

# **Agricultural Wiring Materials and Electric Code Update**

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## **Agricultural Wiring Materials**

A listing of recommended wiring materials for agricultural use was presented in a 1998. publications [8]. The last pages of this paper contain the most recent update.

## **National Electrical Code**

Every three years the National Electrical Code (NEC) is revised. This revision is under the auspices of the National Fire Protection Association (NFPA). NFPA is a recognized standards developing organization. The process for revision is well documented and follows a rigorous schedule to accommodate meeting and printing deadlines as the proposed changes are publicly reviewed. Proposals to change the 2002 NEC for the 2005 Edition of the NEC were submitted by Nov. 1, 2002. The proposals were accepted, rejected or modified at Code Panel meetings in January of 2003. All proposals and panel actions were published in the Report on Proposals (ROP) in July of 2003 [1]. Comments on the proposal actions were submitted by October 31, 2003. The Code making panels met again in December of 2003 to act on the comments that were received. All of the panels' actions on the comments were published in the Report on Comments (ROC) in April of 2004 [2]. Final voting on the changes occurred at the NFPA Annual meeting in May of 2004. At that meeting only acceptance or deletion of the proposed changes were allowed. No new material could be added since there have been no opportunities for public review. The 2005 NEC [5] was published in September of 2004.

There were 20 Code Panels (committees) that reviewed change proposals submitted for their assigned Articles. The Code Panels made recommendations or modifications to those proposals. A correlating committee reviewed all of the Panel actions. The American Society of Agricultural Engineers (ASAE) was represented on Panels 13 and 19. LaVerne Stetson was the principal delegate on Panel 13 and Barry Bauman (Distribution Engineer, Alliant Energy, Beloit, WI) on Panel 19.

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In the past, many localities have exempted rural agricultural facilities from the applications of the NEC. However, the numbers of states, counties, or localities that exempt agriculture is reduced each year as the electrical applications and electrical equipment increase and rural agricultural operations become more like industrial applications. In any case, the NEC is the document that is used to set minimum requirements for electrical installations and resolve disputes on electrical wiring or electrical equipment issues. Many rural agricultural issues fall under Articles processed by Panel 19. This paper will discuss the changes that were processed by Panel 19 and other rural agriculturally related changes.

## NEC Article 547- Agricultural Buildings

Article 547, Agricultural Buildings, was added to the 1978 NEC. Since the 1978 edition, Article 547 has been modified during each revision of the NEC.

In order to put the items in NEC Article 547 Agricultural Buildings in perspective, it is important to know the general structure of the NEC. Chapters 1-4 are the basic rules that apply to all electrical wiring applications. Chapters 5-7 are additional rules, or exceptions, for special occupancies or installations. Article 547, Agricultural Buildings is in Chapter 5. Therefore the items in 547 are exceptions or additional rules. Many sections in Chapters 1-4 cover general agricultural applications but the information in 547 provides specific guidance.

Some examples of sections that apply to agricultural buildings in general are: (1) 110.3(B) requires all equipment to be installed according to the listing or labeling. (2) 110.11 requires that all material should be able to withstand environments where there are deteriorating agents, (3) 300.6 requires protection of equipment from corrosion in damp and corrosive areas, and (4) 250.24 & 250.32, in the 2005 NEC contain rules for grounding and bonding of services. There are many other general rules, such as sizing of conductors, overcurrent protection, grounding of equipment and motor applications in Chapters 1-4.

There were special requirements in Article 547 for grounding of submersible pump motors and metal well casings. However, these requirements were moved to Article 250 so they became requirements for all applications and were deleted from 547.

**1987:** The specific requirements for a copper equipment grounding conductor in all circuits were added in the 1987 NEC. This edition also had the first specific changes to installation of services for 547 installations. The requirements of a “four wire system without overcurrent protection at the distribution point” were added. This was done to permit some new devices being used for stray voltage concerns. The equipotential plane was described as a method for mitigating stray voltages [7].

**1996:** In 1996 the equipotential plane and voltage gradient were required for new installations.

**1999:** In 1999 [3] the requirements for an equipotential plane were modified. Gradient ramps requirements were changed to be more permissive depending upon the neutral-to-earth voltage level. Exceptions where equipotential planes were not required were added for slotted floors and for areas with no metal likely to become energized [6]. A requirement for a main disconnecting means for the entire premises was added in 1999. Additional rules in 547-8 in the 1999 NEC provided for 3-wire or 4-wire services to buildings housing animals. These new service rules brought many questions from the field.

**2002:** The 2002 NEC [4] (1) clarified the wiring methods including the requirement for a main disconnect, (2) clearly stated the methods for providing service to agricultural buildings, (3) reduced the requirement for the use of equipotential planes from all concrete confinement areas to livestock confinement buildings or areas that contain metal equipment accessible to livestock that is likely to become energized, and (4) eliminated

the requirements for voltage gradients at the entrances and exits to equipotential planes.

