PHILIPPINE ELECTRICAL CODE

(P E C)

PEC I - Electrical installation inside buildings.

PEC II - Electrical installation outside buildings.

* PEC consists of rules which are intended to make use of electricity safe for person and property.

* Two (2) categories of PEC rules *

1. Mandatory Rules - characterized by the use of the word “SHALL’’.

2. Advisory Rules - characterized by the use of the word “SHOULD” or are stated as recommendations of that which is advised but not required.

* OBJECTIVES *

a) Safe Use of Electricity

- to establish basic materials quality and electrical work standards for the safe use of electricity for light, heat, power, communications, signaling and for other purposes.

b) Adequacy - Strict compliance with the provisions of this Code will ensure safety in electrical installation and construction, but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

* The use of PEC is mandated by R.A. 7920 (formerly R.A. 184), also known as the New Electrical Engineering Law. Likewise, referral codes are also used which are mandated by their corresponding laws.

1. P.D. 1096 - National Building Code

2. P.D. 1185 - Fire Code of the Philippines

3. Structural Code

R.A. 7920 - is an act providing for a more responsive and comprehensive regulation for the practice, licensing, and registration of electrical engineers and electricians.

* Government Authorities who implement PEC *

1. Office of the Building Official

2. Office of the City Electrician (City Electrical Supervising Engineer)

3. Office of the Municipal Electrician (Municipal Electrical Supervising Engineer)

4. Regional Office of the DOLE

* SCOPE OF THE PEC *

PEC covers the electric conductors including optical fiber cable and installed within or on, to or from:

1. Public and private buildings

2. Electrical generating plants

3. Temporary and permanent substations

4. Industrial plants

5. Transformer stations

6. Railway switchyards

7. Yards, carnival, parking, etc.

8. Watercraft

9. Dockyards

10. Airfields

11. Quarries and mines

12. Mobile homes, travel trailers and recreational vehicles

13. Offshore facilities

14. Other premises which requires electrical installation except to those which are done in; a) Aircraft b) motor vehicles c) railway rolling stocks

PERMITS AND INSPECTION CERTIFICATES

A permit is required before undertaking any electrical installation.

An inspection is also required after which certificate of electrical inspection (CEI) is issued by the authority.

EXCEPTIONS

A permit is not required for;

1. the installation of electrical portable equipment rated not more than 1,200 VA.

2. reconnection of disconnected service due to non-payment of electric bill or change of occupants for a period of one year.

Requirements for Electrical Permit

a) An application form (DPWH form No. 77-001-E) shall be accomplished, signed and submitted by a duly registered Professional Electrical Engineer. However, if the installation does not exceed 20 lighting and/or receptacle outlets or 4000 volt-amperes, 230 volts, the application may be prepared, signed and submitted by a duly registered electrical engineer or master electrician.

b) The application shall include additionally, the name and signature and seal of the electrical practitioner who will take charge of the installations as well as the signature of the owner or his authorized representative.

c) Five (5) sets of plans and specifications bearing the signature and seal of the responsible Professional Electrical Engineer shall be submitted together with the application. However, if the installation does not exceed 20 lighting and or receptacle outlets or 4,000 VA, 230 V; five (5) sets of sketches and bill of materials may be prepared signed and submitted by the responsible Registered Electrical Engineer or Master Electrician.

According to P.D. 1096, no plans is required for building made of indigenous materials or which cost is not more than P15,000.00.

ELECTRIC CIRCUITS IN BUILDING

* SERVICES *

No. of Service

A building or other structure served shall be supplied by only one service.

EXCEPTIONS

1. For fire pump where a separate service is required.

2. For emergency electrical system where a separate service is required.

3. Multiple-Occupancy building

4. Capacity Requirements. Two or more services shall be permitted:

a) Where the capacity requirements are in excess of 2,000 amperes at a supply voltage of 600 volts or less; or

b) Where the load requirements of a single-phase installation are greater than the serving agency normally supplies through one service; or

5. Building of Large Area (10,000 m2 or more Total Area).

6. For different voltage characteristics, such as for different voltage, frequencies, or phases, or for different uses, such as for different rate schedules.

