

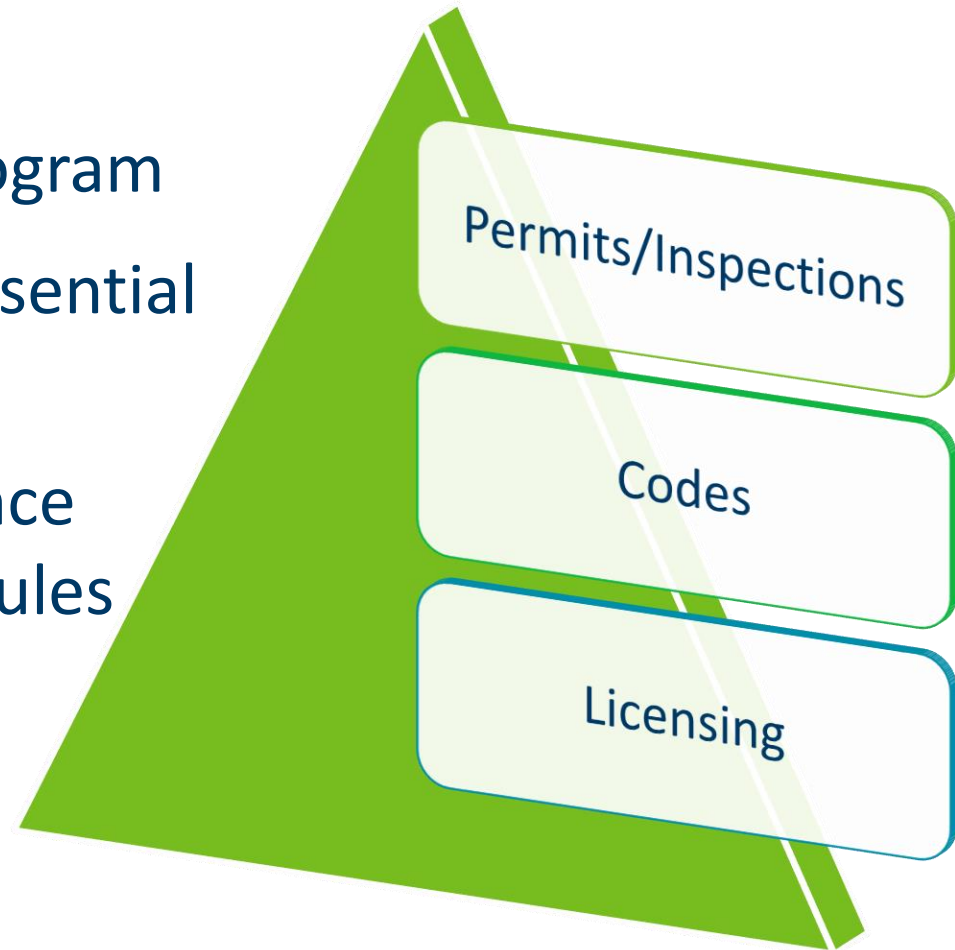


# NEC Article 547 – The History and Purpose

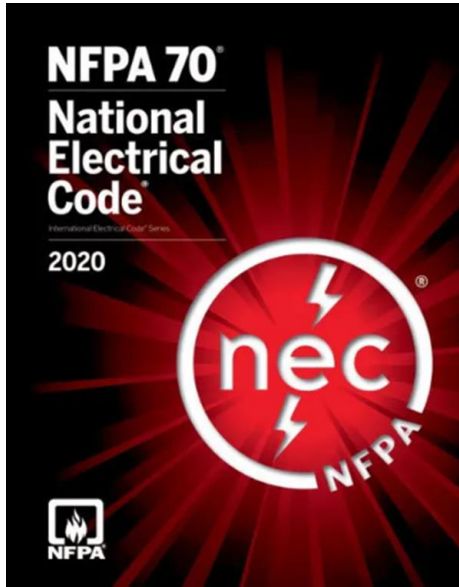
Dean Hunter | Chief Electrical Inspector

# How does Minnesota assure electrical work is safe?

- Licensing is the foundation of the program
- Codes and standards establish the essential uniform rules
- Permits/Inspections ensure compliance with all codes, standards, laws, and rules



# Electrical Safety for People and Property



- The practical safeguarding of persons and property from hazards arising from the use of electricity.
- Not intended as a design specification or an instruction manual for untrained persons.

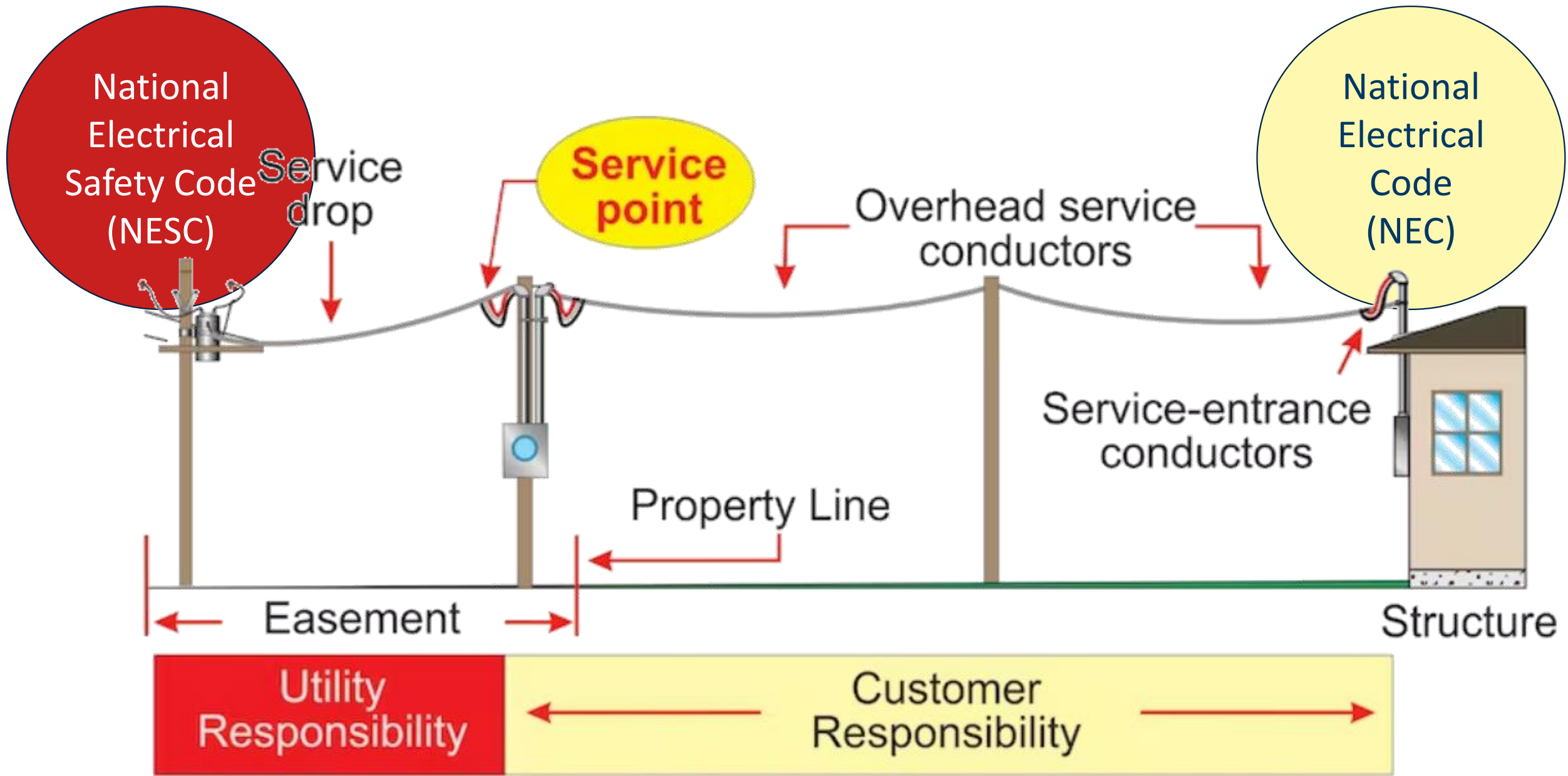


## MINNESOTA STRAY VOLTAGE GUIDE

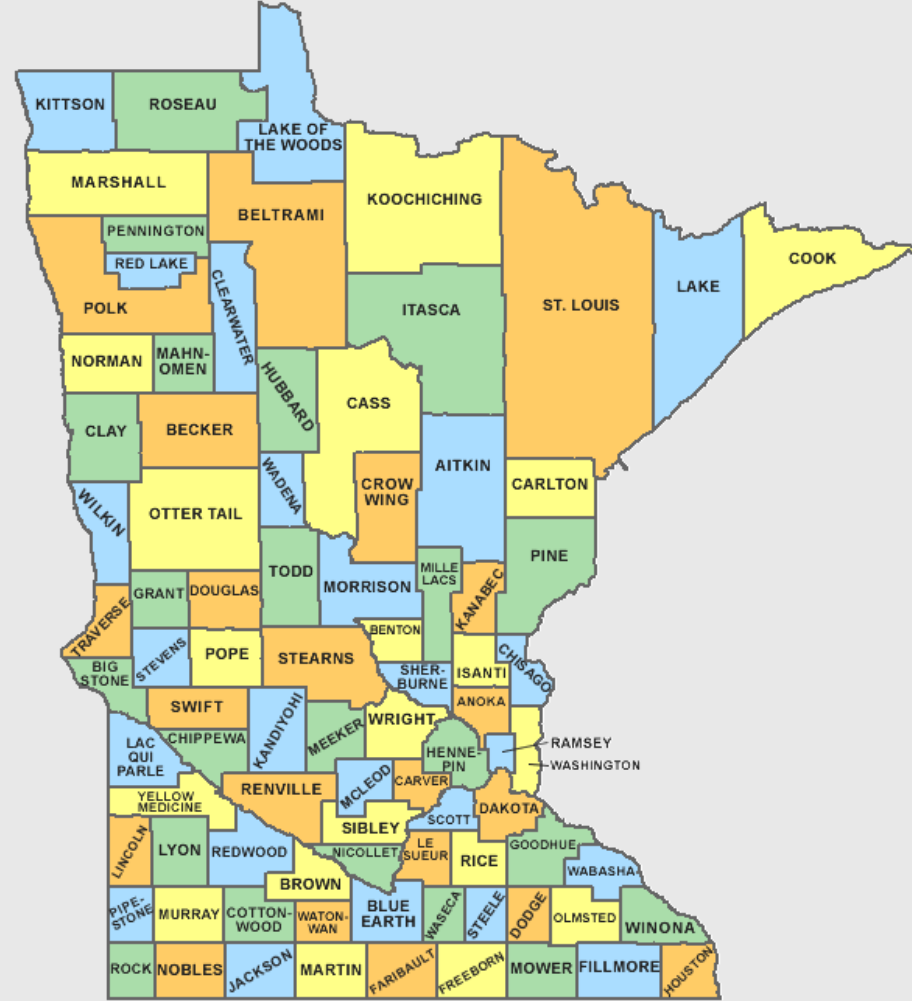
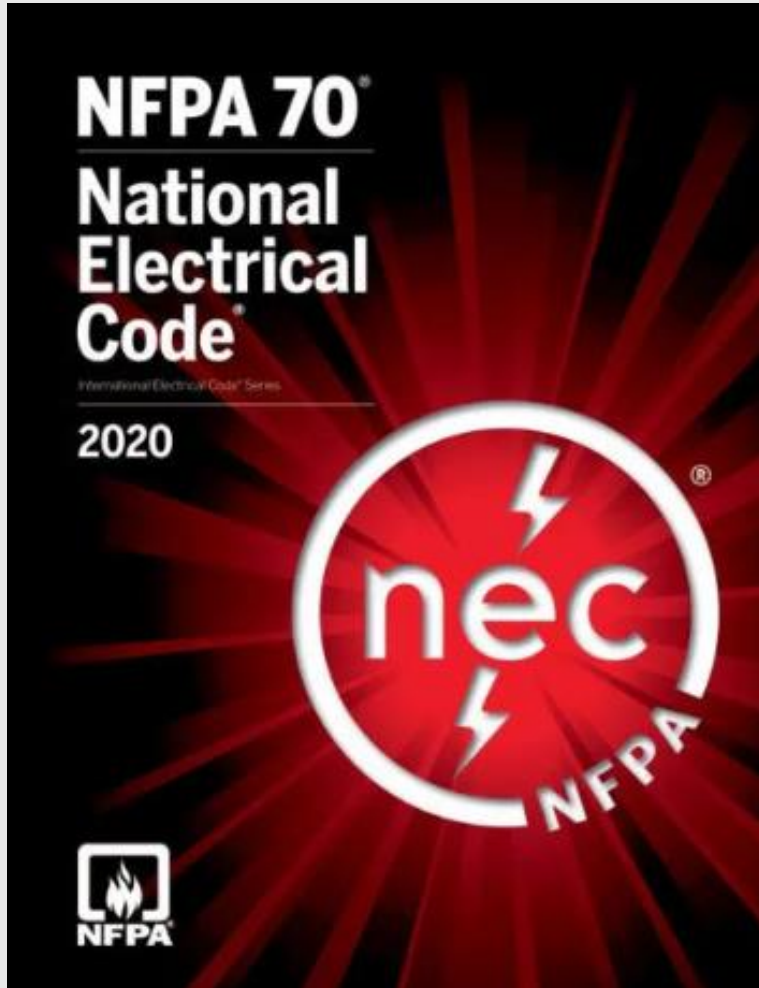
A Guide Addressing Stray Voltage Concerns

### **23. Where is the demarcation between the electric utility system and the premises electrical system?**

The NESC<sup>®</sup> and the NEC<sup>®</sup> share a common definition for “service point”, which is defined as the point of connection between the facilities of the serving utility and the premises wiring. The location of the service point is typically determined by the electric utility. The service point location can vary greatly depending on several different configurations and characteristics of the electrical installation.



