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2017 NEC® - Keeping Up With the Times

Article 706 Energy Storage Systems
Article 712 Direct-Current Microgrids

NECA Academy of
Electrical Contractors

June 12, 2015 | Jeff Sargent, NFPA Regional Electrical Code Specialist

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The 2017 NEC Process

Completed to this Point

Process Stage	Process Step	Dates for TC with CC	Wks
	Public Input Closing Date for Paper Submittal	10/3/2014	
Public Input Stage (First Draft)	Public Input Closing Date for Online Submittal (e-PI)	11/7/2014	9
	Final date for First Draft Meeting	1/12-24/2015	8
	Posting of First Draft and Panel Ballot	3/20/2015	2
	Final date for Receipt of First Draft ballot	4/3/2015	1
	Final date for Receipt of First Draft ballot - recirc	4/10/2015	1
	Posting of First Draft for CC Meeting	4/17/2015	6
	Final date for CC First Draft Meeting	5/29/2015	4
	Posting of First Draft and CC Ballot	6/26/2015	1
	Final date for Receipt of CC First Draft ballot	7/3/2015	1
	Final date for Receipt of CC First Draft ballot - recirc	7/10/2015	1
	Post Final First Draft for Public Comment	7/17/2015	10

Remaining 2017 Revision Schedule

Process Stage	Process Step	Dates for TC with CC	Wks
	Public Input Closing Date for Paper Submittal	10/3/2014	
Public Input Stage (First Draft)	Public Input Closing Date for Online Submittal (e-PI)	11/7/2014	9
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	Posting of First Draft for CC Meeting	4/17/2015	6
	Final date for CC First Draft Meeting	5/29/2015	4
	Posting of First Draft and CC Ballot	6/26/2015	1
	Final date for Receipt of CC First Draft ballot	7/3/2015	1
	Final date for Receipt of CC First Draft ballot - recirc	7/10/2015	1
	Post Final First Draft for Public Comment	7/17/2015	10

Remaining 2017 Revision Schedule

Comment Stage (Second Draft)	Public Comment Closing Date for Paper Submittal	8/21/2015	
	Public Comment Closing Date for Online Submittal (e-PC)	9/25/2015	5
	Final date for Second Draft Meeting	11/2-14/2015	7
	Posting of Second Draft and Panel Ballot	1/4/2016	2
	Final date for Receipt of Second Draft Ballot	1/15/2016	1
	Final date for receipt of Second Draft ballot - recirc	1/22/2016	2
	Posting of Second Draft for CC Mtg	2/5/2016	2
	Final date for CC Second Draft Meeting	2/22-26/2016	3
	Posting of Second Draft for CC Ballot	3/18/2016	1
	Final date for Receipt of CC Second Draft ballot	3/25/2016	1
	Final date for Receipt of CC Second Draft ballot - recirc	4/1/2016	1
	Post Final Second Draft for NITMAM Review	4/8/2016	3

Remaining 2017 Revision Schedule

Tech Session Preparation	Notice of Intent to Make a Motion (NITMAM) Closing Date	4/29/2016	2
	Posting of Certified Amending Motions	5/13/2016	3
Tech Session	Association Meeting for Documents with CAMs	6/13-16/2016	
Appeals and Issuance	Appeal Closing Date for NEC CAMs (20 Days)	7/6/2016	
	SC Issuance Dates for Documents with CAMs	8/11/2016	

