

356 Flexible Nonmetallic Conduit FNMC

The 2020 NEC now contains rules for FNMC that are similar to the rules for LPMC, except that any run of FNMC shall contain an internal EGC sized by Table 250.122.



380.12(7) Newly-prohibited Uses for Multi-outlet Assemblies

- Where connected by cord and plug



Art. 392 Conductor Ampacity in Cable Trays

- Harmonization between the code panels has been done: The revised table numbering in Art 310 and in Art 311 is followed through in Art. 392.

New Sec 406.13(A) –(D)

Receptacle & Cord Caps

N 406.13 Single-Pole Separable-Connector Type. Single-pole separable connectors shall be listed and labeled and shall comply with 406.13(A) through (D).

(A) Locking or Latching Type. Single-pole separable connectors shall be of either the locking or latching type and marked with the manufacturer's name or identification and voltage and ampere ratings.

(B) Identification. Connectors designated for connection to the grounded circuit conductor shall be identified by a white-colored housing; connectors designated for connection to the grounding circuit conductor shall be identified by a green-colored housing.

(C) Interchangeability. Single-pole separable connectors shall be permitted to be interchangeable for ac or dc use or for different current ratings or voltages on the same premises, provided they are listed for ac/dc use and marked in a suitable manner to identify the system to which they are intended to be connected.

(D) Connecting and Disconnecting. The use of single-pole separable connectors shall be performed by a qualified person and shall comply with at least one of the following conditions:

- (1) Connection and disconnection of connectors are only possible where the supply connectors are interlocked to the source, and it is not possible to connect or disconnect connectors when the supply is energized.
- (2) Line connectors are of the listed sequential-interlocking type so that load connectors are connected in the following sequence and that disconnection is in the reverse sequence:
 - (a) Equipment grounding conductor connection
 - (b) Grounded circuit conductor connection, if provided
 - (c) Ungrounded conductor connection
- (3) A caution notice that complies with 110.21(B) is provided on the equipment employing single-pole separable connectors, adjacent to the line connectors, indicating that connections are to be performed in the following sequence and that disconnection is in the reverse sequence:
 - (a) Equipment grounding conductor connectors
 - (b) Grounded circuit-conductor connectors, if provided
 - (c) Ungrounded conductor connectors

408.3(A) SWITCHBOARDS AND PANELBOARDS

- **DELETED** IN 2020 NEC: “Barricades shall be placed in all service panelboards, switchboards, and switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.”

New 408.18(C) Clearance Rules for Conductor Terminations

(C) Connections. Each section of equipment that requires rear or side access to make field connections shall be so marked by the manufacturer on the front. Section openings requiring rear or side access shall comply with 110.26. Load terminals for field wiring shall comply with 408.18(C)(1), (C)(2), or (C)(3) as applicable.

(1) Equipment Grounding Conductors. Load terminals for field wiring shall be so located that it is not necessary to reach across uninsulated ungrounded bus in order to make connection;

(2) Grounded Circuit Conductors. Where multiple branch or feeder grounded circuit conductor load terminals for field wiring are grouped together in one location, they shall be so located that it is not necessary to reach across uninsulated ungrounded bus, whether or not energized, in order to make connections.

Where only one branch or feeder set of load terminals for field wiring are grouped with its associated ungrounded load terminals, they shall be so located that it is not necessary to reach across energized uninsulated bus including other branch or feeder bus in order to make connections. Bus on the line side of service, branch, or feeder disconnects is considered energized with respect to its associated load side circuits.

(3) Ungrounded Conductors. Load terminals for ungrounded conductors shall be so located that it is not necessary to reach across energized uninsulated bus in order to make connections. Bus on the line side of service, branch, or feeder disconnects is considered energized with respect to its associated load side circuits.

408.56 Minimum Space Between Live Uninsulated Parts and Other Uninsulated Parts in Switchgear

- Table 408.56 shows the minimum clearances

Δ Table 408.56 Minimum Spacings Between Bare Metal Parts

AC or DC Voltage	Opposite Polarity Where Mounted on the Same Surface		Opposite Polarity Where Held Free in Air		Live Parts to Ground*	
	mm	in.	mm	in.	mm	in.
Not over 125 volts, nominal	19.1	¾	12.7	½	12.7	½
Not over 250 volts, nominal	31.8	1¼	19.1	¾	12.7	½
Not over 1000 volts, nominal	50.8	2	25.4	1	25.4	1

*For spacing between live parts and doors of cabinets, the dimensions in 312.11(A) shall apply.

312.11 SPACING WITHIN CABINETS

(NOT NEW, BUT NEWLY REFERRED TO IN ART. 408.56)

312.11 Spacing. The spacing within cabinets and cutout boxes shall comply with 312.11(A) through (D).

(A) General. Spacing within cabinets and cutout boxes shall provide approved spacing for the distribution of wires and cables placed in them and for a separation between metal parts of devices and apparatus mounted within them in accordance with 312.11(A)(1), (A)(2), and (A)(3).

(1) Base. Other than at points of support, there shall be an airspace of at least 1.59 mm (0.0625 in.) between the base of the device and the wall of any metal cabinet or cutout box in which the device is mounted.

(2) Doors. There shall be an airspace of at least 25.4 mm (1.00 in.) between any live metal part, including live metal parts of enclosed fuses, and the door.

Exception: Where the door is lined with an approved insulating material or is of a thickness of metal not less than 2.36 mm (0.093 in.), uncoated, the airspace shall not be less than 12.7 mm (0.500 in.).

(3) Live Parts. There shall be an airspace of at least 12.7 mm (0.500 in.) between the walls, back, gutter partition, if of metal, or door of any cabinet or cutout box and the nearest exposed current-carrying part of devices mounted within the cabinet where the voltage does not exceed 250. This spacing shall be increased to at least 25.4 mm (1.00 in.) for voltages of 251 to 1000, nominal.

Exception: Where the conditions in 312.11(A)(2), Exception, are met, the airspace for nominal voltages from 251 to 600 shall be permitted to be not less than 12.7 mm (0.500 in.).

(B) Switch Clearance. Cabinets and cutout boxes shall be deep enough to allow the closing of the doors when 30-ampere branch-circuit panelboard switches are in any position, when combination cutout switches are in any position, or when other single-throw switches are opened as far as their construction permits.

(C) Wiring Space. Cabinets and cutout boxes that contain devices or apparatus connected within the cabinet or box to more than eight conductors, including those of branch circuits, meter loops, feeder circuits, power circuits, and similar circuits, but not including the supply circuit or a continuation thereof, shall have back-wiring spaces or one or more side-wiring spaces, side gutters, or wiring compartments.

(D) Wiring Space — Enclosure. Side-wiring spaces, side gutters, or side-wiring compartments of cabinets and cutout boxes shall be made tight enclosures by means of covers, barriers, or partitions extending from the bases of the devices contained in the cabinet, to the door, frame, or sides of the cabinet.

Exception: Side-wiring spaces, side gutters, and side-wiring compartments of cabinets shall not be required to be made tight enclosures where those side spaces contain only conductors that enter the cabinet directly opposite to the devices where they terminate.

Partially enclosed back-wiring spaces shall be provided with covers to complete the enclosure. Wiring spaces that are required by 312.11(C) and are exposed when doors are open shall be provided with covers to complete the enclosure. Where space is provided for feed-through conductors and for splices as required in 312.8, additional barriers shall not be required.

NEW 408.13 PANELBOARD ORIENTATION

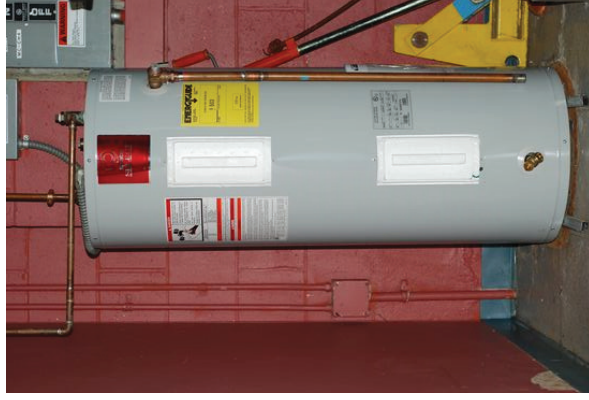
“Panelboards shall not be installed in the face-up position”

Art 410 LUMINAIRES

- The 2020 NEC contains several details dealing with luminaire physical mounting and electrical connections; but most of them are simply restatements of existing rules.