**2005:** The reference to knob & tube wiring was deleted from 547.5(A). The definition of the site isolating device was moved to 547.2. The wording in 547.9 was revised to change the location and accessibility of the site isolation device and underground wiring was addressed. The following is the text of Article 547.

## **Article 547 Agricultural Buildings, 2005 NEC**

**547.1 Scope.** The provisions of this article shall apply to the following agricultural buildings or that part of a building or adjacent areas of similar or like nature as specified in 547.1(A) and 547.1(B).

**(A) Excessive Dust and Dust with Water.** 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) Corrosive Atmosphere.** Agricultural buildings where a corrosive atmosphere exists. Such buildings include areas where the following conditions exist:

- (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) Similar conditions exist.

### **547.2 Definitions.**

**Distribution Point.** An electrical supply point from which service drops, service laterals, feeders, or branch circuits to agricultural buildings, associated farm dwelling(s), and associated buildings under single management are supplied.

FPN No. 1: Distribution points are also known as the center yard pole, meterpole, or the common distribution point.

FPN No.2: The service point as defined in Article 100 is typically at the distribution point.

**Equipotential Plane.** 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 plane.

**Site-Isolating Device.** A disconnecting means installed at the distribution point for the purposes of isolation, system maintenance, emergency disconnection, or connection of optional standby systems.

**547.3 Other Articles.** For agricultural buildings not having conditions as specified in 547.1, the electrical installations shall be made in accordance with the applicable articles in this *Code*.

**547.4 Surface Temperatures.** Electrical equipment or devices installed in accordance with the provisions of this article shall be installed in a manner such that they will function at full rating without developing surface temperatures in excess of the specified normal safe operating range of the equipment or device.

### **547.5 Wiring Methods .**

**(A) Wiring Systems.** 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. The wiring methods of Article 502,

Part II, shall be permitted for areas described in 547.1(A).

FPN: See 300.7 and 352.44 for installation of raceway systems exposed to widely different temperatures.

**(B) Mounting.** All cables shall be secured within 200 mm (8 in.) of each cabinet, box, or fitting. The 6-mm (V4-in.) airspace required for nonmetallic boxes, fittings, conduit, and cables in 300.6(C) shall not be required in buildings covered by this article.

**(C) Equipment Enclosures, Boxes, Conduit Bodies and Fittings.**

(1) Excessive Dust. 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 and shall have no openings (such as holes for attachment screws) 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 within the enclosure, box, conduit body, or fitting. 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 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.

FPN No. 1: See Table 430.91 for appropriate enclosure type designations.

FPN No.2: Aluminum and magnetic ferrous materials may corrode in agricultural environments.

**(D) Flexible Connections.** Where necessary to employ flexible connections, dusttight flexible connectors, liquidtight flexible 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.

**(E) Physical Protection.** All electrical wiring and equipment subject to physical damage shall be protected.

**(F) Separate Equipment Grounding Conductor.** Noncurrent-carrying metal parts of equipment, raceways, and other enclosures, where required to be grounded, shall be grounded by a copper equipment grounding conductor installed between the equipment and the building disconnecting means. If installed underground, the equipment grounding conductor shall be insulated or covered.

**(G) Receptacles.** All 125-volt, single-phase, 15- and 20ampere general-purpose receptacles installed in the following locations shall have ground-fault circuit-interrupter protection for personnel:

- (1) In areas having an equipotential plane
- (2) Outdoors
- (3) Damp or wet locations
- (4) Dirt confinement areas for livestock

**547.6 Switches, Receptacles, Circuit Breakers, Controllers, and Fuses.** Switches, including push buttons, relays, and similar devices, receptacles, circuit breakers, controllers, and fuses, shall be provided with enclosures as specified in 547.5(C).

**547.7 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.

**547.8 Luminaires (Lighting Fixtures).** Luminaires (lighting fixtures) shall comply with 547.8(A) through 547.8(C).

**(A) Minimize the Entrance of Dust.** Luminaires (lighting fixtures) shall be installed to minimize the

entrance of dust, foreign matter, moisture, and corrosive material.

**(B) Exposed to Physical Damage.** Any luminaire (lighting fixture) that may be exposed to physical damage shall be protected by a suitable guard.

**(q) Exposed to Water.** A luminaire (fixture) that may be exposed to water from condensation: building cleansing water, or solution shall be watertight.

**547.9 Electrical Supply to Building(s) or Structure(s) from a Distribution Point.** Overhead electrical supply shall comply with 547.9(A) and 547.9(B), or with 547.9(C). Underground electrical supply shall comply with 547.9(C) and 547.9(D).

