Agricultural Buildings

The technical information provided herein is to assist qualified persons in planning and installing electric service to farms and residences. **Qualified person** is defined in Article 100 of the National Electrical Code (2008 edition) *as one who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.* Qualified persons are encouraged to review the National Fire Protection Association (NFPA) 70E-2004, Standards for Electrical Safety in the Workplace, for electrical safety training requirements. **A person who is not qualified should not attempt the planning and installation of electric service.**

Your electric cooperative and its officers, directors, employees and agents disclaim any and all liability for any personal injury, property damage or other damages of any kind, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use or reliance on the material contained in the following specifications. No warranties are made, whether express or implied, as to the accuracy or completeness of the information contained herein.

Note: Any reference to "Code" or "Code Handbook" in the following information refers to the 2008 National Electrical Code and the NEC 2008 Handbook respectively.

Why Article 547?

The Code is very specific about agricultural wiring. In order to have a good understanding what sections of the Code pertain to agricultural wiring, it is important to know the Code's arrangement.

According to 90.3 of the Code, the arrangement consists of an introduction and nine chapters. The requirements noted in Chapters 1 through 4 apply to all installations. The requirements in Chapters 5, 6, and 7 apply to special occupancies, special equipment, or other special conditions and can supplement or modify the requirements found in Chapters 1 through 4. Chapter 8 covers communication systems and is not subject to the previous seven chapters except when it refers back to them. Chapter 9 contains tables.

Since Chapters 1-4 of the Code are the **basic rules that apply to all** electrical wiring applications — the rules found there also pertain to agricultural wiring. Since Article 547-*Agricultural Buildings* is located in Chapter 5 of the Code, it simply contains **additional rules or exceptions** to Chapters 1-4.

Where does Article 547 apply?

The provisions of Code Article 547 apply to the following agricultural buildings or that part of a building or adjacent areas of similar or like nature as specified in (a) and (b) below:

(a) Agricultural buildings where excessive dust and dust with water may accumulate, including all areas of poultry, livestock, and fish confinement systems where litter dust or feed dust, including mineral feed particles may accumulate.

(b) Agriculture buildings where a corrosive atmosphere exists. Such buildings include the areas where the following conditions exists: (1) poultry and animal excrement may cause corrosive vapors; (2) corrosive particles may combine with water; (3) the area is damp and wet by reason of periodic washing for cleaning and sanitizing with water and cleansing agents; (4) where similar conditions exist.

Surface Temperatures — Location of electrical equipment or devices installed in agricultural buildings as explained in (a) and (b) above shall be so they will function at full rating without developing surface temperatures in excess of their specified normal operating temperature.

Wiring Methods

Note: It is a good idea to contact your insurance company — to inquire about special requirements they may demand — when wiring an agricultural building.

1. Wiring Systems **—** In agricultural buildings as described in (a) and (b) above, Types UF, NMC, copper SE cables, jacketed Type MC cable, rigid nonmetallic conduit, liquidtight flexible nonmetallic conduit, or other cables or raceways suitable for the location — with approved termination fittings — shall be the wiring methods employed. Note: The wiring methods of Article 502, Part II of the Code shall be permitted for areas described in (a) above.
2. Mounting **—** Cables installed are required to be secured within 8 inches of cabinets, boxes or fittings. Nonmetallic boxes, fittings, conduit and cables shall be permitted to be mounted directly to any building surface covered by the Agricultural Buildings article in the Code — without maintaining the ¼" airspace required by 300.6(D) of the Code.

Equipment Enclosures, Boxes, Conduit Bodies, and Fittings

1. Excessive Dust — All equipment enclosures, boxes, conduit bodies, and fittings installed in areas of buildings where excessive dust may be present shall be designed to minimize the entrance of dust. These devices shall not have any openings (such as mounting holes) through which dust could enter the enclosure.
2. Damp or Wet Locations — In damp or wet locations, equipment enclosures, boxes, conduit bodies and fittings shall be placed or equipped so as to prevent moisture from entering or accumulating. In wet locations, including normally dry or damp locations where surfaces are periodically washed or sprayed with water, boxes, conduit bodies, and fittings shall be listed for use in wet locations and the equipment enclosures shall be weatherproof.
3. Corrosive Atmosphere — Where wet dust, excessive moisture, corrosive gases or vapors, or other corrosive conditions may be present, equipment enclosures, boxes, conduit bodies, and fittings shall have corrosion resistance properties suitable for the conditions.
4. Flexible Connections — Where necessary to employ flexible connections — dusttight flexible connectors, liquidtight flexible metal conduit, liquidtight flexible nonmetallic conduit, or flexible cord listed and identified for hard usage — shall be used. All connectors and fittings used shall be listed and identified for the purpose.

5. Physical Protection — All electrical wiring and equipment subject to physical damage shall be protected.
6. Separate Equipment Grounding Conductor — All equipment grounding conductors installed in Agricultural Buildings shall be a **copper** conductor. If installed underground, the equipment grounding conductor shall be insulated or covered. The intent of this is to help improve the conductor's longevity because of the highly corrosive locations that are typical of many farm buildings.
7. Receptacles — All 125-volt, single phase, 15- and 20-ampere general purpose receptacles shall have ground-fault circuit-interrupter (GFCI) protection if installed (a) in areas having an equipotential plane (b) outdoors (c) damp or wet locations (d) dirt confinement areas for livestock.

All enclosures — housing switches including pushbuttons, relays and similar devices; receptacles, circuit breakers, controllers and fuses — shall be suitable for the conditions encountered as explained above.

Motors — Motors and other rotating electrical machinery shall be totally enclosed or designed so as to minimize the entrance of dust, moisture or corrosive particles.

Luminaires — Lighting fixtures in agricultural buildings shall be installed to minimize the entrance of dust, foreign matter, moisture and corrosive material. A suitable guard for the lighting fixture must be used if the fixture is exposed to physical damage. If the lighting fixture is exposed to water caused from condensation, building cleansing water, or solution — a watertight fixture must be utilized.

Equipotential planes and bonding of equipotential planes — 547.2 of the Code defines equipotential plane as an area where wire mesh or other conductive elements are embedded in or placed under concrete, bonded to all metal structures and fixed nonelectrical equipment that may become energized, and connected to the electrical grounding system to prevent a difference in voltage from developing within the planes.