422.13 Storage Type Water Heaters

- “The branch circuit overcurrent device and conductors for fixed storage type water heaters that have a capacity of 120 gallons or less shall be sized not smaller than 125% of the rating of the water heater.”



422.16 New Rules for Specific Appliances

When the following appliances are energized through cord and plug, the receptacle shall be accessible, and the cord shall contain an EGC:

- In-Sink Waste Disposer
- Dishwasher and Trash Compactor
- Range Hood or Range Hood with Microwave Oven



422.40 The male cord cap shall be of the polarized, grounding type.

425.22(B) AMPERE RATINGS OF ELEMENTS OF ELECTRODE INDUSTRIAL PROCESS HEATING EQUIPMENT

(B) Resistance Elements. Resistance-type heating elements in fixed industrial process heating equipment shall be protected at not more than 60 amperes. Equipment rated more than 48 amperes and employing such elements shall have the heating elements subdivided, and each subdivided load shall not exceed 48 amperes.



Resistance-type heating elements in fixed industrial process heating equipment shall be permitted to be subdivided into circuits not exceeding 120 amperes and protected at not more than 150 amperes where one of the following is met:

- (1) Elements are integral with and enclosed within a process heating surface.
- (2) Elements are completely contained within an enclosure identified as suitable for this use.
- (3) Elements are contained within an ASME-rated and stamped vessel.

430.2 DEF. OF ELECTRONICALLY PROTECTED MOTORS

“A motor that is provided with electronic control that is an integral part of the motor and protects the motor against dangerous overheating due to failure of the electronic control, overload, and failure to start.”



445.6 GENERATOR LISTING

- New requirement in the 2020 NEC:
“Stationary generators 600 volts and less shall be listed.”



445.18(C) REMOTE EMERGENCY GENERATOR SHUTDOWN

“Generators with greater than 15kW rating shall be provided with a remote emergency stop switch to shut down the prime mover. The remote emergency stop switch shall be located outside the equipment room of generator enclosure and shall also meet the requirements of 445.18(B)(1) and (B)(2).



450.9 VENTILATION (surrounding transformers)

- “ ...Transformer top surfaces that are horizontal and readily accessible shall be **marked to prohibit storage.**”



450.23(A)(3)

- The 2020 NEC provides for two additional circumstances where less flammable liquid-insulated transformers can be installed indoors:
- (2) If an automatic fire extinguishing system and a liquid confinement area is present if the transformer is 35kV or less
- (3) If the installation complies with 450.26 (i.e. in a vault).

Fluid Offerings



MINERAL OIL

Type II (Inhibited) Ergon Hyvolt II

- Mainly Outdoor (Fire Point = 165 Deg. C)
- Least Expensive of all Fluids

SILICONE

(Dow Corning 561)

- "Less Flammable Liquid" (Fire Point = 343 Deg. C)
- Indoor Use
- Expensive Fluid

BIOTEMP™

(ABB)

Renewable Natural Agricultural Product

- Certified by UL® as "Less-Flammable Fluid"
- Fire Point = 360 Deg. C
- Factory Mutual Approved
- Biodegrades 97% in 21 days
- No fusing restrictions
- LESS FLAMMABLE SEED OIL

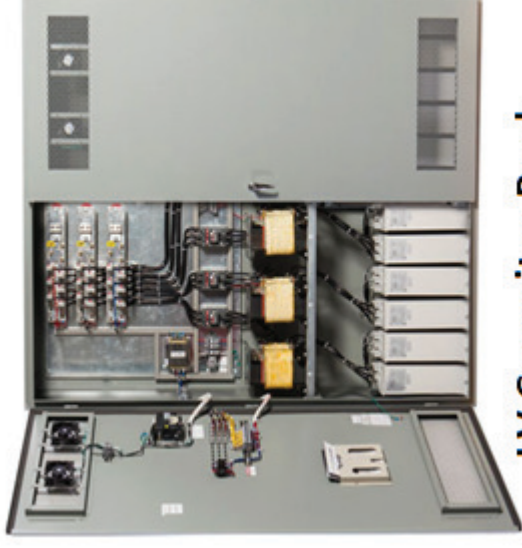
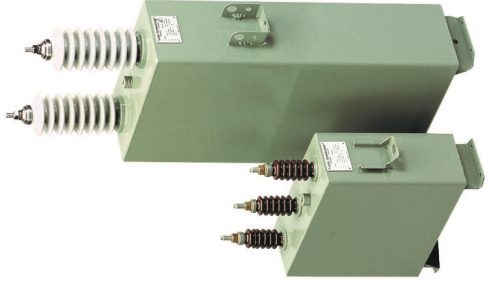
FR3 FLUID™

(Cooper Industries)

- Certified by UL® as "Less-Flammable Fluid"
- Fire Point = 360 Deg. C
- Factory Mutual Approved
- Biodegrades 99% in 21 days
- No fusing restrictions
- LESS FLAMMABLE SEED OIL

460 Def. of SAFE ZONE

- A **safe zone** around capacitors is defined by “A low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor.”



LV Capacitor Bank

460.25(D) PROTECTIVE DEVICES FOR CAPACITORS

- “Protective devices for capacitors or capacitor equipment shall be rated or adjusted to operate within the limits of the safe zone for individual capacitors.”

480.7(C)

“Battery circuits exceeding 240 volts DC nominal between conductors or to ground and subject to field servicing shall have provisions to **disconnect the series-connected strings into segments** not exceeding 240 volts DC nominal for maintenance by qualified persons. Non-load-break bolted or plug-in disconnects shall be permitted. “



480.7(F) NOTIFICATION AND IDENTIFICATION OF BATTERY
DISCONNECT

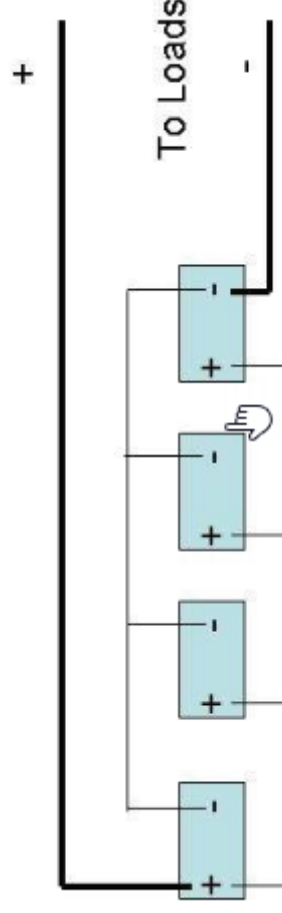
- “The disconnecting means shall be legibly marked in the field.”
- The marking shall be of sufficient durability to withstand the environment involved and shall include:
 1. Nominal battery voltage.
 2. Available fault current derived from the stationary battery system.
 3. An Arc Flash label per NFPA 70E-2018.

480.7(G) IDENTIFICATION OF BATTERY POWER SOURCES PER:

- 702.7 “A sign shall be placed at the service-entrance equipment for commercial and industrial installations that indicate the type and location of each onsite optional standby power source
- If the facility features a microgrid, Sec. 712.10 requires a permanent directory denoting all DC electric power sources operating to supply the DC microgrid shall be installed outside the building at each source or other approved visible source location capable of acting as the primary DC source.

480.12 BATTERY INTERCONNECTIONS

- “Flexible cables, as identified in Art 400, in sizes 2/0 and larger shall be permitted within the battery enclosure from battery terminals to a nearby junction box where they shall be connected to an approved wiring method. Flexible battery cables shall also be permitted between batteries and cells within the battery enclosure. Such cables shall be listed and identified for the environmental conditions. Flexible, find-stranded cables shall only be used with terminals, lugs, devices, or connectors in accordance with 110.14.



480.13 GROUND FAULT DETECTION

- Battery circuits exceeding 100 volts between the conductors or to ground shall be permitted to operate with ungrounded conductors, provided a ground-fault detector and indicator is installed to monitor for ground faults.