# A little history of the NEC and our state

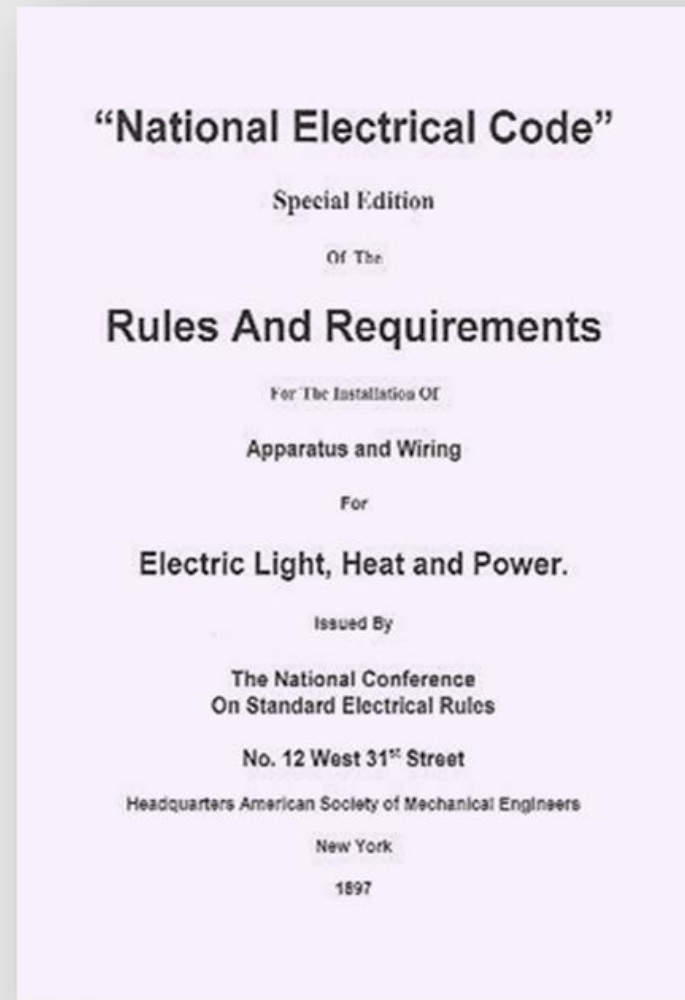


# The Beginning of the NEC

The first National Electrical Code was published in 1897

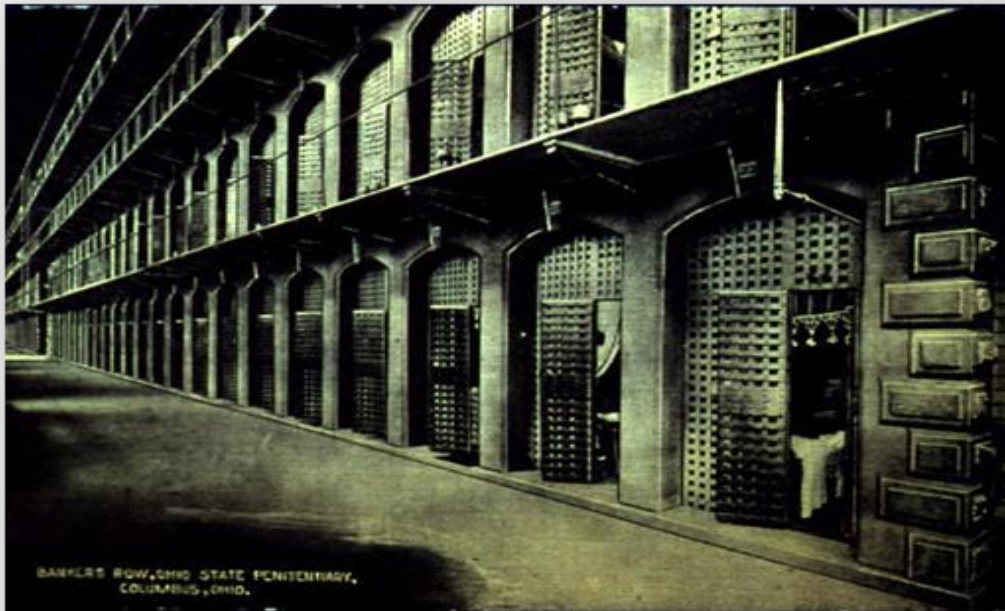
At their 1894 meeting, the **National Board of Fire Underwriters** accepted full sponsorship and undertook the printing of the “Rules and Requirements of the National Board of Fire Underwriters”

March 24, 1911, the Underwriters’ National Electric Association relinquished control over the Electrical Committee to the **National Fire Protection Association.**



# 1897- City of Saint Paul

- **Ordinance No. 1917** *No alteration or change in the wiring of any building...Any person who shall willfully violate any of the provisions of this ordinance shall be deemed guilty of a misdemeanor and upon conviction shall be fined not less than five dollars nor more than twenty-five dollars, or shall be imprisoned for not less than ten days nor more than thirty days.*



Passed by the Assembly February 11, 1897

# 1899- Required Registration

In cities and counties with a population of 125,000 or more....

“All persons engaged in the business of installing or repairing wires and devices inside or outside of any building for the transmission of electricity”



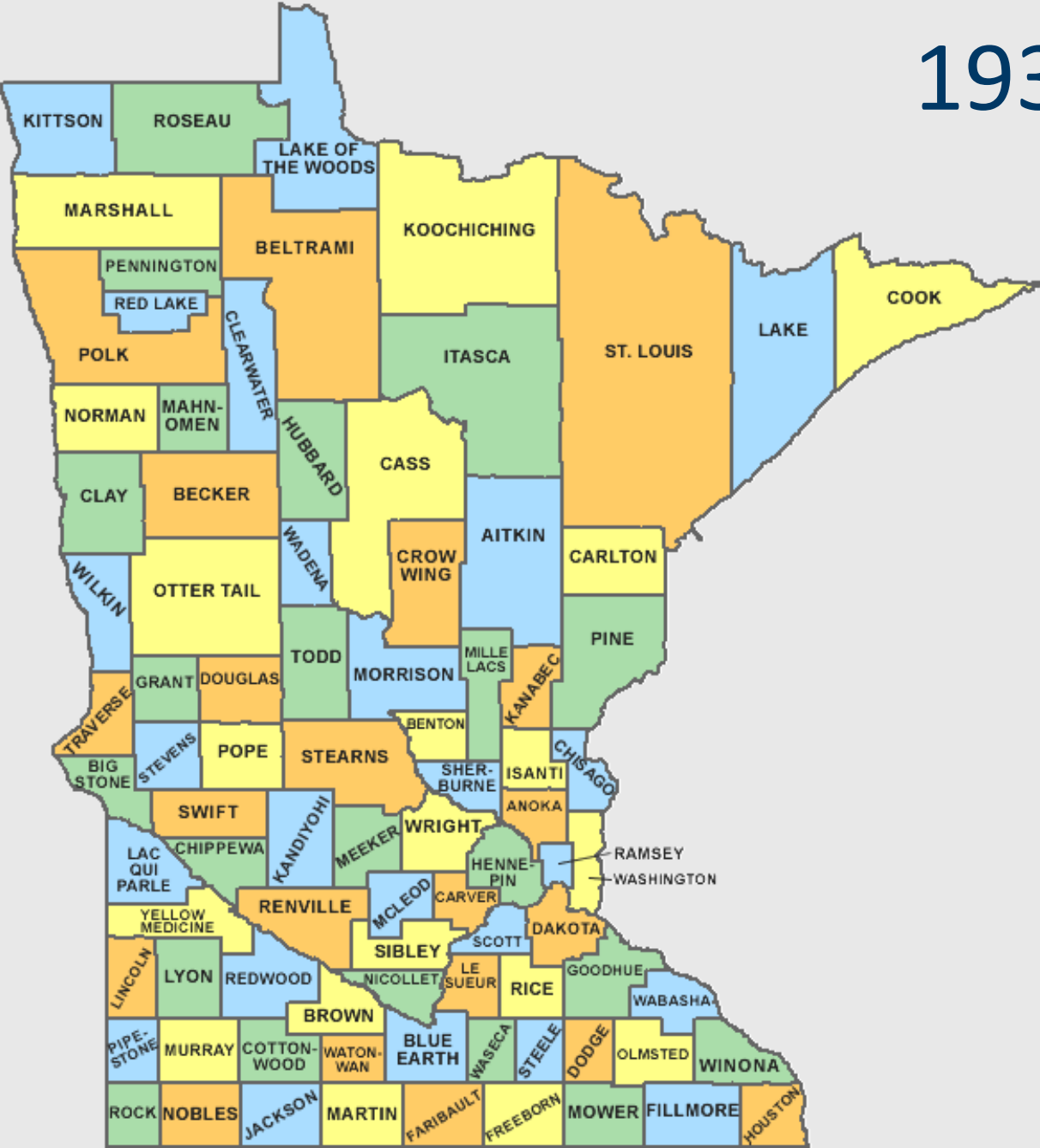
# Board of Electricity - In The Beginning

- 1899- Signed by Governor John Lind on July 8, 1899
- 1899- No fees were associated with registration or licensing
- 1907- Licenses became renewable
- No meeting place and no staff until 1928, when “part-time” staff and space was made available
- As of 1932, no licenses had been issued for Duluth



# 1937 - Mandatory Licensing

Governor Elmer Benson made electrical licensing mandatory statewide



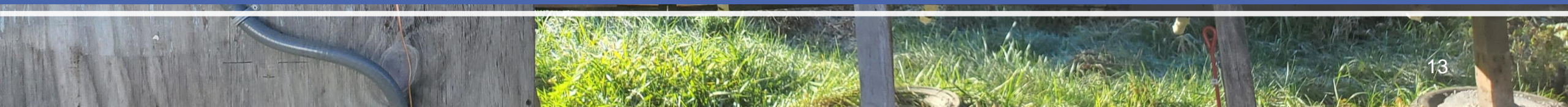
# 1951 Legislative Change

- 1951- State inspections became mandatory... “every new electrical installation in any construction, remodeling, replacement, or repair shall be inspected by the board (commissioner) for compliance with accepted standards of construction for safety to life and property.”





# Why do we inspect??







# 2005 Consolidation – Department of Labor and Industry

- Gov. Tim Pawlenty signed an executive order on April 4, 2005, which transferred a number of construction-code-related organizations to the Department of Labor and Industry.

The screenshot shows the homepage of the Minnesota Department of Labor and Industry. At the top, there is a navigation bar with the department's logo, the text "DEPARTMENT OF LABOR AND INDUSTRY", and links for "DIRECTIONS" and "CONTACT US". Below this is a main navigation menu with "ABOUT THE DEPARTMENT", "FOR BUSINESS", and "FOR WORKERS". The main content area features a large banner image of a construction site with a white hard hat in the foreground. Below the banner is a row of four service tiles: "MAKE A PAYMENT", "APPLY FOR OR RENEW A LICENSE", "GET A PERMIT", and "CHECK A LICENSE OR REGISTRATION". Each tile has a corresponding image and a right-pointing arrow. Below these are two larger content blocks: "MINNESOTA STATE BUILDING CODES" with an image of a house under construction and a link to view more information, and "WORKER RIGHTS AND PROTECTIONS" with an image of workers and a link to view information about paychecks, minimum wage, breaks, overtime, workplace safety, and more.

