Chapter 5. Special Occupancies

SPEAKER:

ENGR. BRIAN A. PASILAN, PEE
PRC Reg. No. 3473
Vice-President, Engineering and Designs
JBR Electro-Mechanical Services, Inc.
Immediate Former President
Ex-Officio Member
Chairman, Seminars and Trainings
IIEE Cebu Chapter

Chapter 5. Special Occupancies

5.0.1.1 Scope — Articles 5.0 Through 5.4

Articles 5.0 through 5.4 cover the requirements for electrical and electronic equipment and wiring for all voltages in:

Class I, Divisions 1 and 2;

Class II, Divisions 1 and 2;

Class III, Divisions 1 and 2 locations: where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

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DEFINITION OF TERMS

❑Combustible Gas Detection System:

A protection technique utilizing stationary gas detectors in industrial establishments.

❑Control Drawing:

A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus, or of the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus, that details the allowed interconnections between the intrinsically safe and associated apparatus or between the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus.

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❑**Dust-Ignition proof:**

Equipment enclosed in a manner that excludes dusts and does not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.

❑**Dust tight:**

Enclosures constructed so that dust will not enter under specified test conditions.

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❑**Electrical and Electronic Equipment:**

Materials, fittings, devices, appliances, and the like that are part of, or in connection with, an electrical installation.

❑**Explosion-proof Apparatus**:

Apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

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❑Hermetically-Sealed:

Equipment sealed against the entrance of an external atmosphere where the seal is made by fusion, for example, soldering, brazing, welding, or the fusion of glass to metal.

❑Nonincendive Circuit:

A circuit, other than field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment is not capable, under specified test conditions, of igniting the flammable gas–air, vapor–air, or dust–air mixture.

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❑Nonincendive Component:

A component having contacts for making or breaking an incendive circuit and the contacting mechanism is constructed so that the component is incapable of igniting the specified flammable gas–air or vapor–air mixture. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion.

❑Nonincendive Equipment:

Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas–air, vapor–air, or dust–air mixture due to arcing or thermal means.

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❑Nonincendive Field Wiring:

Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas–air, vapor–air, or dust–air mixture. Normal operation includes opening, shorting, or grounding the field wiring.

❑Nonincendive Field Wiring Apparatus:

Apparatus intended to be connected to nonincendive field wiring.

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❑Oil-Immersion:

Electrical equipment immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

❑Purged and Pressurized:

The process of (1) purging, supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level; and (2) pressurization, supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of a flammable gas or vapor, a combustible dust, or an ignitable fiber.

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❑**Unclassified Locations:**

Locations determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; or any combination thereof.

5.0.1.5 Classifications of Locations.

A. Classifications of Locations:

Locations shall be classified depending on the properties of the flammable vapors, liquids, or gases, or combustible dusts or fibers that may be present, and the likelihood that a flammable or combustible concentration or quantity is present.

Where ***pyrophoric*** materials are the only materials used or handled, these locations shall not be classified.

Each room, section, or area shall be considered individually in determining its classification.

PYROPHORIC

- Pyrophoric chemicals were commonly defined as those that would ignite on exposure to air.

- The reaction could be to atmospheric oxygen, water vapor, or both.

- They can also be water-reactive, where heat and hydrogen (a **flammable** gas) are produced.

PYROPHORIC HAZARDS

Other common hazards include:

- **CORROSIVITY**
- **TERATOGENECITY**
- **Organic peroxide formation**, along with damage to the liver, kidneys, and central nervous system

Hazards of Pyrophoric Chemicals

1. Liquids

While not exhaustive, pyrophoric liquids often include specific chemicals from the following chemical families:

- **Alkyl metals** (e.g., t-butyllithium, trimethylaluminum, and diethylzinc)
- **Alkyl metal halides** (e.g., diethylaluminum bromide)
- **Alkyl magnesium halides 'Grignard reagents'** (e.g., methylmagnesium bromide)
- **Alkylphosphines** (e.g., triethylphosphine)
- **Boranes** (e.g., borane dimethylsulfide complex)

Hazards of Pyrophoric Chemicals

2. Pyrophoric Solids

Pyrophoric solids include the following chemicals:

- **White phosphorous**
- **Uranium IV oxide**
- **Super fine metal powders** (e.g., iron, lead, nickel, platinum, aluminum)

Hazards of Pyrophoric Chemicals

3. Flammable Gases that Ignite in the Presence of Air

Gases that ignite on exposure to air will be listed as “Flammable.”

