

NEC 2017 Code Changes

Chapter 7 – Special Conditions

All of Article 706 is new to the 2017 NEC Code.

ARTICLE 706 - Energy Storage Systems

Part I. General

706.1 Scope. This article applies to all permanently installed energy storage systems (ESS) operating at over 50 volts ac or 60 volts dc that may be stand-alone or interactive with other electric power production sources.

Informational Note: The following standards are frequently referenced for the installation of energy storage systems:

- (1) NFPA 111-2013, Standard on Stored Electrical Energy Emergency and Standby Systems
- (2) IEEE 484-2008, Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
- (3) IEEE 485-1997, Recommended Practice for Sizing Vented Lead- Acid Storage Batteries for Stationary Applications
- (4) IEEE 1145-2007, Recommended Practice for Installation and Maintenance of Nickel Cadmium Batteries for Photovoltaic (PV) Systems
- (5) IEEE 1187-2002, Recommended Practice for Installation Design, and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications

- (6) IEEE 1578-2007, Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management
- (7) IEEE 1635/ASHRAE 21-2012, Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications
- (8) UL 810A, Electrochemical Capacitors
- (9) UL 1973, Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
- (10) UL 1989, Standard for Standby Batteries
- (11) UL Subject 2436, Spill Containment For Stationary Lead Acid Battery Systems
- (12) UL Subject 9540, Safety of Energy Storage Systems and Equipment

706.2 Definitions.

Battery. Two or more cells connected together electrically in series, in parallel, or a combination of both to provide the required operating voltage and current levels.

Cell. The basic electrochemical unit, characterized by an anode and a cathode, used to receive, store, and deliver electrical energy.

Container. A vessel that holds the plates, electrolyte, and other elements of a single unit, comprised of one or more cells, in a battery. It can be referred to as a jar or case.

Diversion Charge Controller. Equipment that regulates the charging process of an ESS by diverting power from energy storage to direct-current or alternating-current loads or to an interconnected utility service.

Electrolyte. The medium that provides the ion transport mechanism between the positive and negative electrodes of a cell.

Energy Storage System (ESS). One or more components assembled together capable of storing energy for use at a future time. ESS(s) can include but is not limited to batteries, capacitors, and kinetic energy devices (e.g., flywheels and compressed air). These systems can have ac or dc output for utilization and can include inverters and converters to change stored energy into electrical energy.

Energy Storage System, Self-Contained. Energy storage systems where the components such as cells, batteries, or modules and any necessary controls, ventilation, illumination, fire suppression, or alarm systems are assembled, installed, and packaged into a singular energy storage container or unit.

Informational Note: Self-contained systems will generally be manufactured by a single entity, tested and listed to safety standards relevant to the system, and readily connected on site to the electrical system and in the case of multiple systems to each other.

Energy Storage System, Pre-Engineered of Matched Components. Energy storage systems that are not self-contained systems but instead are pre-engineered and field-assembled using separate components supplied as a system by a singular entity that are matched and intended to be assembled as an energy storage system at the system installation site.

Informational Note: Pre-engineered systems of matched components for field assembly as a system will generally be designed by a single entity and comprised of components that are tested and listed separately or as an assembly.

Energy Storage System, Other. Energy storage systems that are not self-contained or pre-engineered systems of matched components but instead are composed of individual components assembled as a system.

Informational Note: Other systems will generally be comprised of different components combined on site to create an ESS. Those components would generally be tested and listed to safety standards relevant to the application.

Flow Battery. An energy storage component similar to a fuel cell that stores its active materials in the form of two electrolytes external to the reactor interface. When in use, the electrolytes are transferred between reactor and storage tanks.

Informational Note: Two commercially available flow battery technologies are zinc bromine and vanadium redox, sometimes referred to as pumped electrolyte ESS.

Intercell Connector. An electrically conductive bar or cable used to connect adjacent cells.

Intertier Connector. In a battery system, an electrical conductor used to connect two cells on different tiers of the same rack or different shelves of the same rack.

Inverter Input Circuit. Conductors between the inverter and the ESS in stand-alone and multimode inverter systems.

Inverter Output Circuit. Conductors between the inverter and another electric power production source, such as a utility for an electrical production and distribution network.

Inverter Utilization Output Circuit. Conductors between the multimode or standalone inverter and utilization equipment.

Nominal Voltage (Battery or Cell). The value assigned to a cell or battery of a given voltage class for the purpose of convenient designation. The operating voltage of the cell or battery may vary above or below this value.