THE OVERHEAD SERVICE-DROP CONDUCTOR

This is the overhead service conductor from the last pole or other aerial support to and including the splices if any, connecting the service entrance conductors at the building or other structure.

SIZE AND RATING:

a) General. Service drop shall have sufficient ampacity to carry the load without a temperature rise detrimental to the covering or insulation ofthe conductors and shall have adequate mechanical strength.

b) Minimum Size. The conductors shall not be smaller than 8 mm2copper, 14 mm2 aluminum or copper-clad aluminum.

CLEARANCES:

a) Above Roofs. Conductors shall have a vertical clearance of not less than 2,500 mm from the roof surface.

b) Vertical Clearance from Ground.

3,100 mm - at the electric service entrance to buildings, or at the drip loop of the building electric entrance, or above areas or sidewalks

3,700 mm - for those areas listed in the 4,600 mm classification when the voltage is limited to 600 volts to ground.

4,600 mm - over residential property and driveways, and those commercial areas not subject to truck traffic.

5,500 mm - over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land transversed by vehicles such as cultivated, grazing, forest, and orchard.

UNDERGROUND SERVICE-LATERAL CONDUCTOR

This is the underground service conductor between the street main, including any risers at a pole or other structure or from transformers, and the first point of any connection to the service-entrance conductors in a terminal box or meter or other enclosure with adequate space, inside or outside the building wall.

INSULATION. Service-lateral conductor shall withstand exposure to atmospheric and other conditions of use without detrimental leakage of current.

EXCEPTIONS

A grounded conductor shall be permitted to be uninsulated as follows:

a) Bare copper used in a raceway.

b) Bare copper for direct burial where bare copper is judged to be suitable for the soil conditions.

c) Bare copper for direct burial without regard to soil conditions where part of cable assembly identified for underground use.

d) Aluminum or copper-clad aluminum without insulation or covering where part of a cable assembly identified for underground use in a raceway or for direct burial.

SIZE AND RATING

a) General. Service lateral conductors shall have sufficient ampacity to carry the current for the load and shall have adequate mechanical strength.

b) Minimum Size. The conductors shall not be smaller than 5.5 mm2copper or 8.0 mm2 aluminum or copper-clad aluminum.

Where two to six service disconnecting means in separate enclosures supply separate loads from one service drop or lateral, one set of service entrance conductors shall be permitted to supply each or several such service equipment enclosures.

EXCEPTION: For installations to supply only limited loads of a single branch circuit such as small polyphase power, controlled water heaters and the like, they shall not be smaller than 3.5 mm2 copper or 5.0 mm2aluminum or copper-clad aluminum.

SERVICE ENTRANCE

Service is defined as the portion of the supply which extends from the street main duct or transformer to the service switch or switchboard of the building supply.

-it is the conductor and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

TYPES:

1. Overhead Service Entrance

The most common type of service entrance employed by the power companies supplying electricity which is either a 2, 3 or 4-wire connection. Generally, the overhead service cable between the building property line and the supply point is supplied by electric company to a limit of 30 meters.

2. The Underground Service Entrance

The underground service entrance consists of a raceway conduit extending from the building to the property line where it is tapped to the main. The type of cable recommended is the underground service entrance cable commonly referred to as USE.

SERVICE - ENTRANCE CONDUCTORS

No. of Service-Entrance Conductor Sets

Each service drop or lateral shall supply only one set of service-entrance conductors.

*EXCEPTIONS:

1. Buildings with more than one occupancy.

2. Where two to six service disconnecting means in a separate enclosures are grouped at one location and supply separate loads from one service drop or lateral.

SIZE AND RATING: Service entrance conductors shall be of sufficient size to carry the computed loads.

Ungrounded conductors shall not be smaller than:

1. 100 A ---- For one family dwelling with six or more 2-wire branchcircuits.