1. Where required — These equipotential planes are required in indoor confinement areas with concrete floors and also outdoors in concrete slabs — where metallic equipment is located that may become energized and accessible to livestock. Also outdoors, the equipotential plane shall encompass the area where the livestock stands while accessing metallic equipment that may become energized.
2. Bonding — Equipotential planes shall be connected to the electrical grounding system. This bonding prevents a difference in voltage from developing between the floor and other metal items the livestock may touch.

The bonding conductor shall be copper, insulated, covered or bare, and not smaller than #8 AWG. The means of bonding to wire mesh or other conductive elements shall be by pressure connectors or clamps of brass, copper, copper alloy, or an equally substantial approved means. Slatted floors that are supported by structures that are a part of an equipotential plane shall not require bonding.

DISTRIBUTION POINT & SITE-ISOLATING DEVICES — Many agricultural sites consist of multiple buildings that are directly related to the overall agricultural operation. It is the intent of 547.9 of the Code to make sure there is a <u>means to shut off all electrical power</u> to the buildings on the agricultural site <u>at a single location</u>.

On a farmstead, for example, this single location will usually be located at the "meter

pole." The meter pole is the central location on the farmstead where the farmstead receives it electrical supply from the electric cooperative supply wiring and then distributes it to all the other farm buildings, including the house.

This meter pole location is referred to in 547.2 of the Code as the **distribution point.** It is defined as *an electrical supply point from which service drops, service conductors, feeders or branch circuits to buildings or structures utilized under single management are supplied.* Other common names for the distribution point — besides being called the meter pole — include "the center yard pole," "common distribution point," or "service point." Even though this location is called many different names, the remaining part of this discussion will use the name "distribution point."

Another interesting term found in 547.2 of the Code is **site-isolating device —** which is defined as *a disconnecting means installed at the distribution point for the purposes of isolation, system maintenance, emergency disconnection, or connection of optional standby systems.* It is important to note that the site-isolating device must be pole mounted — as required by 547.9(A)(2) of the Code — and as its name implies, it is an isolating switch and is not considered to be the service disconnecting means for the agricultural premises as explained by 547.2 of the Code Handbook.

Proper Wiring at the Distribution Point and to Buildings/Structures

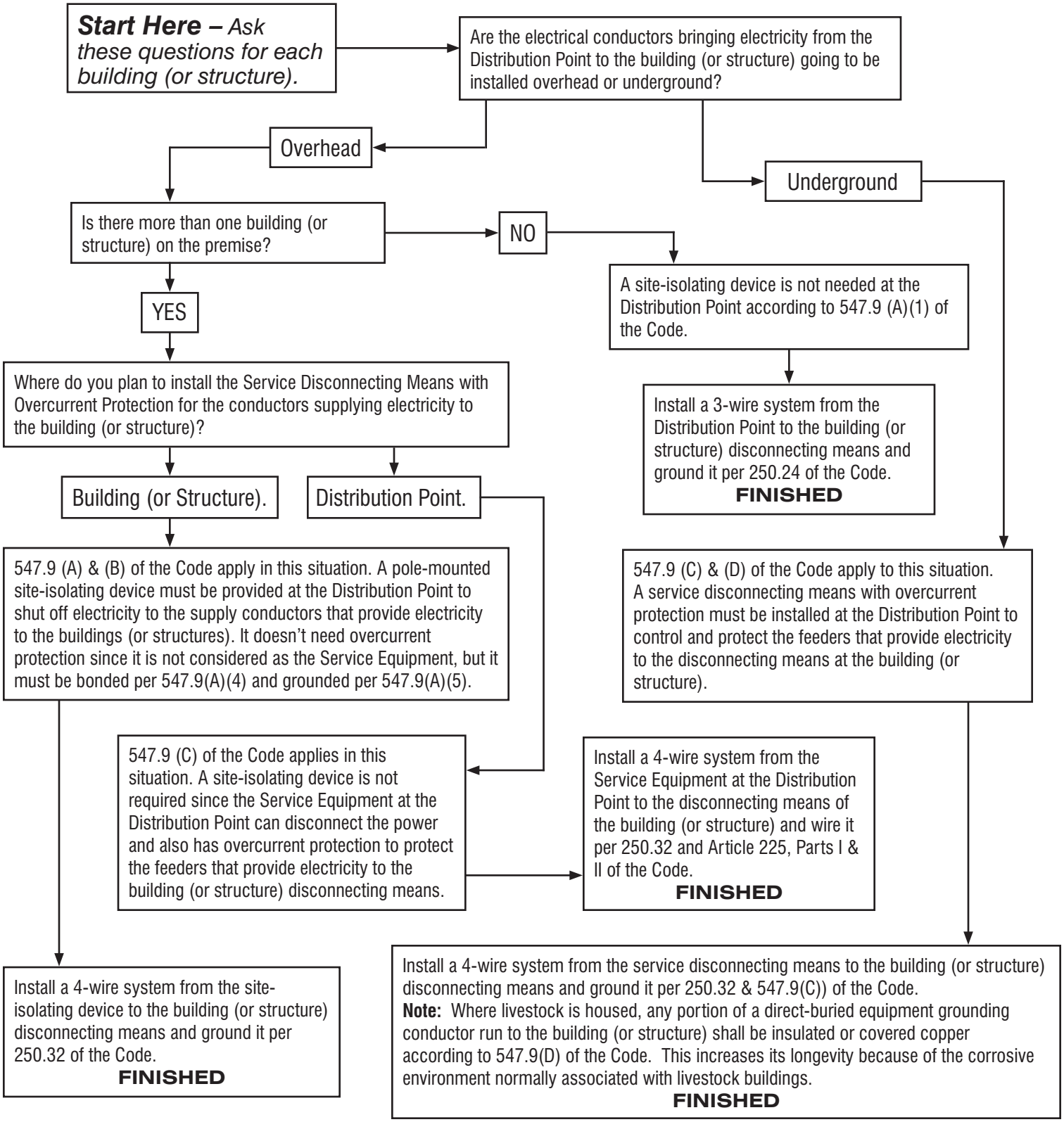
Based on whether the buildings or structure receive their supply from the distribution point overhead or underground — and where the overcurrent protection is located for those conductors, 547.9 of the Code has some very specific requirements.