Sealed Cell or Battery. A cell or battery that has no provision for the routine addition of water or electrolyte or for external measurement of electrolyte specific gravity.

Informational Note: Some cells that are considered to be sealed under conditions of normal use, such as valve-regulated lead acid or some lithium cells, contain pressure relief valves.

Terminal. That part of a cell, container, or battery to which an external connection is made (commonly identified as a post, pillar, pole, or terminal post).

706.3 Other Articles. Wherever the requirements of other articles of this Code and Article 706 differ, the requirements of Article 706 shall apply. If the ESS is capable of being operated in parallel with a primary source(s) of electricity, the requirements in 705.6, 705.12, 705.14, 705.16, 705.32, 705.40, 705.100, 705.143, and Part IV of Article 705 shall apply.

706.4 System Classification. ESS shall be classified as one of the types described as follows:

(1) ESS, self-contained

Informational Note: Some self-contained systems may be listed.

(2) ESS, pre-engineered of matched components

(3) ESS, other

706.5 Equipment. Monitors, controls, switches, fuses, circuit breakers, power conversion systems, inverters and transformers, energy storage components, and other components of the energy storage system other than lead-acid batteries, shall be listed. Alternatively, self contained ESS shall be listed as a complete energy storage system.

706.6 Multiple Systems. Multiple ESSs shall be permitted to be installed in or on a single building or structure.

706.7 Disconnecting Means.

(A) ESS Disconnecting Means. A disconnecting means shall be provided for all ungrounded conductors derived from an ESS. A disconnecting means shall be readily accessible and located within sight of the ESS.

Informational Note: See 240.21(H) for information on the location of the overcurrent device for conductors.

(B) Remote Actuation. Where controls to activate the disconnecting means of an ESS are not located within sight of the system, the disconnecting means shall be capable of being locked in the open position, in accordance with 110.25, and the location of the controls shall be field marked on the disconnecting means.

(C) Busway. Where a dc busway system is installed, the disconnecting means shall be permitted to be incorporated into the busway.

(D) Notification. The disconnecting means shall be legibly marked in the field. The marking shall meet the requirements of 110.21(B) and shall include the following:

- (1) Nominal ESS voltage
- (2) Maximum available short-circuit current derived from the ESS
- (3) The associated clearing time or arc duration based on the available short-circuit current from the ESS and associated overcurrent protective devices if applicable
- (4) Date the calculation was performed

Exception: *The labeling in 706.7(D)(1) through (D)(4) shall not be required if an arc flash label is applied in accordance with acceptable industry practice.*

Informational Note No. 1: Industry practices for equipment labeling are described in NFPA 70E-2015, Standard for Electrical Safety in the Workplace. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.

Informational Note No. 2: Battery equipment suppliers can provide information about short circuit current on any particular battery model.

(E) Partitions and Distance. Where energy storage system input and output terminals are more than 1.5 m (5 ft) from connected equipment, or where the circuits from these terminals pass through a wall or partition, the installation shall comply with the following:

(1) A disconnecting means shall be provided at the energy storage system end of the circuit. Fused disconnecting means or circuit breakers shall be permitted to be used.

(2) A second disconnecting means located at the connected equipment shall be installed where the disconnecting means required by 706.7(E)(1) is not within sight of the connected equipment.

Informational Note No. 1: For remote disconnect controls in information technology equipment rooms, see 645.10.

Informational Note No. 2: For overcurrent protection of batteries, see 240.21(H).

(3) Where fused disconnecting means are used, the line terminals of the disconnecting means shall be connected toward the energy storage system terminals.

(4) Disconnecting means shall be permitted to be installed in energy storage system enclosures where explosive atmospheres can exist if listed for hazardous locations.

(5) Where the disconnecting means in (1) is not within sight of the disconnecting means in (2), placards or directories shall be installed at the locations of all disconnecting means indicating the location of all other disconnecting means.

706.8 Connection to Other Energy Sources. Connection to other energy sources shall comply with the requirements of 705.12.

(A) Load Disconnect. A load disconnect that has multiple sources of power shall disconnect all energy sources when in the off position.

(B) Identified Interactive Equipment. Only inverters and ac modules listed and identified as interactive shall be permitted on interactive systems.

(C) Loss of Interactive System Power. Upon loss of primary source, an ESS with a utility interactive inverter shall comply with the requirements of 705.40.