**m** DEPARTMENT OF LABOR AND INDUSTRY

DIRECTIONS CONTACT US

ABOUT THE DEPARTMENT FOR BUSINESS FOR WORKERS

MAKE A PAYMENT | APPLY FOR OR RENEW A LICENSE | GET A PERMIT | CHECK A LICENSE OR REGISTRATION

FOR BUSINESSES ▶

FOR WORKERS AND THE PUBLIC ▶

SAFETY AND HEALTH AT WORK ▶

WORKERS' COMPENSATION ▶

**MINNESOTA STATE BUILDING CODES**

The 2020 Minnesota State Building Code is in effect. [View more information.](#)

**WORKER RIGHTS AND PROTECTIONS**

[Information about paychecks, minimum wage, breaks, overtime, workplace safety and more.](#)

# What is the role of the Minnesota Department of Labor and Industry- Electrical Division

## Electrical Licensing:

- 2,700+ Electrical Contractors
- 1,000+ Technology System Contractors
- 6,000+ Master electrician licenses
- 10,000+ Journeyworker Licenses
- 5,000+ Power Limited Technician Licenses
- 15,000+ Registered Unlicensed Individuals

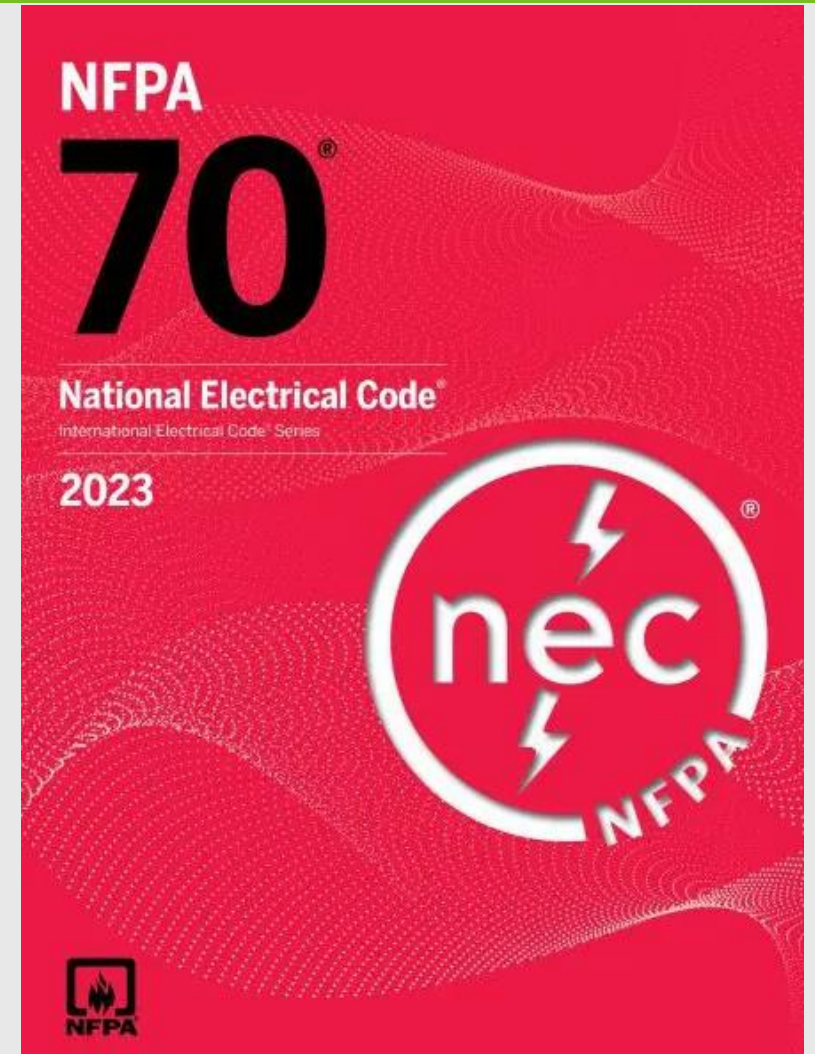
## Electrical Inspections:

- 2022 - 138,320 permits were filed
- 2022 - 183,493 electrical inspections completed

# 2023 NEC Code Adoption – Board of Electricity

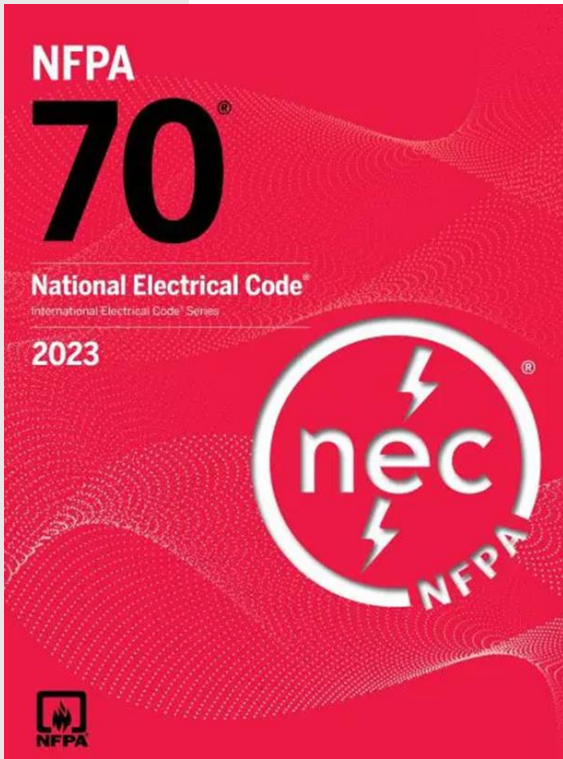
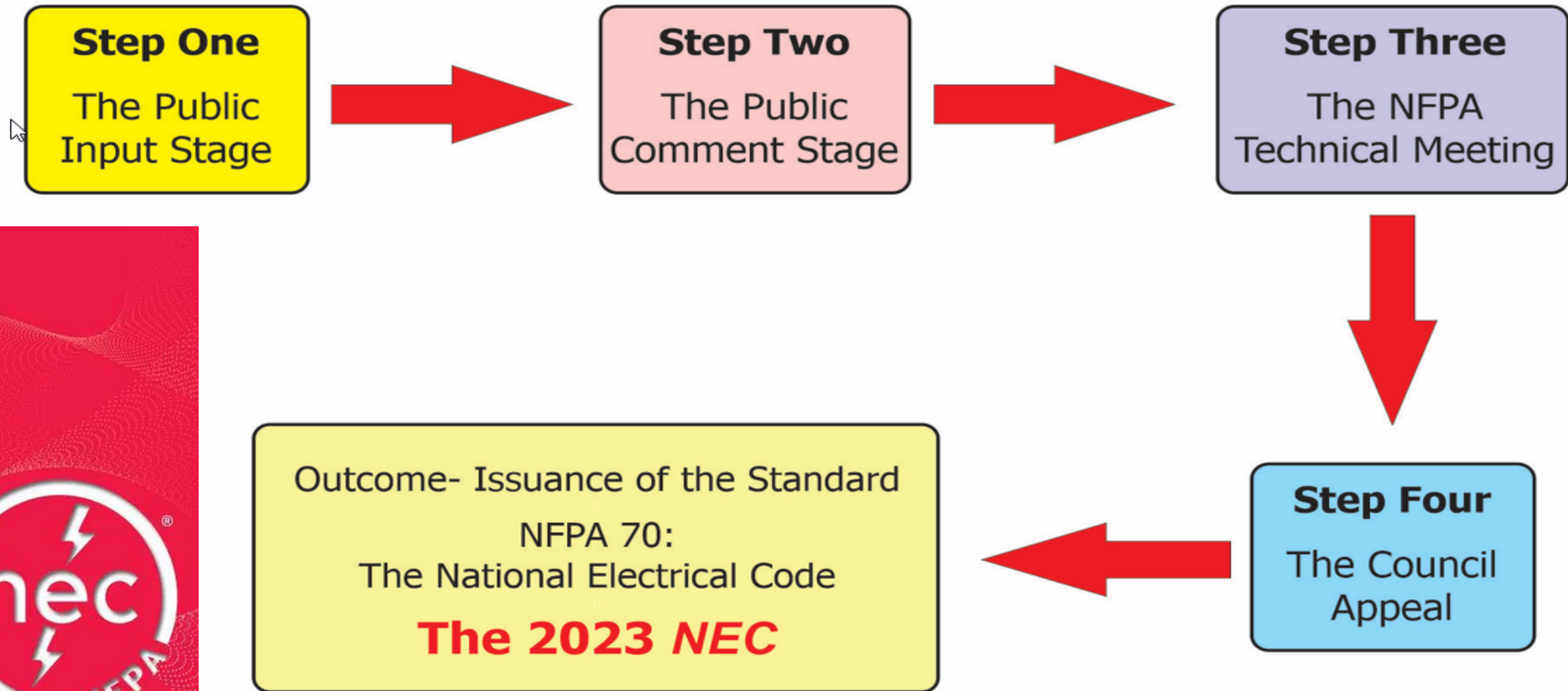
## Board Members:

- (1) one member shall be an electrical inspector;
- (2) two members shall be representatives of the electrical suppliers in rural areas;
- (3) two members shall be master electricians, who shall be contractors;
- (4) two members shall be journeyworker electricians;
- (5) one member shall be a registered consulting electrical engineer;
- (6) two members shall be power limited technicians, who shall be technology system contractors primarily engaged in the business of installing technology circuits or systems; and
- (7) one member shall be a public member as defined by section 214.02.



# Model Code Development Process

The process of updating the National Electrical Code from one cycle to the next



# The Development of the 2023 NEC

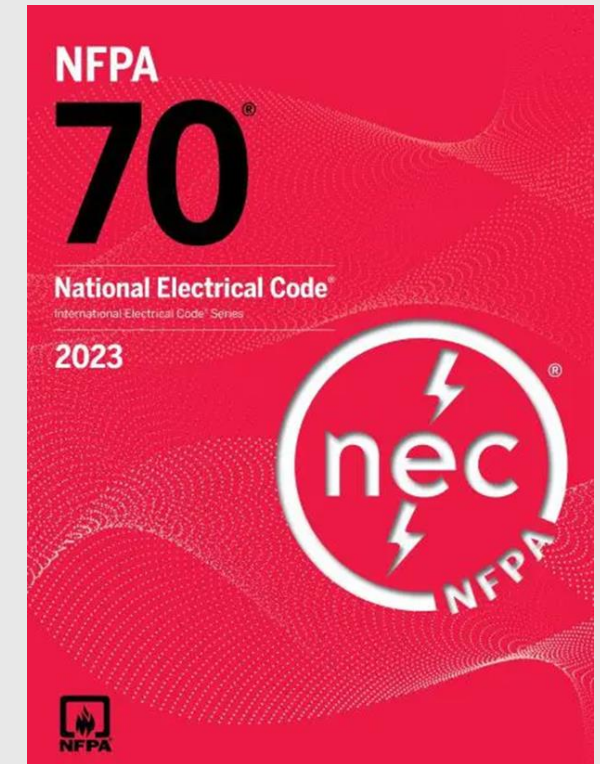
## Interesting information about this revised document

⚠️ There following were submitted to NFPA for this edition of the *Code*:

🔗 [4006 Public Inputs](#)

🔗 [1805 First Revisions](#)

🔗 [1956 Public Comments](#)

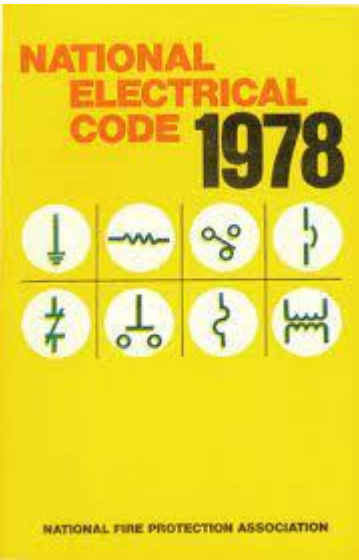




**mn** DEPARTMENT OF  
LABOR AND INDUSTRY



## History of NEC Article 547 (Ag Requirements)



Since the 1978 edition of the NEC, Article 547 has morphed and changed to try to keep pace with ever changing technology.

Because agricultural buildings are considered a chapter 5 “special occupancy”, it is always important to note that the “general wiring methods” found in chapters 1-4 of the NEC apply unless modified or supplemented in Article 547 (NEC 90.3).



