ARTICLE
706 Energy Storage Systems

Part I. General

Δ **706.1 Scope.** This article applies to all energy storage systems (ESS) having a capacity greater than 3.6 MJ (1 kWh) that may be stand-alone or interactive with other electric power production sources. These systems are primarily intended to store and provide energy during normal operating conditions.

Energy storage systems (ESS) store energy for later use. Wind power and photovoltaic (PV) systems generate power when the resource is available, not necessarily when the energy is needed. Energy storage optimizes the use of stand-alone alternative energy by storing energy during peak production times so that the energy can be used at a time when wind or sunlight is not available. Increasingly, energy storage is being used to take advantage of utility generating capacity during overnight hours when demand for energy is low and the time-of-use energy rates are customer friendly. Storing energy might reduce the need to build additional generating stations. Energy storage can be installed at the generating facility, or it can be geographically distributed throughout the service area.

The overall scope of Article 706 covers the complete assembly for storing and exporting electrical energy. In accordance with 706.5, this assembly of components is required to be listed as an ESS. UL 9540, *Energy Storage Systems and Equipment*, contains product safety requirements for electrochemical, chemical, mechanical, and thermal ESS. A battery-based ESS certified in accordance with UL 9540 is subject to the installation requirements of Article 706, rather than with Article 480. A group of separate components that includes storage batteries; that is provided with support systems (racks), charge controller(s), and inverters; and that does not have an overall listing as an ESS is a storage battery system and as such is subject to the requirements of Article 480.

Informational Note No. 1: See Article 480 for installations that meet the definition of *stationary standby batteries*.

Informational Note No. 2: For batteries rated in ampere hours, kWh is equal to the nominal rated voltage times ampere-hour rating divided by 1000.

Informational Note No. 3: The following standards are frequently referenced for the installation of ESSs:

(1) NFPA 1-2021, *Fire Code*
(2) NFPA 111-2019, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*
(3) NECA 416-2016, *Recommended Practice for Installing Energy Storage Systems (ESS)*
(4) UL 810A, *Electrochemical Capacitors*
(5) NFPA 855-2020, *Standard for the Installation of Stationary Energy Storage Systems*
(6) UL 1973, *Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power, and Light Electric Rail (LER) Applications*
(7) UL 1989, *Standard for Standby Batteries*
(8) UL 9540, *Standard for Safety Energy Storage Systems and Equipment*
(9) UL Subject 2436, *Spill Containment For Stationary Lead Acid Battery Systems*

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706.3 Qualified Personnel. The installation and maintenance of ESS equipment and all associated wiring and interconnections shall be performed only by qualified persons.

Informational Note: See Article 100 for the definition of *qualified person*.

706.4 System Requirements. Each ESS shall be provided with a nameplate plainly visible after installation and marked with the following:

(1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for supplying the ESS can be identified
(2) Rated frequency
(3) Number of phases, if ac
(4) Rating (kW or kVA)
(5) Available fault current derived by the ESS at the output terminals
(6) Maximum output and input current of the ESS at the output terminals
(7) Maximum output and input voltage of the ESS at the output terminals
(8) Utility-interactive capability, if applicable

706.5 Listing. Energy storage systems shall be listed.

706.6 Multiple Systems. Multiple ESSs shall be permitted to be installed on the same premises.

Δ **706.7 Commissioning and Maintenance.**

N **(A) Commissioning.** ESSs shall be commissioned upon installation. This shall not apply in one- and two-family dwellings.

Informational Note: See NFPA 855-2020, *Standard for the Installation of Stationary Energy Storage Systems*, for information related to the commissioning of ESSs.

N **(B) Maintenance.** ESSs shall be maintained in proper and safe operating condition. The required maintenance shall be in accordance with the manufacturer's requirements and industry standards. A written record of the system maintenance shall be kept and shall include records of repairs and replacements necessary to maintain the system in proper and safe operating condition. This shall not apply in one- and two-family dwellings.