500.7(K)(4) NEW PROTECTION TECHNIQUE: COMBUSTIBLE
GAS DETECTION SYSTEMS INSIDE OF A CONTROL PANEL

(4) Interior of a Control Panel. Inside the interior of a control panel containing instrumentation or other equipment utilizing or measuring flammable liquids, gases, or vapors, which is provided with combustible gas detection equipment shall be permitted to utilize electrical equipment, installation methods, and wiring practices suitable for Class I, Division 2 installations.

An alarm (audible or visual, or both) shall be sounded at not more than 40 percent of the lower flammable limit.

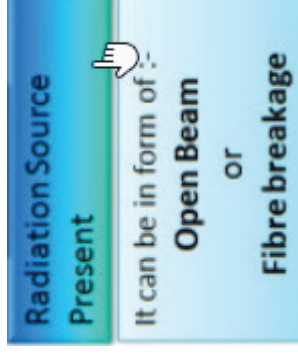


500.7(M) NEW PROTECTION TECHNIQUE: PROTECTED OPTICAL RADIATION “op pr”

500.7(M) Protected Optical Radiation “op pr.” This protection technique shall be permitted for equipment in Class I or II, Division 2 locations for which the equipment is identified.

Informational Note: The identified class and division depends on the intended explosive atmosphere as part of the protection technique evaluation.

The optical radiation in the Hazardous Areas (potentially explosive atmospheres) can ignite the surrounding atmosphere and may result in explosion.



1. Optical Radiation is absorbed by surfaces or particles and thus get heated up .Under certain (favorable) conditions this process may result in a sufficiently high temperature causing ignition of the surrounding atmosphere.
2. Direct LASER induced breakdown of the gas at the FOCUS of a strong beam, producing PLASMA and a SHOCK WAVE , both eventually acting as the IGNITION SOURCE. These processes may be supported by a solid material close to the breakdown point.

500.7(N) NEW PROTECTION TECHNIQUE: OPTICAL SYSTEM WITH INTERLOCK “op sh”

(N) Optical System With Interlock “op sh.” This protection technique shall be permitted for equipment in Class I or II, Division 1 or 2 locations for which the equipment is identified.

Informational Note: The identified class and division depends on the intended explosive atmosphere and the number of faults applied as part of the protection technique evaluation.

EXPLANATION

The factor that it is necessary to consider is the minimum ignition radiation power, that is the amount of energy that could be transferred to the surrounding environment by a light source without turning itself into an ignition source.

It was discovered that under certain circumstances the value could be as low as 50 mW. For safety reasons a reduction factor should be considered and a 35 mW limit could be employed as a safe value.

500.7(O) NEW PROTECTION TECHNIQUE: PROTECTION BY SKIN EFFECT TRACE HEATING “IEEE 844.1”

N (O) Protection by Skin Effect Trace Heating “IEEE 844.1”. This protection technique shall be permitted for skin effect trace heating equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 2 for which it is listed.

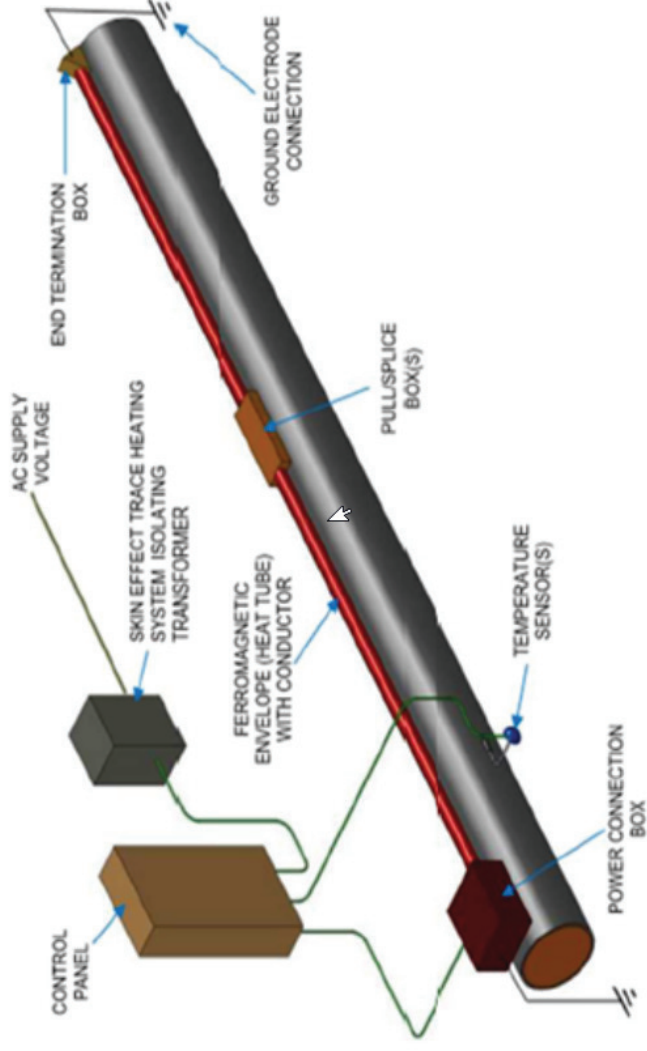


Fig. 1 Basic Skin Effect Trace Heating System

500.7(K) “COMBUSTIBLE GAS DETECTION SYSTEM” AS A
PROTECTION TECHNIQUE

- A combustible gas detection system shall be permitted as a means of protection in industrial establishments with restricted public access, and where the conditions of maintenance and supervision ensure that only qualified persons service the installation.
- 500.7(K)(1)” The applications for the use of combustible gas detection systems as a protection technique shall be limited to 500.7(K)(2), (K)3, or (K)(4) (see the next three slides)

500.7(K)(2) COMBUSTIBLE GAS DETECTION SYSTEMS IN AREA WITH INADEQUATE VENTILATION

Δ (2) Inadequate Ventilation. A location, enclosed space, or building that is classified as a Class I, Division 1 location due to inadequate ventilation, that is provided with a combustible gas detection system shall be permitted to utilize electrical equipment, installation methods, and wiring practices suitable for Class I, Division 2 installations. Sensing a gas concentration of not more than 40 percent of the lower flammable limit or a gas detector system malfunction shall activate an alarm (audible or visual, or both, as most appropriate for the area).

500.7(K)(3) COMBUSTIBLE GAS DETECTION SYSTEMS IN AREA NOT CONTAINING A SOURCE OF FLAMMABLE GAS OR VAPORS

(3) **Interior of a Building or Enclosed Space.** Any building or enclosed space that does not contain a source of flammable gas or vapors that is located in, or with an opening into, a Class I, Division 2 hazardous (classified) location that is provided with a combustible gas detection system shall be permitted to utilize electrical equipment, installation methods, and wiring practices suitable for unclassified installations under all of the following conditions:

- (1) An alarm (audible or visual, or both) shall be sounded at not more than 20 percent of the lower flammable limit.
- (2) Sensing a gas concentration of not more than 40 percent of the lower flammable limit or a gas detector system malfunction shall both activate an alarm (audible or visual, or both, as most appropriate for the area) and initiate automatic disconnection of power from all electrical devices in the area that are not suitable for Class I, Division 2.

(3) The power disconnecting device(s) shall be suitable for Class I, Division 1 if located inside the building or enclosed space. If the disconnecting device(s) is located outside the building or enclosed space, it shall be suitable for the location in which it is installed.

Redundant or duplicate equipment (such as sensors) shall be permitted to be installed to avoid disconnecting electrical power when equipment malfunctions are indicated.

When automatic shutdown could introduce additional or increased hazard, this technique shall not be permitted.

200.7(L) NEW PROTECTION TECHNIQUE: INHERENTLY SAFE OPTICAL RADIATION “op is”

N (L) Inherently Safe Optical Radiation “op is.” This protection technique shall be permitted for equipment in Class I or II, Division 1 or 2 locations for which the equipment is identified.

Informational Note: The identified class and division depends on the intended explosive atmosphere and the number of faults applied as part of the protection technique evaluation.