The 1978 NEC covered:

Wiring Methods

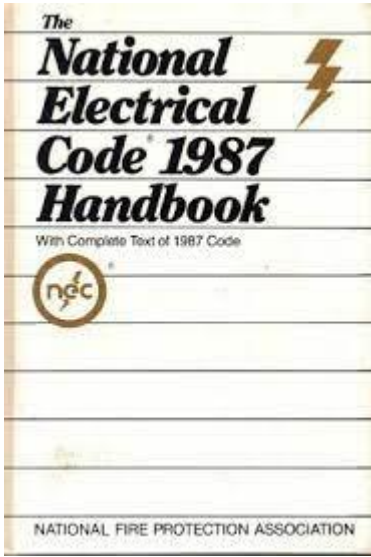
Boxes, Fitting, and Wiring  
Devices

Flexible Connections

Switches, Circuit Breakers, Motor  
Controller, and Fuses

Motors

Lighting Fixtures



For the 1987 NEC, the Correlating Committee created an Ad Hoc subcommittee to address “Electrical Grounding of Agricultural Buildings”. The committee introduced many grounding requirements that still exist today.

- The changes included copper Equipment Grounding Conductors (EGCs) for all circuits.
- The introduction of the term “Equipotential Plane” (EP) was included to define the area used to reduce the potential effects of stray voltage and mandated that the conductive elements be connected to the grounding system.
- In addition, underground installations required EGCs to be insulated or covered copper.
- There was also a 4-wire system requirement added for when an overcurrent device was not provided at the distribution point

# CMP-19 1987 NEC Action

Log # 1363

19- 16 - (547-7(b)-(New)): Accept in Principle

Secretary's Note: It was the action of the Correlating Committee that this proposal be referred to CMP 5 for information.

SUBMITTER: Ad Hoc Subcommittee on Electrical Grounding of Agricultural Buildings, NEC Correlating Committee

RECOMMENDATION: Add new section to read:

"Concrete Imbedded Elements. Wire mesh or other conductive elements where provided in the concrete floor of animal confinement areas to provide an equipotential plane, shall be bonded to the building grounding electrode system. The bonding conductor shall be copper, insulated, covered or bare, not smaller than No. 8. 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.

An equipotential plane is an area where a wire mesh or other conductive elements are imbedded in concrete, bonded to all adjacent conductive equipment, structures, or surfaces and connected to the electrical grounding system to prevent a difference in voltage from developing within the plane."

SUBSTANTIATION: Livestock frequently come in contact with electrically powered equipment or metal structural components upon which equipment is mounted that is bonded to the grounding system of the building or structure electrical supply system. If a neutral-to-earth voltage is present on the premises due to primary or secondary neutral voltage drop or ground faults, the livestock due to their physical structure will make contact directly across the neutral-to-earth voltage from the point of contact with the equipment or structure to the earth or other ungrounded metal structure connected to the earth.

If a wire mesh or other conductive grid is imbedded in a concrete floor or platform, and if this grid is bonded to the electrical system grounding bus, livestock making contact between the concrete floor or

PANEL ACTION: Accept in Principle.

Change "Imbedded" to "Embedded" in title and definition.

Include proposed second paragraph as a definition titled:

"Equipotential Plane: An equipotential plane is an area where a wire mesh or other conductive elements are embedded in concrete, bonded to all adjacent conductive equipment, structures, or surfaces and connected to the electrical grounding system to prevent a difference in voltage from developing within the plane."

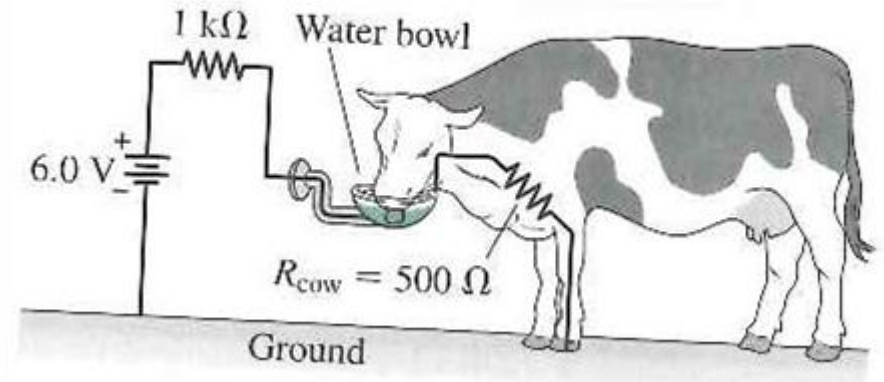
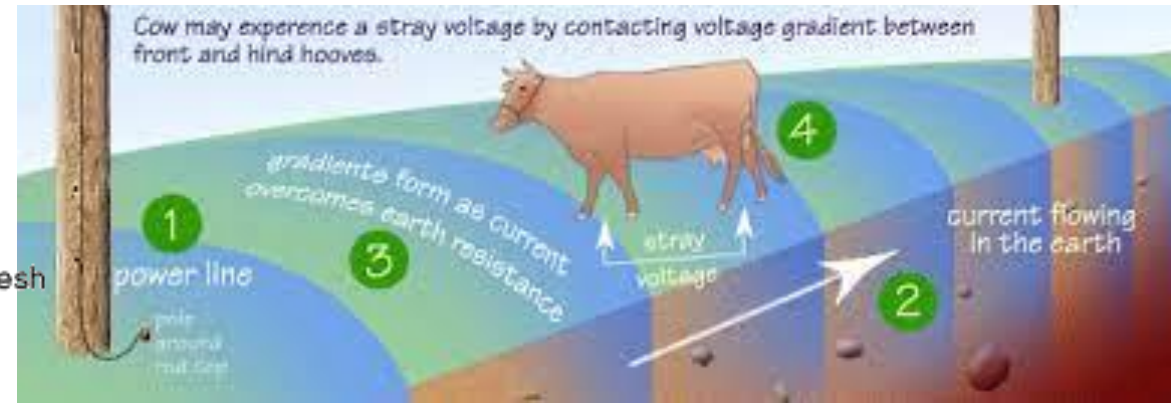
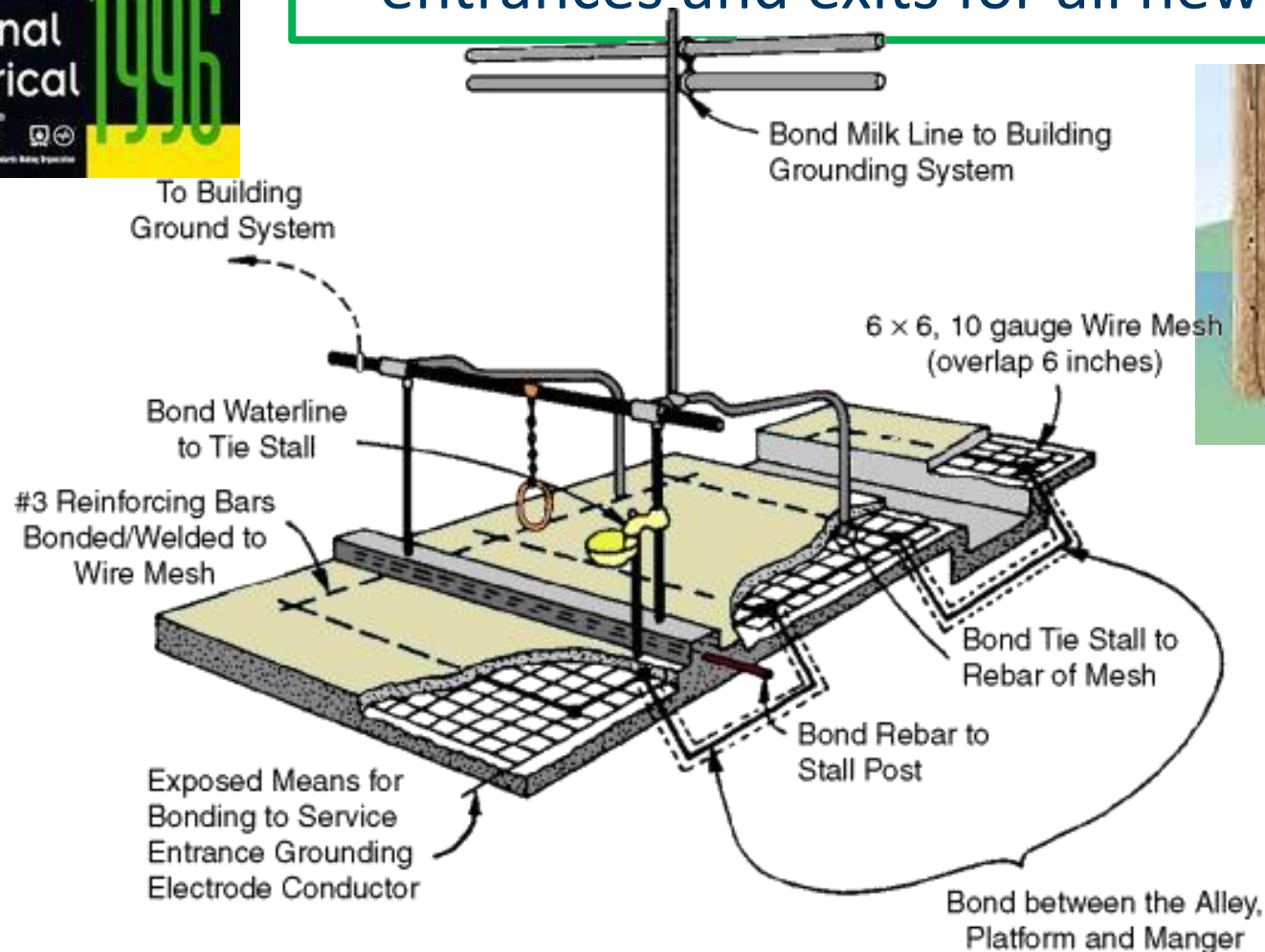
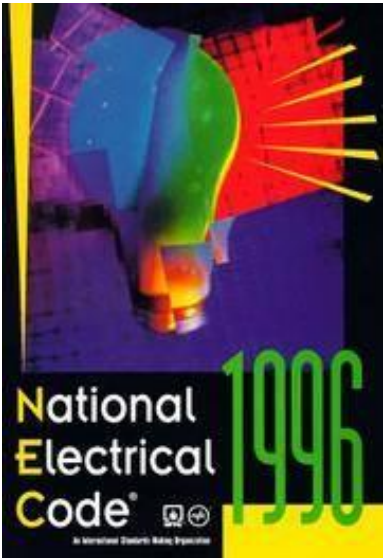
Add a fine print note to read as follows:

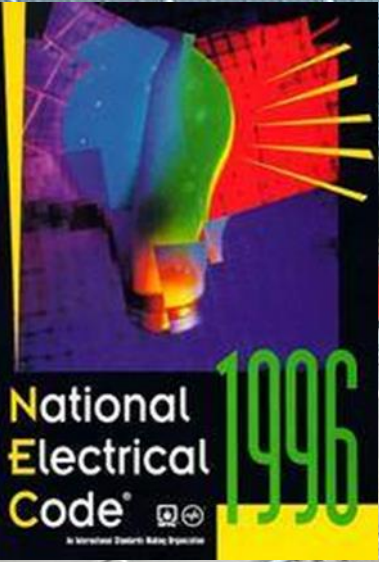
(FPN): If a wire mesh or other conductive grid is embedded in a concrete floor or platform, and if this grid is bonded to the electrical system grounding bus, livestock making contact between the concrete floor or platform and the equipment or metal structure will be less likely to be exposed to a level of voltage that may alter animal behavior or productivity.

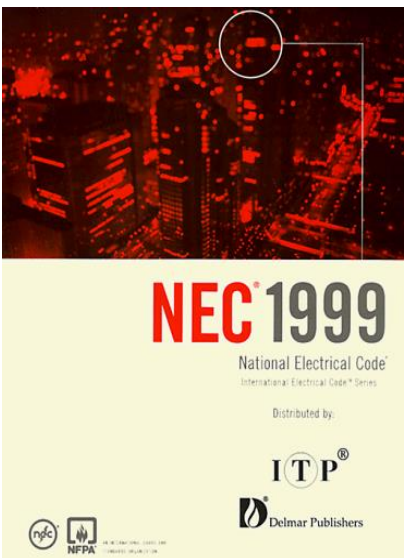
PANEL COMMENT: Revised to fully implement the technical subcommittee's intent.

VOIE ON PANEL ACTION: Unanimously Affirmative.

