

Most Common Errors in Service Entrance Installations Prior to Final DU Inspection

**Residential and Small-Medium Commercial Buildings
Secondary Voltage
RME Forum – November 29, IIEE Convention**

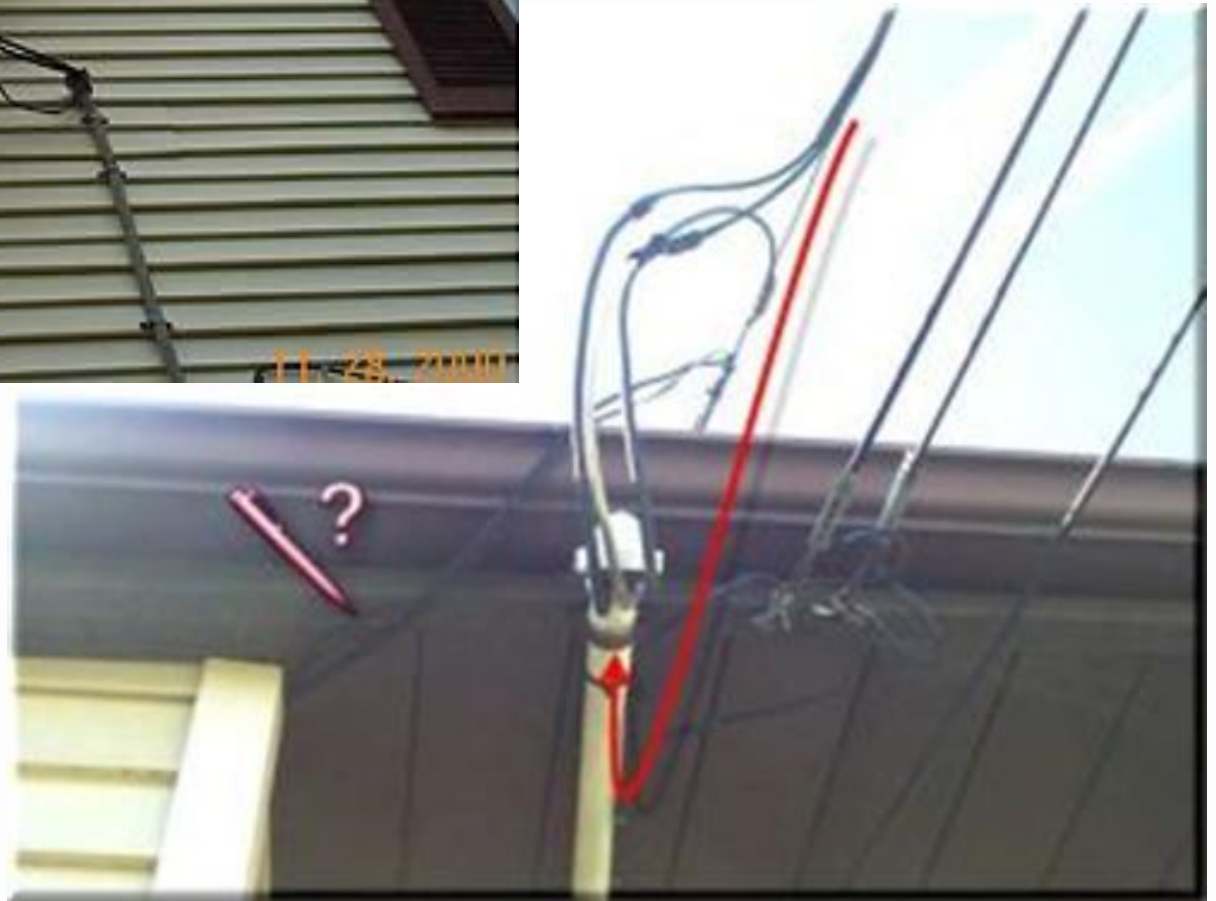
Format of Presentation:

- 1. Error Mentioned or Shown**
- 2. Relevant PEC Code 2009 Article/s**
- 3. Picture of Correct Installations**

1. No Sufficient Drip Loops for Service Entrance Wires



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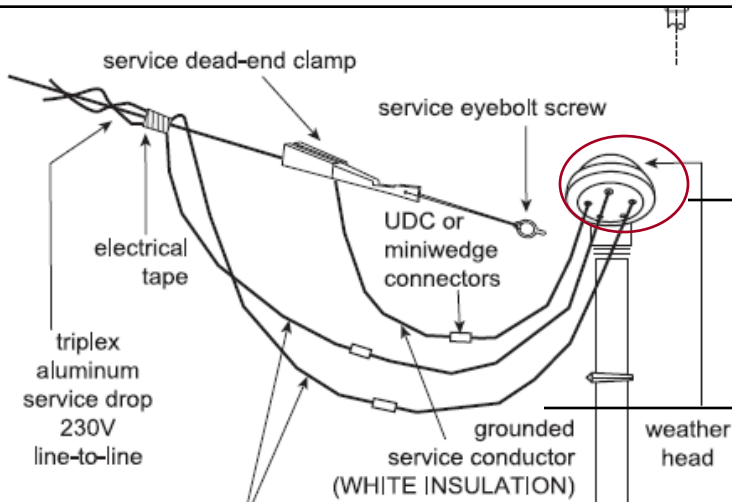
Article 2.30.4.15

Overhead Service Locations

(f) Drip Loops. Drip loops shall be formed on individual conductors. To prevent the entrance of moisture, service entrance conductors shall be connected to the service drop conductors either (1) below the level of the service head or (2) below the level of the termination of the service entrance cable sheath.

(g) Arranged That Water Will Not Enter Service Raceway or Equipment. Service-drop conductors and service-entrance conductors shall be arranged **so that water will not enter service raceway or equipment.**

(Installation)



- A rain-tight service head (weather head) shall be provided.

0.6-m (2 ft) minimum - drip loop

- The service entrance conductors shall be provided with drip loop, which shall not be shorter than 0.6-m (2 ft).



2. Service wires without sufficient clearance from building openings

Service wire without sufficient clearance from building opening



Service wire without sufficient clearance from building opening



Article 2.30 – Services

2.30.1.9 Clearances on Buildings

(a) Clearances. Service conductors installed as open conductors or multiconductor cable without an overall outer jacket shall have a clearance of **not less than 900 mm from windows** that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.