2. 60 A ---- For one family dwelling with an initial computed load of 10 kVA above.

3. 40 A ---- For other loads.

EXCEPTIONS:

1. For loads consisting of not more than 2 - wire branch circuits, 5.5 mm2copper or 8.0 mm2 aluminum or copper-clad aluminum.

2. By special permission, for loads limited by demand or by the source of supply, 5.5 mm2 copper or 8.0 mm2 aluminum or copper-clad aluminum.

3. For limited loads of single branch circuit, 3.5 mm2 copper or 5.5 mm2aluminum or copper-clad aluminum.

INSTALLATION OF SERVICE CONDUCTORS

Service entrance conductors shall be installed in accordance with the applicable requirements of this Code covering the type of wiring method used and limited to the following methods:

1. Open-wiring on insulators

2. Rigid Metal Conduit (RMC)

3. Intermediate Metallic Tubing (IMT)

4. Electrical Metallic Tubing (EMT)

5. Service-Entrance Cables

6. Wireways

7. Busways

8. Auxiliary gutters

9. Rigid Non-Metallic Conduit (RNMC)

10. Cable Bus

11. Mineral-Insulated Metal-Sheated Cable

12. Type MC Cables

PROTECTION:

Service entrance conductors subjected to physical damage shall be protected in any of the following ways or methods:

1. By RMC

2. By IMC

3. By RNMC suitable for the location

4. By EMT

5. Type MC cable or other approved means

THE SERVICE EQUIPMENT-DISCONNECTING MEANS

GENERAL:

The service-disconnecting means shall be provided to disconnect all conductors in a building or other structures from the service-entrance conductor.

NUMBER OF DISCONNECTING MEANS:

The service disconnecting means for each set or each subset of service entrance conductor shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, or in a switchboard.

LOCATION:

The service disconnecting means shall be installed either inside or outside the building or other structure at a readily accessible location nearest the point of entrance of the service entrance conductor

RATING:

The service disconnecting means shall have a rating of not less than the load to be carried. In no case shall the rating be lower than specified through:

1. One circuit installation -- The service disconnecting means shall have a rating of not less than 15 amperes.

2. Two circuit installation -- The service disconnecting means shall have a rating of not less than 30 amperes.

3. One family dwelling -- The service disconnecting means shall have a rating of:

60 A -- where the initial computed loads is 10 kVA or more

100 A -- where the initial installations consist of six or more 2-wire branch circuit.

4. Others -- For all other installations, the service disconnecting means shall have a rating of not less than 40 amperes.

NOTES:

The service disconnecting means shall simultaneously disconnect all ungrounded conductors and shall be capable of being closed on a fault equal to or greater than the maximum available short-circuit current.

Service entrance conductor shall have a short-circuit protective device in each ungrounded conductors.

Fuses shall have an Interrupting Rating no less than the maximum available short circuit current in the circuit at their supply terminals.

Circuit breakers shall be free to open in case the circuit is closed on an overload. Circuit breakers shall have an interrupting rating not less than the maximum available short-circuit current at its supply terminals.

FEEDERS AND MAIN

Essential considerations being adapted or followed.

1. On large installation, one feeder is provided for each floor.

2. In small installations, one or two feeders is satisfactory.

3. Feeder for motor must be separate and independent from the light circuits.

4. Feeders requiring more than 50 mm diameter conduit should not be used.

5.Feeders should be subdivided if there are several bends or offsets because a 50 mm conduit is the largest that could be economically used.

6. Feeders radiating from the distributing panel should be provided each with a properly rated switch and circuit breaker.

7. Good practice dictates that feeders and main shall be installed inside a conduit pipe as it carries high voltage that should be well protected.

7 REQUIRED PARTS OF A STANDARD ELECTRICAL PLAN

A. GENERAL NOTES / SPECIFICATION

Specification written on electrical plan should indicate :

1. That the design is done in accordance with the P.E.C. and all electrical works shall comply with the provisions of all authorities having juris- diction on the use of electrical power.