Informational Note: See NFPA 70B-2019, *Recommended Practice for Electrical Equipment Maintenance*, or ANSI/NETA ATS-2017, *Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems*, for information related to general electrical equipment maintenance and developing an effective electrical preventive maintenance (EPM) program.

• **706.9 Maximum Voltage.** The maximum voltage of an ESS shall be the rated ESS input and output voltage(s) indicated on the ESS nameplate(s) or system listing.

Part II. Disconnecting Means

706.15 Disconnecting Means.

Δ **(A) ESS Disconnecting Means.** Means shall be provided to disconnect the ESS from all wiring systems, including other power systems, utilization equipment, and its associated premises wiring.

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N **(B) Location and Control.** The disconnecting means shall be readily accessible and shall comply with one or more of the following:

(1) Located within the ESS
(2) Located within sight and within 3 m (10 ft) from the ESS
(3) Where not located within sight of the ESS, the disconnecting means, or the enclosure providing access to the disconnecting means, shall be capable of being locked in accordance with 110.25

Where controls to activate the disconnecting means of an ESS are used and are not located within sight of the ESS, the disconnecting means shall be lockable in accordance with 110.25, and the location of the controls shall be marked on the disconnecting means.

For one- and two-family dwellings, an ESS shall include an emergency shutdown function to cease the export of power from the ESS to premises wiring of other systems. An initiation device(s) shall be located at a readily accessible location outside the building and shall plainly indicate whether in the "off" or "on" position. The "off" position of the device(s) shall perform the ESS emergency shutdown function.

See also

Section 230.85 and associated commentary for information on emergency disconnects for services supplying one- and two-family dwellings

Δ **(C) Notification and Marking.** Each ESS disconnecting means shall plainly indicate whether it is in the open (off) or closed (on) position and be permanently marked as follows:

"ENERGY STORAGE SYSTEM DISCONNECT"

The disconnecting means shall be legibly marked in the field to indicate the following:

(1) Nominal ESS output voltage
(2) Available fault current derived from the ESS
(3) An arc-flash label applied in accordance with acceptable industry practice
(4) Date the calculation was performed

Exception: List items (2), (3), and (4) shall not apply to one- and two-family dwellings.

Informational Note No. 1: See NFPA *70E*-2018, *Standard for Electrical Safety in the Workplace*, for industry practices for equipment labeling. 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: ESS electronics could include inverters or other types of power conversion equipment.

For ESS disconnecting means where the line and load terminals could be energized in the open position, the device shall be marked with the following words or equivalent:

WARNING
ELECTRIC SHOCK HAZARD
TERMINALS ON THE LINE AND LOAD
SIDES MAY BE ENERGIZED IN THE OPEN POSITION

The notification(s) and marking(s) shall comply with 110.21(B).

(D) Partitions Between Components. Where circuits from the input or output terminals of energy storage components in an ESS pass through a wall, floor, or ceiling, a readily accessible disconnecting means shall be provided within sight of the energy storage component. Fused disconnecting means or circuit breakers shall be permitted to be used.

N **(E) Disconnecting Means for Batteries.** In cases where the battery is separate from the ESS electronics and is subject to field servicing, 706.15(E)(1) through (E)(4) shall apply.

Informational Note: Batteries could include an enclosure, battery monitoring and controls, or other related battery components.

N **(1) Disconnecting Means.** A disconnecting means shall be provided for all ungrounded conductors. A disconnecting means shall be readily accessible and located within sight of the battery.

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

N **(2) Disconnection of Series Battery Circuits.** Battery circuits exceeding 240 volts dc nominal between conductors or to ground 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.

N **(3) Remote Activation.** Where a disconnecting means is provided with remote controls to activate the disconnecting means and the controls for the disconnecting means are not located within sight of the battery, 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.

N **(4) Notification.** 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 the following:

(1) Nominal battery voltage
(2) Available fault current derived from the stationary standby battery system

Informational Note No. 1: Battery equipment suppliers can provide information about available fault current on any particular battery model.