Exception: Conductors run above the top level of a window shall be permitted to be less than the 900 mm requirement

Article 2.30 – Services

2.30.1.9 Clearances on Buildings

(b) Vertical Clearance. The vertical clearance of final spans above, or within 900 mm measured horizontally of, platforms, projections or surfaces from which they might be reached shall be maintained.

(c) Building Openings. Overhead service conductors shall not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, shall not be installed where they obstruct entrance to these building openings

Article 2.30 – Services

2.30.2 Overhead Service-Drop Conductors

b. Vertical Clearance from Ground

- 3000 mm – at the electric service entrance to buildings, also at the lowest point of the drip loop of the building electric entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for service-drop cables supported on and cabled together with a grounded bare messenger where the voltage does not exceed 300 volts to ground

Article 2.30 – Services

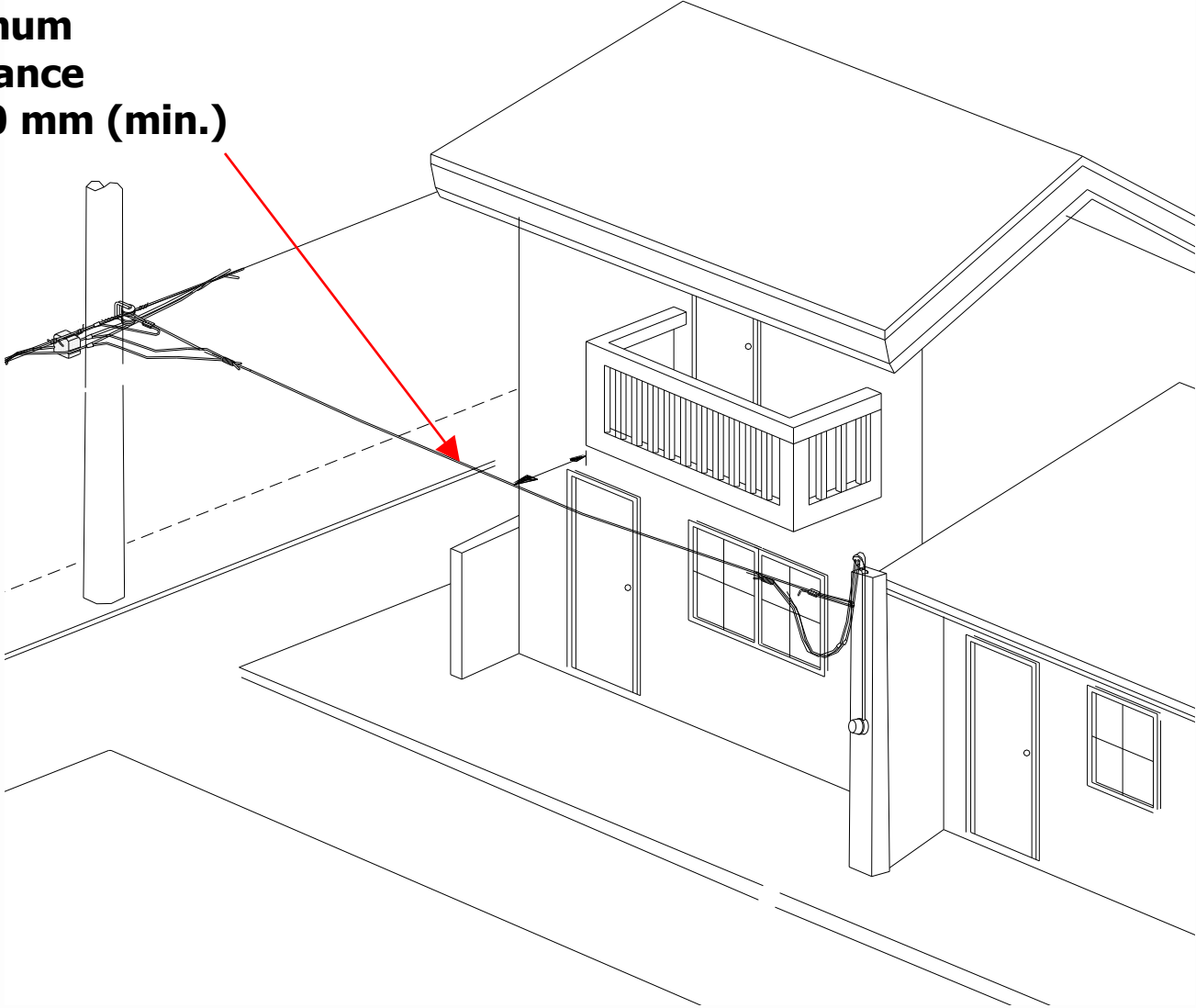
2.30.2 Overhead Service-Drop Conductors

b. Vertical Clearance from Ground

- (2) 3600 mm – over residential property and driveways and those commercial areas not subject to truck traffic where voltage does not exceed 300 volts to ground
- (3) 4500 mm – for those areas listed in the 3600 mm classification where the voltage exceeds 300 volts to ground
- (4) 5500 mm – over public street, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles, such as cultivated, grazing, forest and orchard