2. The nature of the service including voltage, phase and frequency.

3. The type of approved wiring to used in installing service entrance,

feeders, sub-feeders, branch circuit conductors, remote control system, fire protection, signal and communication system.

4. All other aspects and details that the designer and the owner would want to be done in the actual construction of the project.

EXAMPLE :

1. Works here under shall comply with the latest edition of the P.E.C, thenational building code, municipal or city ordinances, office of the municipal or city electrician, & Meralco.

2. Type of services shall be 230 volts, 1 phase, 2 wire system, 60 hertz and there shall be only one service drop to the building.

3. Method of wiring shall be EMT both exposed and embedded work with proper fitting and supports. In cases where concealed conduits wiring is impracticable to use, metal moulding may be applied.

4. All materials and equipment shall be new and approved type for both location and purpose intended.

5. All lighting and convenience outlet circuit homeruns shall be wired with no less than 2 sq. mm and 3.5 sq. mm respectively, unless otherwise indicated on the plan.

6. Lighting and power panel board shall be circuit breaker type surface or flushed mounted or as indicated on the plan; door shall be provided with locked and milled key, a line circuit directory card and holder shall be provided in innerface or door.

7. Whenever required and necessary, full boxes and junction boxes of proper sizes shall be installed at convenient and inconspicuous locations although such boxes are not shown on the plans nor mentioned in the specification.

8. All outdoor installation shall be weather proof type.

9. All electrical work shall be done under the direct and immediate supervision of a duly licensed Electrical Engineer.

B. LEGEND AND SYMBOLS

The legend or symbols shall show symbols or configurations and figures of devices and equipment used. Standard Electrical symbols can be obtained from the appendix - a of the Philippine Electrical Code.

C. LOCATION PLAN

Location or site plan with proposed structures and owner's land drawn to appropriate metric scale shall show:

1. Bordering areas showing public or well known streets.

2. Location of service drop, service equipment and nearest pole of the utility company furnishing electrical energy.

3. Clearance of the path or run of service drops and service structure wires to adjacent existing or proposed structures.

D. RISER DIAGRAM

The riser diagram consists of the schematic diagram of service entrance, feeders and branch circuits. This indicates:

1. The number of branch circuits, the size of conductors, size of conduit and protection for each branch circuit.

2. The sizes of feeders, its conduit and feeder's protection.

3. The type of service, size of service entrance conductor, conduits and main protective device.

E. TITLE BLOCK:

Title block or nameplate of plans and drawings shall be a standard strip of 40 mm high at the bottom of each sheet.

It shall contain the following:

1. Name and location of proposed installation, project, or watercraft;

2. Name, signature and address of owner/manager/operator;

3. Title of sheet and sheet number;

4. Scale used;

5. Name, signature and dry seal of professional electrical engineer together with registration number, Professional Tax Receipt (PTR) and Tax Identification Number (TIN);

6. Initial of draftsman; and

7. Date drawn or revised.

F. ELECTRICAL LIGHTING AND POWER LAYOUT

Electrical layout for each floor of the building shall indicate the location of:

1. Location of lighting outlets.

2. Location of convenience outlets.

3. Location of switches with their corresponding symbols.

4. Location of outlets for air conditioning units.

5. Location of telephone, intercom and master antenna television outlets.

6. Location of service equipment and/or disconnecting means.

7. Location of service kilowatthour meter.

G. SCHEDULE OF LOADS AND COMPUTATIONS:

Schedule of loads in tabulated form shall indicate:

A. MOTOR LOADS:

1. Motor as numbered or identified in power layout.

2. Type of motor

3. HP/kW/kVA rating

4. Voltage rating

5. Full load current rating

6. Frequency rating

7. Number of phases

B. LIGHTING AND POWER LOADS:

1. Panel as numbered in the riser diagram.

2. Circuit designation number.

3. Number and lightning outlets in each circuits.

4. Number of switches in each circuit.

5. Number of convinience outlet

6. Voltage circuit

7. Fuse rating or trip rating of circuit protective device.

C. OTHER LOADS

1. Designation number on plan

2. Description loads

3. Classification of service duty

4. Rating in kilovolt ampere (KVA) or kilowatt (KW)

5. Phase loading indicating full load line current

6. Voltage rating

DESIGN COMPUTATION

Or design analysis where necessarry shall be included on the drawings or may be submitted on separate sheets of uniform size paper, shall allow :

1. Illumination design computations and tabulated lighting levels in lux critical areas in institutional, Industrial recreational & commercial building.