The following flow chart is a guideline to follow to install proper electric wiring at the distribution point and to the other buildings and structures served by the distribution point. It is assuming that all buildings on the premise are under the same single management and that 120/240-volt, single-phase voltage is supplied.

Following the flow chart are some explanations of some grounding and bonding requirements found in the flowchart.

Proper Wiring at the Distribution Point and to Agricultural Buildings (or Structures) based on 547.9 of the Code

(120/240 Volt, Single Phase)



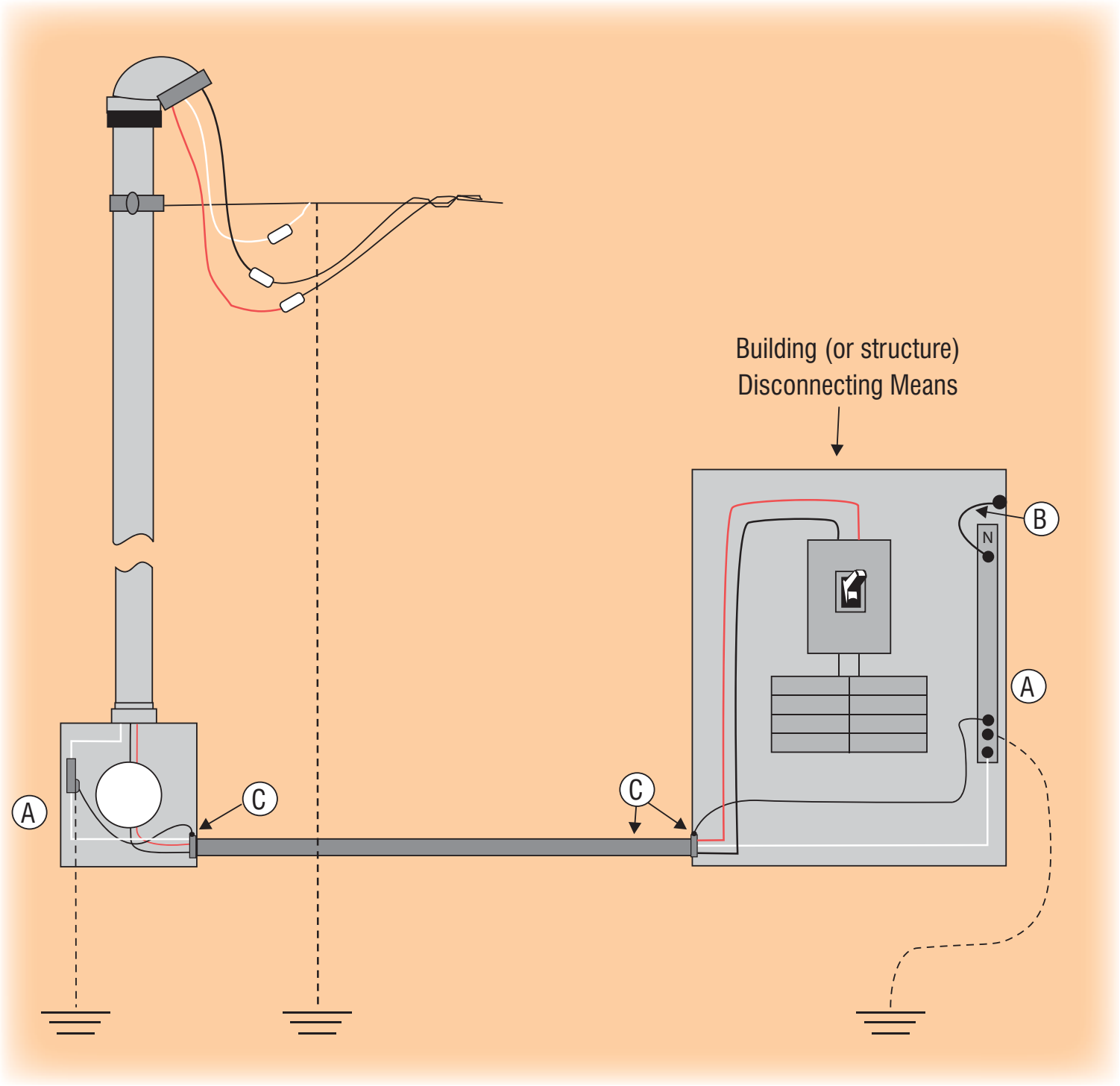
Explanation of Code References found in the Flowchart (based on 120/240 Volt Single Phase)

250.24

This reference is for a 3-wire system — consisting of 2 ungrounded conductors and a grounded conductor (neutral).

- 250.24(A)(1) of the Code allows you different locations to ground the building's electrical system to the earth — from any accessible point from the load end of the service drop or service lateral to and including the terminal or bus to which the grounded service conductor is connected at the building (or structure) disconnecting means. However, your cooperative may have a preferred location — it's best to check with them.
- 250.24(B) of the Code requires that the building (or structure) disconnecting means must have the neutral terminal bar connected to the disconnecting means enclosure. This means of connection is called the "main bonding jumper". This main bonding jumper shall be a wire, bus, a screw or other suitable conductor as allowed per 250.28(A) of the Code. If it is a screw, it must be green-colored as required per 250.28(B) of the Code*. If the building (or structure) disconnecting means main bonding jumper is a wire or busbar — and it is installed from the neutral terminal bar to an equipment grounding terminal bar — the grounding electrode conductor may be attached to the equipment grounding terminal bar as allowed per 250.24(A)(4) of the Code.*
- Any metallic conduit that contains service conductors must be bonded to the meter case and to the building (or structure) disconnecting means as required by 250.92 of the Code.