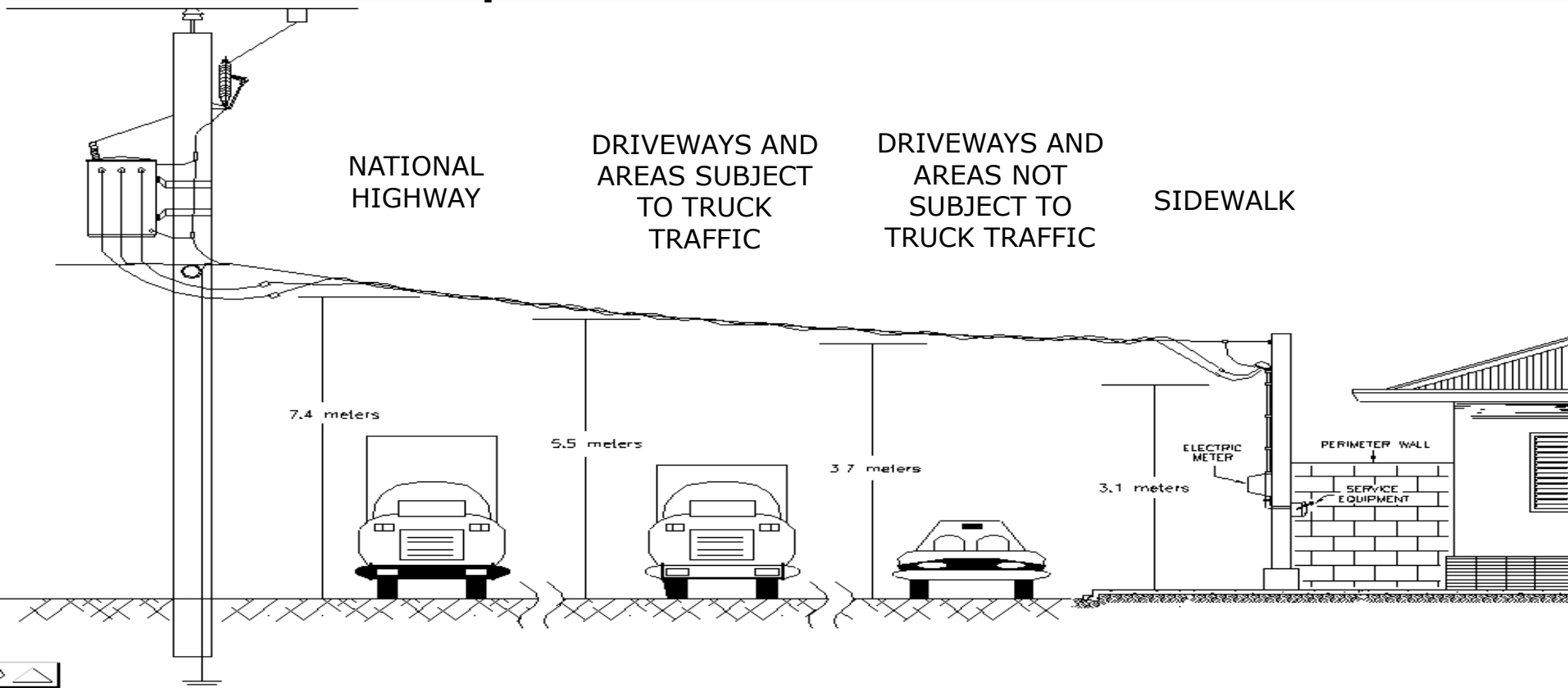
SERVICE DROP

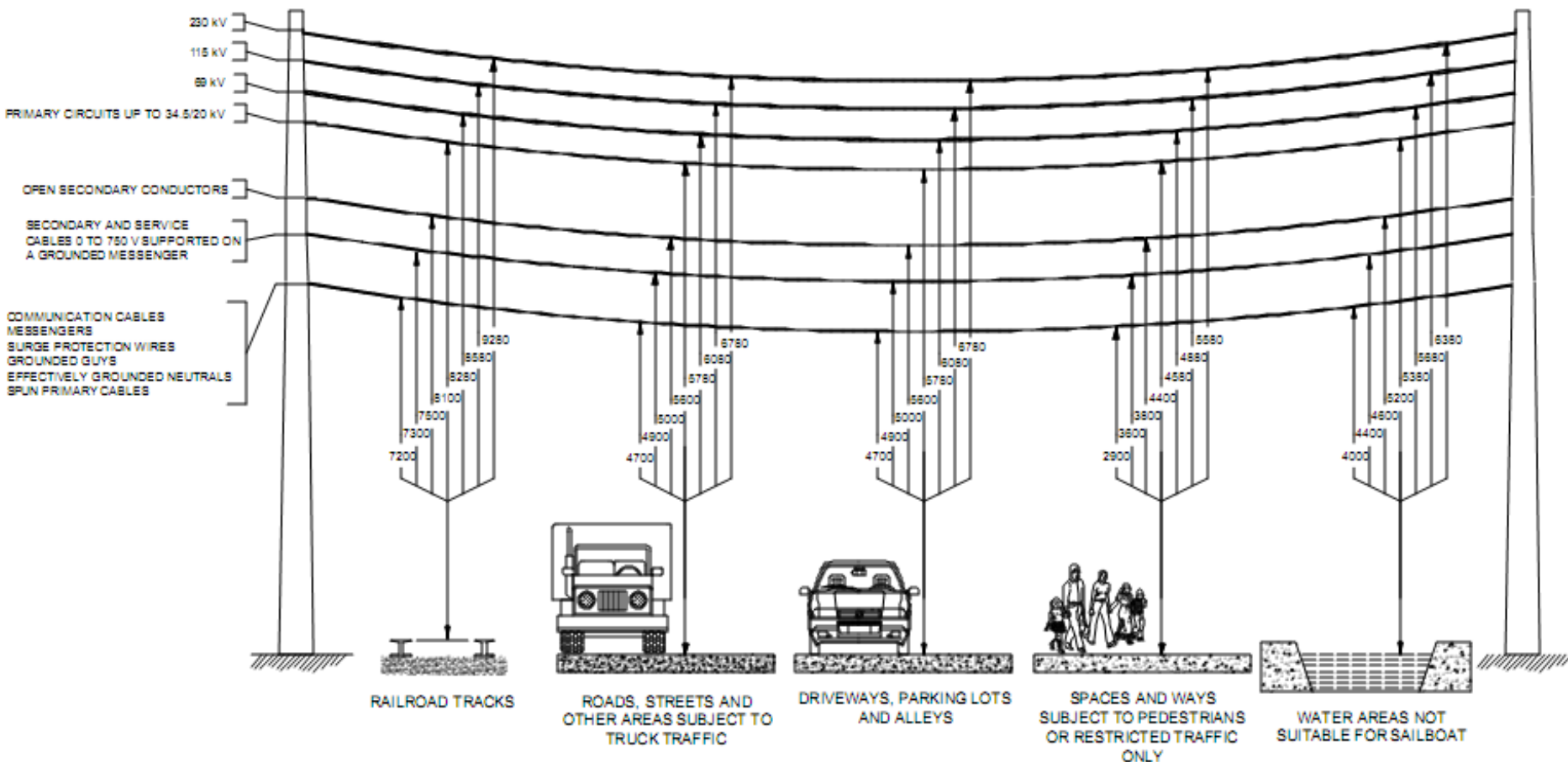
**Minimum
Clearance
= 900 mm (min.)**



Service Entrance Pole (Pole Height)

The poles shall have **sufficient height** to obtain the applicable minimum vertical clearance of service drop, service point, and the point of attachment





- Notes:**
1. This figure is based on Table 4.2.1.1(a).
 2. All dimensions are in mm.