2. Feed lines and protective devices of motors, electrical equipment and appliances indicating types and ratings.

3. Sizes of branch circuit wires, Feeders and busbars including protective devices.

4. Size and type of service entrance wires, race ways and equipment.

5. Setting / ratingsof over current devices.

GROUNDING PROTECTION

A ground is an electrical connection which may either be intentional or accidental between an electric circuit or equipment and the earth, or to some conducting body that serves in place of the earth. The purpose of grounding a circuit is to fix permanently a zero voltage point in the system. The grounded line of a circuit should not be broken nor fused to maintain a solid and uninterrupted connection to the ground.

Grounding could be accomplished in the following manner:

1. Connection to a buried cold water main.

2. Connection to a rod or group of rods.

3. Connection to a buried ground plate.

THE PANELBOARD

A panelboard is a single panel or group of panel units designed for assembly in the form of a single panel. This includes buses, automatic overcurrent protective devices, and with or without switches for the control of light, heat or power circuit. It is designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.

Principles applied in installing panel board

1. The approach should be accessible and convenient.

2. The panelboard must be centrally located to shorten the home wiring runs.

3. It must be installed near the load center. As in most cases, panelboard is installed near the kitchen and the laundry where heavy loads are expected.

MAIN- is the feeder interior wiring extending from service switch, generator bus, or converter bus to the main distribution.

BRANCH CIRCUIT- is defined as the circuit conductors between the final overcurrent device protecting the circuit and the outlets. This means that the branch circuit is only the wiring between the circuit overcurrent protection device such as fuses or circuit breaker and the outlets. However, it is a common knowledge and practice that the branch circuit comprises the entire circuit including the outlet receptacles and other wiring devices.

PROTECTION OF THE BRANCH CIRCUIT

Any current in excess of the rated current capacity of the equipment or the rated ampacity of the conductor is called overcurrent.

The causes of overcurrent are:

1. Overload in the equipment conductors.

2. Short circuit or ground fault

As per PEC requirement, conductors shall be protected against overcurrent in accordance with their ampacities (Art. 4.5.1.3)

Ampacity - is the current-carrying capacity of an electric conductor.

THE CIRCUIT BREAKER AND THE FUSE

A circuit breaker is an overcurrent protective device also designed to function as a switch. It is equipped with an automatic tripping device to protect the branch circuit from overload and ground fault.

A fuse is also an overcurrent protective device with a circuit opening fusible element which opens when there is an overcurrent in the circuit. It is considered as the simplest and the most common circuit protective device used into the house wiring connection.

Advantages of circuit breaker over a fuse

1. The circuit breaker acts as a switch aside from its being an overcurrent device.

2. When there is an overcurrent, the circuit breaker trips automatically and after correcting the fault, it is ready to be switched on again, unlike the fuse which has to be discarded and replaced after it is busted.

Advantages of fuse over a circuit breaker

1. One of its major advantage is its reliability and stability. It can stay on its position for years and act when called on to act as designed, unlike the circuit breaker which requires proper maintenance and periodic testing to keep it into a tip-top condition.

2. The cost of a fuse is less than that of a circuit breaker.

Standard Ampere Ratings of Fuses and Inverse time circuit breakers

15, 20, 25, 30, 40, 45, 60, 70, 80, 90, 100, 110, 125, 150, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000 and 6000

Fuses, circuit breakers or combinations shall not be connected in parallel.

Exception: Circuit breakers or fuses, factory assembled in parallel, and approved as a unit.

