Accessories.** Any pipe or duct systems foreign to the electrical installation should not enter or pass through a transformer vault. If the presence of such foreign systems cannot be avoided, appurtenances thereto which require maintenance at regular intervals shall not be located inside the vault. Arrangements shall be made if necessary to avoid possible trouble from condensation, leaks and breaks in such foreign systems. Piping or other facilities provided for fire protection or for water-cooled transformers are not deemed to be foreign to the electrical installation.

4548. **Storage in Vaults.** Materials shall not be stored in transformer vaults.

ARTICLE 460—CAPACITORS

4601. **Application of Other Articles.** This article shall not apply to capacitors constituting a component part of other apparatus and conforming with the requirements for such apparatus. Capacitors installed in hazardous locations shall comply with the provisions of this article except as modified by Article 500.

4602. **Location.** Capacitors shall be enclosed in vaults complying with the provisions of Article 450 unless they are askarel insulated or unless each unit contains not more than 3 gallons of a combustible oil.

4603. **Mechanical Protection.** Appropriate provisions shall be made to minimize the possibility of damage to capacitors from external causes if the capacitors are located where they are exposed to mechanical injury.

4604. **Transformers Used with Capacitors.** Transformers used with capacitors shall be installed in accordance with Article 450. The kva rating shall be not less than 135 per cent of the capacitor kva rating.

4605. **Drainage of Stored Charge.** Capacitors shall be provided with a means of draining the stored charge.

a. **Time of Discharge.** The residual voltage of a capacitor shall be reduced to 50 volts or less within