- New language mandated conductive elements (wire mesh) be embedded into a concrete floor to form the EP.
- Also added was a requirement for a voltage gradient at entrances and exits for all new installations



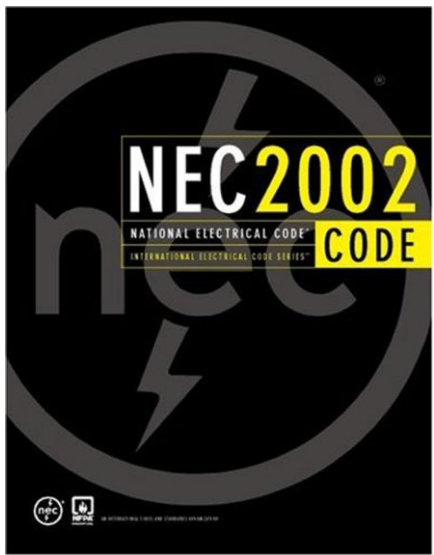




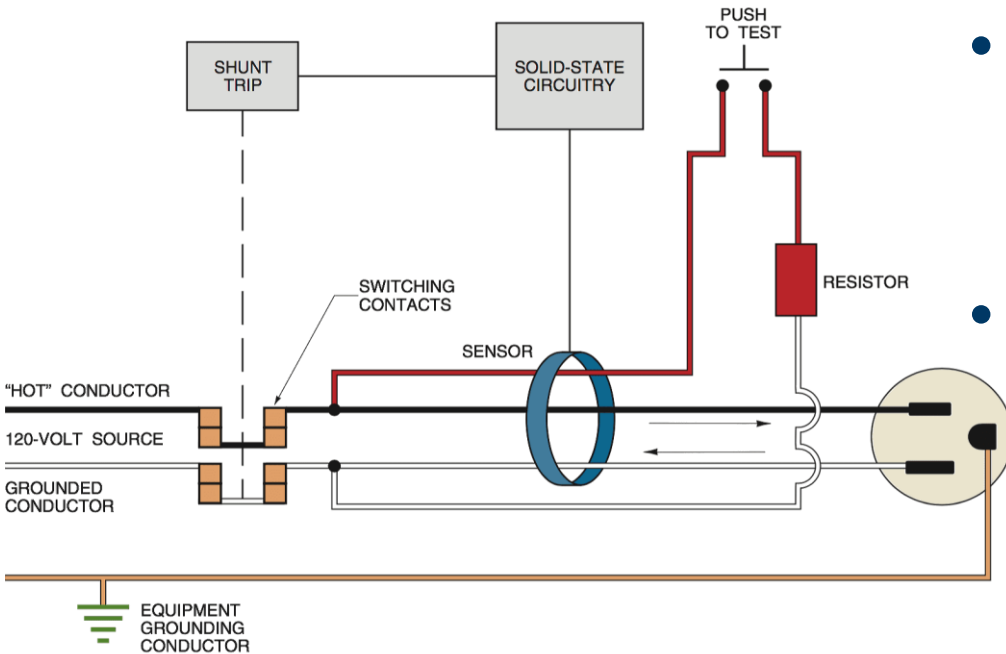
- The distribution point disconnect was required during this code cycle.



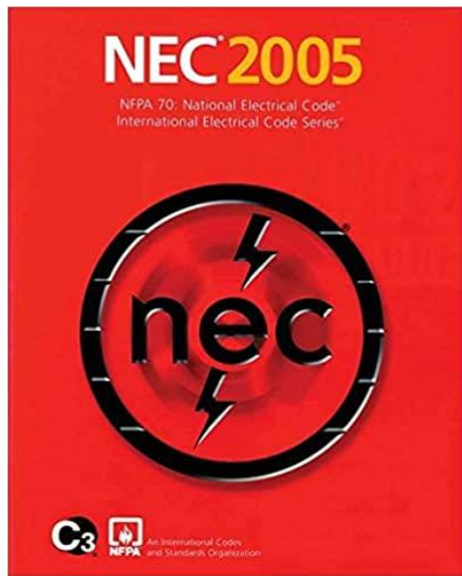
- Additional options requiring 3 or 4 wire distribution systems were introduced, depending on where the overcurrent protection device was located.
- Initially, required rules for the voltage gradient(s) at entrances and exits were revised to more permissive language
- Exception for the EP was added for the slatted floor installations supported by a structure that is part of the EP grounding system.



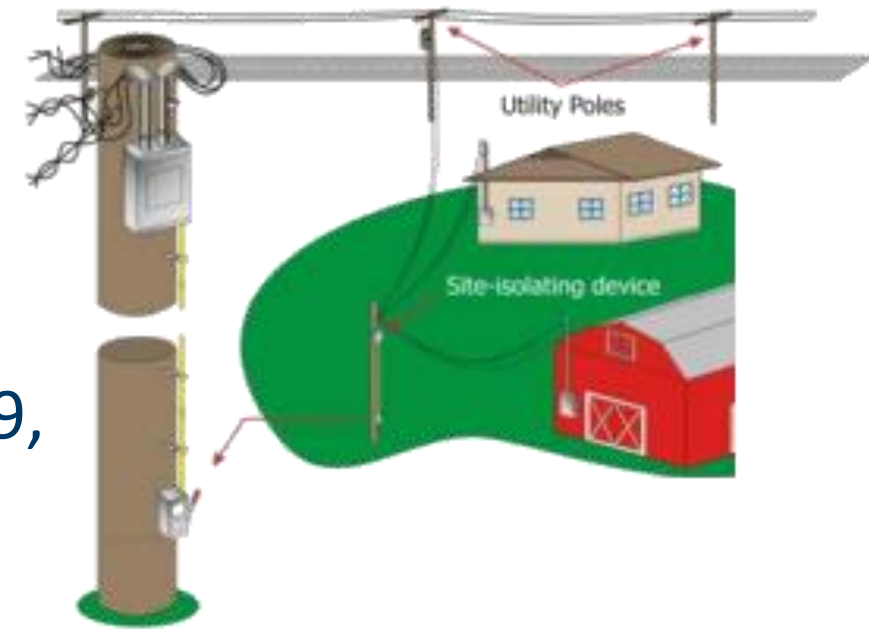
- GFCI protection was required for the 125-volt, 15 or 20-amp general use receptacles in the outdoors, wet and damp locations, and where an EP was installed
- Language deleted the requirements for voltage gradients at entrances and exits.
- The code text clarified the language around the requirement for the premise site isolation disconnect.



- Rules were added recognizing that the utility provided disconnect could be used as the site isolation device.
- Also, the EP bonding requirements were adjusted to include only areas where conductive elements were “likely to become energized”.



- The term “site isolation device” was defined.
- The new verbiage limited the site isolation device to a pole top disconnect as stated in section 547.9, generally used in an overhead distribution system.



- The underground installations (ground mounted disconnects) would simply be referred to as the distribution point.
- The clarification mandated that the feeders and branch circuits, when extended from the distribution point, required an overcurrent protection device.
- Remember, during this code cycle, the site isolation switch was not required to have overcurrent protection, which is still the case today.

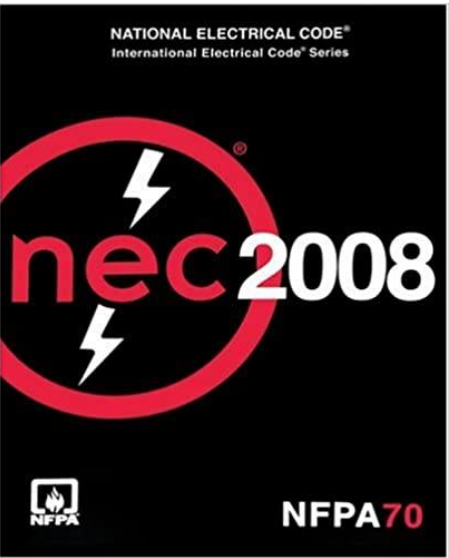
# NEC 2005

NFPA 70: National Electrical Code®  
International Electrical Code Series™

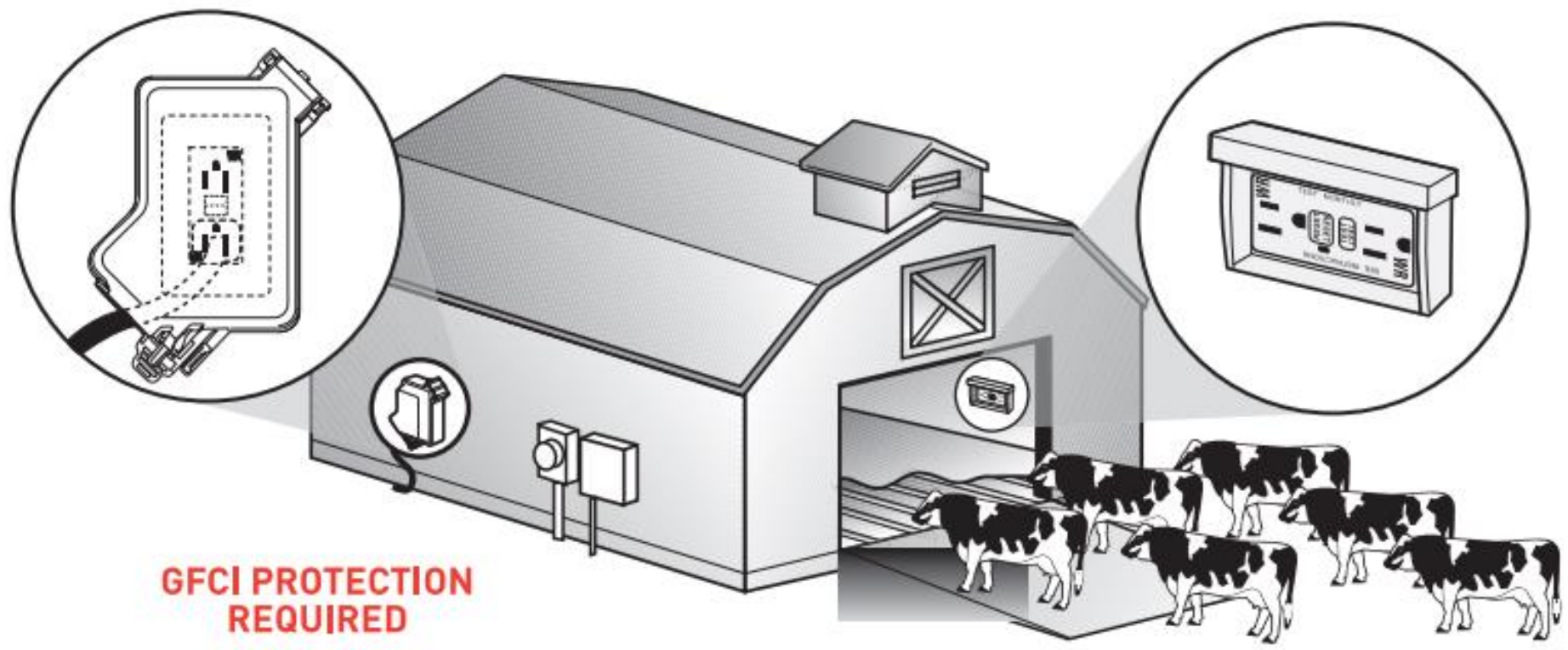


C3 NFPA An International Codes and Standards Organization





- New language was included to require an additional GFCI protected 125-volt, 15 or 20-amp receptacle within 3' of where an accessible non-protected GFCI receptacle was located.



- Also, luminaires were required to have a suitable guard where exposed to physical damage.