Public Comment Closing Dates

Paper: **August 21, 2105**

Electronic: **September 25, 2015**

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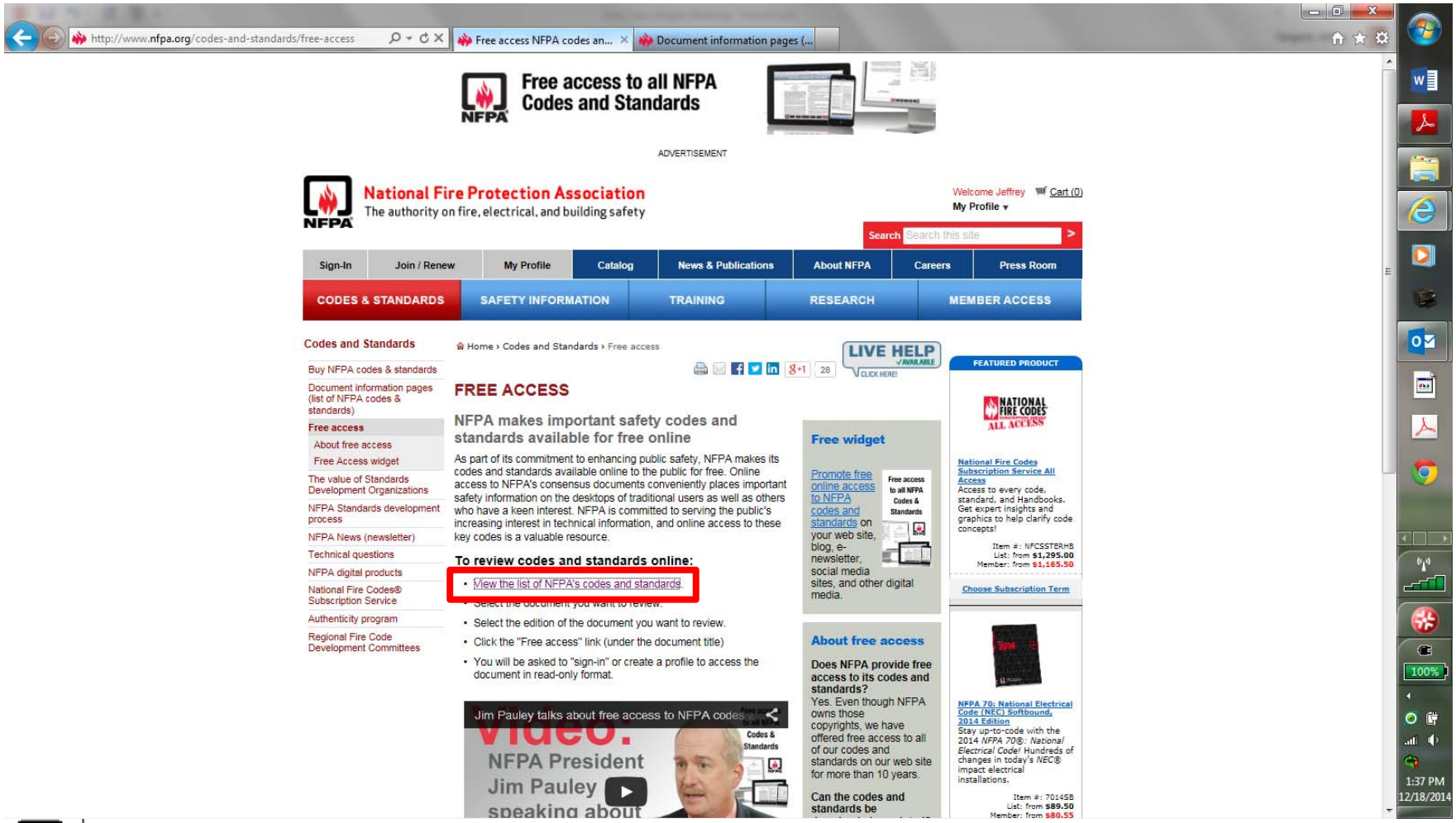
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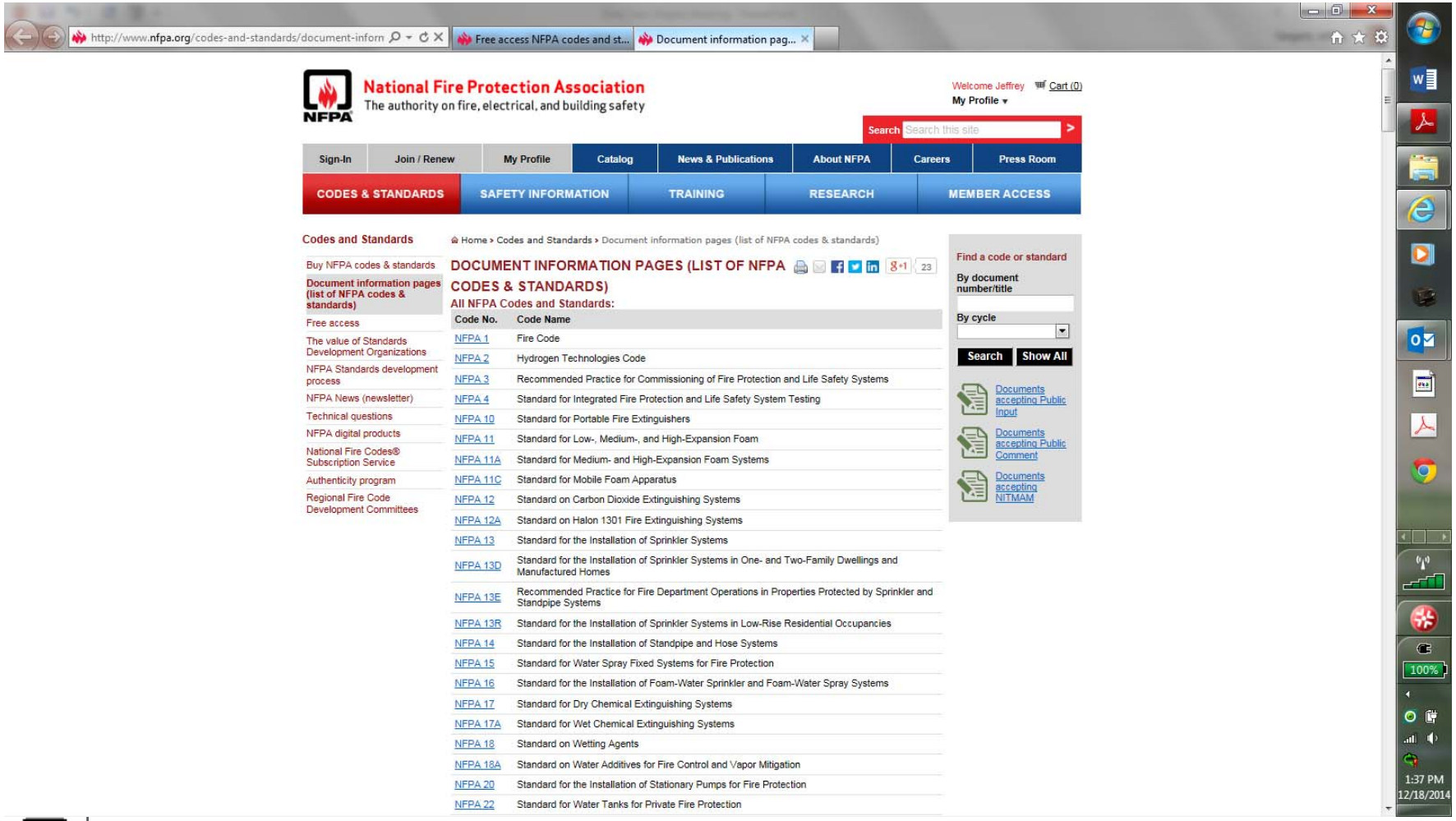
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NFPA 12A Standard on Halon 1301 Fire Extinguishing Systems
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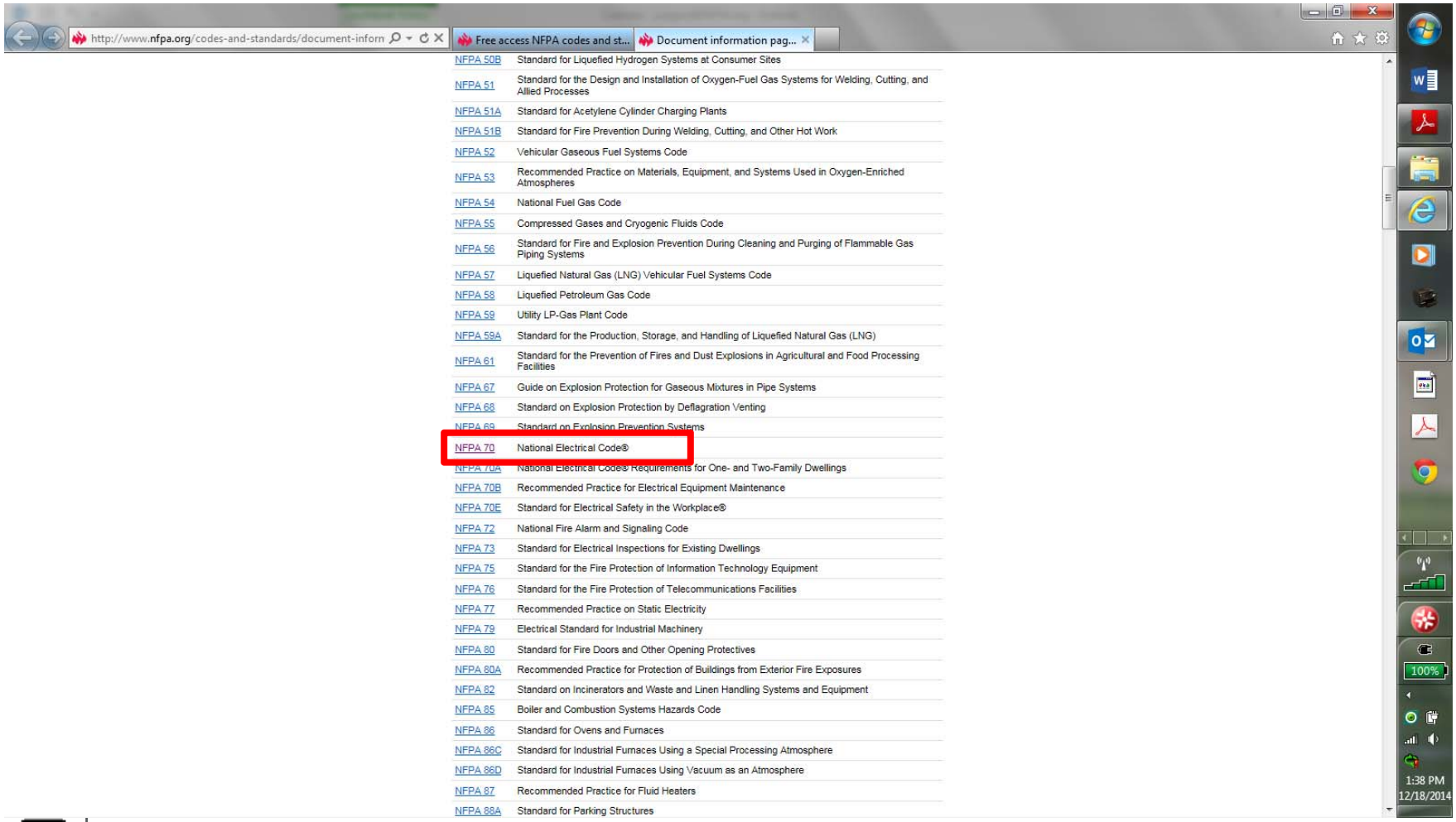
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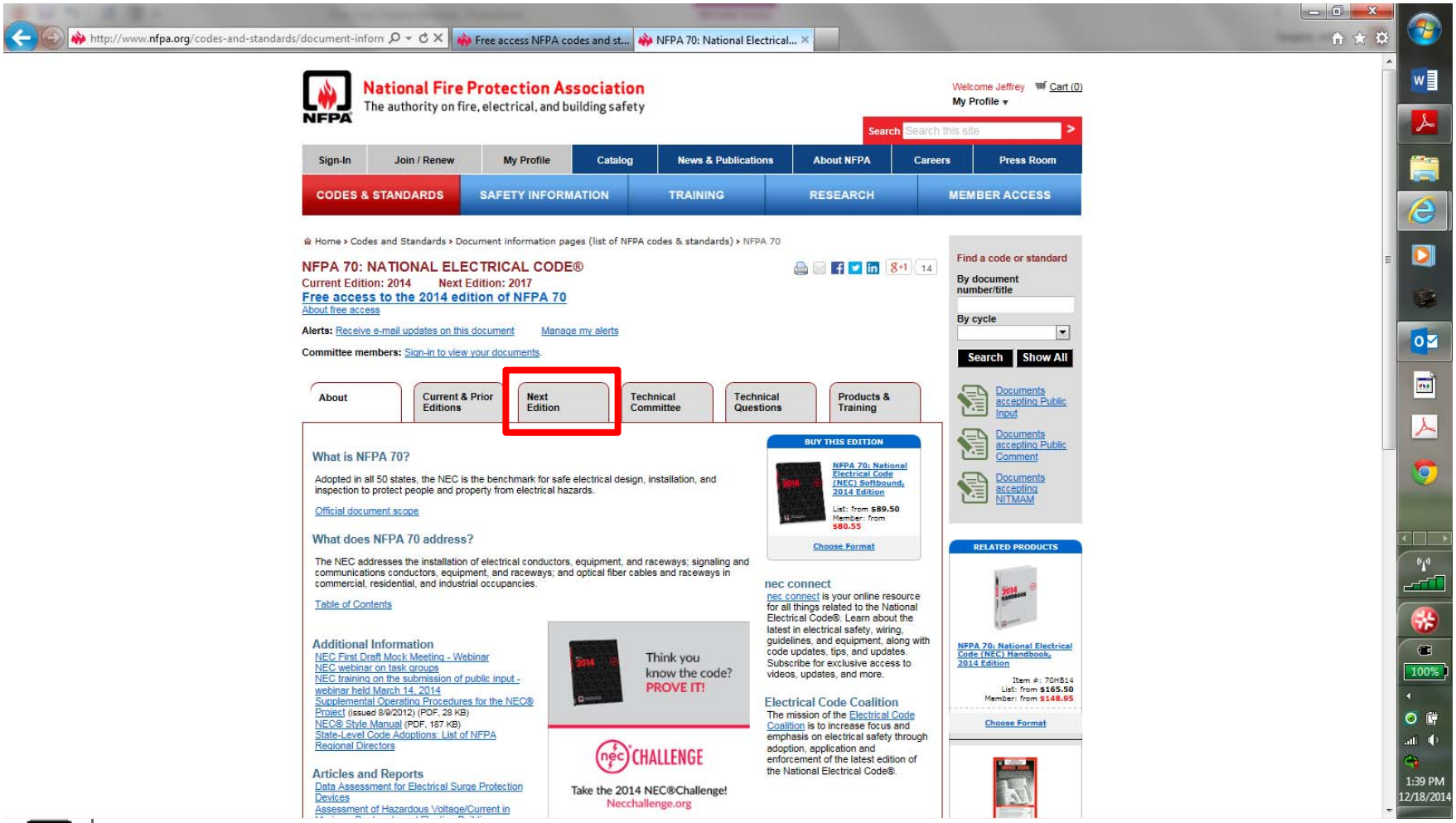
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Official document scope
What does NFPA 70 address?