250.24



(A) A grounding electrode conductor must connect the neutral conductor to a grounding electrode at the:
1. Service drop, or
2. Meter enclosure, or
3. Service disconnect

(B) Main Bonding Jumper

(C) Metal Raceways containing service conductors must be bonded to meter enclosures and to service enclosures

250.32

This reference is for a 4-wire system — consisting of 2 ungrounded conductors, a grounded conductor (neutral) and an equipment grounding conductor. A 4-wire system is always used in the following three situations:

(1) Between the main disconnect on the premises and a building (or structure) disconnecting means

At the main disconnect

- Both the grounded conductor (neutral) and the equipment grounding conductor of the load side 4-wire supply going to the building (or structure) disconnecting means are connected to the neutral terminal bar in the main disconnect. *The equipment grounding conductor may be connected to the equipment grounding terminal bar if the main disconnect has one installed.*

At the building (or structure) disconnecting means

- This disconnecting means must have an equipment grounding terminal bar installed — which by its design — will connect to the metal enclosure.
- A main bonding jumper must not be used to connect the neutral terminal bar to the metal enclosure.
- The neutral terminal bar must not be connected to the equipment grounding terminal bar.
- An grounding electrode conductor connects the equipment grounding terminal bar to the earth through a grounding electrode
- The grounded conductor (neutral) in the 4-wire supply is connected to the neutral terminal bar.
- The equipment grounding conductor in the 4-wire supply is connected to the equipment grounding terminal bar.
- When installing branch circuits in the building (or structure) disconnecting means, connect all neutrals (grounded) conductors to the neutral terminal bar and connect all equipment grounding conductors to the equipment grounding terminal bar.
- Use caution so that grounded conductors (neutrals) and equipment grounding conductors within the branch circuit are not connected together at any device or utilization equipment.
- Make sure that when installing a 240-volt branch circuit, that it is indeed a 240-volt circuit and not a 120/240-volt circuit before you connect the equipment grounding conductor to the equipment grounding terminal bar. *Special color coding requirements: If it is a 240-volt branch circuit, and you are using a 2-conductor cable with ground (e.g., 10-2-G NM), you must recolor the white conductor as an ungrounded conductor as required in 200.7(C)(1). If you are using a 3-conductor cable (e.g., 10-3 NM), you must (1) strip the white conductor bare or (2) color the exposed white insulation green or (3) mark the exposed white insulation with green tape or green adhesive labels as required in 250.119(B)(1), (2) or (3).*

(2) Between a building (or structure) disconnecting means and a subpanel located in the same building

Example — This wiring method is used when the building (or structure) disconnecting means has been filled to capacity but additional circuits are still needed; or when it is more convenient to install a 2nd breaker panel on the 2nd floor of a building for the

branch circuits on the 2nd floor. In these situations usually a second breaker panel called a "subpanel" is installed. The subpanel receives its electricity from the building (or structure) disconnecting means.

At the building (or structure) disconnecting means

- Both the grounded conductor (neutral) and the equipment grounding conductor of the load side 4-wire supply going to the subpanel are connected to the neutral terminal bar in the building (or structure) disconnecting means only **if** the disconnecting means was supplied with a 3-wire system. If the disconnecting means was supplied with a 4-wire system, the grounded conductor (neutral) of the 4-wire system going to the subpanel is connected to the neutral terminal bar. The equipment grounding conductor of the 4-wire system going to the subpanel is connected to the equipment grounding terminal bar.

At the subpanel

- This subpanel must have an equipment grounding terminal bar installed — which by its design — will connect to the metal enclosure.
- A main bonding jumper must not be used to connect the neutral terminal bar to the metal enclosure.
- The neutral terminal bar must not be connected to the equipment grounding terminal bar.
- Connection to a grounding electrode is not allowed in the subpanel.
- The grounded conductor (neutral) in the 4-wire supply is connected to the neutral terminal bar.
- The equipment grounding conductor in the 4-wire supply is connected to the equipment grounding terminal bar.
- When installing branch circuits in the building (or structure) disconnecting means, connect all neutrals (grounded) conductors to the neutral terminal bar and connect all equipment grounding conductors to the equipment grounding terminal bar.
- Use caution so that grounded conductors (neutrals) and equipment grounding conductors within the branch circuit are not connected together at any device or utilization equipment.
- Make sure that when installing a 240-volt branch circuit, that it is indeed a 240-volt circuit and not a 120/240-volt circuit before you connect the equipment grounding conductor to the equipment grounding terminal bar. *Special color coding requirements: If it is a 240-volt branch circuit, and you are using a 2-conductor cable with ground (e.g., 10-2-G NM), you must recolor the white conductor as an ungrounded conductor as required in 200.7(C)(1). If you are using a 3-conductor cable (e.g., 10-3 NM), you must (1) strip the white conductor bare or (2) color the exposed white insulation green or (3) mark the exposed white insulation with green tape or green adhesive labels as required in 250.119(B)(1), (2) or (3).*

(3) Between a building (or structure) disconnecting means and the disconnecting means of a second building (or structure)

Example — This wiring method is used when building #2 receives its electricity from building #1 — such as a detached garage or shed receiving its supply of electricity from the breaker panel in the house.