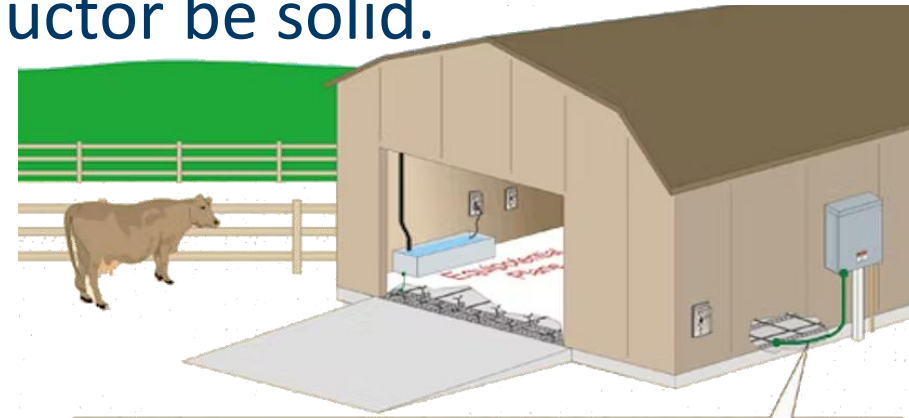
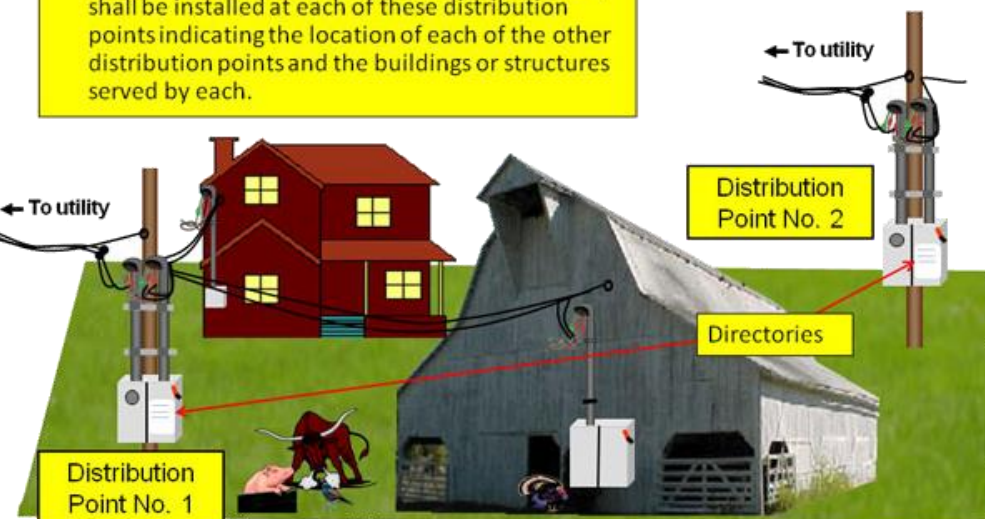
- The panel deleted the language for the GFCI protected receptacle within 3' of the accessible non-protected GFCI receptacle.

The Exclusion for requiring GFCI protection for an accessible receptacle supplying dedicated loads where the GFCI receptacle is located within 3 feet of non GFCI receptacle has been deleted.



- This code cycle required labeling for all the agricultural site distribution points and mandated that the #8 AWG EP bonding conductor be solid.

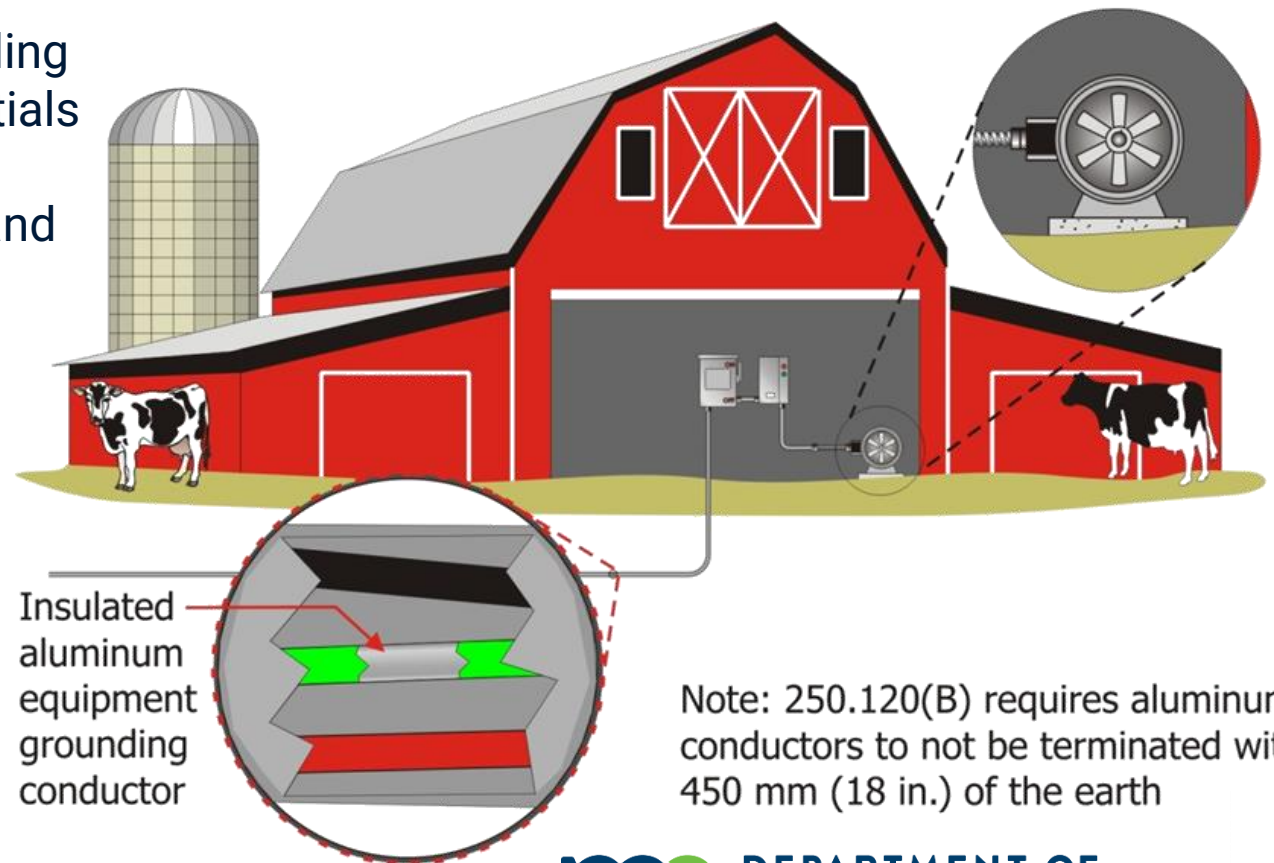
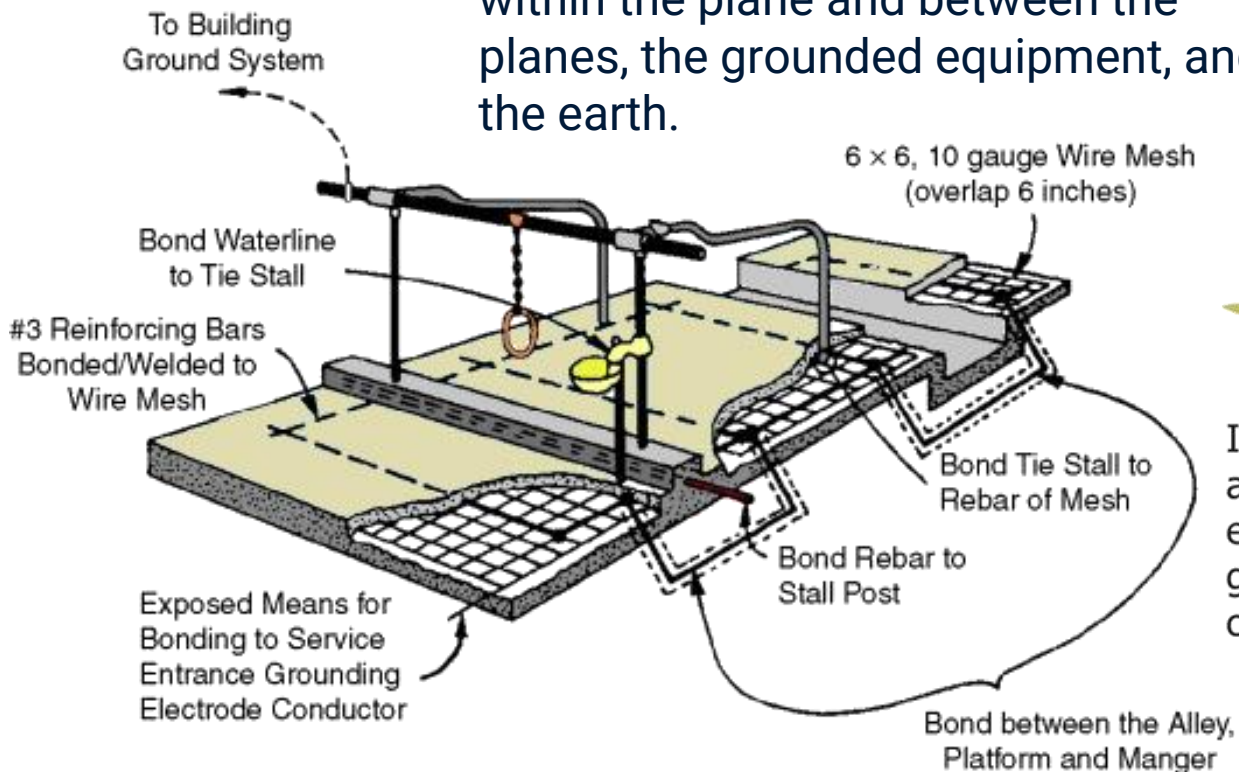
Where a site is supplied by more than one distribution point, a permanent label or directory shall be installed at each of these distribution points indicating the location of each of the other distribution points and the buildings or structures served by each.



Mandated that the #8 AWG EP bonding conductor be solid.

- The definition for EP was revised.
- New provisions allowed for the separate covered or insulated underground EGC to be either copper or aluminum.

Connected to the electrical grounding system to minimize voltage potentials within the plane and between the planes, the grounded equipment, and the earth.



NFPA 70®

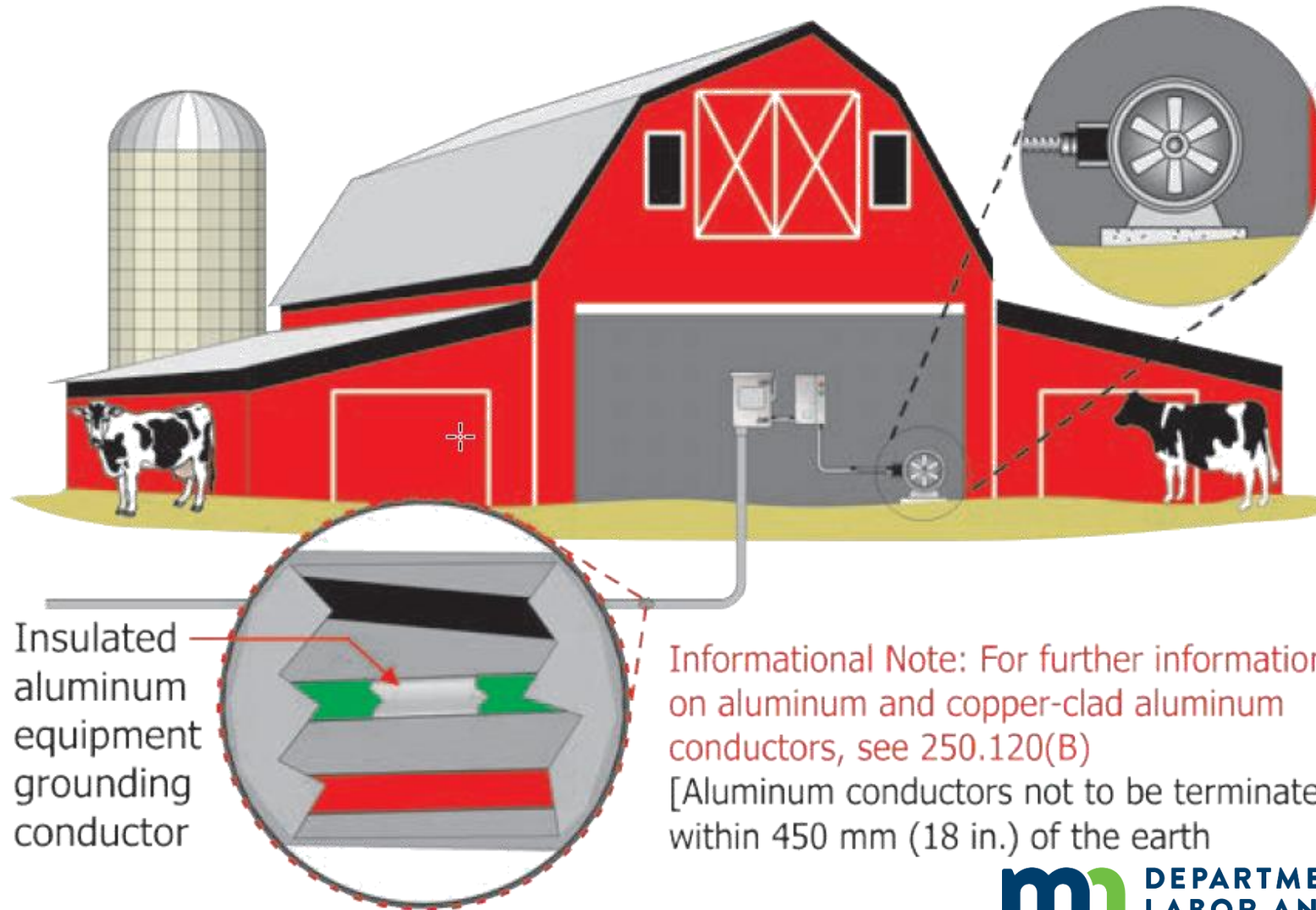


National Electrical Code®

2017



The term ‘covered” was deleted in section 547.5(F). The separate underground EGCs were required to be “insulated” only.