Fig. 4.2.1.1 (a): Vertical Clearance of Wires, Conductors or Cables Above Ground, Rails or Water [where wires, conductors or cables cross over or overhang the surface]

**3. For customers with
generating set:
no interlock for transfer switch**

For customers with generating set:
no interlock for transfer switch



Article 7.1.1.7 Legally Required Standby Systems- Transfer Equipment.



(a) General. Transfer equipment, including automatic transfer switches, shall be automatic and identified for standby use and approved by the authority having jurisdiction.

Transfer equipment **shall be designed and installed to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment.** Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 7.5.

(c) Automatic Transfer Switches. Automatic transfer switches shall be electrically operated and mechanically held.

Article 7.2.1.6 Optional Standby System- Transfer Equipment.



Transfer equipment shall be suitable for the intended use and designed and installed so as **to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment.**

Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 7.5.

Transfer equipment, located on the load side of branch circuit protection, shall be permitted to contain supplementary overcurrent protection having an interrupting rating sufficient for the available fault current that the generator can deliver. The supplementary overcurrent protection devices shall be part of a listed transfer equipment.

Transfer equipment shall be required for all standby systems subject to the provisions of this article and for which an electric-utility supply is either the normal or standby source.



The transfer switch could be **manually or automatically operated.**



Double Throw Transfer Switch



Non-automatic Transfer Switch

Automatic Transfer Switch

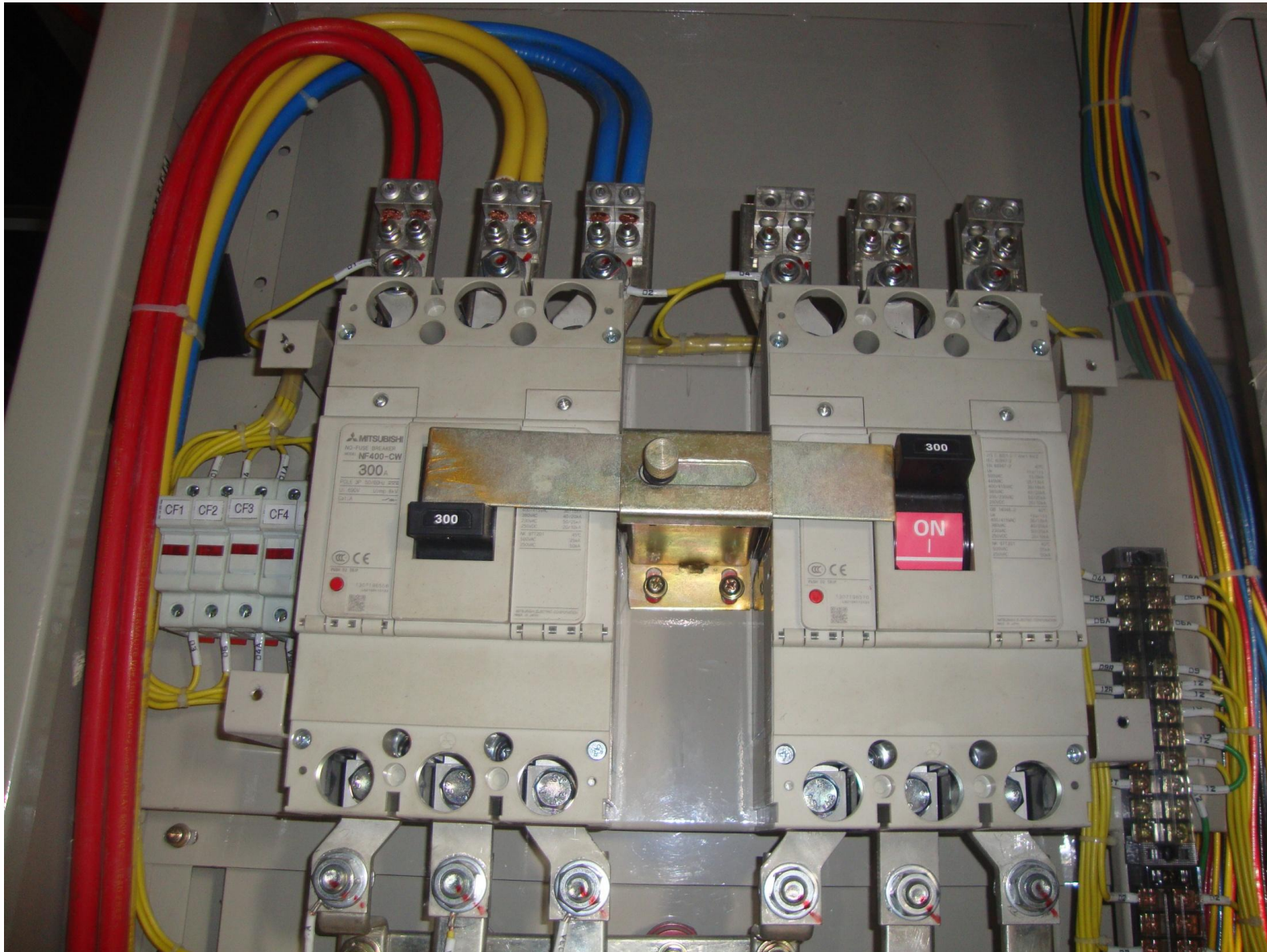


The transfer switch shall be provided with **mechanical and/or electrical interlock.**





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Indicating lights shall be provided to indicate that the transfer switch is connected to the **normal** source (green) or to the **emergency** source (red).



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**4. No GSC for each
service entrance
conduit or raceway**

No GSC for each service entrance raceway



Article 2.50.2.5 – Grounding Service-Supplied Alternating-Current Systems.



(1) Routing and Sizing. This conductor **shall be routed with the phase conductors** and shall not be smaller than the required grounding electrode conductor specified in Table 2.50.3.17 but shall not be required to be larger than the largest ungrounded service-entrance phase conductor. In addition, for service-entrance phase conductors larger than 1100 kcmil copper or 850 mm² aluminum, the grounded conductor shall not be smaller than 12½ percent of the area of the largest service-entrance phase conductor. The grounded conductor of a 3-phase, 3-wire delta service shall have an ampacity not less than that of the ungrounded conductors.