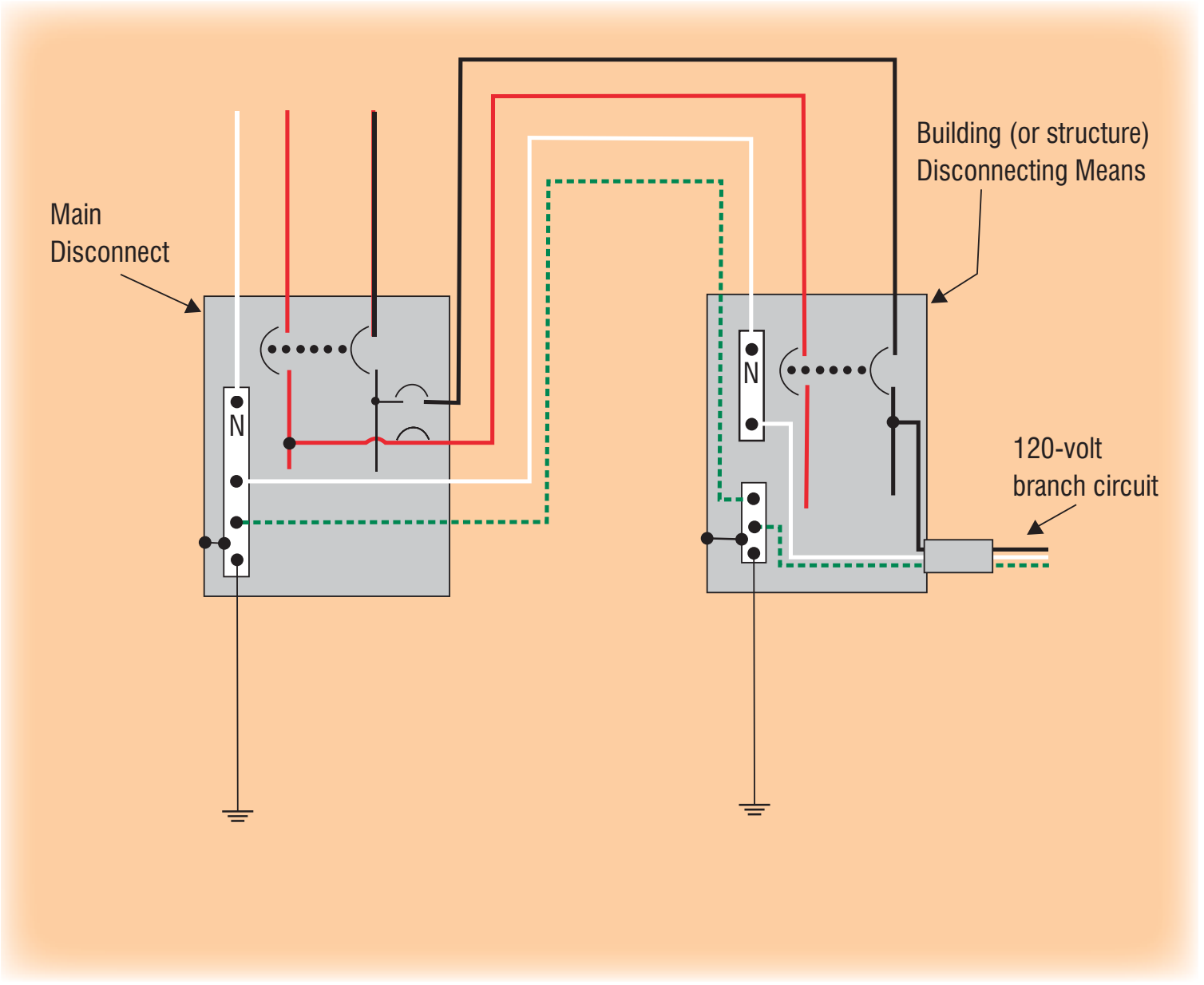
At the building (or structure) disconnecting means

- Both the grounded conductor (neutral) and the equipment grounding conductor of the load side 4-wire supply going to the subpanel are connected to the neutral terminal bar in the building (or structure) disconnecting means only **if** the disconnecting means was supplied with a 3-wire system. If the disconnecting means was supplied with a 4-wire system, the grounded conductor (neutral) of the 4-wire system going to the subpanel is connected to the neutral terminal bar. The equipment grounding conductor of the 4-wire system going to the subpanel must be same size as the largest supply conductor and is connected to the equipment grounding terminal bar.

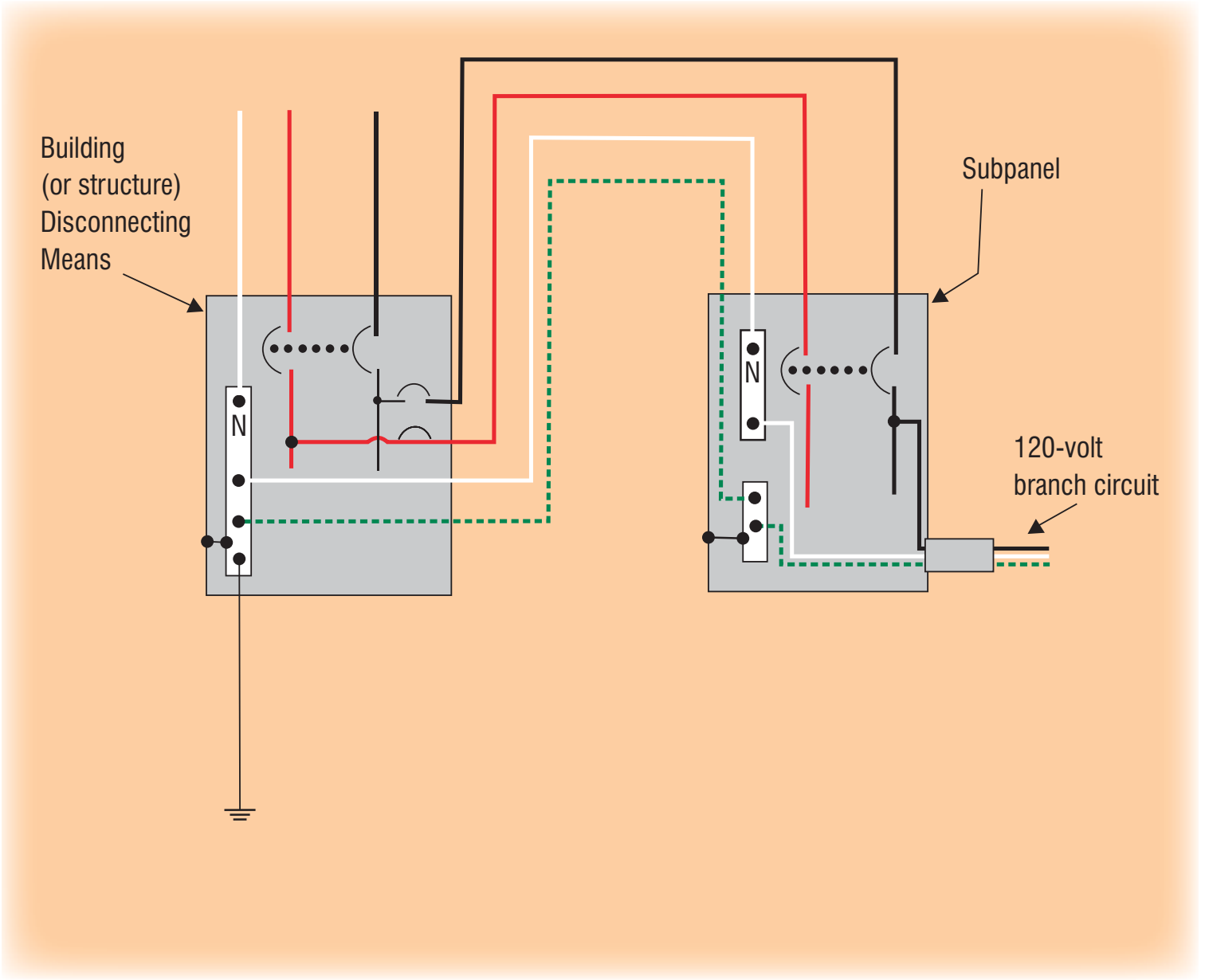
At the second building (or structure) disconnecting means