Position of Knife Switches

a) Single-throw Knife Switches. Single-throw knife switches shall be so placed that gravity will not tend to close them. Single-throw knife switches, approved for use in the inverted position, shall be provided with a locking device that will ensure that the blades remain in the open position when so set.

b) Double-throw Knife Switches. Double-throw knife switches shall be permitted to be mounted so that the throw will be either vertical or horizontal. Where the throw is vertical, a locking device shall be provided to hold the blades in the open position when so set.

RECEPTACLES AND WIRING DEVICES

ELECTRICAL CONDUCTORS AND INSULATORS

Electrical Conductors are substances that offer a very low resistance to current flow.

Insulators are substances that offer a very high resistance to current flow.

List of some good electrical conductors

1. Silver 6. Zinc

2. Copper 7. Platinum

3. Aluminum 8. Iron

4. Nickel 9. Tin

5. Brass 10. Lead

List of some insulating materials

1. Rubber 8. Asbestos

2. Porcelain 9. Thermoplastics

3. Varnish 10. Paper

4. Slate 11. Oils

5. Glass 12. Wax

6. Mica 13. Dry air

7. Latex

WIRES AND CABLES

Wires are those electrical conductors which are 8 mm2 (AWG no. 8) or smaller, while cables are those larger than the wires. They are either solid or stranded.

Stranded wire - consists of a group of wires twisted to form metallic string. The total circular-mil area of a stranded wire is found by multiplying the circular mil area of each strand by the total number of strand.

Cord is the term given to an insulated stranded wire.

CIRCULAR MIL. This is the unit of cross section in the American wire gauge. The term “mil” means one-thousandth of an inch (0.001 in.). It is the area of a circular wire having a diameter of one mil. To find the number of circular mils in a circle of a given diameter, we have to square the number of mils in the diameter.

Area in circular mil = (diameter in mils)2

1 inch = 1,000 mils

MCM = 1,000 circular mils

SQUARE MIL. It is the area of a square having its side equal to 1 mil.

Square mil = (sides)2 = (1 mil)2 = (0.001 in.)2 = 1 x 10-6 in.2

Square mil = 0.7854 x circular mils

CONDUCTOR AREAS:

CONVERSION FACTOR

Square inch = square mil x 0.000001

Square mil = square inch x 1,000,000

Square mil = circular mils x 0.7854

Circular mil = square mils x 1.273

Millimeter = inches x 25.4

Square mm = circular mils x 0.0005067

COMMONLY USED PREFIXES

PREFIX UNIT SYMBOL

deci 1 x 10-2 d milli 1 x 10-3 m

micro 1 x 10-6 m

nano 1 x 10-9 n

pico 1 x 10-12 p

deka 1 x 101 da

hecto 1 x 102 h

kilo 1 x 103 k

Mega 1 x 106 M

Giga 1 x 109 G

COMMONLY USED ENGLISH-METRIC EQUIVALENTS

English to Metric Metric to English

LENGTH

1 in = 25.4 mm 1 mm = 0.0394 in

1 in = 2.54 cm 1 cm = 0.394 in

1 ft = 304.8 mm 1 cm = 0.033 ft

1 ft = 30.48 cm 1 m = 39.37 in

1 ft = 0.305 m 1 m = 3.28 ft

1 yd = 0.915 m 1 km = 3280.83 ft

1 mi = 1609.34 m 1 km = 0.621 mi

1 mi = 1.609 km

AREA

1 sq in = 645.16 sq mm 1 sq cm =0.155 sq in

1 sq in = 6.45 sq cm 1 sq cm = 0.0011 sq ft

1 sq ft = 929.03 sq cm 1 sq m = 10.764 sq ft

1 sq ft = 0.093 sq m 1 sq m = 1.2 sq yd

DIFFERENT TYPES OF CABLES

1. Armored Cable. This type of cable, the type AC is a fabricated assembly of insulated conductors enclosed in flexible metalsheath. Armored cable is used in both exposed and concealed work.