**(A) Site-Isolating Device.** Site-isolating devices shall comply with 547.9(A)(1) through (A)(9).

(1) Where Required. A site-isolating device shall be installed at the distribution point where two or more agricultural buildings, structures, associated farm dwelling(s), or other buildings are supplied from the distribution point.

(2) Location. The site-isolating device shall be pole-mounted and shall meet the clearance requirements of 230.24(A).

(3) Operation. The site-isolating device shall simultaneously disconnect all ungrounded service conductors from the premises wiring.

(4) Bonding Provisions. The site-isolating device enclosure shall be bonded to the grounded circuit conductor and the grounding electrode system.

(5) Grounding. At the site-isolating device, the system grounded conductor shall be connected to a grounding electrode system via a grounding electrode conductor.

(6) Rating. The site-isolating device shall be rated for the calculated load as determined by Part V of Article 220.

(7) Overcurrent Protection. The site-isolating device shall not be required to provide overcurrent protection.

(8) Accessibility. Where the site-isolating device is not readily accessible, it shall be capable of being remotely operated by an operating handle installed at a readily accessible location. The operating handle of the site-isolating device, when in its highest position, shall not be more than 2.0 m (6 ft 7 in.) above grade or a working platform.

(9) Series Devices. An additional site-isolating device for the premises wiring system shall not be required where a site-isolating device meeting all applicable requirements of this section is provided by the serving utility as part of their service requirements.

**(B) Service Disconnecting Means and Overcurrent Protection at the Building(s) or Structure(s).** Where the service disconnecting means and overcurrent protection are located at the building(s) or structure(s), the requirements of 547.9(B)(1) through (B)(3) shall apply.

(1) Conductor Sizing. The supply conductors shall be sized in accordance with Part V of Article 220.

(2) Conductor Installation. The supply conductors shall be installed in accordance with the requirements of Part II of Article 225.

(3) Grounding and Bonding. For each building or structure, the conditions in either (B)(3)(a) or (B)(3)(b) shall be permitted.

(a) System with grounded neutral conductor. The grounded Circuit Conductor shall be connected to the

building disconnecting means and to the grounding electrode system of that building or structure where all the requirements of 250.32(B)(2) are met.

FPN: A system with a grounded neutral conductor is commonly referred to as a "3-wire system" in single-phase applications.

(b) System with separate equipment grounding conductor. A separate equipment-grounding conductor shall be run with the supply conductors to the building(s) or structure(s), and the following conditions shall be met:

FPN: A system with a separate equipment grounding conductor is commonly referred to as a "4-wire system" in single-phase applications.

- (1) The equipment grounding conductor shall be the same size as the largest supply conductor if of the same material, or adjusted in size in accordance with the equivalent size columns of Table 250.122 if of different materials.
- (2) The equipment grounding conductor is bonded to the grounded circuit conductor and the site-isolating device at the distribution point.
- (3) A grounding electrode system is provided in accordance with Part III of Article 250 and connected to the equipment-grounding conductor at the building(s) or structure(s) disconnecting means.
- (4) The grounded circuit conductor is not connected to a grounding electrode or to any equipment-grounding conductor on the load side of the distribution point.

**(C) Service Disconnecting Means and Overcurrent Protection at the Distribution Point.** Where the service disconnecting means and overcurrent protection for each set of feeder conductors are located at the distribution point, feeders to building(s) or structure(s) shall meet the requirements of 250.32 and Article 225, Parts I and II.

FPN: Methods to reduce neutral-to-earth voltages in livestock facilities include supplying buildings or structures with 4-wire single-phase services, sizing 3-wire single-phase service and feeder conductors to limit voltage drop to 2 percent, and connecting loads line-to-line,

**(D) Direct-Buried Equipment Grounding Conductors.** Where livestock is housed, any portion of a direct-buried equipment grounding conductor run to the building or structure shall be insulated or covered copper.

**547.10 Equipotential Planes and Bonding of Equipotential Planes.** The installation and bonding of equipotential planes shall comply with 547.10(A) and 547.10(B). For the purposes of this section, the term *livestock* shall not include poultry.

**(A) Where Required.** Equipotential planes shall be installed in all concrete floor confinement areas in livestock buildings, and in all outdoor confinement areas such as feedlots, containing metallic equipment that may become energized and is accessible to livestock. The equipotential plane shall encompass the area where the livestock stands while accessing metallic equipment that may become energized.

**(B) Bonding.** Equipotential planes shall be bonded to the electrical grounding system. The bonding conductor shall be copper, insulated, covered or bare, and not smaller than 8 AWG. The means of bonding to wire mesh or 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.