- This disconnecting means must have an equipment grounding terminal bar installed — which by its design — will connect to the metal enclosure.
- A main bonding jumper must not be used to connect the neutral terminal bar to the metal enclosure.
- The neutral terminal bar must not be connected to the equipment grounding terminal bar.
- An grounding electrode conductor connects the equipment grounding terminal bar to the earth through a grounding electrode
- The grounded conductor (neutral) in the 4-wire supply is connected to the neutral terminal bar.
- The equipment grounding conductor in the 4-wire supply is connected to the equipment grounding terminal bar.
- When installing branch circuits in the building (or structure) disconnecting means, connect all neutrals (grounded) conductors to the neutral terminal bar and connect all equipment grounding conductors to the equipment grounding terminal bar.
- Use caution so that grounded conductors (neutrals) and equipment grounding conductors within the branch circuit are not connected together at any device or utilization equipment.
- Make sure that when installing a 240-volt branch circuit, that it is indeed a 240-volt circuit and not a 120/240-volt circuit before you connect the equipment grounding conductor to the equipment grounding terminal bar. *Special color coding requirements: If it is a 240-volt branch circuit, and you are using a 2-conductor cable with ground (e.g., 10-2-G NM), you must recolor the white conductor as an ungrounded conductor as required in 200.7(C)(1). If you are using a 3-conductor cable (e.g., 10-3 NM), you must (1) strip the white conductor bare or (2) color the exposed white insulation green or (3) mark the exposed white insulation with green tape or green adhesive labels as required in 250.119(B)(1), (2) or (3).*

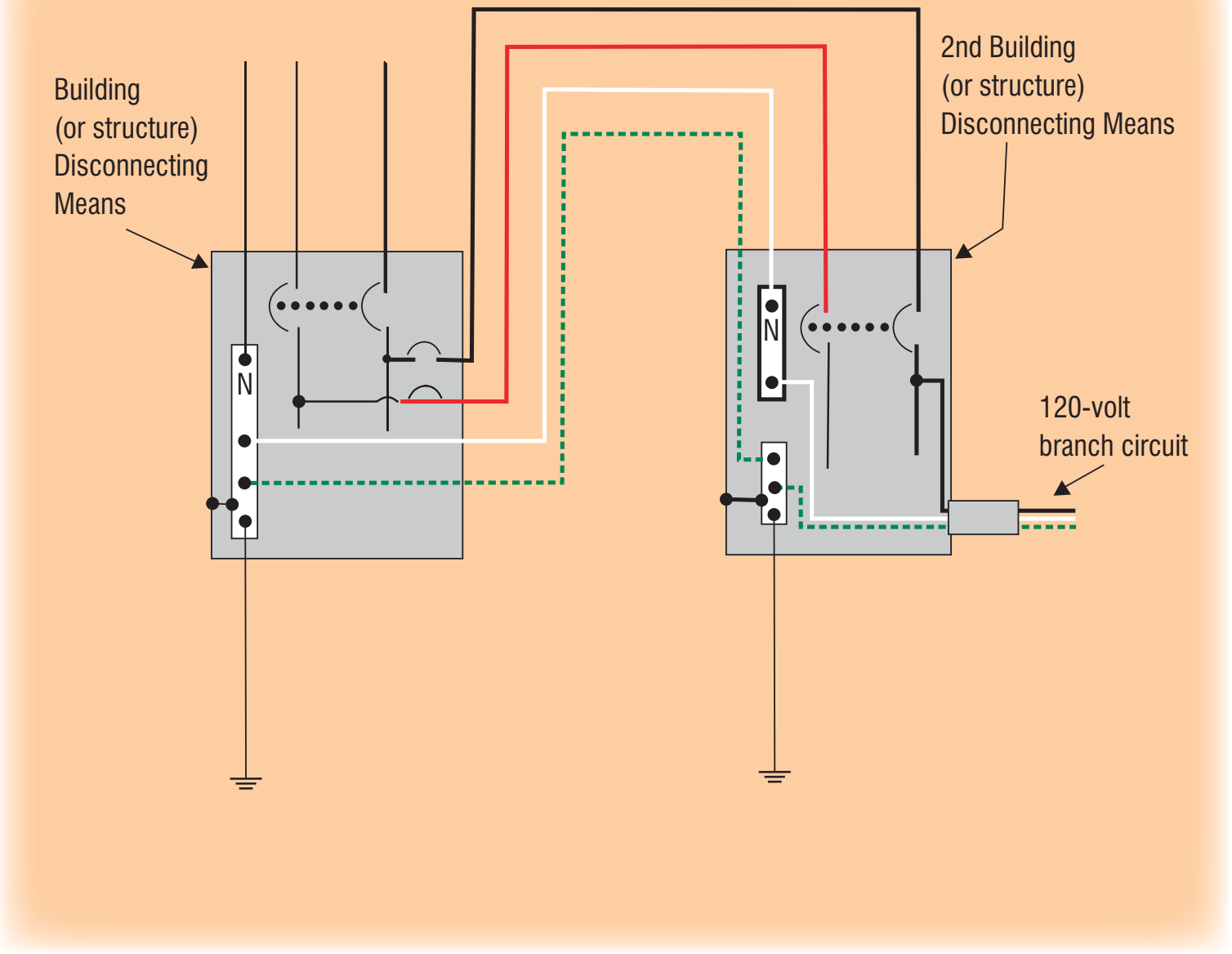
(1) Between the Main Disconnect on the Premises and a Building (or Structure) Disconnecting Means



(2) Between a Building (or Structure) Disconnecting Means and a Subpanel Located in the Same Building



(3) Between a Building (or Structure) Disconnecting Means and the Disconnecting Means of a Second Building (or Structure)



547.9(A) & (B)

These two references are for agricultural buildings (or structures) receiving electricity from a distribution point via an overhead system — when the disconnecting means with overcurrent protection for the overhead electrical supply is located at the building (or structure).