(2) **Parallel Conductors.** Where the service-entrance phase conductors are installed in parallel, the size of the grounded conductor shall be based on the total circular mil area of the parallel conductors as indicated in this section. Where installed in two or more raceways, the size of the grounded conductor in each raceway shall be based on the size of the ungrounded service-entrance conductor in the raceway but not smaller than 50 mm².

3.0.1.20 Induced Currents in Metal Enclosures or Metal Raceways.

(a) Conductors Grouped Together. Where conductors carrying alternating current are installed in metal enclosures or metal raceways, they shall be arranged so as to avoid heating the surrounding metal by induction. **To accomplish this, all phase conductors and, where used, the grounded conductor and all equipment grounding conductors shall be grouped together.**

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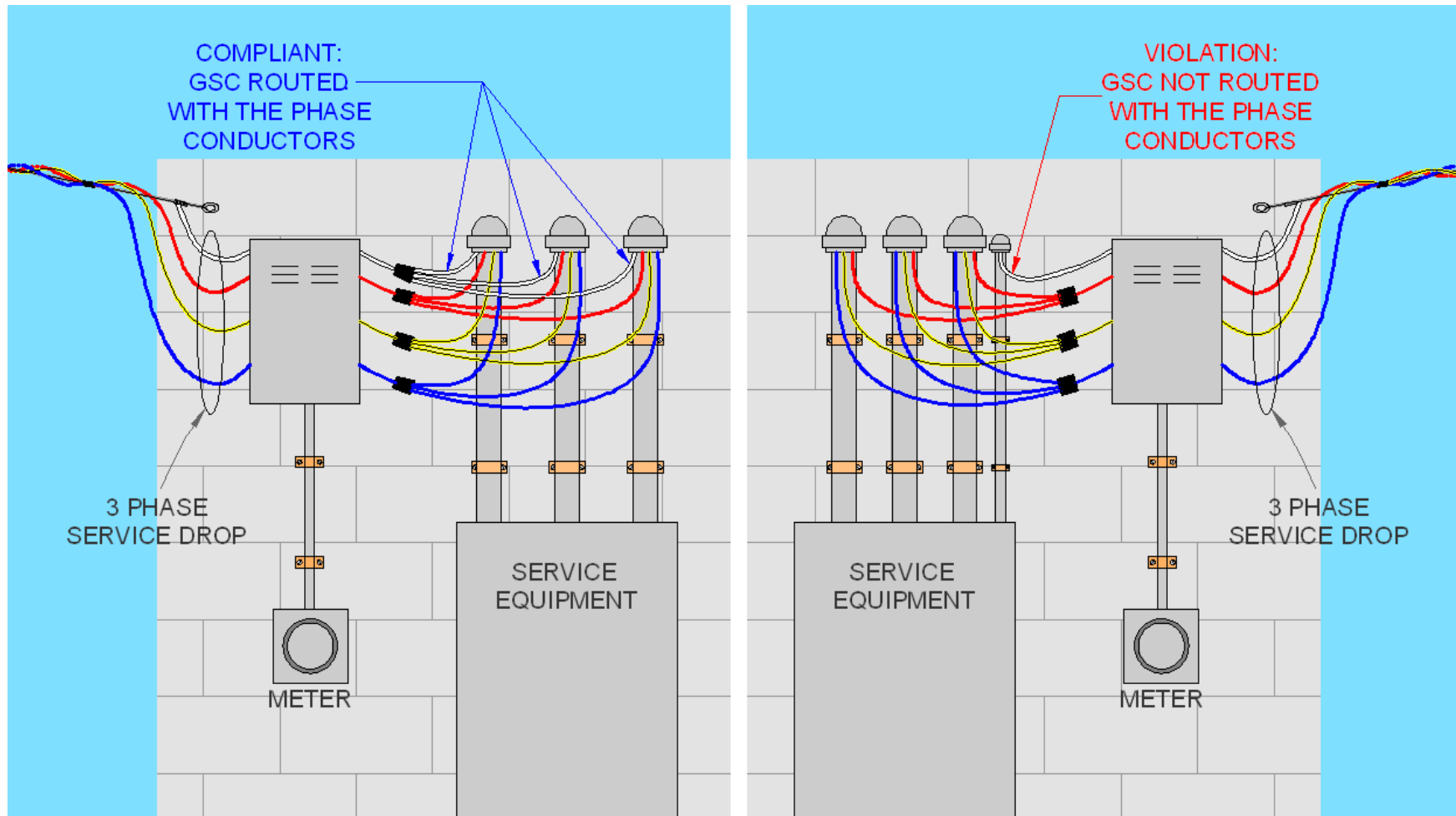
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- For parallel service entrance, each raceway shall have a GSC installed and grouped w/ the phase conductors and shall be of the same size, length, material, insulation and termination. Sizing shall be in accordance w/ Table 2.50.3.17.



- Sizing shall be in accordance with Table 2.50.3.17.
- This is accomplished by sizing it based on the total area of the largest phase conductor.