- **Silane -** ignite when exposed to air under most environmental conditions
- **Diborane -** will ignite spontaneously in moist air .
- **Arsine -** may ignite on exposure to air depending on humidity and temperature
- **Phosphine -** may ignite on exposure to air depending on humidity and temperature

B. Class I Locations:

Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Class I locations shall include those specified in 5.0.1.5(b)(1) and (b)(2).

(1) Class I, Division 1. A Class I, Division 1 location is a location

a. In which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions, or

b. In which ignitable concentrations of such gases or vapors may exist frequently because of repair or

c. In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

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FPN No. 1: This classification usually includes the following locations:

(1) Where volatile flammable liquids or liquefied flammable gases are transferred from one container to another.

(2) Interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used.

(3) Locations containing open tanks or vats of volatile flammable liquids.

(4) Drying rooms or compartments for the evaporation of flammable solvents.

(5) Locations containing fat- and oil-extraction equipment using volatile flammable solvents.

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6) Portions of cleaning and dyeing plants where flammable liquids are used.

7) Gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape.

8) Inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids.

9) The interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers.

10) All other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

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FPN No. 2: In some Division 1 locations, ignitable concentrations of flammable gases or vapors may be present continuously or for long periods of time. Examples include the following:

(1) The inside of inadequately vented enclosures containing instruments normally venting flammable gases or vapors to the interior of the enclosure.

(2) The inside of vented tanks containing volatile flammable liquids.

(3) The area between the inner and outer roof sections of a floating roof tank containing volatile flammable fluids.

(4) Inadequately ventilated areas within spraying or coating operations using volatile flammable fluids.

(5) The interior of an exhaust duct that is used to vent ignitable concentrations of gases or vapors.

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(2) Class I, Division 2. A Class I, Division 2 location is a location

a) In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems or in case of abnormal operation of equipment, or

b) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation and which might become hazardous through failure or abnormal operation of the ventilating equipment, or

b) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

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C. Class II Locations:

Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations shall include those specified in 5.0.1.5(c)(1) and (c)(2).

(1) Class II, Division 1. A Class II, Division 1 location is a location

- **a.** In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures, or
- **b.** Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes, or
- **c.** In which Group E combustible dusts may be present in quantities sufficient to be hazardous.

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(2) Class II, Division 2. A Class II, Division 2 location is a location

A. In which combustible dust due to abnormal operations may be present in the air in quantities sufficient to produce explosive or ignitable mixtures; or

B. Where combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air; or

C. In which combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitable by abnormal operation or failure of electrical equipment.

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D. Class III Locations

Class III locations are those that are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. Class III locations shall include those specified in 5.0.1.5(d)(1) and (d)(2).

(1) Class III, Division 1. A Class III, Division 1 location

- is a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

(2) Class III, Division 2. A Class III, Division 2 location

- is a location in which easily ignitable fibers are stored or handled other than in the process of manufacture.

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Being ignorant is not so much a shame, as being unwilling to learn.

-Benjamin Franklin

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PEC ARTICLES RELATED TO REQUIREMENTS OF TRANSFORMER EQUIPMENT SAFETY

PEC Article 4.50.1.9 Ventilation

- The ventilation shall be adequate to dispose of the transformer full-load losses without creating a temperature rise that is in excess of the transformer rating.
- Transformers with ventilating openings shall be installed so that the ventilating openings are not blocked by walls or other obstructions.
- The required clearances shall be clearly marked on the transformer.

PEC Article 4.50.1.10 Grounding

- Exposed non–current-carrying metal parts of transformer installations, including fences, guards, and so forth, shall be grounded where required under the conditions and in the manner specified for electric equipment and other exposed metal parts in Article 2.50.

PEC ARTICLES RELATED TO SPECIFIC PROVISIONS OF TRANSFORMERS

PEC Article 4.50.2 Specific Provisions Applicable to Different Types of Transformers

4.50.2.1 Dry-Type Transformers Installed Indoors

(a) Not Over 112½ kVA

Dry-type transformers installed indoors and rated 112½ kVA or less:

- **A separation of at least 305 mm (12 in.) from combustible material unless separated from the combustible material by a fire-resistant, heat-insulated barrier..**

PEC ARTICLES RELATED TO SPECIFIC PROVISIONS OF TRANSFORMERS

(b) Over 112½ kVA.

Individual dry-type transformers of more than 112½ kVA rating

- **Installed in a transformer room of fire-resistant construction.**
- **Unless specified otherwise in this article, the term fire resistant means a construction having a minimum fire rating of 1 hour.**

(c) Over 35,000 Volts.