(3) An arc-flash label in accordance with acceptable industry practice

Informational Note No. 2: See NFPA *70E*-2021, *Standard for Electrical Safety in the Workplace*, for assistance in determining the severity of potential exposure, planning safe work practices, determining arc-flash labeling, and selecting personal protective equipment.

(4) Date the calculation was performed

706.16 Connection to Energy Sources. The connection of an ESS to sources of energy shall comply with 706.16(A) through (F).

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

(B) Identified Interactive Equipment. ESS that operate in parallel with other ac sources shall use inverters that are listed and identified as interactive.

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

(D) Unbalanced Interconnections. Unbalanced ac connections between an ESS and other ac electric power production sources shall be in accordance with 705.45

Δ **(E) Other Energy Sources.** The connection of an ESS to other energy sources shall be in accordance with 705.12.

(F) Stand-Alone Operation. Where the output of an ESS is capable of operating in stand-alone mode, the requirements of 710.15 shall apply.

See also

Section 710.1 and associated commentary for more information on power production sources operating in stand-alone mode being used as the alternate source for an optional standby system

Part III. Installation Requirements

706.20 General.

Δ **(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. Ventilation of an ESS shall be permitted to be provided in accordance with the manufacturer's recommendations and listing for the system.

Informational Note No. 1: See NFPA 855-2020, *Standard for the Installation of Stationary Energy Storage Systems*, for technology-specific guidance. Not all ESS technologies require ventilation.

Informational Note No. 2: See IEEE 1635-2018/ASHRAE Guideline 21-2018, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*, as a source for design of ventilation of batteries.

(B) Dwelling Units. An ESS for one- and two-family dwelling units shall not exceed 100 volts dc between conductors or to ground.

Exception: Where live parts are not accessible during routine ESS maintenance, a maximum ESS voltage of 600 volts dc shall be permitted.

(C) Spaces About ESS Components.

(1) General. Working spaces for ESS shall comply with 110.26 and 110.34.

(2) Space Between Components. ESSs shall be permitted to have space between components in accordance with the manufacturer's instructions and listing.

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

706.21 Directory (Identification of Power Sources). ESS shall be indicated by markings or labels that shall be in accordance with 110.21(B).

Δ **(A) Facilities with Utility Services and ESS.** Plaques or directories shall be installed in accordance with 705.10.

(B) Facilities with Stand-Alone Systems. Plaques or directories shall be installed in accordance with 710.10.

Part IV. Circuit Requirements

706.30 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 706.30(A)(1) through (A)(5).

(1) Nameplate-Rated Circuit Current. Circuit current shall be the rated current indicated on the ESS nameplate(s) or system listing. Where the ESS has separate input (charge) and output (discharge) circuits or ratings, these shall be considered individually. Where the same terminals on the ESS are used for charging and discharging, the rated current shall be the greater of the two.

(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 ac output current rating of the inverter when the inverter is producing rated power.

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

Δ **(B) Conductor Ampacity.** The ampacity of the output circuit conductors of the ESS(s) connected to the wiring system serving the loads to be serviced by the system shall not be less than the

greater of the nameplate(s)-rated circuit current as determined in accordance with 706.30(A)(1) or 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.

706.31 Overcurrent Protection.

Δ **(A) Circuits and Equipment.** Protection devices for ESS circuits shall be in accordance with 706.31(B) through (F). Circuits shall be protected at the source from overcurrent. A circuit conductor connected at one end to a supply with integral fault protection, where the conductor is rated for the maximum circuit current from that supply, and also connected to sources having an available maximum circuit current greater than the ampacity of the conductor, shall be protected from overcurrent at the point of connection to the higher current source.

Informational Note: Listed electronic power converter circuits powered by an ESS have integral fault protection. Where these circuits are connected to higher current sources such as a utility service, the overcurrent device is more appropriately installed at the higher current source end of the circuit conductor.