FPN No.1: Methods to establish equipotential planes are described in American Society of Agricultural Engineers. (ASAE) EP473-2001, *Equipotential Planes in Animal Confinement Areas*.

FPN No.2: Low grounding electrode system resistances may reduce potential differences in livestock facilities.

## Discussion of NEC 2005 Section 547.9

In the 1999 Code the purpose and requirements of the main disconnecting means required were more clearly defined in 547.9(A) under the heading of “Site-Isolating Device”. This was done to clearly state the functions and requirements and to provide a term that would not be confused with an isolating switch or a disconnecting means. There are switches available that will meet the requirements of the site isolating device. Of course circuit breakers could also be used as site isolation devices as overcurrent **can** be provided. The section also recognized that some power suppliers now provide or require a disconnecting means. *This Site isolating device is illustrated in Fig. 1.*

The changes in the location requirement of site isolation devices in the 2005 NEC 547.9(A)(2) limits this device to a pole mounting as it has to meet the clearance requirements of 230.24(A). It is not clear how to apply this if an underground service is used. In 547.9(a)(8) it appears that the site isolating device can be readily accessible ,but it will not be if it meets the clearance requirements of 230.24(A). This seems to limit the site isolation device to a pole-top disconnect.

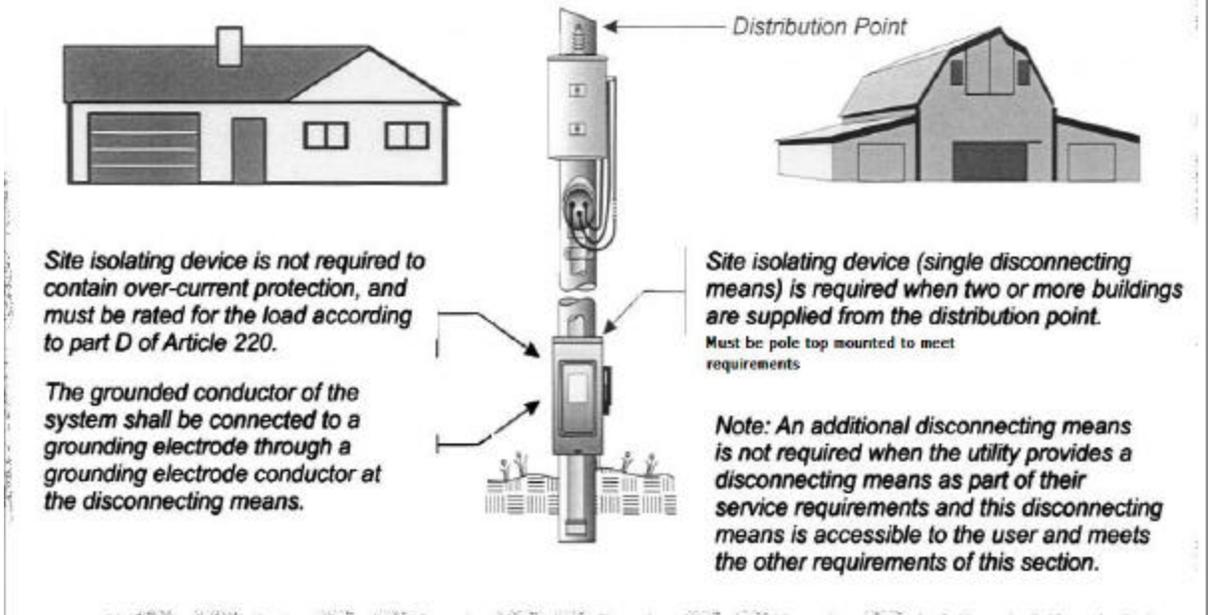
The methods of supplying power to buildings covered under this Article in 547.9(B) describe the requirements and methods permitted for supplying power when the service equipment is at the building. 547.9(B)(1)(a) is the common three-wire service used in most 120-240 volt single-phase installations. This service can be used if there are no metallic paths between the distribution point and the buildings served. A schematic of how this would be used is shown in Fig 2. This also allows three-wire service to an existing dwelling to be maintained and agrees with section 250.24.

547.9(B)(1)(b) is the four-wire service unique to agricultural installations that has been in Article 547 since 1987. It is very difficult to meet all the requirements of this method. This method is shown in Fig. 3. Note that the equipment-grounding conductor must be of the same ampacity as the ungrounded supply conductors and must be copper if run underground.