- **Installed in a vault complying with Part 4.50.3.**

PEC ARTICLES RELATED TO SPECIFIC PROVISIONS OF TRANSFORMERS

4.50.2.2 Dry-Type Transformers Installed Outdoors.

(a) Not Over 112½ kVA

Dry-type transformers installed outdoors shall have a weatherproof enclosure.

- **Transformers exceeding 112½ kVA shall not be located within 300 mm of combustible materials of buildings unless the transformer has Class 155 insulation systems or higher and is completely enclosed except for ventilating openings.**

PEC ARTICLES RELATED TO SPECIFIC PROVISIONS OF TRANSFORMERS

4.50.2.6 Oil-Insulated Transformers Installed Indoors

- **Oil-insulated transformers installed indoors shall be installed in a vault constructed as specified in Part 4.50.3.**

Exception:
Where the rated input current of the autotransformer is less than 9 amperes, an overcurrent device rated or set at not more than 167 percent of the input current shall be permitted.

Exception:
Where the nominal voltage does not exceed 600, avault shall not be required if suitable arrangements are made to prevent a transformer oil fire from igniting other materials and the total 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.

PEC ARTICLES RELATED TO SPECIFIC PROVISIONS OF TRANSFORMERS

4.50.2.7 Oil-Insulated Transformers Installed Outdoors

- **Combustible material, combustible buildings, and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on roofs, attached to or adjacent to a building or combustible material.**

In cases where the transformer installation presents a fire hazard, one or more of the following safeguards shall be applied:

- **Space separations**
- **Fire-resistant barriers**
- **Automatic fire suppression systems**
- **Enclosures that confine the oil of a ruptured transformer tank**

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

4.50.3 Transformer Vaults

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.

4.50.3.2 Walls, Roofs, and Floors.

- The walls and roofs of vaults shall be constructed of materials that have adequate structural strength for the conditions with a minimum fire resistance of 3 hours.
- The floors of vaults in contact with the earth shall be of concrete that is not less than 100 mm thick

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

- **But where the vault is constructed with a vacant space or other stories below it, the floor shall have adequate structural strength for the load imposed thereon and a minimum fire resistance of 3 hours.**

- **studs and wallboard construction shall not be acceptable.**

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Exception:
Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1 hour rating shall be permitted.

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

4.50.3.3 Doorways

Vault doorways shall be protected in accordance with 4.50.3.3 (a), (b), and (c).

(a) Type of Door

- **Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours.**

- **The authority having jurisdiction shall be permitted to require such a door for an exterior wall opening where conditions warrant.**

Exception:
Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1 hour rating shall be permitted.

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

(b) Sills

- A door sill or curb that is of sufficient height to confine the oil from the largest transformer within the vault
- In no case shall the height be less than 100 mm.

(c) Locks

- Doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to licensed electrical practitioner or non licensed electrical practitioner under the supervision of a licensed electrical practitioner.
- Personnel doors shall swing out and be equipped with panic bars, pressure plates, or other devices that are normally latched but open under simple pressure.

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

4.50.3.5 Ventilation Openings

Where required by 4.50.1.9, openings for ventilation shall be provided in accordance with 4.50.3.5(a) through 4.50.3.5(f).

(a) Location

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

(b) Arrangement

- **A vault ventilated by natural circulation of air shall be permitted to have roughly half of the total area of openings required for ventilation in one or more openings near the floor**
- **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 shall be permitted in one or more openings in or near the roof.**

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

(c) Size

For a vault ventilated by natural circulation of air to an outdoor area:

- **the combined net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than 1,900 mm2 (3 in.2) per kVA of transformer capacity in service, and in no case shall the net area be less than 0.1 m2 (1 ft2) 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.**

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

(e) Dampers

- All ventilation openings to the indoors shall be provided with automatic closing fire dampers that operate in response to a vault fire. Such dampers shall possess a standard fire rating of not less than 1½ hours.

(f) Ducts

- Ventilating ducts shall be constructed of fire-resistant material.

4.50.3.6 Drainage

Where practicable, vaults containing more than 100 kVA transformer capacity:

- provided with a drain or other means that will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable

- The floor shall be pitched to the drain where provided.

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

4.50.3.7 Water Pipes and Accessories

- **Any pipe or duct system foreign to the electrical installation shall not enter or pass through a transformer vault.**
- **Piping or other facilities provided for vault fire protection, or for transformer cooling, shall not be considered foreign to the electrical installation.**

4.50.3.8 Storage in Vaults

- **Materials shall not be stored in transformer vaults.**

PEC ARTICLES RELATED TO TRANSFORMER VAULTS

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