Δ **(B) Overcurrent Device Ampere Ratings.** Overcurrent protective devices, where required, shall be not less than 125 percent of the maximum currents calculated in 706.30(A).

Exception: Where the assembly, including the overcurrent protective devices, is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent devices shall be permitted to be not less than the maximum currents calculated in 706.30(B).

(C) Direct Current Rating. Overcurrent protective devices, either fuses or circuit breakers, used in any dc portion of an ESS shall be listed 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 circuits from the input or output terminals of energy storage components in an ESS pass through a wall, floor, or ceiling, overcurrent protection shall be provided at the energy storage component end of the circuit.

706.33 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.

(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) ESS Using Interactive Inverters. Systems using interactive inverters to control energy storage state-of-charge by diverting excess power into an alternate electric power production and distribution system, such as utility, shall comply with 706.33(B)(3)(a) and (B)(3)(b).

(a) These systems shall not be required to comply with 706.33(B)(2).
(b) These systems shall have a second, independent means of controlling the ESS charging process for use when the alternate system is not available 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 V. Flow Battery ESSs

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

Informational Note: Due to the unique design features and difference in operating characteristics of flow batteries as compared with that of storage batteries such as lead acid or lithium ion batteries, the requirements for flow batteries have been included herein (Article 706, Part V).

Δ **706.40 General.** The system and system components shall also meet Parts I, II, and III of this article.

Informational Note: See NFPA 855-2020, *Standard for the Installation of Stationary Energy Storage Systems*, for installation requirements for ESS, including requirements for flow batteries.

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 VI. Other Energy Storage Technologies

Part VI applies 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*. The systems shall comply with Parts I, II, III, and IV of this article.

N **706.51 Flywheel ESS (FESS).** Flywheel ESS (FESS) using flywheels as the storage mechanism shall also comply with all of the following:

(1) FESS shall not be used for one- or two-family dwelling units.

Informational Note No. 1: FESS are intended for high-power shorter term applications. They contain parts that rotate under high speed with hazardous kinetic energy and include parts such as magnetic bearings that require ongoing monitoring and maintenance and, therefore, are not suitable for residential-type applications.

(2) FESS shall be provided with bearing monitoring and controls that can identify bearing wear or damage to avoid catastrophic failure.

Informational Note No. 2: The bearing monitoring controls should be evaluated as part of the listing evaluation.

(3) FESS shall be provided with a containment means to contain moving parts that could break from the system upon catastrophic failure.

Informational Note No. 3: The containment means should be evaluated as part of the listing evaluation.

(4) The spin-down time of the FESS shall be provided in the maintenance documentation.

ARTICLE 708 Critical Operations Power Systems (COPS)

Part I. General

Δ **708.1 Scope.** This article applies to the installation, operation, monitoring, control, and maintenance of the portions of the premises wiring system intended to supply, distribute, and control electricity to designated critical operations areas (DCOA) in the event of disruption to elements of the normal system.

Critical operations power systems are those systems so classed by municipal, state, federal, or other codes by any governmental agency having jurisdiction or by facility engineering documentation establishing the necessity for such a system. These systems include but are not limited to power systems, HVAC, fire alarm, security, communications, and signaling for designated critical operations areas.

Informational Note No. 1: Critical operations power systems are generally installed in vital infrastructure facilities that, if destroyed or incapacitated, would disrupt national security, the economy, public health or safety; and where enhanced electrical infrastructure for continuity of operation has been deemed necessary by governmental authority.

Informational Note No. 2: See *NFPA 1600*-2019, *Standard on Continuity, Emergency, and Crisis Management*, for further information on disaster and emergency management.

Informational Note No. 3: See NFPA 110-2019, *Standard for Emergency and Standby Power Systems*, for further information regarding performance of emergency and standby power systems.

Informational Note No. 4: See NFPA *101*-2021, *Life Safety Code*, or the applicable building code, for specification of locations where emergency lighting is considered essential to life safety.