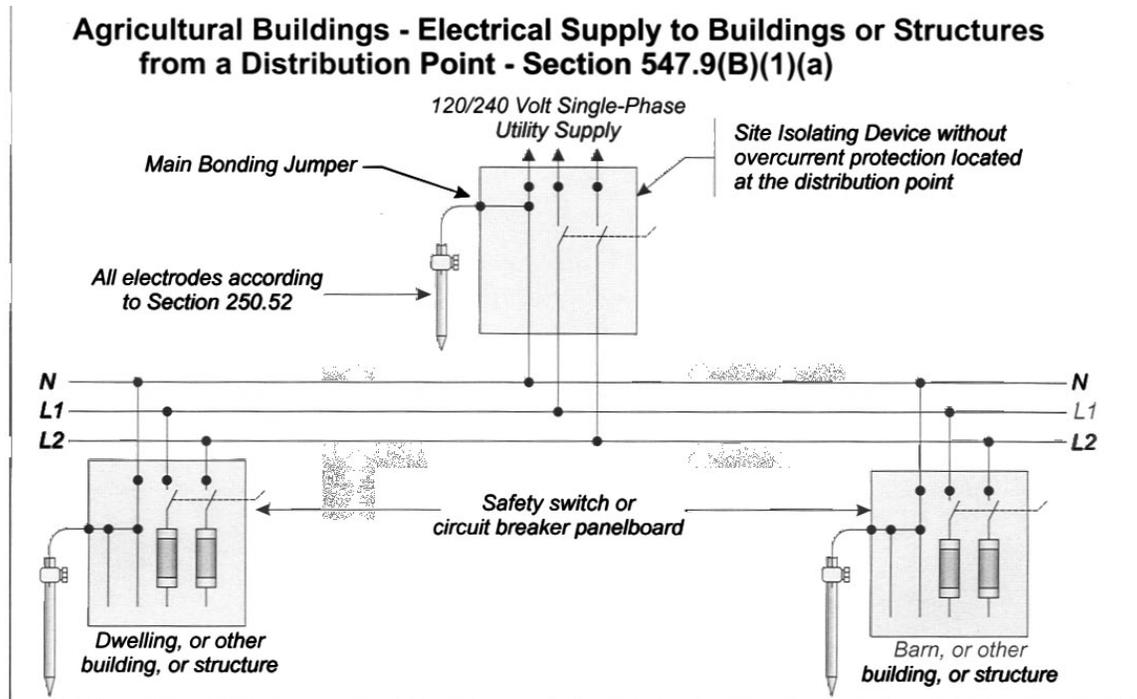
The best method of 4-wire services (in the author’s opinion) is to use the requirements in 547.9(C). This is illustrated in Fig. 4. The overcurrent protection shown in Fig. 4 is supplied in the site-isolating device. This method allows for a reduction in the size of the equipment-grounding conductor and will meet the requirements of NEC section 250.32(B)(1).

The requirements of 547.9 now limit underground services to 4-wire systems with overcurrent protection at the site isolation device. In addition there are no provisions to use he six disconnect at the distribution point for services to multiple buildings. Perhaps these should be reviewed or the next revision of the NEC.