Table 2.50.3.17 Grounding Electrode Conductor for Alternating-Current Systems

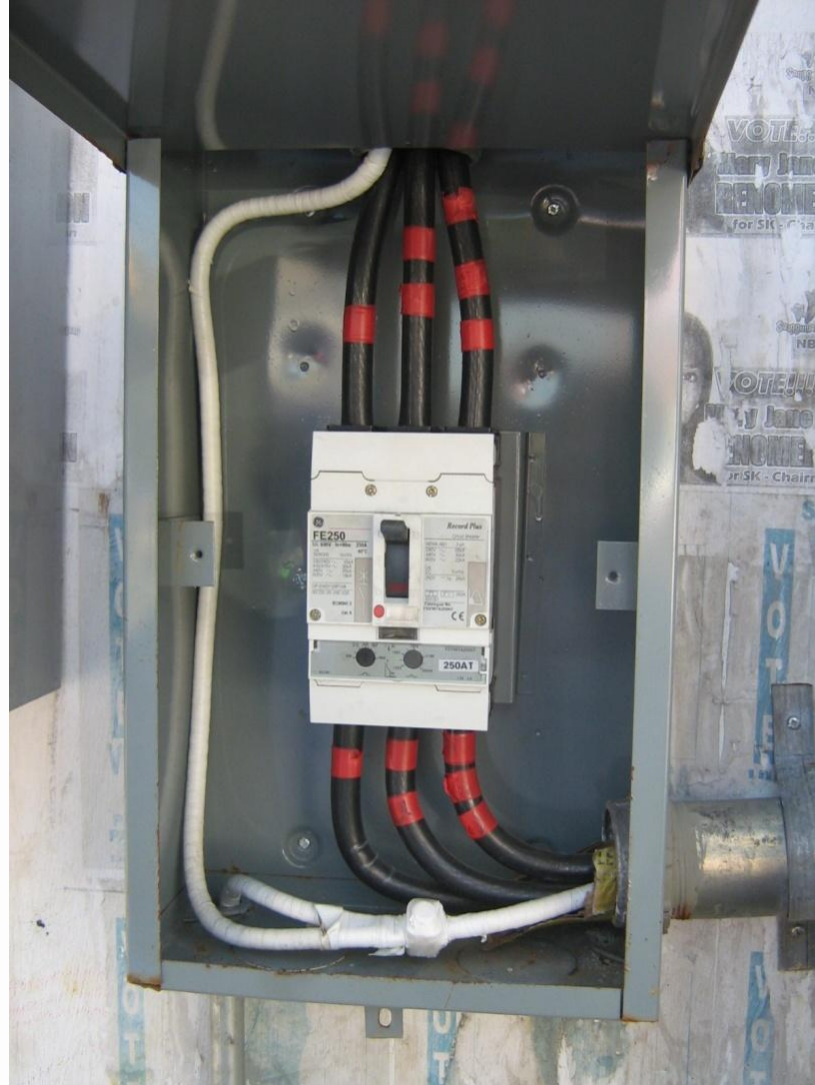
Size of Largest Service Entrance Conductor or Equivalent Area for Parallel Conductors (mm ²)	Size of Grounding Electrode Conductors (mm ²)
Copper	Copper
30 or smaller	8
38 or 50	14
60 or 80	22
Over 80 through 200	30
Over 200 through 325	50
Over 325 through 500	60
Over 500	80

5. GSC not bonded to service equipment enclosure



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4. GSC not bonded to service equipment enclosure



Article 1.1.1. General (Definitions)

Bonding Jumper, System. The connection between the grounded circuit conductor and the equipment grounding conductor at a separately derived system.

Article 2.50.2.5 Grounding Service-Supplied Alternating-Current Systems.

(b) Main Bonding Jumper. For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 2.50.2.9.

2.50.2.9 Main Bonding Jumper and System Bonding Jumper.

For a grounded system, main bonding jumpers and system bonding jumpers shall be installed as follows:

- (a) **Material.** Main bonding jumpers and system bonding jumpers shall be of copper or other corrosion-resistant material. A main bonding jumper and a system bonding jumper **shall be a wire, bus, screw, or similar suitable conductor.**
- (b) **Construction.** Where a main bonding jumper or a system bonding jumper is a screw only, the screw shall be identified with a green finish that shall be visible with the screw installed.
- (c) **Attachment.** Main bonding jumpers and system bonding jumpers shall be attached in the manner specified by the applicable provisions of 2.50.1.8.

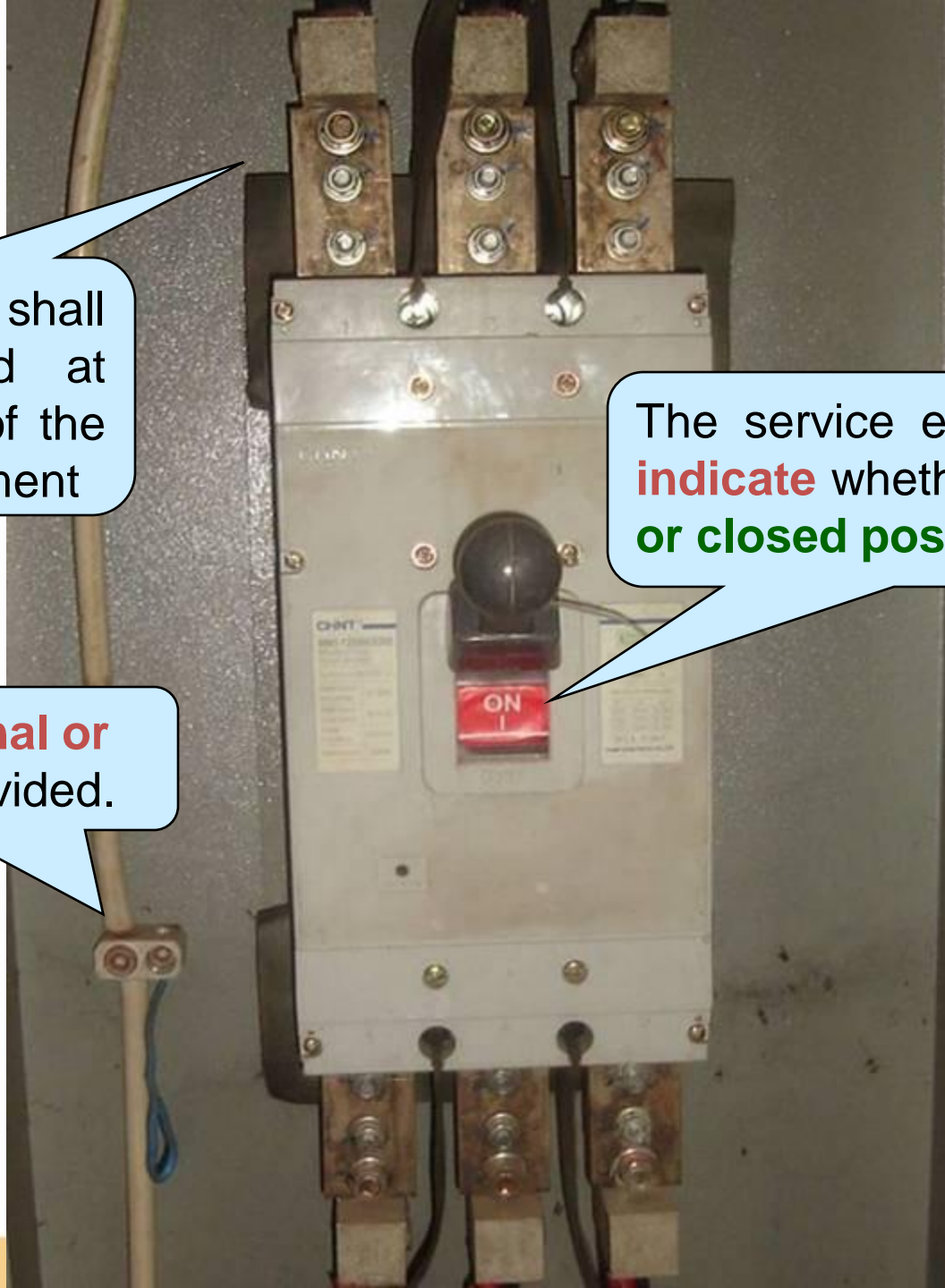
2.50.1.8 Connection of Grounding and Bonding Equipment.