2. Metal Clad Cable. Cable of the type MC is a factory assembled cable of one or more conductors, each individually insulated and enclosed in a metallic sheath of interlocking tape, or a smooth or corrugated tube. This type is used specifically for services, feeders, branch circuits, either exposed or concealed and for indoor or outdoor work.

3. Mineral Insulated Cable. This type of cable, type MI, is a factory assembly of one or more conductors insulated with a highly compressed refractory mineral insulation and enclosed in liquid-tight and gas-tight continuous copper sheath. The type MI is used in dry, wet or continuously moist location as service, feeders or branch circuit.

4. Nonmetallic Sheathed Cable. Types NM and NMC are factory assembled two or more insulated conductors having a moisture-resistant outer sheath, flame-retardant and non-metallic material. These types are used specifically for one or two dwelling not exceeding 3 storey buildings.

5. Shielded Nonmetallic Sheathed Cable. This type of cable, the type SNM, is a factory assembly of two or more insulated conductors in an extruded core or moisture-resistant and flame-retardant material, covered with an overlapping spiral metal tape. This type is used in hazardous locations and in cable trays or in raceways.

6. Service Entrance Cable. This is a single conductor or multiconductor assembly provided with or without an over-all covering, primarily used for services and of the types SE and USE.

7. Underground Feeder and Brach Circuit Cables. This type of cable, the type UF cable is a moisture-resistant cable used for underground, including direct burial in the ground, as feeder or branch circuit.

8. Power and Control Tray Cable. Type TC cable is a factory assembly of two or more insulated conductors with or without associated bare or covered grounding under a metallic sheath. This is used for installation in cable trays, raceways or where supported by a messenger wire.

9. Flat Cable Assemblies. This is an assembly of parallel conductors formed integrally with an insulating material web designed specifically for field installation in metal surface raceway. Cables of this type are the types FC.

10. Flat Conductor Cable. This type of cable, type FCC consists of three or more flat conductors placed edge to edge, separated and enclosed within an insulating assembly. This used for general purpose, appliance branch circuits and for individual branch circuits specifically on hard, smooth, continuous floor surfaces, etc.

12.Medium Voltage Cables. MV cable is a single or multiconductor solid dielectric insulated cable rated 2,001 volts or higher and is used for power systems up to 35,000 volts. The MV cables are of different types and characteristics.

RACEWAYS

Raceways are channels designed for holding wires, cables or bus-bars, which are either made of metal or insulating materials. The common types of raceways in household wiring are the a) conduits, b) connectors, and c) others.

a) Conduits

Conduits, pipes or tubings are the most common electrical raceway.

According to the type of materials used, conduit maybe classified as either metallic such as steel pipes or nonmetallic such as PVC, and the like.

According to its make, conduits maybe classified as: rigid metal, flexible metal, rigid nonmetal and flexible nonmetal.

b) Connectors

A connector is a metal sleeve usually made of copper that is slipped over and secured to the butted ends of conductors in making joint. A connector is also called a splicing sleeve.

c) Other Raceways

Aside from the conduits and connectors there are still numerous types and kinds of raceways, among these are the a) conduit couplings, elbows and other fittings; b) conduit supports, such as clamps, hangers,etc; c) cable trays, cablebus; d) metal raceways;e) nonmetal raceways.

OUTLETS, RECEPTACLES and other WIRING DEVICES

OUTLETS. An outlet is a point in the wiring system at which current is taken to supply utilization equipment. The kinds of outlets are: convenience outlet or attachment cap, lighting outlet, and receptacle outlet.

A convenience outlet or attachment cap is a device which by insertion in a receptacle, establishes connection between the conductor of the flexible cord and the conductors connected permanently to the receptacle.

A lighting outlet is an outlet intended for direct connection of a lampholder, a lighting fixture, or a pendant cord terminating in a lampholder.

A receptacle outlet is an outlet where one or more receptacles are installed.