## Agricultural Buildings - Electrical Supply to Buildings or Structures from a Distribution Point - Section 547.9

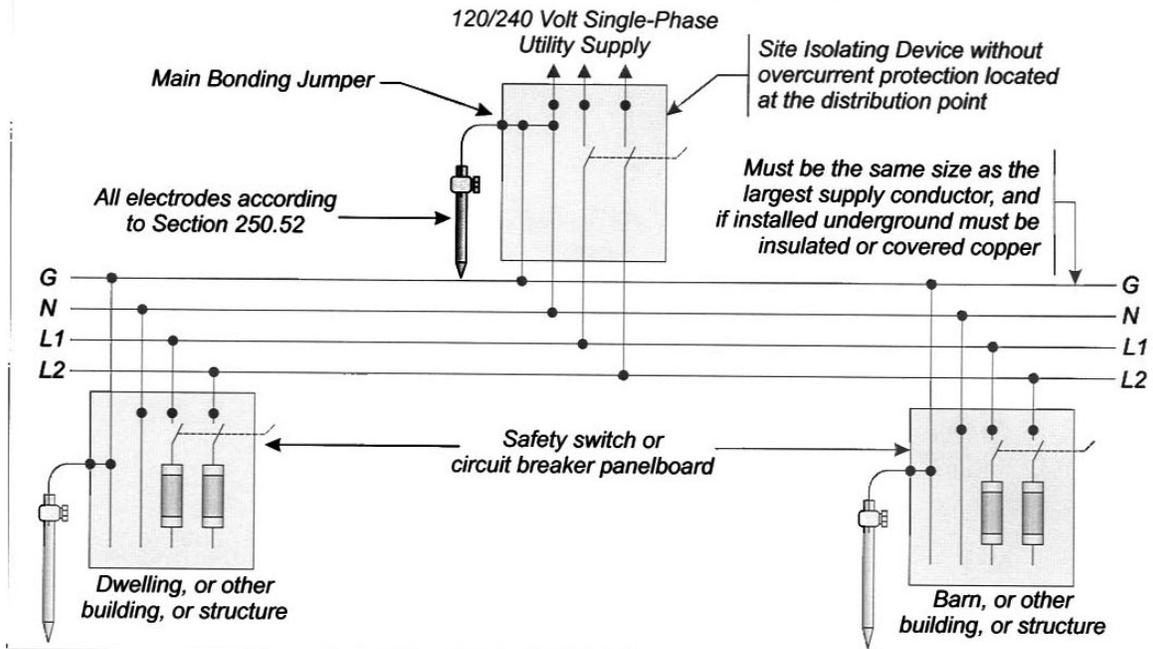


**Fig. 1-- Site –Isolating Device at a Distribution point**



**Fig. 2-- Three-wire service to buildings from Distribution Point**

**Agricultural Buildings - Electrical Supply to Buildings or Structures from a Distribution Point - Section 547.9(B)(1)(b)**



**Fig. 3-- Four-wire service to buildings with no overcurrent protection at Distribution Point**

## Agricultural Buildings - Electrical Supply to Buildings or Structures from a Distribution Point - Section 547.9 (C)

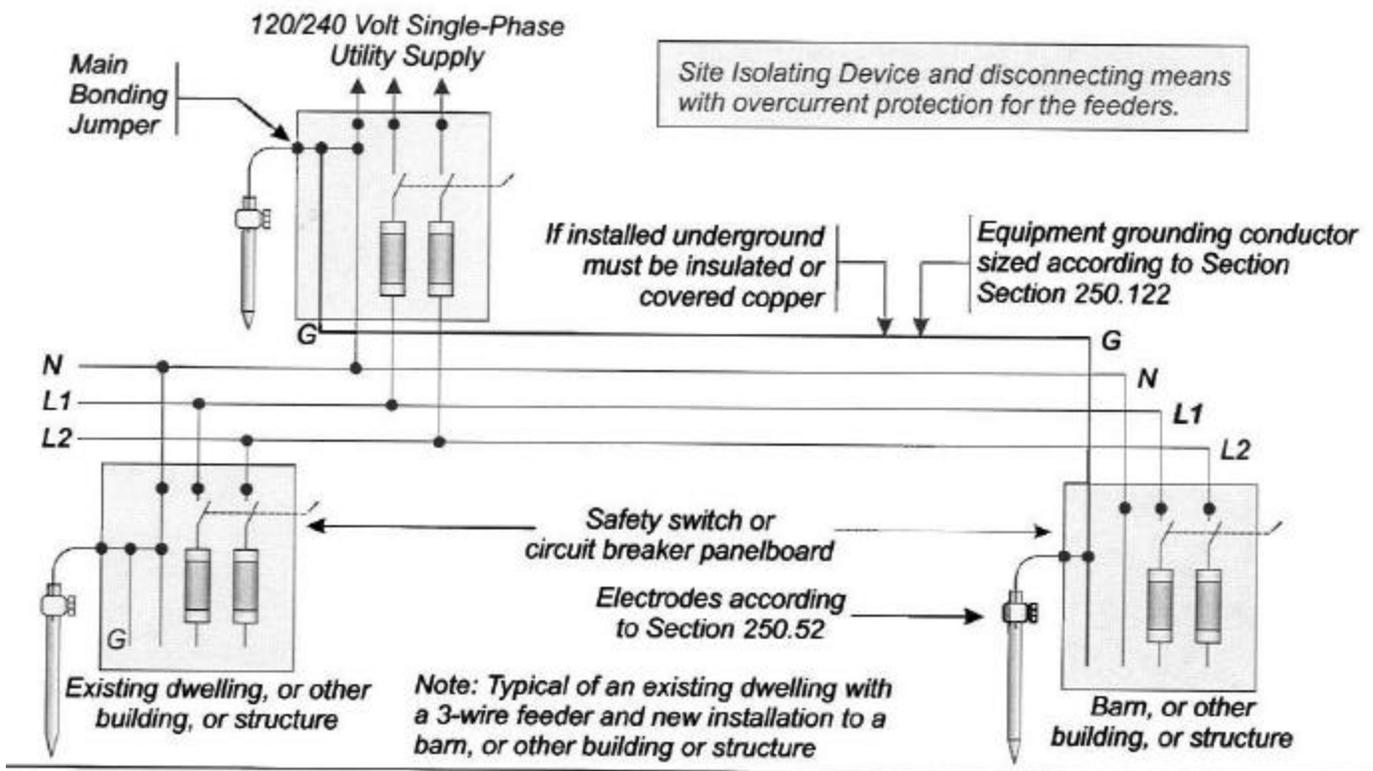


Fig. 4—Four-wire service to buildings with overcurrent protection at Distribution Point

### Other Selected NEC Sections of Note for Agricultural Applications

Section 100 has a new definition of a supplementary overcurrent device. This helps define the overcurrent protection recommended for agricultural ventilation fans.