Grounding conductors and bonding jumpers shall be connected by exothermic welding, listed pressure connectors, listed clamps, or other listed means.

Connection devices or fittings that depend solely on solder shall not be used. Sheet metal screws shall not be used to connect grounding conductors or connection devices to enclosures.



Main Bonding Jumper – A conductor, screw or strap that bonds the service disconnecting means to the GSC.



No devices shall be connected at the **lineside** of the service equipment

The service equipment shall **indicate** whether it is in **open** or **closed position**

A **ground terminal or bus** shall be provided.

6. GSC without distinctive white markings

GSC without distinctive white markings



2.0.1.6 – Means of Identifying Grounded Conductors



- (a) Sizes 14 mm² or Smaller.** An insulated grounded conductor of 14 mm² shall be identified by a **continuous white or gray outer finish or by three continuous white stripes on other than green insulation along its entire length.** Wires that have their outer covering finished to show a white or gray color but have colored tracer threads in the braid identifying the source of manufacture shall be considered as meeting the provisions of this section.
- (b) Sizes 14 mm² or Larger.** An insulated grounded conductor of larger than 14 mm² shall be identified by one of the following means
- (1) By a continuous white or gray outer finish**
 - (2) By three continuous white stripes along its entire length on other than green insulation
 - (3) At the time of installation by a distinctive white or gray marking at its termination. This marking shall encircle the conductor or insulation



GSC with distinctive white markings



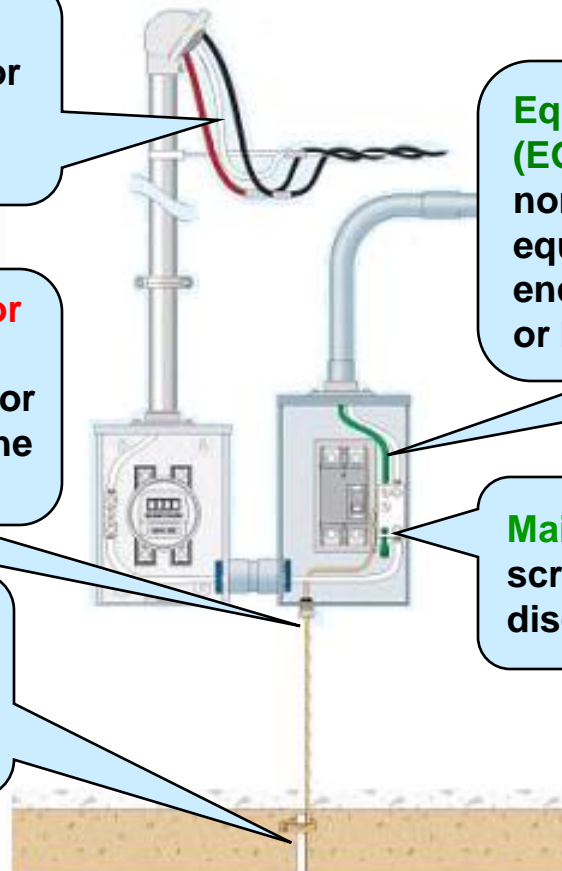
GSC with distinctive
white markings

GROUNDING (Components)

Grounded Service Conductor (GSC) - the grounded conductor from the service point to the service disconnecting means.

Grounding Electrode Conductor (GEC) - the conductor use to connect the grounded conductor to the grounding electrode at the service.

Grounding Electrode (GE) – a device that establishes an electrical connection to the earth.



Equipment Grounding Conductor (EGC) - conductor used to connect non-current-carrying metal parts of equipment, raceways, and other enclosures required to be grounded or bonded.

Main Bonding Jumper - a conductor screw or strap that bonds the service disconnecting means to the GSC.