The NEC addresses the installation of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways in commercial, residential, and industrial occupancies.
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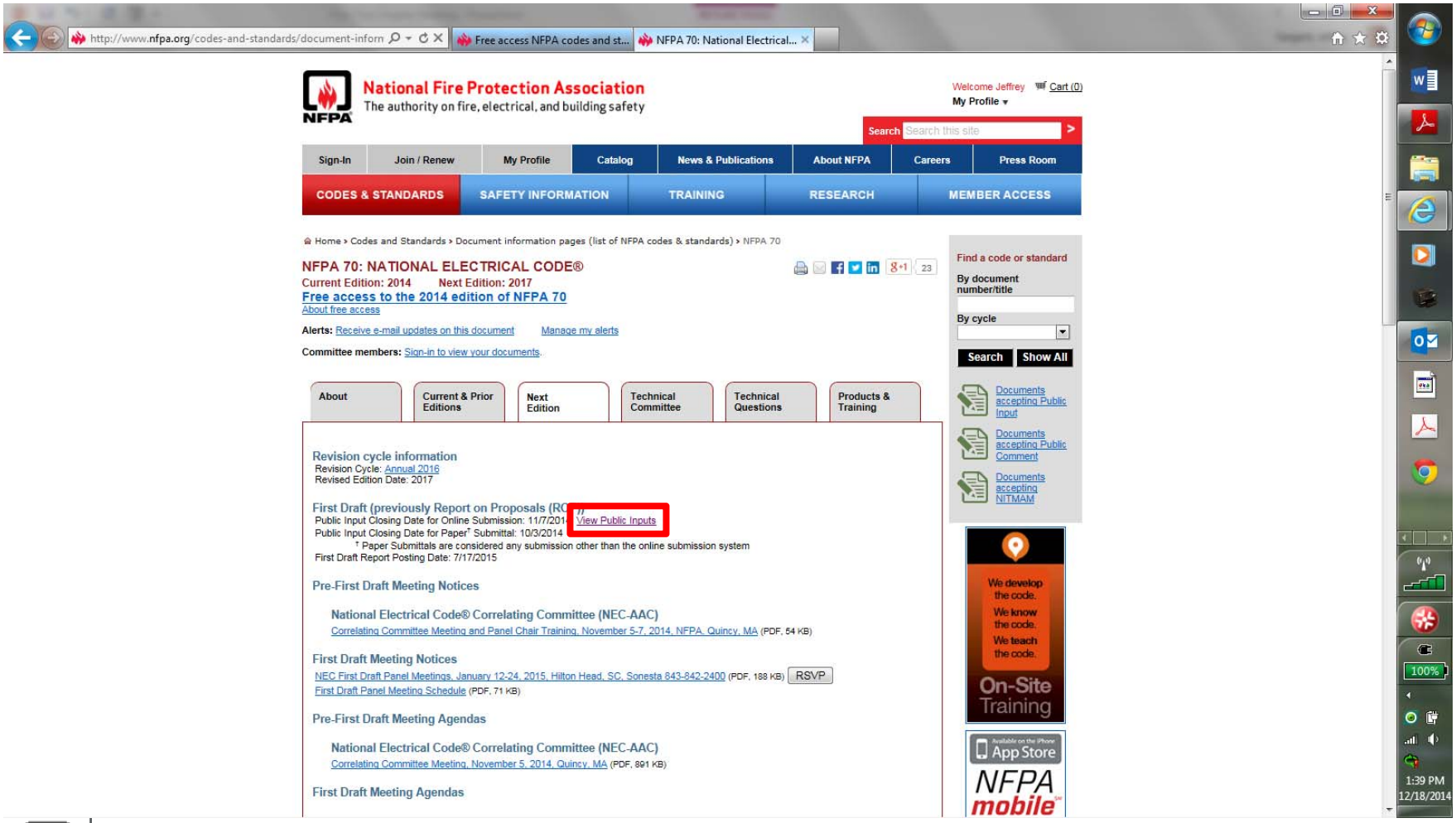
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Correlating Committee Meeting and Panel Chair Training, November 5-7, 2014, NFPA, Quincy, MA (PDF, 54 KB)
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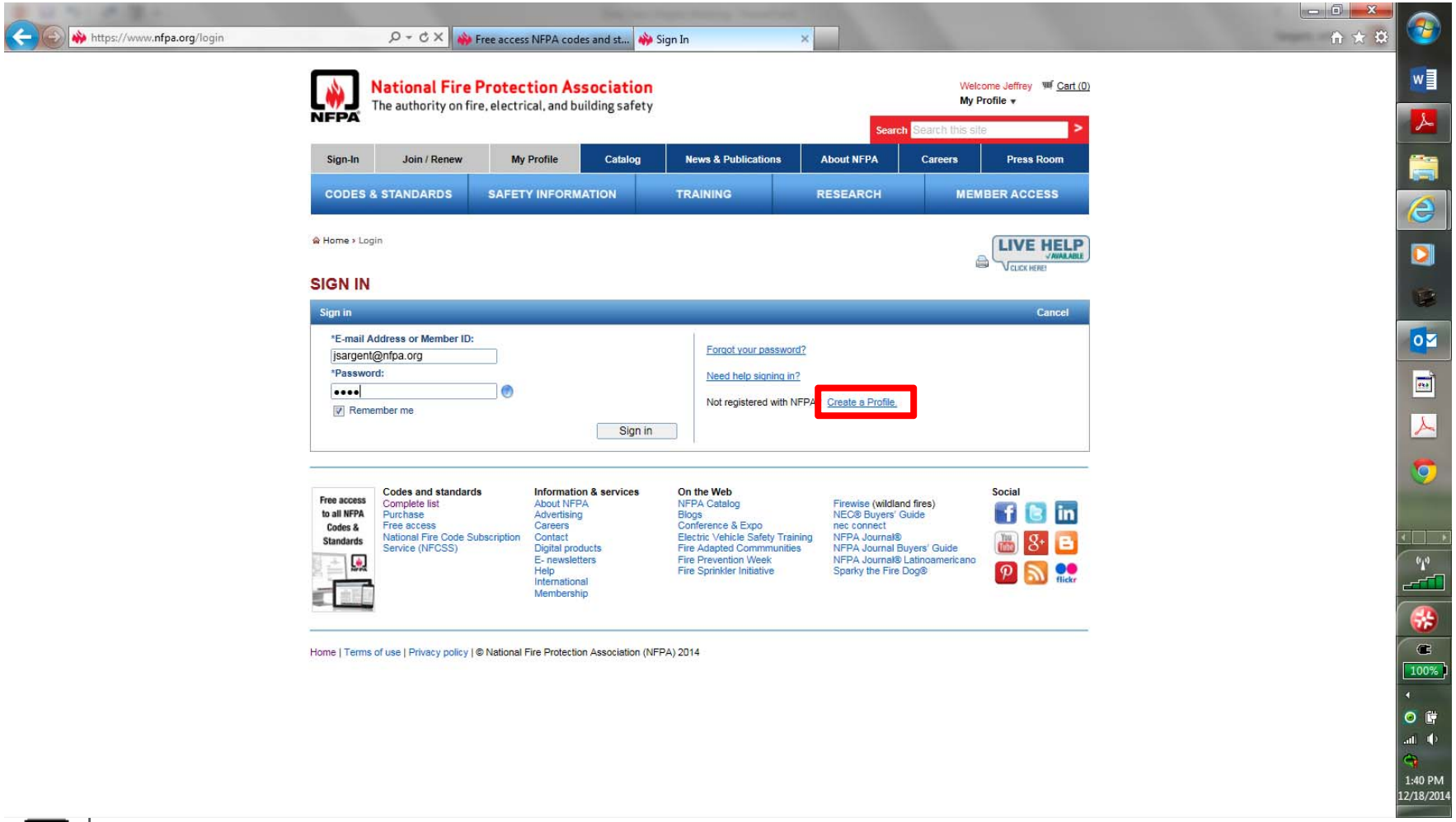
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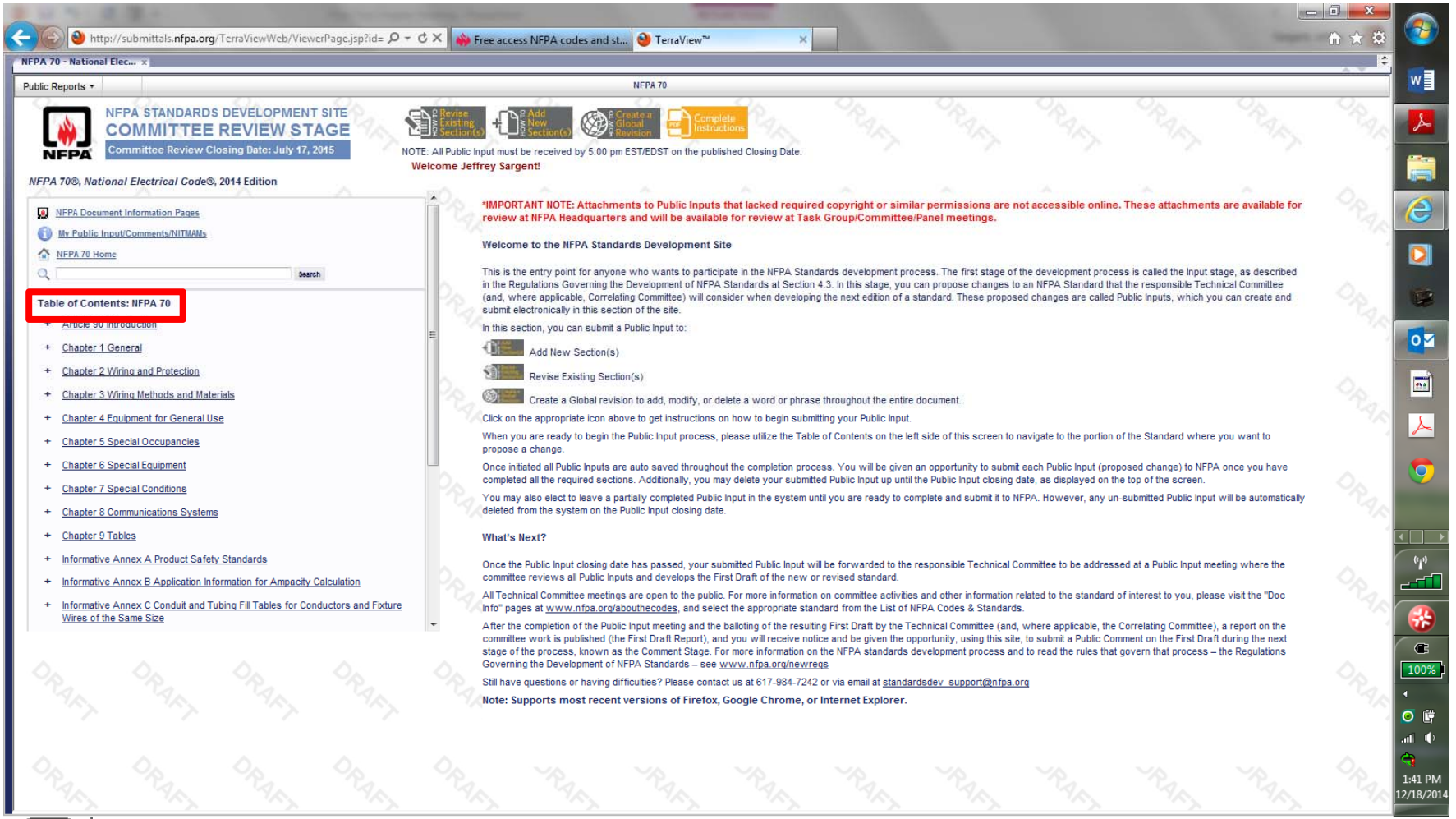
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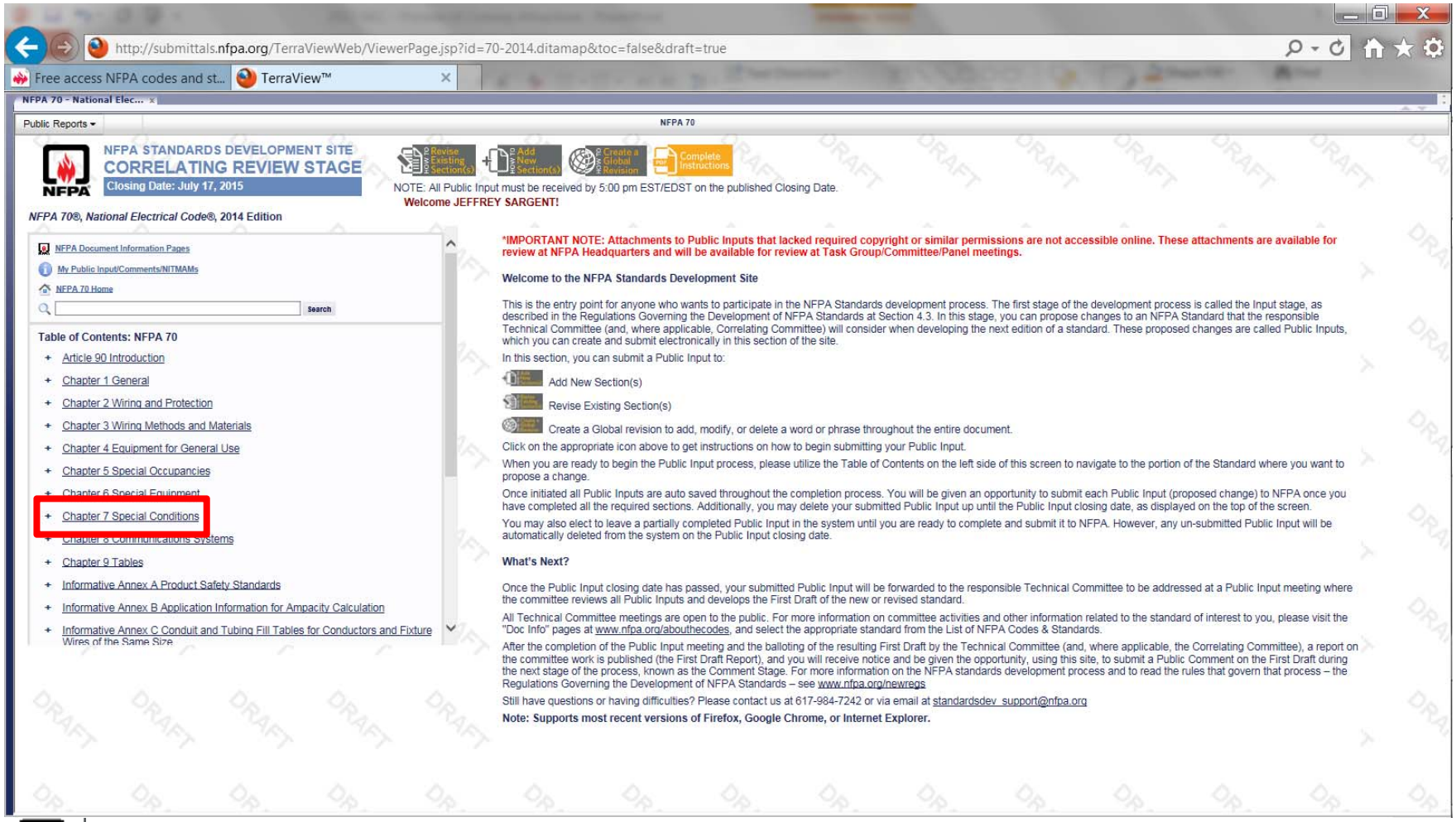