500.8(G) About “Equipment Involving Optical Radiation:”

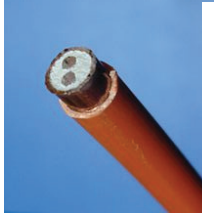
N (G) Equipment Involving Optical Radiation. For equipment involving sources of optical radiation (such as laser or LED sources) in the wavelength range from 380 nm to 10 μm, the risk of ignition from optical radiation shall be considered for all electrical parts and circuits that may be exposed to the radiation, both inside and outside the optical equipment. This includes optical equipment, which itself is located outside the explosive atmosphere, but its emitted optical radiation enters such atmospheres.

Informational Note: For additional information on types of protection that can be applied to minimize the risk of ignition in explosive atmospheres from optical radiation, see ANSI/UL 60079-28-2017, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

Exception: *All luminaires (fixed, portable, or transportable) and hand lights intended to be supplied by mains (with or without galvanic isolation) or powered by batteries, with any continuous divergent light source, including LEDs, shall be excluded from this requirement.*

501.10(A)(1) C1D1 WIRING METHODS

- Threaded RMC or threaded IMC
- PVC, RTRC, HDPE buried 24" w/2"
- concrete
- MI cable
- MC-HL
- ITC-HL

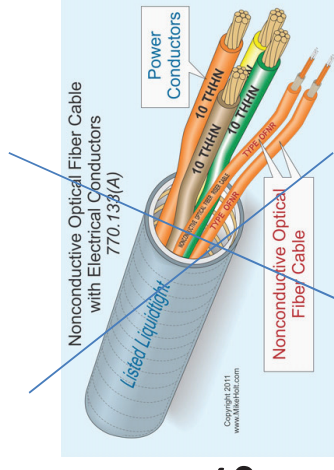


- MC-HL
- ITC-HL

• Sealed Optical fiber cables in raceways

• TC-ER-HL

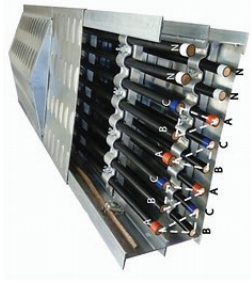
• Type P cable



(NO LONGER PERMITTED)

501.10(A)(1) C1D2 WIRING METHODS

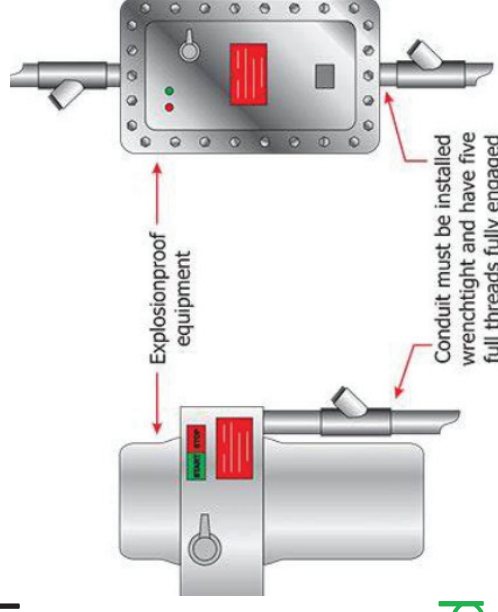
- RMC or IMC, either threaded or threadless
- Enclosed gasketed busways and wireways
- PLTC cable
- ITC and ITC-ER cable
- MC, MV, TC, TC-ER cable in cable tray
- PVC, RTRC, HDPE
- Sealed Optical fiber cables in raceways



- Cablebus
- TC-ER-HL cable
- Type P cable

501.15(A)(1) FITTINGS PERMITTED BETWEEN ENCLOSURE AND SEAL

- 2020 NEC STATES: “Only **threaded** couplings or explosionproof fittings such as unions reducers, elbows, and capped elbows not larger than the trade size of the conduit shall be permitted between the sealing fitting and the explosionproof enclosure.”



- 2018 stated: “Only **explosionproof unions, couplings, reducers, elbows, and capped elbows** that are not larger than the trade size of the conduit shall be permitted between the sealing fitting and the explosionproof enclosure.”

501.105(B)(6) PLUG AND REC. IN C1D2

-Def. of Nonincendive Field Wiring: Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is **not capable**, due to arcing or thermal effects, of igniting the flammable gas-, vapor-, or dust-air mixture.

501.105(B)(6): Plug and Rec must be listed for use in C1D2 locations and listed for use with flexible cord, except:

- 1) Where the circuit involves only nonincendive wiring, or 2) labeling is done as shown in this NEC clipping:



Exception No. 2: In industrial establishments where the conditions of maintenance and supervision ensure that only qualified individuals service the installation, the Class I, Division 2 listing is not required when the requirements of 501.105(B)(6)(2), (B)(6)(3), and (B)(6)(4) are satisfied and the receptacle carries a label warning against plugging or unplugging when energized.

- (2) The flexible cord does not exceed 900 mm (3 ft), is of a type listed for extra-hard usage, or if listed for hard usage is protected by location.
- (3) Only necessary receptacles are provided.
- (4) Unless the attachment plug and receptacle are interlocked mechanically or electrically, or otherwise designed so that they cannot be separated when the contacts are energized and the contacts cannot be energized when the plug and socket outlet are separated, a switch complying with 501.105(B)(2) shall be provided so that the attachment plug or receptacle is not depended on to interrupt current.

502.10(A)(1) CID1 WIRING METHODS

- Threaded RMC or threaded IMC
- PVC, RTRC, HDPE buried 24" w/2" concrete
- MI cable
- MC-HL
- ITC-HL
- Sealed Optical fiber cables in raceways
- TC-ER-HL in cable tray in one layer with 1-cable-dia between cables to prevent dust buildup
- Type P cable in cable tray in one layer with 1-cable-dia between cables to prevent dust buildup



502.10(B)(1) CID2 WIRING METHODS

- RMC or IMC, (can be PVC coated) either threaded or threadless
- EMT and dusttight wireways
- PLTC cable
- ITC and ITC-ER cable
- MC, MV, TC, TC-ER cable in cable tray
- PVC, RTRC, HDPE
- Sealed Optical fiber cables in raceways
- Cablebus
- TC-ER-HL cable
- Type P cable

NEW 502.150(B)(5) SIGNALING, ALARM, REMOTE-CONTROL, AND COMMUNICATIONS SYSTEMS, AND METERS, INSTRUMENTS, AND RELAYS

(5) Connections. To facilitate replacements, process control instruments shall be permitted to be connected through flexible cord, attachment plug, and receptacle, provided that all of the following conditions apply:

- (1) Attachment plug and receptacle are listed for use in Class II, Division 2 locations, and listed for use with flexible cords.

Exception No. 1: A Class II, Division 2 listing is not required if the circuit involves only nonincendive field wiring.

Exception No. 2: In industrial establishments where the conditions of maintenance and supervision ensure that only qualified individuals service the installation, the Class II, Division 2 listing is not required when the requirements of list items 502.150(B)(5)(2), (B)(5)(3), and (B)(5)(4) are satisfied and the receptacle carries a label warning against plugging or unplugging when energized.

- (2) The flexible cord does not exceed 900 mm (3 ft), is of a type listed for extra-hard usage, or if listed for hard usage is protected by location.
- (3) Only necessary receptacles are provided.
- (4) Unless the attachment plug and receptacle are interlocked mechanically or electrically, or otherwise designed so that they cannot be separated when the contacts are energized, and the contacts cannot be energized when the plug and socket outlet are separated, a switch complying with 502.115(B) shall be provided so that the attachment plug or receptacle is not depended on to interrupt current.

Exception: The switch shall not be required if the circuit is nonincendive field wiring.