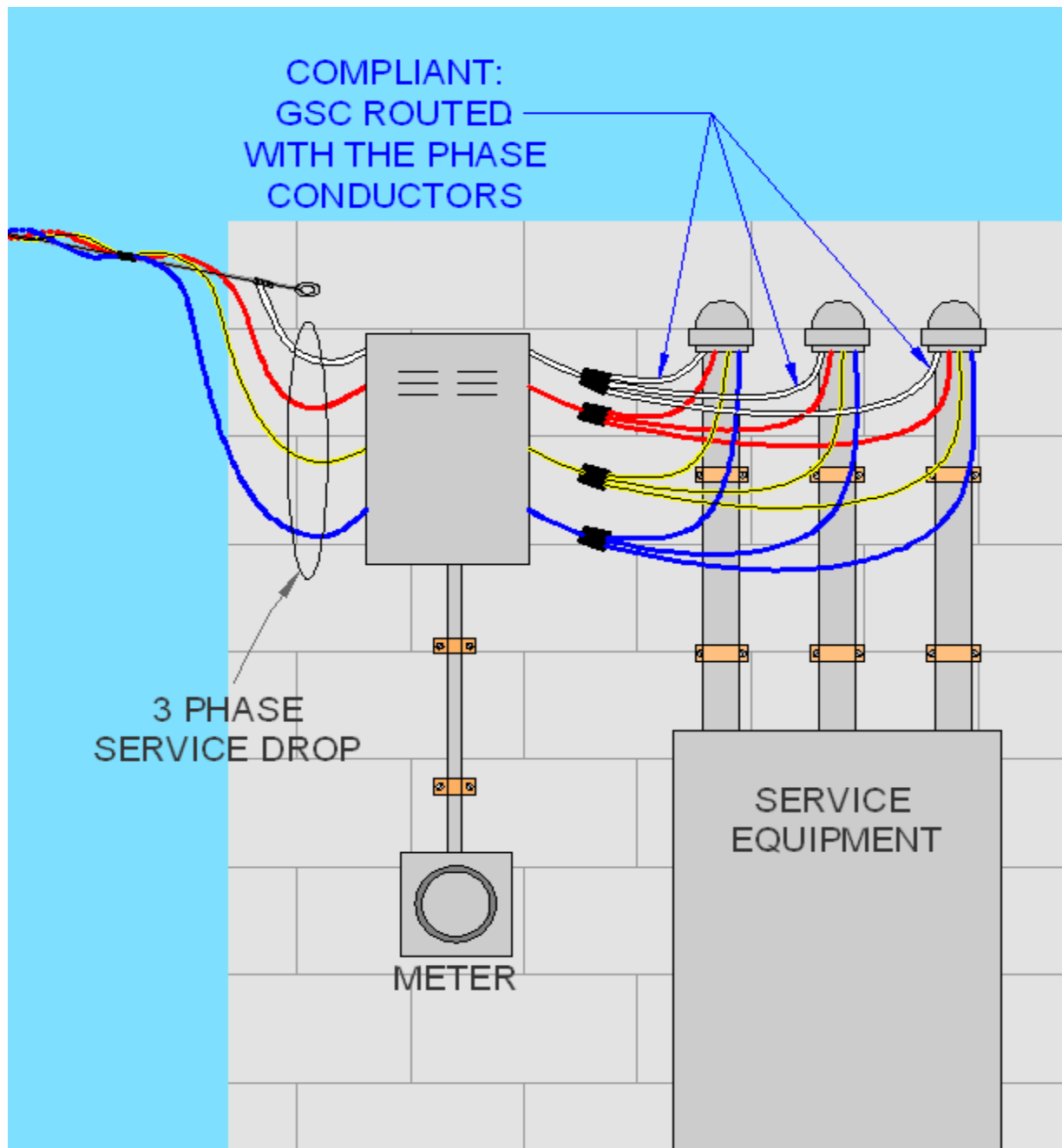
7. Separate Phase or Color Markings for Service Entrance Wires

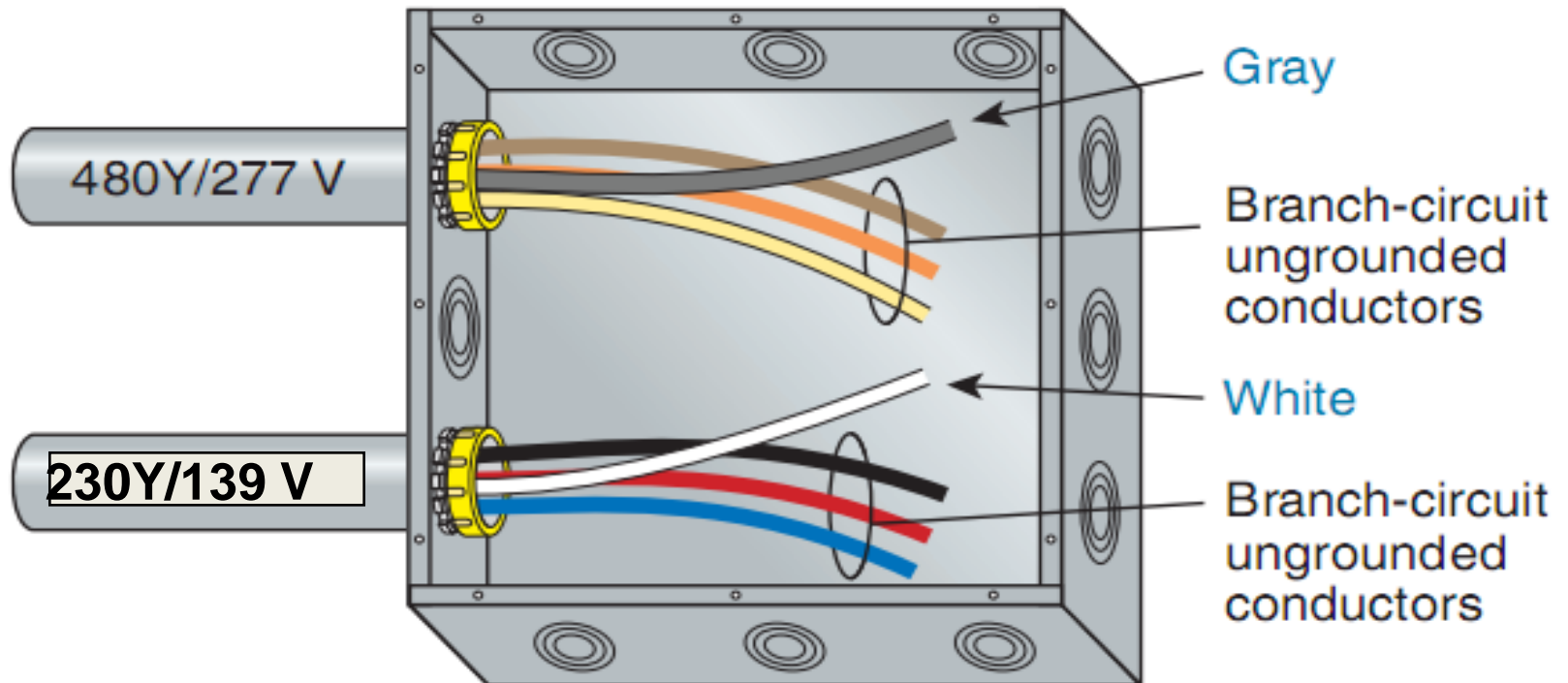
Identification of Ungrounded Conductors



2.10.1.5 Identification for Branch Circuits.

(C) Ungrounded Conductors. Where the premises wiring system has a branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit, where accessible, shall be identified by the system. The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means and shall be permanently posted at each branch-circuit panelboard.





San Francisco requires the following color codes:

- 120/240 Single Phase - "A" Black, "B" Red
- 120/208 Three Phase - "A" Black, "B" Red, "C" Blue
- 120/240 Three Phase - "A" Black, "B" Purple, "C" Red
- 277/480 Three Phase - "A" Brown, "B" Orange, "C" Yellow

They do not permit orange to be used for the high leg (B phase) of a 120/240 delta system. They require it to be purple.

-End of Presentation-

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Service Entrance Installations
Prior to Final DU Inspection**