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Chapter 8 Communications Systems
Chapter 9 Tables
Informative Annex A Product Safety Standards
Informative Annex B Application Information for Ampacity Calculation
Informative Annex C Conduit and Tubing Fill Tables for Conductors and Fixture Wires of the Same Size
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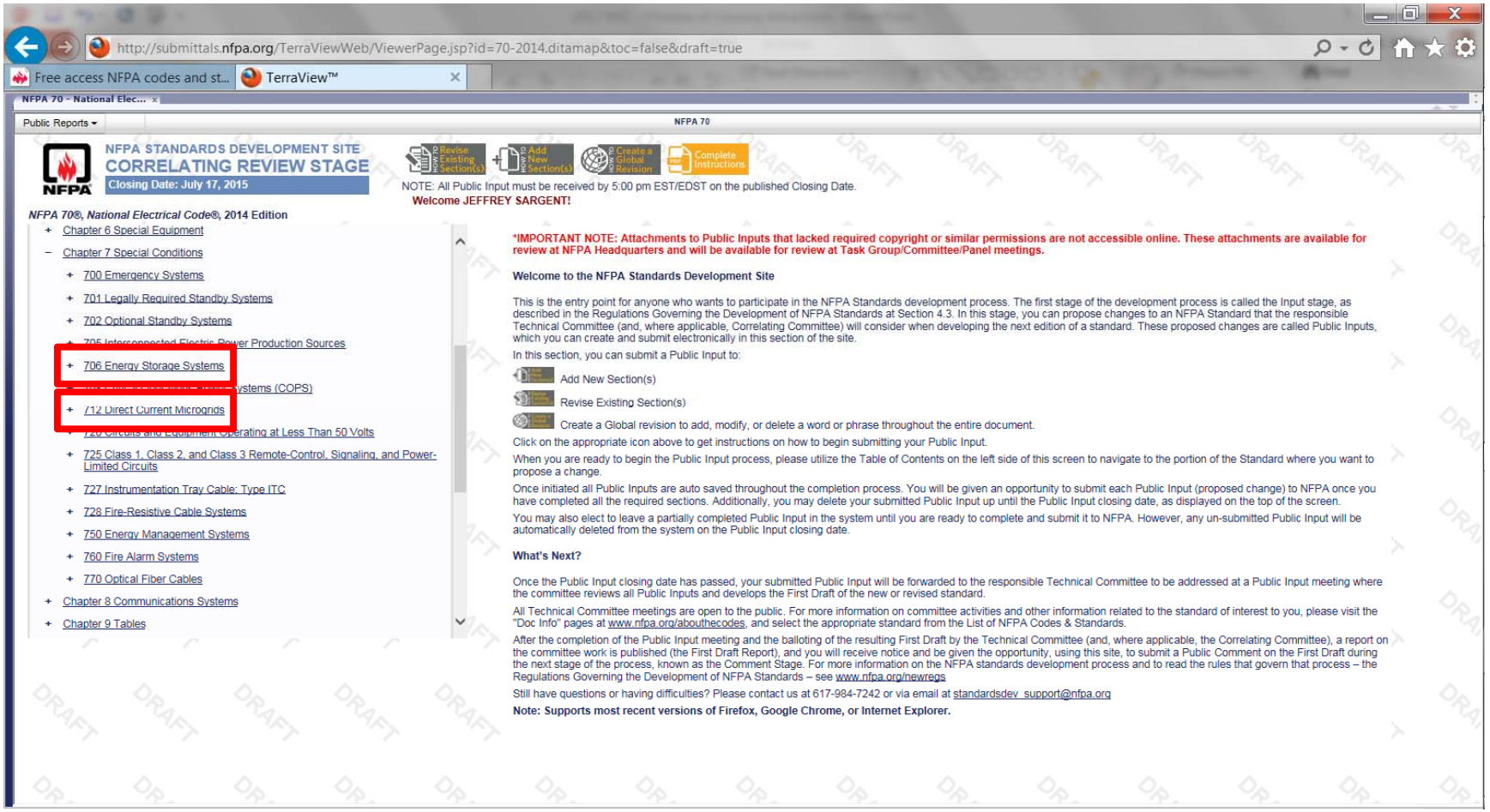
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NFPA 70®, National Electrical Code®, 2014 Edition
+ Chapter 6 Special Equipment
– Chapter 7 Special Conditions
+ 700 Emergency Systems
+ 701 Legally Required Standby Systems