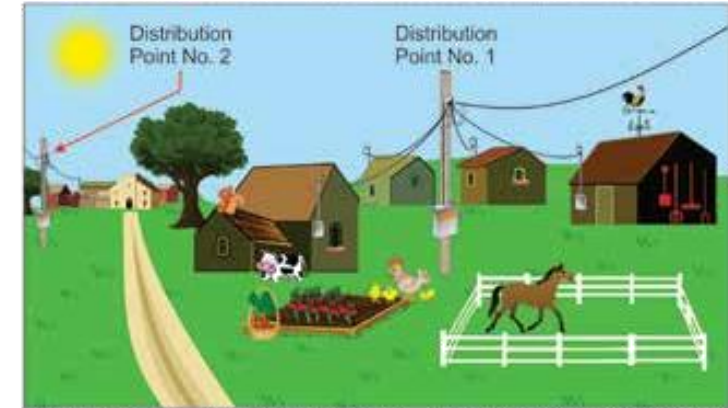




- GFCI protection is required for other agricultural related structures according to section 210.8(B).
- However, in outdoor, wet and damp locations, dirt confinement areas, and where an EP is installed, only the 125-volt, 15 and 20-amp receptacle(s) will require the GFCI protection.

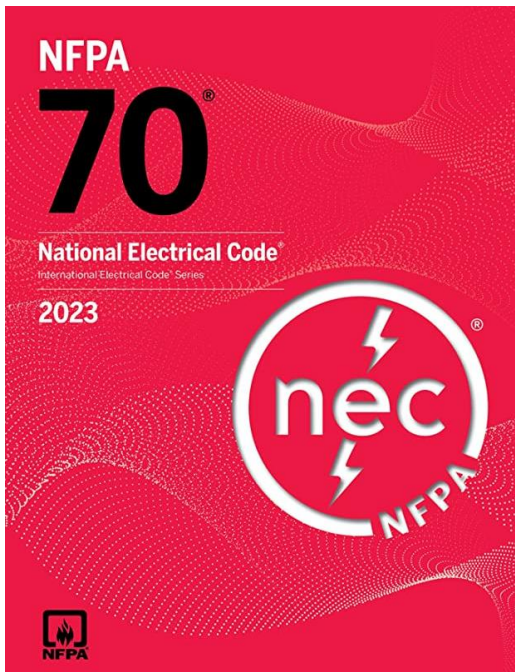


Any agricultural building or structure for livestock located on the same premises is required to be supplied from a distribution point (previously "permitted" to be supplied from a distribution point)



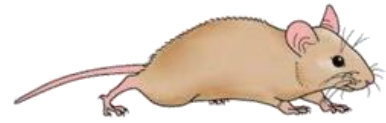
Existing agricultural building or structure (for other than livestock) and any existing non-Article 547 buildings or structures is permitted to be supplied in accordance with 250.32(B)(1) Ex. No. 1

- The distribution point required by section 547.9 clarifies that the disconnect is only required for buildings or structures that confine livestock.
- Also, the revised text allows non-ag buildings or structures to be fed with existing 3 wire feeders if they meet the requirements of section 250.32(B)(1) Exception 1.

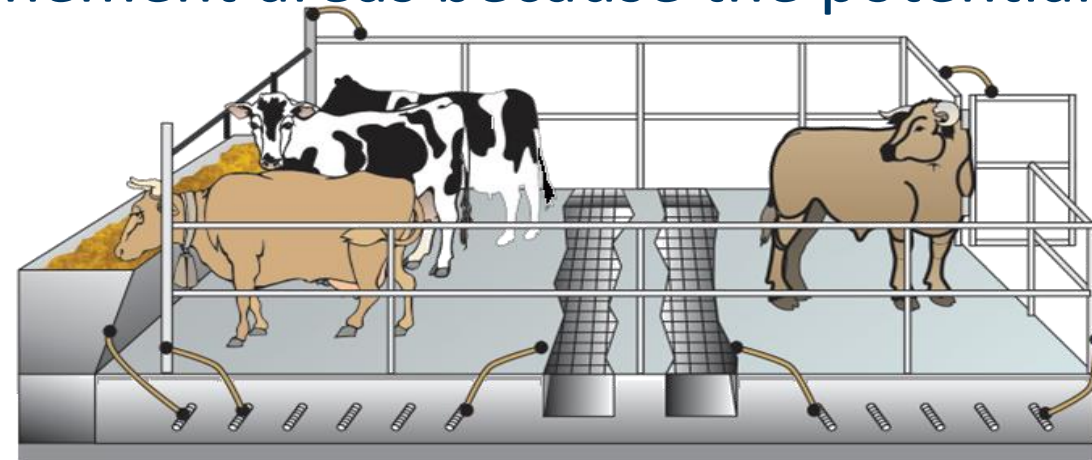


- Article 547 was reorganized to be user friendly. The Article was broken up into three parts General, Installations, Distribution and renumbered.
- New Language was included that Nonmetallic cables is not be allowed to be concealed within walls and above ceilings of buildings or portions thereof, which are contiguous with or adjoined to livestock confinement areas because the potential of rodent damage.

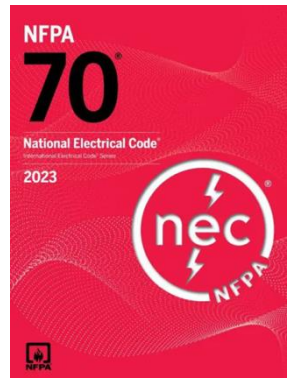
Rodents and other pest damage wiring systems



- Equipotential planes are to be bonded :
  - ❖ the grounding electrode conductor (GEC)
  - ❖ any grounding electrode of the grounding electrode system (GEC) or
  - ❖ the equipment-grounding terminal in a panelboard of the electrical grounding system associated with the equipotential plane.



# Article 547 - Scope



## 547.1 Scope.

This article applies 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) or (B).

### 547.1(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.

### 547.1(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.



# PROPER FARM WIRING SUMMARY

Building or area	Wiring Method	Light Fixtures	Boxes, Fittings, Controls	Motors	Panelboards	Equipotential Plane See Note #1
Open-sided building or structure (no gates or doors to confine livestock)	Types SE, UF or PVC	General use	General use	TEFC	Not permitted	Required
Horse barn or stable	Types SE, UF or PVC	Enclosed over stalls, hay or bedding areas. General use elsewhere. See Note #2	In bedding areas, switches and receptacle outlets and controls must be in dusttight enclosures with weatherproof covers	TEFC	General use	Required
Milking parlor	Types SE, UF or PVC	Listed for wet locations	Watertight and corrosion resistant	TEFC	Not permitted	Required
Dairy barn	Types SE, UF or PVC	Enclosed, listed for wet locations and corrosion resistant	Dusttight, watertight and corrosion resistant	TEFC	Not permitted	Required
Milk room	Types SE, UF or PVC ,or EMT with watertight fittings	Listed for wet locations	Watertight	TEFC	Raintight	Not required
Equipment room, office, lunch room or other ancillary areas	General use. See Note #3	General use	General use	General use	General use	Not required
Poultry confinement	Types SE, UF or PVC	Dusttight, watertight and corrosion resistant	Dusttight, watertight and corrosion resistant	TEFC	Not permitted	Not required, but permitted
Silo and feed rooms and similar areas	Types SE, UF or PVC	Listed for damp locations, corrosion resistant and dusttight	Moisture and corrosion resistant and dusttight	TEFC	Raintight	Not Required
Hay or bulk feed storage or similar areas	Types SE, UF, PVC or EMT	Enclosed and dusttight	Dusttight	TEFC	Not permitted	Not required



## MINNESOTA STRAY VOLTAGE GUIDE

A Guide Addressing Stray Voltage Concerns

Livestock confinement	Types SE, UF or PVC	Enclosed and listed for wet locations. Dusttight, watertight and corrosion resistant	Dusttight, watertight and corrosion resistant	Totally enclosed fan cooled (TEFC)	Not permitted	Required
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**MINNESOTA STRAY VOLTAGE GUIDE**  
A Guide Addressing Stray Voltage Concerns



# Wiring Methods.

## 547.20 Wiring Methods.

Wiring methods shall be limited to the following:

- (1) Type UF
- (2) Type NMC
- (3) Type SE cable-copper
- (4) Jacketed Type MC cable
- (5) Raceways identified for the locations specified in 547.1(A) and (B)

The wiring methods of Article 502, Part II, shall be permitted for areas described in 547.1.



# Wiring Methods.

Table 110.28 Enclosure Selection

Provides a Degree of Protection Against the Following Environmental Conditions	For Outdoor Use									
	Enclosure Type Number									
	3	3R	3S	3X	3RX	3SX	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Rain, snow, and sleet	X	X	X	X	X	X	X	X	X	X
Sleet*	—	—	X	—	—	X	—	—	—	—
Windblown dust	X	—	X	X	—	X	X	X	X	X
Hosedown	—	—	—	—	—	—	X	X	X	X
Corrosive agents	—	—	—	X	X	X	—	X	—	X
Temporary submersion	—	—	—	—	—	—	—	—	X	X
Prolonged submersion	—	—	—	—	—	—	—	—	—	X

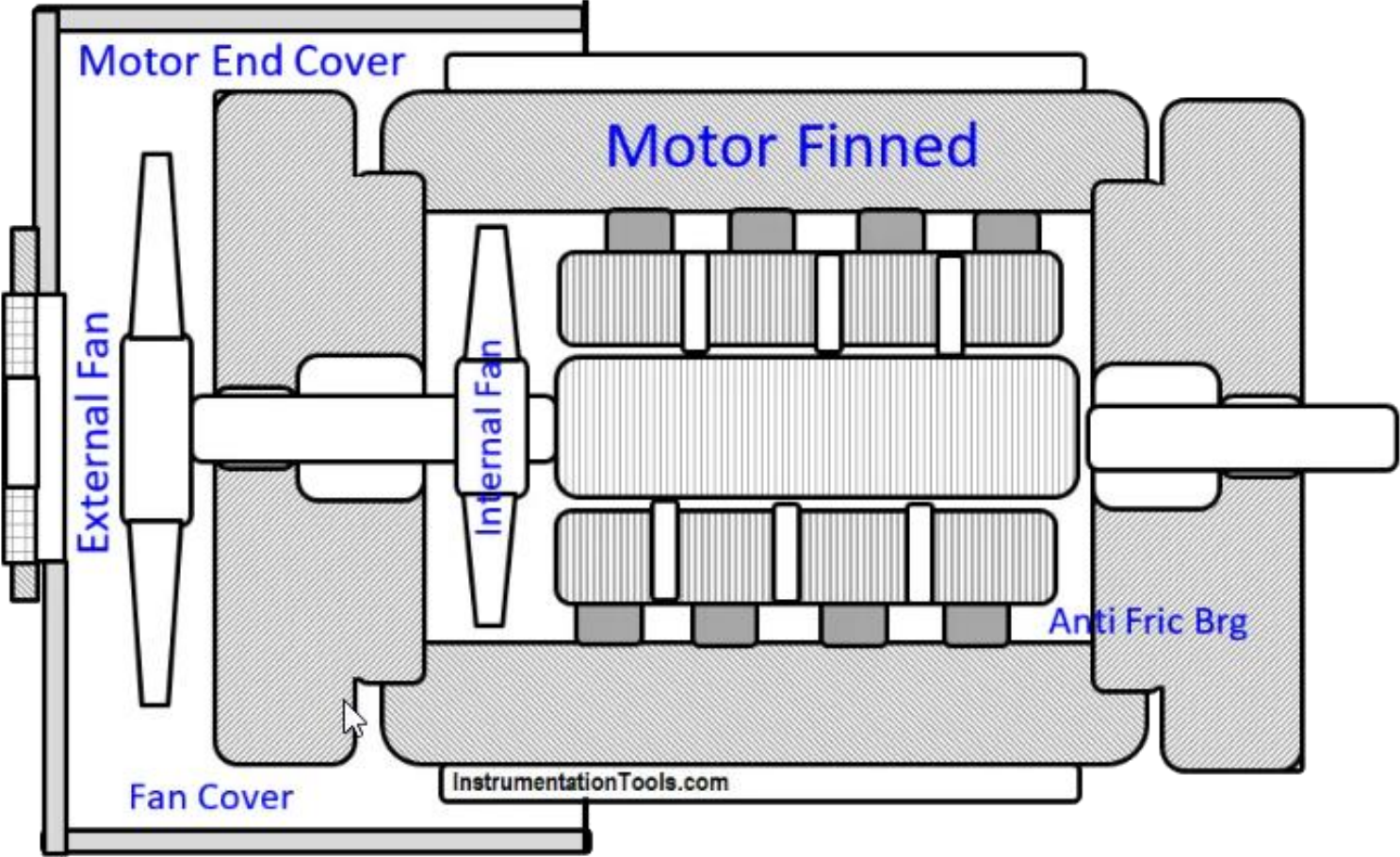
# Wiring Methods.