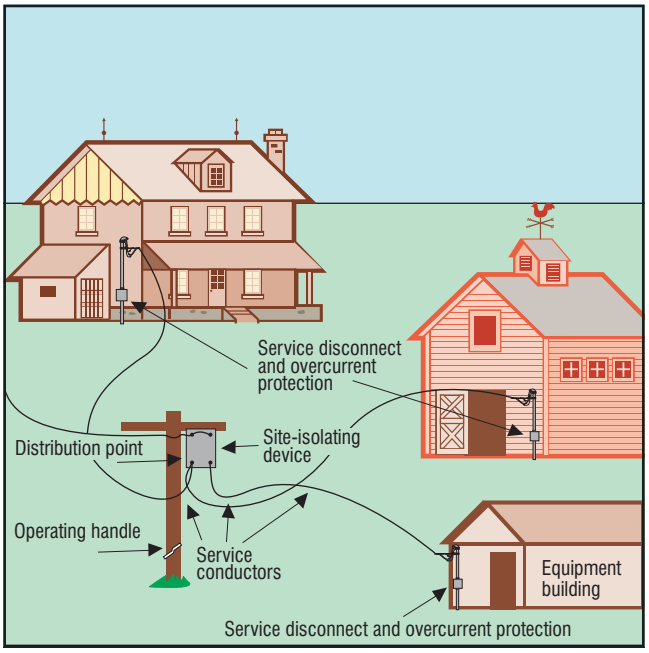
At the distribution point

- If two or more buildings (or structures) are on the premises, a site isolating device is needed to shut off power to the overhead supply for emergencies, maintenance, or connection to an alternate power source during a power outage.
- The site isolating device is not required to have overcurrent protection.
- The site isolating device shall be pole mounted and readily accessible. If not readily accessible, it shall be capable of being remotely operated by an operating handle installed at a readily accessible location. This operating handle — in its highest position — shall not be more than 6ft 7in above grade or working platform.
- The site isolating device shall be permanently marked to identify it as a site-isolating device. This marking shall be located on the operating handle or immediately adjacent thereto.
- At the site isolating device, the grounded conductor (neutral) shall be connected to the earth through a grounding electrode conductor.
- If the serving utility provides a site-isolating device as part of their service requirements, an additional site-isolating device is not required.
- The site-isolating device is not considered as the service disconnecting means.
- A 4-wire overhead system is run from the distribution point to each building (or structure) being served.
- Each grounded conductor (neutral) in the 4-wire supply is connected to the grounded conductor (neutral) in the site-isolating device.
- Each equipment grounding conductor in the 4-wire supply is connected to the grounded conductor (neutral) in the site-isolating device.
- Note: CT type metering is usually installed by the cooperative in this type of application.

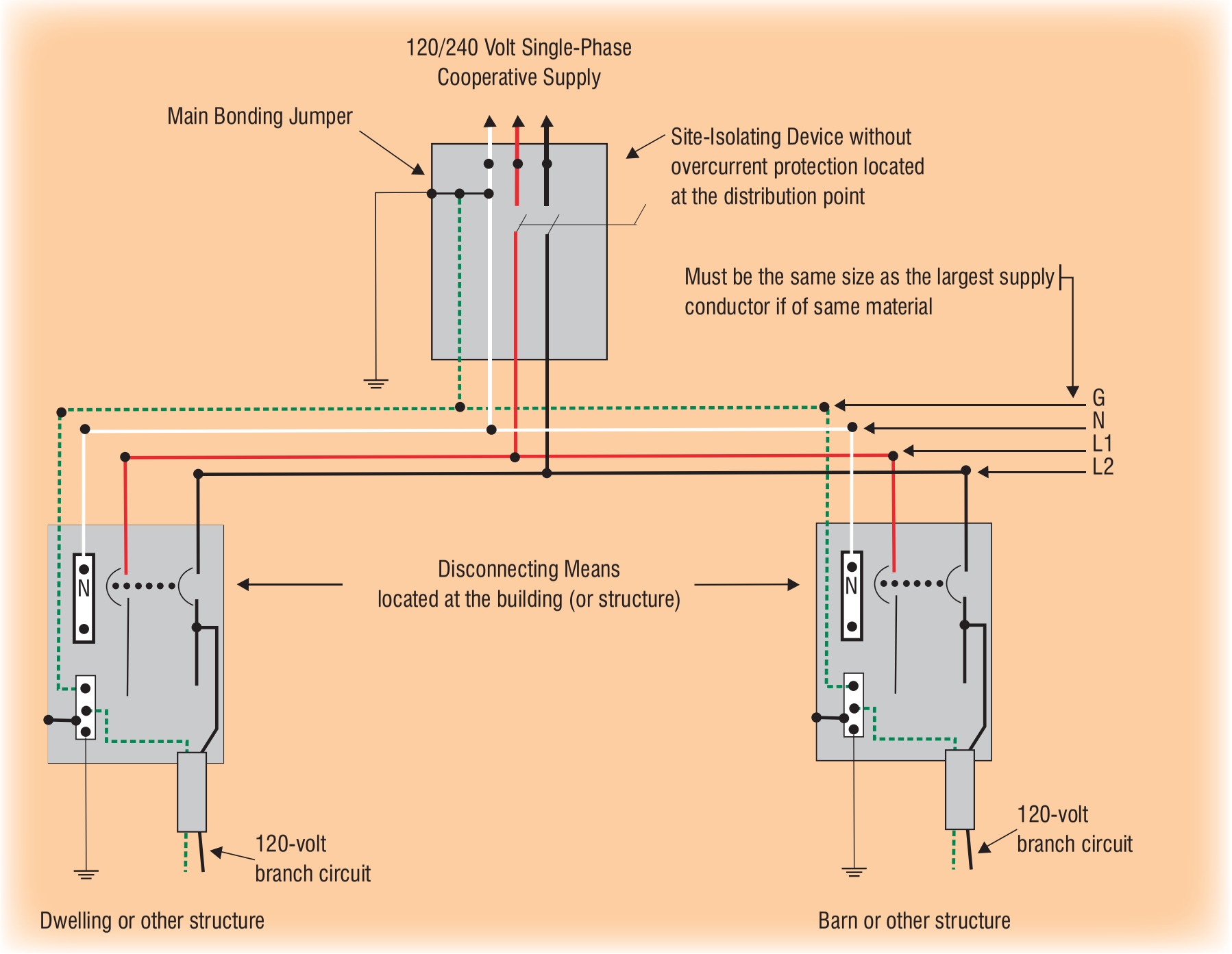
At the building (or structure) disconnecting means