TYPES OF WIRES

A. TYPES T, TW, THW

The most ordinary type of plastic insulated wire is the “type T”. It may be used only in dry locations. Some manufactures no longer make the ordinary Type T, instead produce Type TW, which is identical in appearance, but may be used in wet or dry locations. Also available is Type THW, is similar to Type TW but withstand a greater degree of heat, and consequently has a higher ampacity rating in the larger sizes.

B. TYPES THHN, THWN

These are comparatively new types of wire, consisting of the basic Type THH and THW but with less thermoplastic insulation, and with a final extruded jacket of nylon. Nylon has exceptional insulating qualities and great mechanical strength, all of which results in a wire which is smaller in diameter than ordinary Types T, TW, TW of corresponding size.

C. TYPE XHHW

In appearance, it resembles Types T, TW, THW but because of somewhat thinner layer of insulation, the over-all diameter is smaller. The insulation is “cross-linked synthetic polymer,” which has an extraordinary properties as to insulating value, heat resistance, and moisture resistance. It may be used in dry or wet locations. While at present, it is an expensive wire, it would be no surprise if in due course

of time, this one single type will replace all the many types and subtypes of Type T or R now recognized by the Code.

D. RUBBER-COVERED WIRE

It consists of copper conductor, tinned to make it easier to remove the insulation, and for easy soldering. Over the copper is a layer of rubber, the thickness of which depends on the size of the wire. Then follows an outer fabric braid which is saturated with moisture-and-fire-resistant compounds; if it is set on fire with a blowtorch, the flame dies out when the torch is removed.

E. OTHER TYPES

Other types such as the basic Type R, which is suitable for only in dry locations, is no longer being made. The most ordinary kind is Type RHW, which may be used for dry or wet locations. Types RH and RHH have insulation which withstands more heat and therefore have a higher ampacity in the larger size. They may be used only in dry locations.

KINDS OF LOCATIONS

DAMP LOCATION

Partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subjected to moderate degree of moisture, such as some basements, some barns, and some cold-storage warehouses.

DRY LOCATION

A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

WET LOCATION

Installations underground or in concrete slabs or masonry in direct contact with the earth, and location subject to saturation with water or other liquids, such as vehicle washing areas, and locations exposed to weather and unprotected.

HAZARDOUS (CLASSIFIED) LOCATIONS

Locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitible fibers or flyings.

1. 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 ignitible mixtures.

a) Class I, Division 1. A Class I, Division 1 location is a location: I) in which igntible concentrations of flammable gases or vapors can exist under normal operating conditions; or ii) in which ignitible concentrations of such gas vapors may exist frequently because of repair or maintenance operations or

because of leakage; or iii) in which breakdown or faulty operation of equipment or processes might release ignitible concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

b) Class I, Division 2. A Class I, Division 2 location is a location: I) in which volatile flammable liquids or flammable gases are handled, processes, or used, but in which the liquids, vapors, or gases will normally be confines 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 ii) in which ignitible 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; iii) that is adjacent to Class I, Division 1 location, and to which ignitible concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Class II Locations. Class II locations are those that are hazardous because of the presence of combustible dust.

a) Class II, Division 1. A class II, Division 1 location is a location: I) in which combustible dust is in the air normal operating conditions in quantities sufficient to produce explosive or ignitible mixtures; or ii) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation devices, or from other causes; or iii) in which combustible dusts of an electrically conductive nature may be present in hazardous quantities.

b) Class II, Division 2. A Class II, Division 2 location is a location where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitible mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and where combustible dust accumulations on, in, or in the vicinity of the electrical equipment may be sufficient to interfere with the safe dissipation of heat from electrical equipment or may be ignitible by abnormal operation or failure of electrical equipment.

3. Class III Locations. Class III locations are those that are hazardous because of the presence of easily combustible 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 ignitible mixtures.

a) Class III, Division 1. A Class III, Divisions 1 location is a location in which easily ignitible fibers or materials producing combustible flyings are handled, manufactured, or used.

b) Class III, Division 2. A Class III, Division 2 location is a location in which easily ignitible fibers are stored or handled.