**ALMOST TOTAL REWRITES IN THE 2020
NEC: ART 505 & ART 506**

**THESE ARTICLES ARE NOT TREATED IN DETAIL IN
THIS INDUSTRIAL 2020 NEC CHANGES PPT PACK**

**511.12 50A & SMALLER RECEPTACLES
UP TO 250V SHALL HAVE PERSONNEL
PROTECTION TYPE GFI IN
COMMERCIAL GARAGES**

513.3(D) NEW DETAILED EXPLANATION
OF AREAS MADE NONCLASSIFIED BY
VIRTUE OF BEING SEPARATED FROM
THE HANGER: (1)“CUT OFF FROM THE
HANGER ITSELF BY WALLS, OR
INSTEAD (2) USING “MECHANICALLY
VENTILATED” AT A RATE OF FOUR OR
MORE AIR CHANGES PER HOUR, OR (3)
DESIGNED WITH POSITIVE AIR
PRESSURE

513.12, AS WAS SEEN IN ART 511 FOR
RECEPTACLES IN COMMERCIAL
PARKING GARAGES, IN AIRCRAFT
HANGERS, 50A & SMALLER
RECEPTACLES OF UP TO 150 VOLTS-TO-
GROUND SHALL HAVE **PERSONNEL
PROTECTION TYPE GFI** IN
COMMERCIAL GARAGES

514.11 DISCONNECT FOR FUEL DISPENSING SYSTEMS
SHALL FEATURE THE FOLLOWING ADDITIONAL

CHARACTERISTIC:

“The emergency shutoff device shall disconnect simultaneously from the source of supply, all conductors of the circuits, including the grounded conductor, if any. The equipment grounding conductors shall remain connected.”

COVERAGES OF THE FOLLOWING LESS-USED ARTICLES
ARE OMITTED FROM THIS COMMERCIAL &
INDUSTRIAL 2020 NEC PPT SLIDE PACK

503	545	680
506	547	682
517	550	685
518	551	692
520	552	710
522	555	712
525	600	720
530	605	750
540	620	810
545	640	820
547	650	830
550	660	840
551	665	
552	669	
540	675	

590.4(G) SPLICES (IN TEMPORARY WIRING)

NEW EXCEPTION TO THE 2017 NEC THAT ALL IN TEMPORARY WIRING, SPLICES MUST ALL BE INSTALLED WITHIN A BOX, CONDUIT BODY, OR OTHER ENCLOSURE WITH A COVER INSTALLED”:

Exception No. 2: On construction sites, branch-circuits that are permanently installed in framed walls and ceilings and are used to supply temporary power or lighting, and that are GFCI protected, the following shall be permitted:

- (1) A box cover shall not be required for splices installed completely inside of junction boxes with plaster rings.
- (2) Listed pigtail-type lampholders shall be permitted to be installed in ceiling-mounted junction boxes with plaster rings.
- (3) Finger safe devices shall be permitted for supplying and connection of devices.



NEW 490.9(A) REUSED TEMPORARY WIRING EQUIPMENT

“Where overcurrent protective devices that have been previously used are installed in a temporary installation, these overcurrent protective devices shall be examined to ensure these devices have been properly installed, properly maintained, and there is no evidence of impending failure.”

[The Phrase “evidence of impending failure” means that there is evidence, such as arcing, overheating. Loose parts, visible damage, or deterioration.”]



NEW 590.9(B) SERVICE OVERCURRENT PROTECTIVE
DEVICES FOR TEMPORARY INSTALLATIONS

- “Overcurrent protective devices for solidly grounded wye electrical services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase shall be **current limiting**.”

NEW 625 ELECTRIC VEHICLE POWER TRANSFER SYSTEM DEFINITIONS

- ELECTRIC VEHICLE POWER **EXPORT**
EQUIPMENT: The equipment, including the outlet on the vehicle, that is used to provide electrical power at voltages greater than or equal to 30 VAC or 60 VDC to loads external to the vehicle, using the vehicle as the source of supply.

625.42 RATING OF POWER TRANSFER EQUIPMENT

- The power transfer equipment must be sized for continuous loads and this must match the maximum load that can be delivered
- For “fastened in place” power transfer equipment, it is permitted to have adjustable settings, as long as it is available to only qualified personnel to set or reset.

625.44(B)(3) & (4) NEWLY-ADDED

RECEPTACLE FORMS

- (3) A non-locking 3-pole 4-wire grounding type receptacle outlet rated 250 volts, single-phase, 30-amp or 50 amp
- (4) A non-locking 2-pole 3-wire grounding type receptacle outlet rated 60 VDC maximum, 15-amp or 20 amp

654.54 NOT ALL VEHICLE CHARGING RECEPTACLES REQUIRE GFI

- If the vehicle charging receptacle is rated at greater than 150 volts to ground or is rated at greater than 50 amperes, then GFI personnel protection is optional.

NEW 625.60 USING THE ELECTRICAL VEHICLE TO EXPORT POWER TO OTHER LOADS

N 625.60 AC Receptacle Outlets Used for EVPE. AC receptacles installed in electric vehicles and intended to allow for connection of off-board utilization equipment shall comply with 625.60(A) through (D).

N (A) Type. The receptacle outlet shall be listed.

N (B) Rating. The receptacle outlet shall be rated 250 volts maximum, single phase 50 amperes maximum.

N (C) Overcurrent Protection. Electric vehicles provided with receptacle outlets for power export shall be provided with overcurrent protection integral to the power export system. The overcurrent protection shall have a nominal rating sufficient for the receptacle it protects. The overcurrent protection shall also be sufficiently rated for the maximum available fault current at the receptacle and shall be included in the interactive equipment evaluation. See 625.48.

N (D) GFCI Protection for Personnel. Ground-fault circuit-interrupter protection for personnel shall be provided for all receptacles. The ground-fault circuit-interrupter indication and reset shall be installed in a readily accessible location.

Informational Note: There are various methods available to achieve ground-fault circuit-interrupter protection.

SEC. 626.51 – RECEPTACLE LISTING FOR ELECTRIFIED TRUCK PARKING SPACES (REEFERS) NOW ALSO

INCLUDES:

- 60A, 250V, 3-PHASE, 3-POLE, 4-WIRE
- 60A, 480V, 3-PHASE, 3-POLE, 4-WIRE



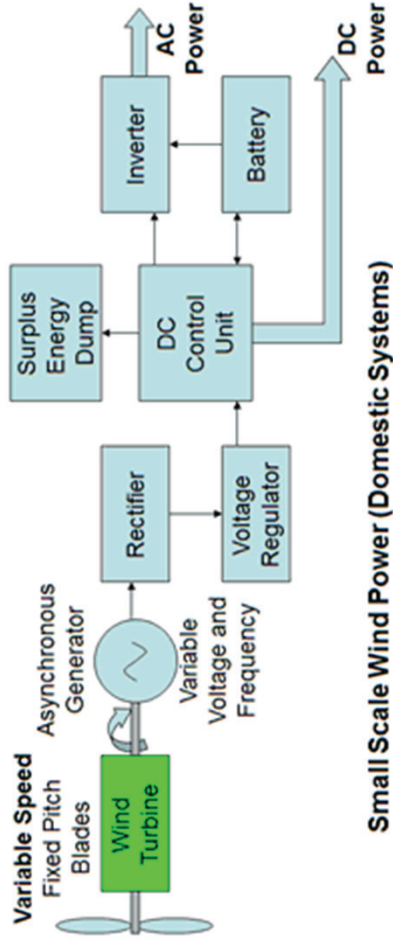
ART 690 SOLAR PHOTOVOLTAIC SYSTEMS

Although not a total rewrite, in this Article, the 2020 NEC contains more new and modified content than unchanged content. Detailed studies are suggested should a PV project arise.



694.7 WIND ELECTRICAL SYSTEMS EQUIPMENT

- Equipment must either
 - Be listed, or
 - Be field labeled



694.54(A) IDENTIFICATION OF POWER SOURCES

694.54 Identification of Power Sources. Wind turbine systems shall be identified according to 694.54(A) through (C).

N (A) Interconnected AC Systems. Plaques or directories shall be installed in accordance with 705.10.

Δ 705.10 Identification of Power Sources. A permanent plaque or directory shall be installed at each service equipment location, or at an approved readily visible location. The plaque or directory shall denote the location of each power source disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording "CAUTION: MULTIPLE SOURCES OF POWER." Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

694.54(B) IDENTIFICATION OF POWER SOURCES

N (B) DC Microgrid Systems. Plaques or directories shall be installed in accordance with 712.10.

Δ 712.10 Directory.

N (A) Source Directory. A permanent directory denoting all dc electric power sources operating to supply the dc microgrid shall be installed at each source location capable of acting as the primary dc source.

N (B) Building Directory. A building supplied by a dc microgrid system shall have a permanent plaque or directory installed outside the building at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power source disconnecting means on or in the building or be grouped with other plaques or directories for other on-site sources.