+ 702 Optional Standby Systems
+ 706 Energy Storage Systems
+ 712 Direct Current Microgrids
+ 725 Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits
+ 727 Instrumentation Tray Cable: Type ITC
+ 728 Fire-Resistive Cable Systems
+ 750 Energy Management Systems
+ 760 Fire Alarm Systems
+ 770 Optical Fiber Cables
+ Chapter 8 Communications Systems
+ Chapter 9 Tables
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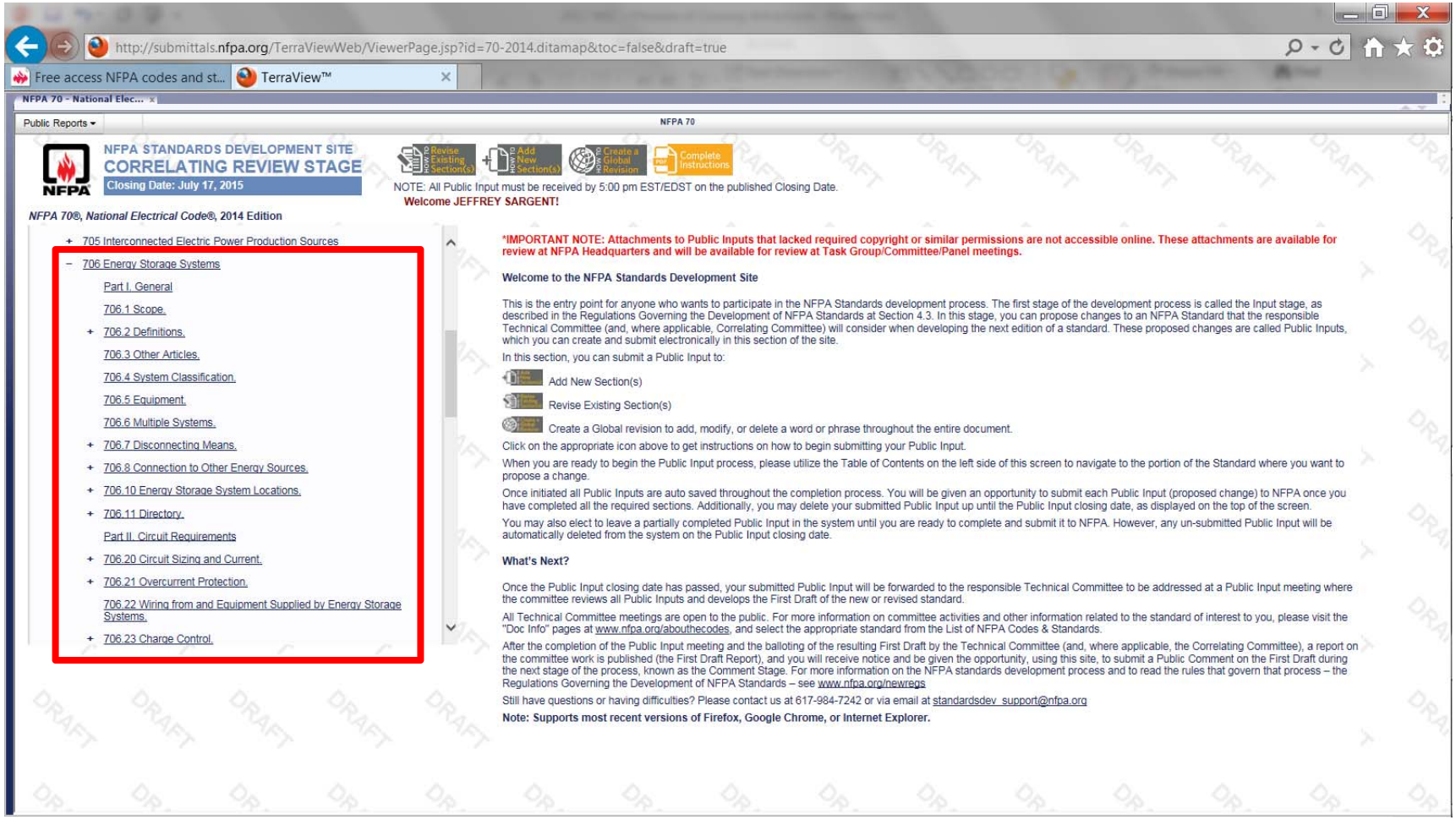
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Welcome JEFFREY SARGENT!
NFPA 70®, National Electrical Code®, 2014 Edition
+ 705 Interconnected Electric Power Production Sources
− 706 Energy Storage Systems