- This disconnecting means must have an equipment grounding terminal bar installed—which by its design—will connect to the metal enclosure.
- A main bonding jumper must not be used to connect the neutral terminal bar to the metal enclosure.
- The neutral terminal bar must not be connected to the equipment grounding terminal bar.
- An grounding electrode conductor connects the equipment grounding terminal bar to the earth through a grounding electrode
- The grounded conductor (neutral) in the 4-wire supply is connected to the neutral terminal bar.
- The equipment grounding conductor in the 4-wire supply is connected to the equipment grounding terminal bar.
- When installing branch circuits in the building (or structure) disconnecting means, connect all neutrals (grounded) conductors to the neutral terminal bar and connect all equipment grounding conductors to the equipment grounding terminal bar.
- Use caution so that grounded conductors (neutrals) and equipment grounding conductors within the branch circuit are not connected together at any device or utilization equipment.

- Make sure that when installing a 240-volt branch circuit, that it is indeed a 240-volt circuit and not a 120/240-volt circuit before you connect the equipment grounding conductor to the equipment grounding terminal bar. *Special color coding requirements: If it is a 240-volt branch circuit, and you are using a 2-conductor cable with ground (e.g., 10-2-G NM), you must recolor the white conductor as an ungrounded conductor as required in 200.7(C)(1). If you are using a 3-conductor cable (e.g., 10-3 NM), you must (1) strip the white conductor bare or (2) color the exposed white insulation green or (3) mark the exposed white insulation with green tape or green adhesive labels as required in 250.119(B)(1), (2) or (3).*



Distribution Point With Site-Isolating Device For Overhead Services



547.9(C)

This references is for agricultural buildings (or structures) receiving electricity from a distribution point via an overhead or an underground system — when the disconnecting means with overcurrent protection for the overhead or underground electrical supply is located at the Distribution Point.

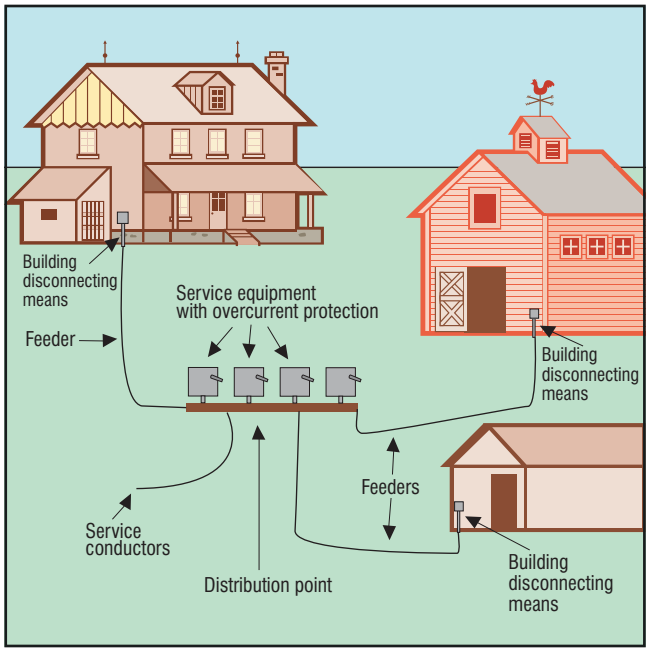
At the distribution point

- A site-isolating device is not needed — since the service equipment (service disconnecting means with overcurrent protection) — located at the distribution point can shut off power to the electricity feeding the buildings (or structures).
- A service disconnecting means with overcurrent protection must be installed for each set of feeders providing electricity to various buildings (or structures). Up to six service disconnecting means can be installed at the distribution point.
- In the service equipment, the grounded conductor (neutral) shall be connected to the earth through a grounding electrode conductor.
- A 4-wire system is run from the distribution point to each building (or structure) being served.
- Each grounded conductor (neutral) in the 4-wire supply is connected to the grounded conductor (neutral) in the service equipment.
- Each equipment grounding conductor in the 4-wire supply is connected to the grounded conductor (neutral) in the service equipment. If the 4-wire supply is installed underground to a building housing livestock, the equipment grounding conductor must be insulated or covered copper.
- Note: CT type metering is usually installed by the cooperative in this type of application.

At the building (or structure) disconnecting means

- This disconnecting means must have an equipment grounding terminal bar installed — which by its design — will connect to the metal enclosure.
- A main bonding jumper must not be used to connect the neutral terminal bar to the metal enclosure.
- The neutral terminal bar must not be connected to the equipment grounding terminal bar.
- An grounding electrode conductor connects the equipment grounding terminal bar to the earth through a grounding electrode
- The grounded conductor (neutral) in the 4-wire supply is connected to the neutral terminal bar.
- The equipment grounding conductor in the 4-wire supply is connected to the equipment grounding terminal bar.
- When installing branch circuits in the building (or structure) disconnecting means, connect all neutrals (grounded) conductors to the neutral terminal bar and connect all equipment grounding conductors to the equipment grounding terminal bar.
- Use caution so that grounded conductors (neutrals) and equipment grounding conductors within the branch circuit are not connected together at any device or utilization equipment.
- Make sure that when installing a 240-volt branch circuit, that it is indeed a 240-volt circuit and not a 120/240-volt circuit before you connect the equipment grounding conductor to the equipment grounding terminal bar. *Special color coding requirements: If it is a 240-volt branch circuit, and you are using a 2-conductor cable with ground (e.g.,*

10-2-G NM), you must recolor the white conductor as an ungrounded conductor as required in 200.7(C)(1). If you are using a 3-conductor cable (e.g., 10-3 NM), you must (1) strip the white conductor bare or (2) color the exposed white insulation green or (3) mark the exposed white insulation with green tape or green adhesive labels as required in 250.119(B)(1), (2) or (3).



Distribution Point With Disconnecting Means For Underground Feeders