Exception: Multiple power production sources that are grouped at one location shall be permitted to be identified as a group.

Δ (2) Individual Source and On-site Standby Generator. An approved combination of one or more of the sources in 695.3(A) and an on-site standby generator complying with 695.3(D). [20:9.3.4]

Exception to 695.3(B)(1) and (B)(2): An alternate source of power shall not be required where a back-up engine-driven fire pump, back-up steam turbine-driven fire pump, or back-up electric motor-driven fire pump with an independent power source in accordance with 695.3(A) or (C) is installed.

695.3(C) MULTIPLE SOURCES OF FIRE PUMP POWER

Δ (C) Multibuilding Campus-Style Complexes. If the sources in 695.3(A) are not practicable and the installation is part of a multibuilding campus-style complex, feeder sources shall be permitted if approved by the authority having jurisdiction and installed in accordance with either 695.3(C)(1) and (C)(3) or (C)(2) and (C)(3).

(1) Feeder Sources. Two or more feeders shall be permitted as more than one power source if such feeders are connected to, or derived from, separate utility services. The connection(s), overcurrent protective device(s), and disconnecting means for such feeders shall meet the requirements of 695.4(B)(1)(b).

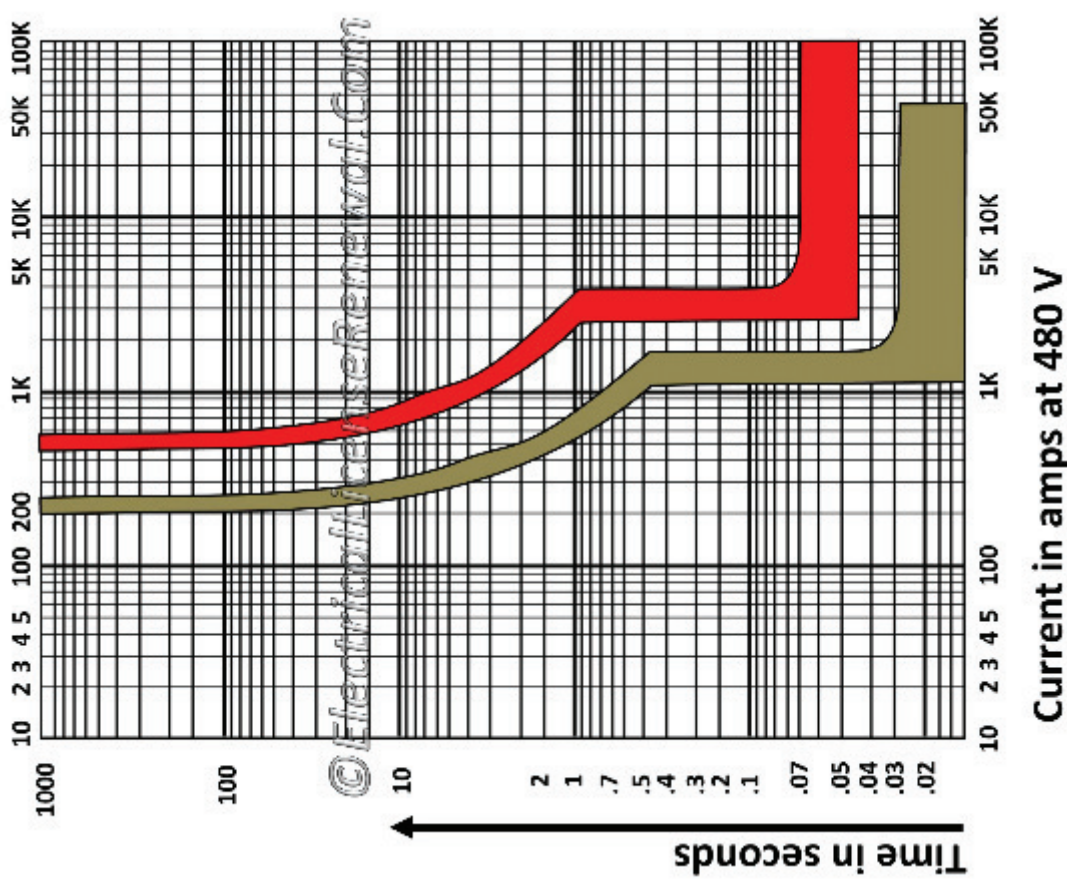
(2) Feeder and Alternate Source. A feeder shall be permitted as a normal source of power if an alternate source of power independent from the feeder is provided. The connection(s), overcurrent protective device(s), and disconnecting means for such feeders shall meet the requirements of 695.4(B)(1)(b).

Δ (3) Selective Coordination. Overcurrent protective device(s) shall be selectively coordinated with all supply-side overcurrent protective device(s).

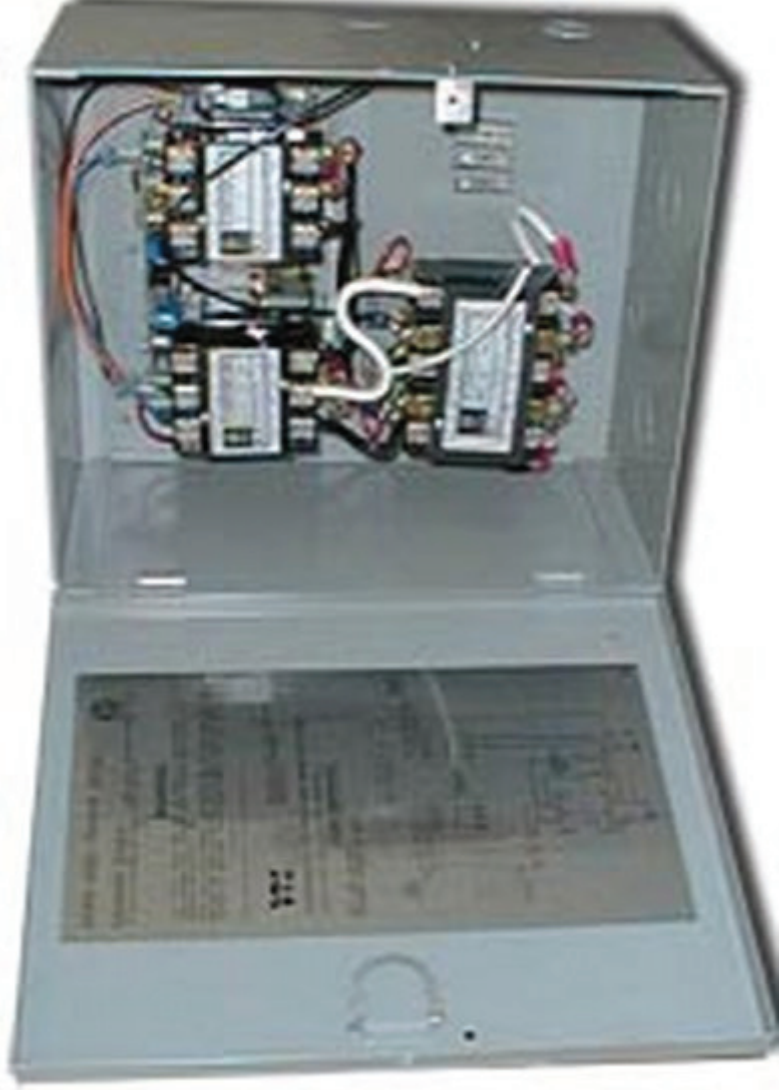
Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems.

695.3(C)(3) SELECTIVE COORDINATION

- Overcurrent protective devices shall be selectively coordinated with all supply-side overcurrent protective devices.
- Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems
- The TCC study shall be documented and made available by one authorized to design, install, and maintain the system.