(D) Unbalanced Interconnections. Unbalanced connections between an energy storage system and electric power production sources shall be in accordance with 705.100.

(E) Point of Connection. The point of connection between an energy storage system and electric power production sources shall be in accordance with 705.12.

706.10 Energy Storage System Locations. Battery locations shall conform to 706.10(A), (B), and (C).

(A) Ventilation. Provisions appropriate to the energy storage technology shall be made for sufficient diffusion and ventilation of any possible gases from the storage device, if present, to prevent the accumulation of an explosive mixture. A pre-engineered or self-contained ESS shall be permitted to provide ventilation in accordance with the manufacturer's recommendations and listing for the system.

Informational Note No. 1: See NFPA 1-2015, Fire Code, Chapter 52, for ventilation considerations for specific battery chemistries.

Informational Note No. 2: Some storage technologies do not require ventilation.

Informational Note No. 3: A source for design of ventilation of battery systems is IEEE 1635-2012/ASHRAE Guideline 21-2012 Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications, and the UBC.

Informational Note No. 4: Fire protection considerations are addressed in NFPA 1-2015, Fire Code.

(B) Guarding of Live Parts. Guarding of live parts shall comply with 110.27.

(C) Spaces About ESS Components. Spaces about the ESS shall comply with 110.26. Working space shall be measured from the edge of the ESS modules, battery cabinets, racks, or trays. For battery racks, there shall be a minimum clearance of 25 mm (1 in.) between a cell container and any wall or structure on the side not requiring access for maintenance. ESS modules, battery cabinets, racks, or trays shall be permitted to contact adjacent walls or structures, provided that the battery shelf has a free air space for not less than 90 percent of its length. Pre-engineered and self-contained ESSs shall be permitted to have working space between components within the system in accordance with the manufacturer's recommendations and listing of the system.

Informational Note: Additional space is often needed to accommodate ESS equipment hoisting equipment, tray removal, or spill containment.

(D) Egress. A personnel door(s) intended for entrance to and egress from rooms designated as ESS rooms shall open in the direction of egress and shall be equipped with listed panic hardware.

(E) Illumination. Illumination shall be provided for working spaces associated with ESS and their equipment and components. Luminaires shall not be controlled by automatic means only. Additional luminaires shall not be required where the work space is illuminated by an adjacent light source. The location of luminaires shall not do either of the following:

(1) Expose personnel to energized system components while performing maintenance on the luminaires in the system space

(2) Create a hazard to the system or system components upon failure of the luminaire

706.11 Directory. ESS shall be indicated by 706.11(A) and (B). The markings or labels shall be in accordance with 110.21(B).

(A) Directory. A permanent plaque or directory denoting all electric power sources on or in the premises shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected.

Exception: *Installations with large numbers of power production sources shall be permitted to be designated by groups.*

(B) Facilities with Stand-Alone Systems. Any structure or building with an ESS that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory installed on the exterior of the building or structure at a readily visible location

acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system.

Part II. Circuit Requirements

706.20 Circuit Sizing and Current.

(A) Maximum Rated Current for a Specific Circuit. The maximum current for the specific circuit shall be calculated in accordance with 706.20(A)(1) through (A)(5).

(1) Nameplate-Rated Circuit Current. The nameplate(s)- rated circuit current shall be the rated current indicated on the ESS nameplate(s) or system listing for pre-engineered or self contained systems of matched components intended for field assembly as a system.

(2) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating.

(3) Inverter Input Circuit Current. The maximum current shall be the continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.

(4) Inverter Utilization Output Circuit Current. The maximum current shall be the continuous inverter output current rating when the inverter is producing rated power at the lowest input voltage.

(5) DC to DC Converter Output Current. The maximum current shall be the dc-to-dc converter continuous output current rating.

(B) Conductor Ampacity and Overcurrent Device Ratings. The ampacity of the feeder circuit conductors from the ESS(s) to the wiring system serving the loads to be serviced by the system shall not be less than the greater of the (1) nameplate(s) rated circuit current as determined in accordance with 706.20(A) or (2) the rating of the ESS(s) overcurrent protective device(s).

(C) Ampacity of Grounded or Neutral Conductor. If the output of a single-phase, 2-wire ESS output(s) is connected to the grounded or neutral conductor and a single ungrounded conductor of a 3-wire system or of a 3-phase, 4-wire, wye connected system, the maximum unbalanced neutral load current plus the ESS(s) output rating shall not exceed the ampacity of the grounded or neutral conductor.