For Indoor Use

Provides a Degree of Protection Against the Following Environmental Conditions	Enclosure Type Number									
	1	2	4	4X	5	6	6P	12	12K	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing	—	X	X	X	X	X	X	X	X	X
Circulating dust, lint, fibers, and flyings	—	—	X	X	—	X	X	X	X	X
Settling airborne dust, lint, fibers, and flyings	—	—	X	X	X	X	X	X	X	X
Hosedown and splashing water	—	—	X	X	—	X	X	—	—	—
Oil and coolant seepage	—	—	—	—	—	—	—	X	X	X
Oil or coolant spraying and splashing	—	—	—	—	—	—	—	—	—	X
Corrosive agents	—	—	—	X	—	—	X	—	—	—
Temporary submersion	—	—	—	—	—	X	X	—	—	—
Prolonged submersion	—	—	—	—	—	—	X	—	—	—

# Motors.

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



Totally Enclosed Fan Cooled (TEFC) Motor

# Luminaires (Light Fixtures)

## Lighting Fixtures

- Lighting fixtures must be designed and installed to minimize the entrance of dust, foreign matter, moisture and corrosive material.
- Lighting fixtures exposed to physical damage must be protected by location or suitable guards.
- Lighting fixtures exposed to water from condensation, cleansing water, power washing, etc. must be listed as suitable for use in wet locations.





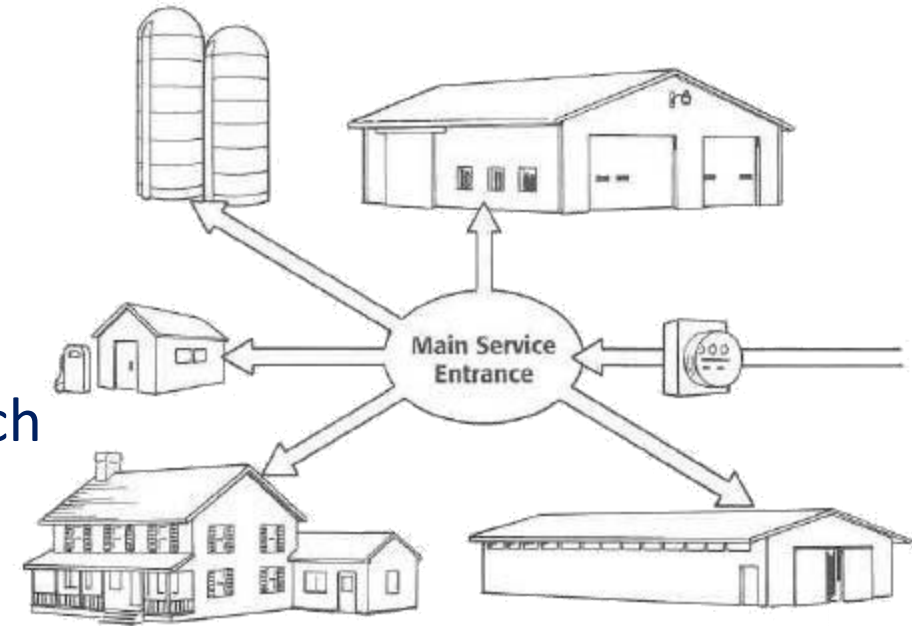
# Electrical Supply from a Distribution Point.

## Overhead distribution systems requires a site isolation device plus...

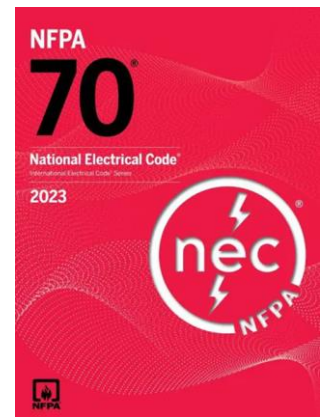
- The system grounded conductor to be connected to the grounding electrode
- When there is no overcurrent protection, a full-size equipment grounding conductor is required from the site isolation device to the structure or building
- The equipment grounding conductor is isolated in each building (per 250.32)
- or the installation may comply with the same rules as an underground distribution system.

## Underground distribution systems requires:

- The service disconnecting means be located at the distribution point
- Overcurrent protection for each set of feeders or branch circuits must be located at the distribution point
- The equipment grounding conductor be installed per 250.32 and 547.5(F).



# 547.40 Electrical Supply to Building(s) or Structure(s) from a Distribution Point



Any agricultural building or structure for livestock located on the same premises shall be supplied from a distribution point. More than one distribution point on the same premises shall be permitted.

Any existing agricultural building or structure for other than livestock not under the scope of Article 547 shall be permitted to be supplied in accordance with 250.32(B)(1), Exception No. 1.

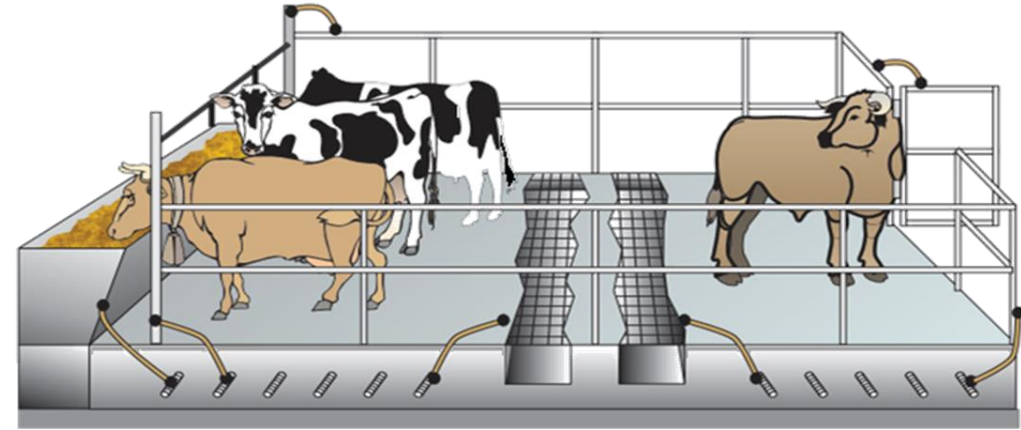


# Equipotential Planes(EP) and Bonding of EPs

**Equipotential planes shall be installed where:**

## **Indoors:**

- Located in confinement areas with concrete floors,
- Where metallic equipment is located that may become energized and is accessible to livestock

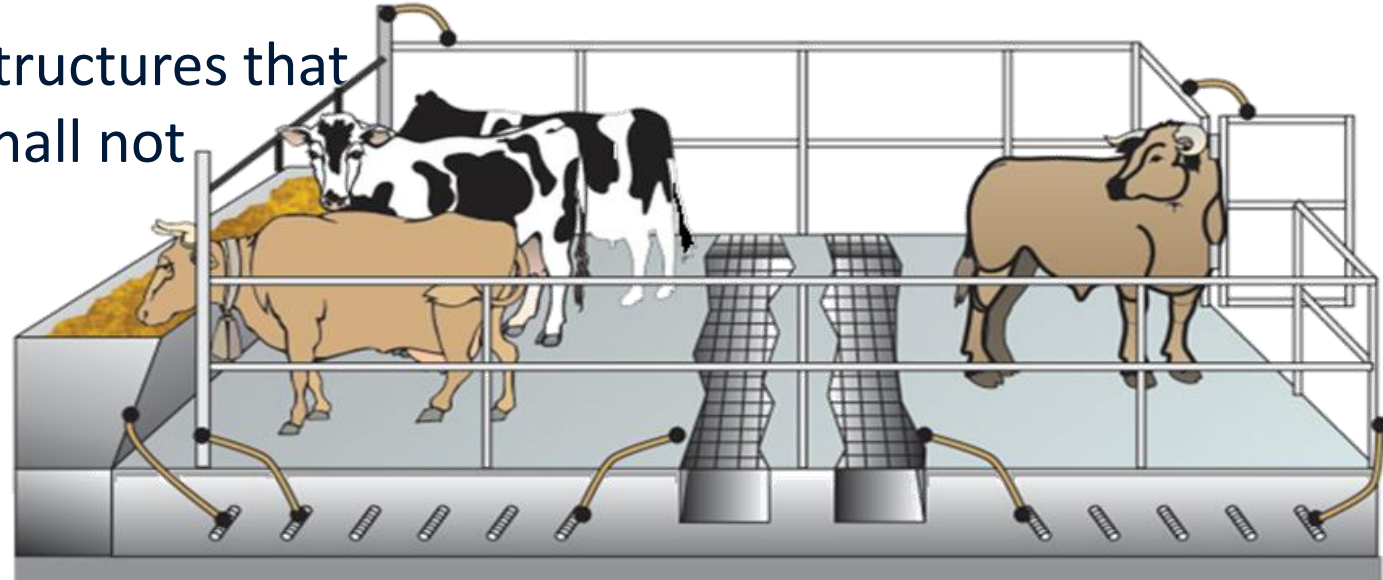


## **Outdoors:**

- In concrete slabs where metallic equipment is located 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.

# Equipotential Planes(EP) and Bonding of EPs

1. Equipotential planes shall be connected to the electrical grounding system.
2. The bonding conductor shall be solid copper, insulated, covered or bare, and not smaller than 8 AWG.
3. The means of bonding to the conductive elements shall be by pressure connectors or clamps of brass, copper, copper alloy, or an equally substantial approved means.
4. Slatted floors that are supported by structures that are a part of an equipotential plane shall not require bonding.





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FOR BUSINESSES



FOR WORKERS AND THE PUBLIC



SAFETY AND HEALTH AT WORK



WORKERS' COMPENSATION



#### MINNESOTA STATE BUILDING CODES

The 2020 Minnesota State Building Code is in effect. View more information.



#### WORKER RIGHTS AND PROTECTIONS

Information about paychecks, minimum wage, breaks, overtime, workplace safety and more.

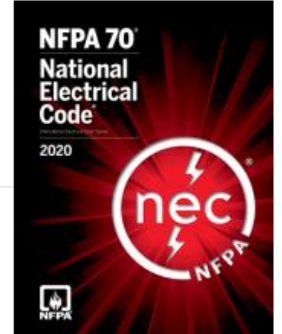
Department website: [dli.mn.gov](http://dli.mn.gov)

## ELECTRICAL CODES AND STANDARDS

### 2020 National Electrical Code

The [Board of Electricity](#) adopted the 2020 National Electrical Code (NEC) with an effective date of Nov. 17, 2020.

Chapter 1315 of the Minnesota State Building Code adopts a national standard for the installation of electrical wiring, apparatus and equipment for electric light, heat, power, technology circuits and systems, and alarm and communication systems. Minnesota's electrical code consists of the National Electrical Code (NEC) as published by the National Fire Protection Association (NFPA). [View electrical laws and rules.](#)



### 2020 NEC

- [2020 NEC Frequently Asked Questions](#)
- [Chart of 2020 NEC Errata and Tentative Interim Amendments](#)
- [2020 Residential Inspection Checklist](#)
- [Free access to the 2020 National Electrical Code](#) (must create a free NFPA account for access)

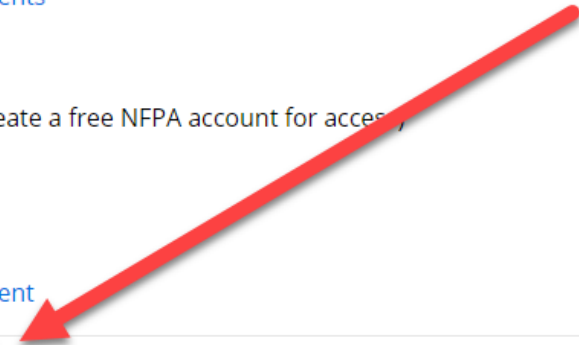
### 2017 NEC

- [2017 NEC Frequently Asked Questions](#)
- [Chart of 2017 NEC Errata and Tentative Interim Amendment](#)

### Bulletins and code resources

#### Agriculture buildings

- [Article 547: agriculture buildings](#)
- [Equipotential plane for livestock confinement](#)
- [Livestock waterers and equipotential planes](#)
- [Minnesota Stray Voltage Guide](#)





# Questions? Thank you!

Dean Hunter

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