700.5 TRANSFER EQUIPMENT SHALL
BE LISTED.



700.5(A) METER MOUNTED TRANSFER SWITCHES SHALL **NOT** BE PERMITTED FOR EMERGENCY USE

Model # MA23-N



GenerLink >

30 Amp Meter Mounted Transfer Switch

★★★★★ (20) ▾

[Write a Review](#)

[Questions & Answers \(72\)](#)

- Plug-and-play design works with portable generators
- Enables you to use entire electrical panel during outages
- Quick and easy installation in minutes

\$650⁰⁰

OR _____

\$109⁰⁰

per month* suggested payments with
6 months* financing on this \$650.00 purchase* **i**

[Apply for a Home Depot Consumer Card](#)

700.6 A VISUAL SIGNAL IS NOW
REQUIRED TO SHOW THAT THE
EMERGENCY SOURCE IS CARRYING
LOAD

700.12(H) DC MICROGRID SYSTEM ARE PERMITTED
FOR USE AS SOURCE OF EMERGENCY POWER

- Permitted where the system is **capable of being isolated** from all non-emergency sources
- The DC microgrid system used as a source of power for emergency systems shall be of suitable rating and capacity to supply and maintain the total emergency load for not less than 2 hours of full-demand operation
- Where a DC microgrid system source serves as the normal power supply for bldg.(s), it shall not serve as the sole source of power for the emergency standby system.

700.23 EMERGENCY LIGHTING FROM DIMMER AND RELAY SYSTEMS

New 2020 NEC additional requirement: Sensing to tell the dimmer and relay equipment to selectively switch on and off certain pre-selected lighting circuits by monitoring of the normal power source upstream of the transfer equipment.

700.5(A) METER MOUNTED TRANSFER SWITCHES SHALL **NOT** BE PERMITTED FOR LEGALLY-REQUIRED EMERGENCY STANDBY SYSTEMS USE

Model # MA23-N



GenerLink >

30 Amp Meter Mounted Transfer Switch

★★★★ (20) ▾

[Write a Review](#) [Questions & Answers \(72\)](#)

- Plug-and-play design works with portable generators
- Enables you to use entire electrical panel during outages
- Quick and easy installation in minutes

\$650⁰⁰

OR _____

\$109⁰⁰

per month* suggested payments with
6 months* financing on this \$650.00 purchase* **i**

[Apply for a Home Depot Consumer Card](#)

Transfer switching equipment shall be automatic, listed, and marked for emergency system use.

701.12(A) POWER SOURCE CONSIDERATIONS FOR LEGALLY REQUIRED STANDBY SYSTEMS

In addition to load size in kW, “In selecting a legally required standby source of power, consideration shall be given to the type of service to be rendered, whether of **short time duration or long time.**”

701.12(B) POWER SOURCE DESIGN AND LOCATION
CONSIDERATIONS FOR LEGALLY REQUIRED STANDBY SYSTEMS

“Consideration shall be given to the location, or design, or both, of all equipment to minimize the hazards that might cause complete failure due to floods, fires, icing, and vandalism.

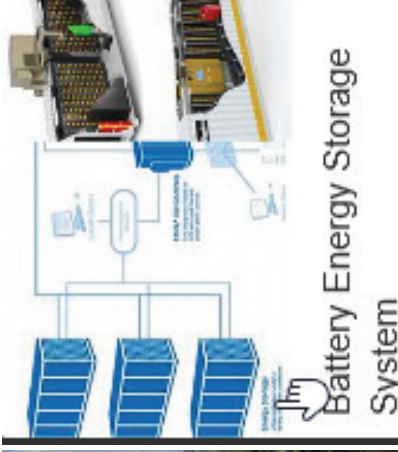
NEW SEC 702.5 TRANSFER SWITCH REQUIREMENTS

- (B) Transfer switches installed between the meter and the meter socket shall be **listed** meter-mounted manual transfer switches and shall be approved.
- (C) The **short circuit current rating and the settings shall be field-marked** on the transfer switch
- (D) Transfer switches shall be listed and shall prevent “interconnections of all sources of supply in any operation of the transfer equipment.”
- (E) For parallel operation, see Art 705, Interconnected Electric Power Production Sources.

IN THE 2020 NEC, MOST OF ART. 705, INTERCONNECTED ELECTRIC POWER PRODUCTION SOURCES, HAS BEEN REWRITTEN

When a facility has more than one power source, what must you do to maintain a safe operation? Article 705 answers that and other questions related to using power sources that operate in parallel with a primary source.

IN THE 2020 NEC, MOST OF ART. 706, ENERGY STORAGE SYSTEMS, HAS BEEN REWRITTEN



760.3(N) TEMPERATURE LIMITATIONS OF POWER-LIMITED AND NON-
POWER-LIMITED FIRE ALARM CABLES

- The requirements of Art 310.14(A)(3) [Table 310.16] on the temperature limitation of conductors shall apply to power-limited fire alarm cables and non-power-limited fire alarms cables.
 - Exception per 760.51(A): Where continuous NPFLA current in all conductors < 10% of rated amps
 - Exception per 760.51(B): Where continuous NPFLA current in more than 3 power conductors < 10% of rated amps

**760.3(0) COLOR OF EQUIPMENT GROUNDING
CONDUCTORS IN POWER-LIMITED AND NON-
POWER-LIMITED FIRE ALARM CABLES**

Per 250.119, the color of Equipment Grounding
Conductors shall be green, green with yellow
stripe(s), with the following Fire Alarm Cable
exceptions:

- Type FPLP
- Type FPLR
- Type FPL

770.49, 770.93, & 770.100 GROUNDING
AND BONDING FA CABLES

The non-current-carrying metal parts of FO cables shall be bonded together and shall be grounded at the point of termination of the cable.

SEE Art 770, PART V -- (ALMOST A
TOTAL REWRITE) INSTALLATION
METHODS FOR F.O. CABLE IN
BUILDINGS

ART 800, GENERAL REQUIREMENTS
FOR COMMUNICATIONS SYSTEMS, IS
ALMOST A TOTAL REWRITE IN THE
2020 NEC.

Note that the Informative Annexes at the back of the book have changed in content, as follows:

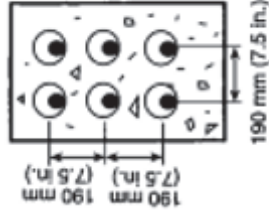
ANNEX A – PRODUCT SAFETY STANDARDS, WITH
NEW NEC ARTICLE REFERENCES
ANNEX E – TYPES OF CONSTRUCTION
ANNEX F – COPS
ANNEX G – SCADA
ANNEX H – ADMINISTRATION & ENFORCEMENT

NEWLY-REWRITTEN ANNEX A- PRODUCT SAFETY STANDARDS

This new Annex now includes each respective NEC Article and points to the UL Standard that would be a reference document in following an Art. 110.3 Examination. Below is a partial copy:

Article	Standard Number	Standard Title
110	UL 310	Electrical Quick-Connect Terminals
	UL 305	Panic Hardware
	UL 486A-486B	Wire Connectors
	UL 486C	Splicing Wire Connectors
	UL 486D	Sealed Wire Connector Systems
	UL 486E	Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
	UL 486F	Bare and Covered Ferrules
	UL 486G	Sealed Twist-On Connecting Devices
	UL 510	Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
	UL Subject 546	Conductor Termination Compounds
	UL 2459	Insulated Multi-Pole Splicing Wire Connectors
210	UL 943	Ground-Fault Circuit-Interruption
	UL 1699	Arc-Fault Circuit-Interruption
230	UL 1053	Ground-Fault Sensing and Relaying Equipment
	UL 2735	Electric Utility Meters
240	UL 198M	Mine-Duty Fuses
	UL 248-1	Low-Voltage Fuses — Part 1: General Requirements
	UL 248-2	Low-Voltage Fuses — Part 2: Class C Fuses

RECOMMEND THAT ONE MAKE USE OF THE ORIGINAL ICEA
46-466 OR THE ETAP UNDERGROUND MODULE **INSTEAD OF**
TRYING TO REFER TO ANNEX B



Detail 3
475 mm x 675 mm
(19 in. x 27 in.)
Electrical duct bank
Six electrical ducts

RECOMMEND AGAINST USING ANNEX C INSTEAD OF CHAPTER 9 CONDUIT FILL CALCULATIONS

TABLE C.12 Continued

Conductor Type	Conductor Size		
	(AWG/ kcmil)	$\frac{3}{4}$ (12)	$\frac{1}{2}$ (16)
Z	14	—	18
	12	—	13
	10	—	8
	8	—	5
	6	—	3
	4	—	2
	3	—	1
	2	—	1
	1	—	1
	XHHW, ZW, XHHW-2,	14	—
	12	—	8



**ANNEX D EXAMPLE CALCULATIONS
ARE SLIGHTLY REVISED**

ONLY SLIGHTLY CHANGED ANNEX E SHOWS TYPES OF CONSTRUCTION.