706.21 Overcurrent Protection.

(A) Circuits and Equipment. ESS circuit conductors shall be protected in accordance with the requirements of Article 240. Protection devices for ESS circuits shall be in accordance with the requirements of 706.21(B) through (F). Circuits shall be protected at the source from overcurrent.

(B) Overcurrent Device Ampere Ratings. Overcurrent protective devices, where required, shall be rated in accordance with Article 240 and the rating provided on systems serving the ESS and shall be not less than 125 percent of the maximum currents calculated in 706.20(A).

(C) Direct Current Rating. Overcurrent protective devices, either fuses or circuit breakers, used in any dc portion of an ESS shall be listed and for dc and shall have the appropriate voltage, current, and interrupting ratings for the application.

(D) Current Limiting. A listed and labeled current-limiting overcurrent protective device shall be installed adjacent to the ESS for each dc output circuit.

Exception: *Where current-limiting overcurrent protection is provided for the dc output circuits of a listed ESS, additional current-limiting overcurrent devices shall not be required.*

(E) Fuses. Means shall be provided to disconnect any fuses associated with ESS equipment and components when the fuse is energized from both directions and is accessible to other than qualified persons. Switches, pullouts, or similar devices that are rated for the application shall be permitted to serve as a means to disconnect fuses from all sources of supply.

(F) Location. Where ESS input and output terminals are more than 1.5 m (5 ft) from connected equipment, or where the circuits from these terminals pass through a wall or partition, overcurrent protection shall be provided at the ESS.

706.23 Charge Control.

(A) General. Provisions shall be provided to control the charging process of the ESS. All adjustable means for control of the charging process shall be accessible only to qualified persons.

Informational Note: Certain types of energy storage equipment such as valve-regulated lead acid or nickel cadmium can experience thermal failure when overcharged.

(B) Diversion Charge Controller.

(1) Sole Means of Regulating Charging. An ESS employing a diversion charge controller as the sole means of regulating charging shall be equipped with a second independent means to prevent overcharging of the storage device.

(2) Circuits with Diversion Charge Controller and Diversion Load. Circuits containing a diversion charge controller and a diversion load shall comply with the following:

- (1) The current rating of the diversion load shall be less than or equal to the current rating of the diversion load charge controller. The voltage rating of the diversion load shall be greater than the maximum ESS voltage. The power rating of the diversion load shall be at least 150 percent of the power rating of the charging source.
- (2) The conductor ampacity and the rating of the overcurrent device for this circuit shall be at least 150 percent of the maximum current rating of the diversion charge controller.

(3) Energy Storage Systems Using Utility-Interactive Inverters. Systems using utility-interactive inverters to control energy storage state-of-charge by diverting excess power into the utility system shall comply with 706.23(B)(3)(a) and (B)(3)(b).

- (a) These systems shall not be required to comply with 706.23(B)(2).
- (b) These systems shall have a second, independent means of controlling the ESS charging process for use when the utility is not present or when the primary charge controller fails or is disabled.

(C) Charge Controllers and DC-to-DC Converters. Where charge controllers and other DC-to-DC power converters that increase or decrease the output current or output voltage with respect to the input current or input voltage are installed, all of the following shall apply:

(1) The ampacity of the conductors in output circuits shall be based on the maximum rated continuous output current of the charge controller or converter for the selected output voltage range.

(2) The voltage rating of the output circuits shall be based on the maximum voltage output of the charge controller or converter for the selected output voltage range.

Part III. Electrochemical Energy Storage Systems

Part III of this article applies to ESSs that are comprised of sealed and non-sealed cells or batteries or system modules that are comprised of multiple sealed cells or batteries that are not components within a listed product.

Informational Note: An energy storage component, such as batteries, that are integrated into a larger piece of listed equipment, such as an uninterruptible power supply (UPS), are examples of components within a listed product.

706.30 Installation of Batteries.

(A) Dwelling Units. An ESS for dwelling units shall not exceed 100 volts between conductors or to ground.

Exception: *Where live parts are not accessible during routine ESS maintenance, an ESS voltage exceeding 100 volts shall be permitted.*

(B) Disconnection of Series Battery Circuits. Battery circuits subject to field servicing, where exceeding 240 volts nominal between conductors or to ground, shall have provisions to disconnect the series-connected strings into segments not exceeding 240 volts nominal for maintenance by qualified persons. Non-load-break bolted or plug-in disconnects shall be permitted.