225.22 Requires that raceways on exteriors of buildings be raintight in wet locations. Be sure you know what a wet location is.

240.21(B) For feeder taps, the overcurrent device can not be rounded up to the next standard rating.

Article 250 has changed to delineate between grounding and bonding. Grounding is connections to earth while bonding is the interconnection of metal parts to provide a low impedance path for fault current.

250.50 was changed to note that all grounding electrodes that are present must be bonded together to provide the grounding electrode system.

230.50(A) specifies that if nonmetallic rigid conduit is used for service conductors it and if the conduit is subject to physical damage, Schedule 80 conduit must be used. In rural agricultural applications physical damage is almost always possible.

Table 300.5 was revised to eliminate notes and exceptions. Review it to ensure you are meeting the minimum cover requirements for buried conductors.

310.4 was changed to note that conductors in parallel are one electrical path but are separate conductors when considering derating factors for conductors in parallel.

In Section 300.7(A), sealing of raceways is required where the raceways are known to be subject to different temperatures. This has always been a recommendation in confined animal housing facilities as different areas or rooms are of different temperatures. The requirement was in previous editions of the NEC but the present wording is clearer.

334.8 now requires derating of NM (also UF cable) when two or more cables are bundled together and pass through wood framing that is to be fire- or draft-stopped.

All references to Design E motors have been removed from Article 430. Design E motors were never produced. Manufacturers upgraded the Design B motors.

430.53(C)(3) eliminated the need for circuit breakers to be marked HACR since inverse time breakers are already evaluated by UL for such a rating.

430 Part X has been added to provide better guidance in installation of variable speed drives.

### **Summary**

Article 547 impacts the installation of services for agricultural applications. The applications of the rules for service to agricultural buildings have been discussed and shown in schematic diagrams. There are more requirements for GFCI receptacles in agricultural applications. Several other changes in the 2002 NEC have been highlighted. Those who use this material need to be familiar with the existing rules in the NEC as well as the new changes.

### **Acknowledgement**

Figures 1-4 were originally developed and copyrighted by Larry T. Smith of National Electrical Seminars, PO Box 45408, Omaha, NE 68145-0408 for use in code classes he conducts. They were used and modified for this paper with his permission.

## References

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## LISTING OF RECOMMENDED ELECTRICAL EQUIPMENT

(Updated February 2005)

Each year there are more wiring materials on the market that will meet the requirements of the corrosive and wet atmospheres in agricultural buildings. The following list of equipment is recommended with some limitations noted. Select equipment from this list or equipment with equivalent ratings. This equipment should make the agricultural building electrically safe and insurable when properly installed and maintained.

**Lampholders-** Not recommended for use in livestock buildings unless gasketed and of a watertight design. (*Note: watertight and waterproof and not synonymous terms*).

**Incandescent--**preferred with plastic globes for washdown when hot. (*Note special high temperature conductor insulation 105-130°C rated wiring required when not listed for 60° or 90° C conductors*)

McGill, 605 (1/2") or 606 (3/4")--rated for 60°C conductors, rated wet locations  
Superior, AO-159-90-- rated for 90°C conductors but not watertight  
Carlson, E962E (3/4") w/tempered glass globe, 60°C conductors, wet locations  
Engineered Products Co., (EPCO) 15005 -rated for 90°C conductors, Polycarbonate globe (800)  
336-1976

**Fluorescent—Tubular--** Prefer industrial quality, corrosion-resistant, with gasketed cover, 0°F starting needed for some applications.

H.E. Williams, Inc. Carthage, MO, (417) 358-4034  
Series 95 fully enclosed, fiberglass, 1- or 2-lamp industrial, 2, 4, or 5 ft with gasketed latched cover  
Hubbell-Killark LZ2N series fixtures  
Nu-Art STAL-2-4', 6' or 8' (aluminum w/ stainless steel latches)  
Rig-a-Lite series IDP (damp locations), FPF (wet locations)  
Retrolite Corp. Warmintser, PA — 888-777-3688  
CVP Models, 2', 4' or 8' models --fiberglass housing with high impact acrylic/DR diffuser (optional brackets for rafter mounting). Starts at 0°F

### **Lampholders—fluorescent**

EPCO, 9, 22, and 28 watt with prismatic globe 15037-38  
McGill, 640-FL22 for damp locations or 645-FL22 for wet locations  
(1/2" conduit), 3/4" conduit are 641FL22 and 646-FI22  
Hubbell, SW/LW/CFL (wet location)

**HID**—High intensity discharge lights. Metal Halide, High Pressure Sodium, or Mercury Vapor, Choose depending upon lighting quality needs. Avoid Mercury Vapor for most applications. Metal Halide retrofit lamps available for existing high pressure sodium lamps

Megalux, High Pressure Sodium @ 50, 70,100, 150 watt. Clear prism adjustable diffuser.