(THIS DATA IS VALUABLE IN POSITIONING TRANSFORMERS AWAY FROM WALLS OF VARIOUS TYPES)

Table E.1 Fire Resistance Ratings for Type I Through Type V Construction (hr)

	Type I		Type II		Type III		Type IV	Type V	
			222 + 111	000	211	200	2HH	111	000
Exterior Bearing Walls^a Supporting more than one floor, columns, or other bearing walls	4	3	2	1	2	2	2	1	0 ^b
Supporting one floor only	4	3	2	1	2	2	2	1	0 ^b
Supporting a roof only	4	3	1	1	2	2	2	1	0 ^b
Interior Bearing Walls Supporting more than one floor, columns, or other bearing walls	4	3	2	1	1	0	2	1	0
Supporting one floor only	3	2	2	1	1	0	1	1	0
Supporting roofs only	3	2	1	1	1	0	1	1	0
Columns Supporting more than one floor, columns, or other bearing walls	4	3	2	1	1	0	H	1	0
Supporting one floor only	3	2	2	1	1	0	H	1	0
Supporting roofs only	3	2	1	1	1	0	H	1	0
Beams, Girders, Trusses, and Arches Supporting more than one floor, columns, or other bearing walls	4	3	2	1	1	0	H	1	0
Supporting one floor only	2	2	2	1	1	0	H	1	0
Supporting roofs only	2	2	1	1	1	0	H	1	0
Floor/Ceiling Assemblies	2	2	2	1	1	0	H	1	0
Roof/Ceiling Assemblies	2	1½	1	1	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls^c	0 ^b	0 ^b	0 ^b	0 ^b	0 ^b	0 ^b	0 ^b	0 ^b	0 ^b

Source: Table 7.2.1.1 from NFPA 5000, Building Construction and Safety Code, 2018 edition.

ONLY SLIGHTLY CHANGED ANNEX F – AVAILABILITY AND RELIABILITY FOR CRITICAL OPERATIONS OF ELECTRICAL POWER SYSTEMS, CONSIDERING:

1. Reliability
2. Maintainability
3. Availability
4. Functional Performance Tests

COPS

**ONLY SLIGHTLY CHANGED ANNEX G
PROVIDING INFORMATION ABOUT
SUPERVISORY CONTROL AND DATA
ACQUISITION OF:**

SCADA

- a. The fire alarm system
- b. The security system
- c. Power distribution
- d. Power generation
- e. HVAC systems
- f. Load shedding,
- g. Fuel levels
- h. Other systems and functions

ONLY SLIGHTLY CHANGED ANNEX H FORMS A TEMPLATE FOR LOCAL ADOPTION OF THE 2020 NEC AND ITS ENFORCEMENT

Authority Having Jurisdiction. The organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

UNCHANGED ANNEX I: TIGHTENING TORQUES

Table I.1 Tightening Torque for Screws

Test Conductor Installed in Connector		Tightening Torque, N·m (lbf·in.)			
		Slotted head No. 10 and larger*			
AWG or kcmil	mm ²	Slot width 1.2 mm (0.047 in.) or less and slot length 6.4 mm (¼ in.) or less	Slot width over 1.2 mm (0.047 in.) or slot length over 6.4 mm (¼ in.)	Split-bolt connectors	Other connectors
30-10	0.05-5.3	2.3 (20)	4.0 (35)	9.0 (80)	8.5 (75)
8	8.4	2.8 (25)	4.5 (40)	9.0 (80)	8.5 (75)
6-4	13.2-21.2	4.0 (35)	5.1 (45)	18.5 (165)	12.4 (110)
3	26.7	4.0 (35)	5.6 (50)	31.1 (275)	16.9 (150)
2	33.6	4.5 (40)	5.6 (50)	31.1 (275)	16.9 (150)
1	42.4	—	5.6 (50)	31.1 (275)	16.9 (150)
1/0-2/0	53.5-67.4	—	5.6 (50)	43.5 (385)	20.3 (180)
3/0-4/0	85.0-107.2	—	5.6 (50)	56.5 (500)	28.2 (250)
250-350	127-177	—	5.6 (50)	73.4 (650)	36.7 (325)
400	203	—	5.6 (50)	93.2 (825)	36.7 (325)
500	253	—	5.6 (50)	93.2 (825)	42.4 (375)
600-750	304-380	—	5.6 (50)	113.0 (1000)	42.4 (375)
800-1000	405-508	—	5.6 (50)	124.3 (1100)	56.5 (500)
1250-2000	635-1010	—	5.6 (50)	124.3 (1100)	67.8 (600)

*For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length shall be measured at the bottom of the slot.

Table I.2 Tightening Torque for Slotted Head Screws Smaller Than No. 10 Intended for Use with 8 AWG (8.4 mm²) or Smaller Conductors

Slot Length of Screw ^a		Tightening Torque, N·m (lbf·in.)	
mm	in.	Slot width of screw smaller than 1.2 mm (0.047 in.) ^b	Slot width of screw 1.2 mm (0.047 in.) and larger ^b
Less than 4	Less than ½	0.79 (7)	1.0 (9)
4	½	0.79 (7)	1.4 (12)
4.8	⅜	0.79 (7)	1.4 (12)
5.5	⅜	0.79 (7)	1.4 (12)
6.4	¼	0.79 (7)	1.4 (12)
7.1	⅜	1.0 (9)	1.7 (15)
Above 7.1	Above ¾	—	2.3 (20)

UNCHANGED ANNEX J

ADA STANDARDS

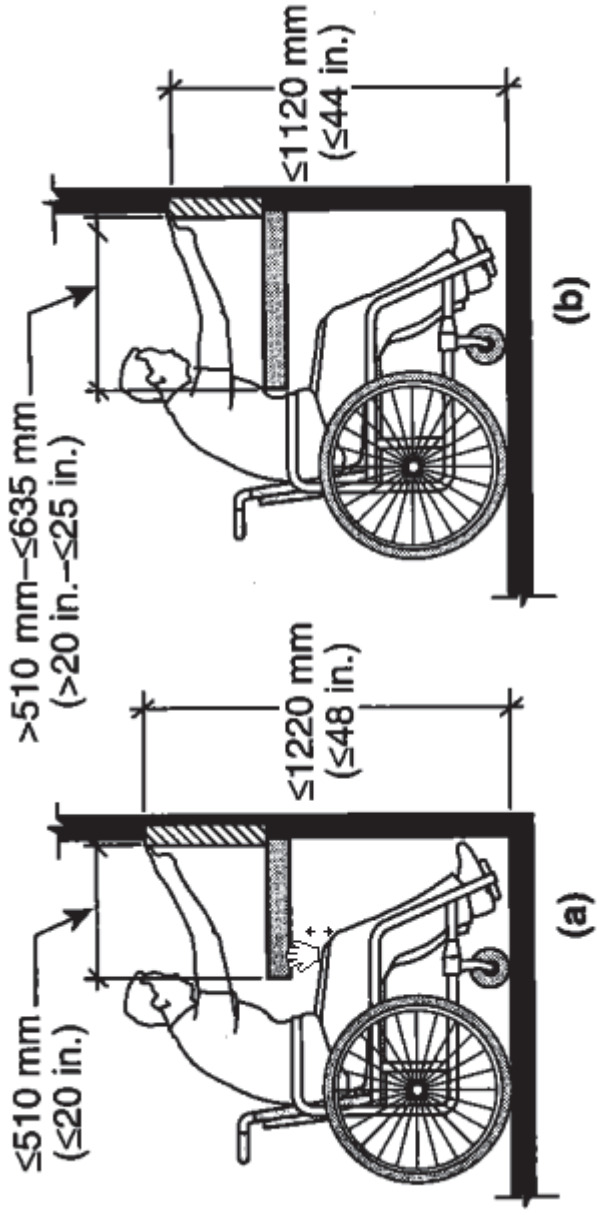


FIGURE J.6.2 Obstructed High Forward Reach.

THANK YOU FOR COMING!



Kiewit

SAFETY MESSAGE: REMEMBER,
ELECTRICAL THINGS CAN HURT
YOU! STAY SAFE OUT THERE!