(C) Storage System Maintenance Disconnecting Means. ESS exceeding 100 volts between conductors or to ground shall have a disconnecting means, accessible only to qualified persons, that disconnects ungrounded and grounded circuit conductor(s) in the electrical storage system for maintenance. This disconnecting means shall not disconnect the grounded circuit conductor(s) for the remainder of any other electrical system. A non-load-break-rated switch shall be permitted to be used as a disconnecting means.

(D) Storage Systems of More Than 100 Volts. On ESS exceeding 100 volts between the conductors or to ground, the battery circuits shall be permitted to operate with ungrounded conductors, provided a ground-fault detector and indicator is installed to monitor for ground faults within the storage system.

706.31 Battery and Cell Terminations.

(A) Corrosion Prevention. Antioxidant material suitable for the battery connection shall be used when recommended by the battery or cell manufacturer.

Informational Note: The battery manufacturer's installation and instruction manual can be used for guidance for acceptable materials.

(B) Intercell and Intertier Conductors and Connections. The ampacity of field-assembled intercell and intertier connectors and conductors shall be of such cross-sectional area that the temperature rise under maximum load conditions and at maximum ambient temperature shall not exceed the safe operating temperature of the conductor insulation or of the material of the conductor supports.

Informational Note: Conductors sized to prevent a voltage drop exceeding 3 percent of maximum anticipated load, and where the maximum total voltage drop to the furthest point of connection does not exceed 5 percent, may not be appropriate for all battery applications. IEEE 1375-2003, Guide for the Protection of Stationary Battery Systems, provides guidance for overcurrent protection and associated cable sizing.

(C) Battery Terminals. Electrical connections to the battery and the cable(s) between cells on separate levels or racks shall not put mechanical strain on the battery terminals. Terminal plates shall be used where practicable.

706.32 Battery Interconnections. Flexible cables, as identified in Article 400, in sizes 2/0 AWG 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 as moisture resistant. Flexible, fine-stranded cables shall only be used with terminals, lugs, devices, or connectors in accordance with 110.14.

706.33 Accessibility. The terminals of all cells or multicell units shall be readily accessible for readings, inspection, and cleaning where required by the equipment design. One side of transparent battery containers shall be readily accessible for inspection of the internal components.

706.34 Battery Locations. Battery locations shall conform to 706.34(A), (B), and (C).

(A) Live Parts. Guarding of live parts shall comply with 110.27.

(B) Top Terminal Batteries. Where top terminal batteries are installed on tiered racks or on shelves of battery cabinets, working space in accordance with the storage equipment manufacturer's instructions shall be provided between the highest point on a storage system component and the row, shelf, or ceiling above that point.

Informational Note: IEEE 1187 provides guidance for top clearance of VRLA batteries, which are the most commonly used battery in cabinets.

(C) Gas Piping. Gas piping shall not be permitted in dedicated battery rooms.

Part IV. Flow Battery Energy Storage Systems

Part IV applies to ESSs composed of or containing flow batteries.

706.40 General. All electrical connections to and from the system and system components shall be in accordance with the applicable provisions of Article 692. The system and system components shall also meet the provisions of Parts I and II of this article. Unless otherwise directed by this article, flow battery ESS shall comply with the applicable provisions of Article 692.

706.41 Electrolyte Classification. The electrolyte(s) that are acceptable for use in the batteries associated with the ESS shall be identified by name and chemical composition. Such identification shall be provided by readily discernable signage adjacent to every location in the system where the electrolyte can be put into or taken out of the system.

706.42 Electrolyte Containment. Flow battery systems shall be provided with a means for electrolyte containment to prevent spills of electrolyte from the system. An alarm system shall be provided to signal an electrolyte leak from the system. Electrical wiring and connections shall be located and routed in a manner that mitigates the potential for exposure to electrolytes.

706.43 Flow Controls. Controls shall be provided to safely shut down the system in the event of electrolyte blockage.

706.44 Pumps and Other Fluid Handling Equipment. Pumps and other fluid handling equipment are to be rated/specified suitable for exposure to the electrolytes.

Part V. Other Energy Storage Technologies

The provisions of Part V apply to ESSs using other technologies intended to store energy and when there is a demand for electrical power to use the stored energy to generate the needed power.

706.50 General. All electrical connections to and from the system and system components shall be in accordance with the applicable provisions of this Code. Unless otherwise directed by this article, other energy storage technologies shall comply with the applicable provisions of Part III of Article 705.