(Bracket for rafter mounting included)

Retrolite, low bay luminaire, lexan lens)

Hubbell, Superbay LM, corrosion resistant stainless steel (wet location)

General Electric, UIM15S1H418ELW -low bay with wet location kit

### **Boxes, Receptacles and Covers**

Switch box--Carlton E981DE, Challenger FSC, Cantex 5133463 .

Switch operator/cover--Carlton E98TSC, Cantex 513330, Cantex 5133335 (plunger) .

Switch cover-- Carlton E98SSC, Cantex 513361 Combination gasket and switch bubble--Pass and Seymour

4515 Corrosive-resistant stainless steel switch cover plate--Pass & Seymour S-725 Grounding switch--

Leviton 5521-2

Receptacle cover--Challenger FSC53 or Carlton E98DRC, Cantex 513352

Weatherproof receptacle cover for protecting plugs left in receptacle. Intermatic, Carlton, T & B Red Dot, Pass & Seymour, Taymac and others now make ra intight when-in-use covers for both standard and GFCI receptacles .

### **Individual Motor Protection**

Fused switch--Bussmann Model SSN (115 Vac)

Circuit breaker--Aerovent (230 Vac, 2-7A)

Carlton 230V switch box/cover--No. V-22FA

Cantex

### **Junction Boxes**

For lampholders--Challenger A04-12 or Carlton E960D

General use—Superior SL4, Carlton E970D, Cantex 5133690

Cover (general use)--Superior AO-51

### **Conduit, Cables and Conductors**

Nonmetallic liquidtight flexible conduit--Carlton Carflex; T&B Xtraflex; Hubbell

Polytuff I, Cantex Enviro-Flex

Type UF cable (rated 90°C for temperatures but 60°C for ampacity)

Type THHN/THWN conductors (90°C rating)

Rigid nonmetallic conduit, schedule 40 or 80

Expansion joints--Carlton E945, Cantex 5144 (15 cm expansion) or short expansion coupling (3

cm expansion), Carlton E955 1/2-in to 2-in size, Cantex 5144 1/2-in to 6-in expansion

Note: Electrical Nonmetallic Tubing (ENT) is not recommended in livestock buildings

because the external corrugations are difficult to sanitize.

### **Adapters, Fittings, Connectors, Etc.**

Thread to conduit--Carlton E943D, Cantex 5140103 (Terminal adapters)

Conduit to thread--Carlton E940D, Cantex 5140043 (female adapters)

UF cable fittings--Hubbell F2 (10/2wg-14/2wg) (specify cable size), Cantex 5133430

Nonmetallic staples with stainless steel nails

Nonmetallic liquidtight flexible conduit fittings--Carlton LT43D, Hubbell, T&B, Arlington Industries

Nonmetallic strain-relief cord fittings--Hubbell F2 (S8) (specify cord size), Cantex

Conduit (3/4") to flexible cord or cable (w/assorted (6) grommets)--Carlton H978E Twist-on waterproof wire connectors--King "One Step" or Ideal - (assorted sizes) Waterproof plug/receptacles for cords:

**Nonmetallic hinged corrosion-resistant entrance enclosures-**

Carlton, Himeline HLA4020,  
Hoffman, A30H2408GQRLP3PT  
RobRoy Industries, Stahlin fiberglass enclosures,

**Flexible Cords and Connectors**

Cords used should have a "wet" rating such as SJW, SJTW, SJTEW, SOW, SEW,  
STW (Note: cords with an E designation are flexible at cold temperatures, are sunlight resistant and suitable for use outdoors)

Plug: Woodhead 14W47 (15A, 125V, 5-15P)

Receptacle: Woodhead 15W47 (15A, 125V, 5-15R)

**Watertight Wraps and Covers**

Direct bury splice kit--3M Scotchlok DBY-6 (not for UV exposure)

Mastic tape--3M Scotch-Sea12229 (UV resistant)

Heat shrinkable tubing, heavy wall--ILSCO No. 21 \*\*\*

Heat shrinkable end caps, heavy wall--ILSCO No. 23\*\*\*

\*\*\*Last three digits designate conductor size

Heat shrinkable wraparound sleeves--Raychem ShrinkWrap CRSM (specify conductor size)

Heat shrinkable end caps--Raychem ShrinkCap ESC (specify conductor size) Heat shrinkable tubing--

Raychem ShrinkTube CSM (specify conductor size)