Part I. General
706.1 Scope.
+ 706.2 Definitions.
706.3 Other Articles.
706.4 System Classification.
706.5 Equipment.
706.6 Multiple Systems.
+ 706.7 Disconnecting Means.
+ 706.8 Connection to Other Energy Sources.
+ 706.10 Energy Storage System Locations.
+ 706.11 Directory.
Part II. Circuit Requirements
+ 706.20 Circuit Sizing and Current.
+ 706.21 Overcurrent Protection.
706.22 Wiring from and Equipment Supplied by Energy Storage Systems.
+ 706.23 Charge Control.
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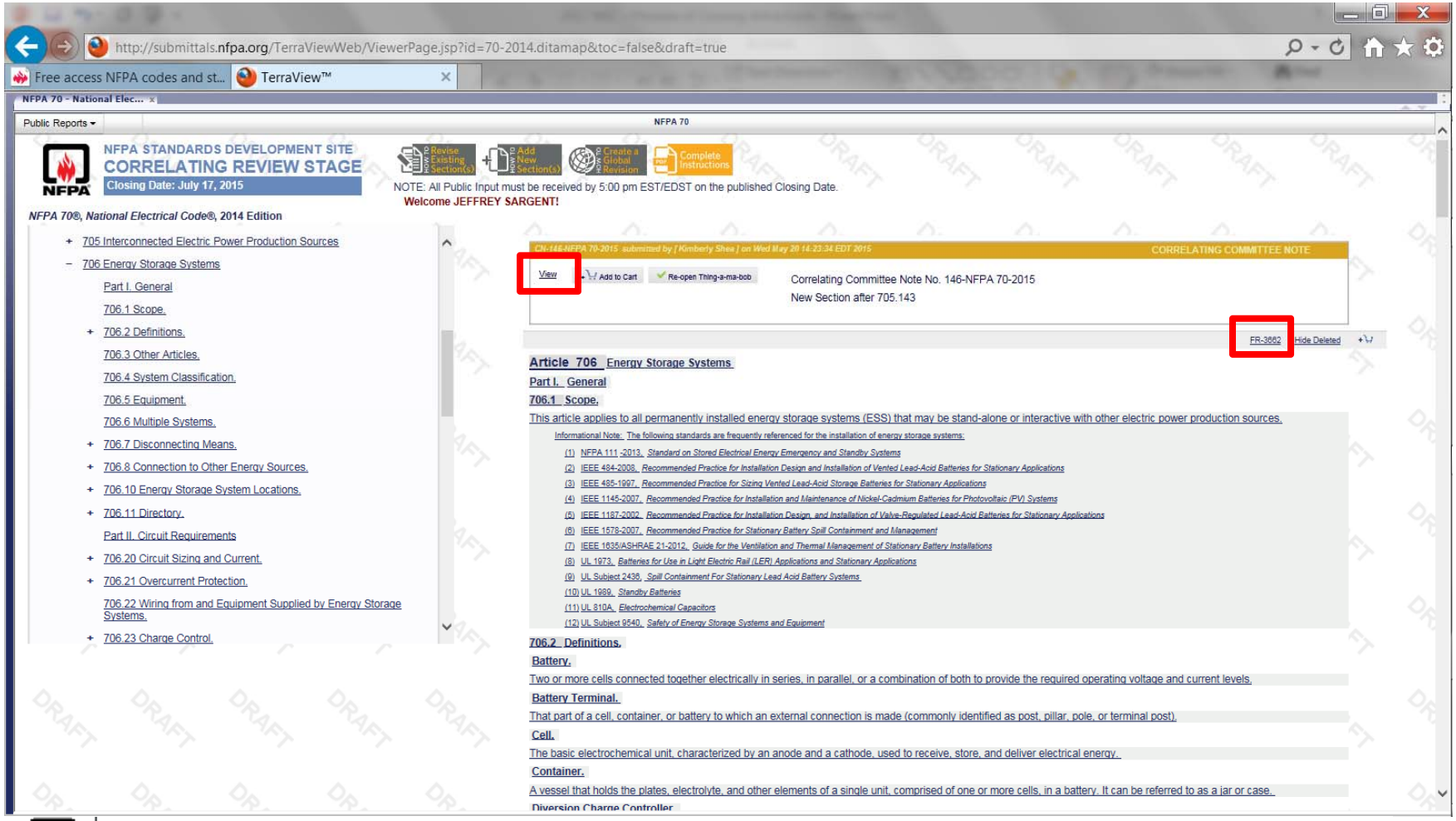
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− 706 Energy Storage Systems
Part I. General
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+ 706.8 Connection to Other Energy Sources.
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+ 706.21 Overcurrent Protection.
706.22 Wiring from and Equipment Supplied by Energy Storage Systems.
+ 706.23 Charge Control.
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Correlating Committee Note No. 146-NFPA 70-2015
New Section after 705.143
FR-3662
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Article 706 Energy Storage Systems
Part I. General
706.1 Scope.
This article applies to all permanently installed energy storage systems (ESS) 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 Spill Containment and Management
(7) IEEE 1635/ASHRAE 21-2012, Guide for the Ventilation and Thermal Management of Stationary Battery Installations
(8) UL 1973, Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
(9) UL Subject 2436, Spill Containment For Stationary Lead Acid Battery Systems
(10) UL 1989, Standby Batteries
(11) UL 810A, Electrochemical Capacitors
(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.
Battery Terminal.
That part of a cell, container, or battery to which an external connection is made (commonly identified as post, pillar, pole, or terminal post).
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
DRAFT

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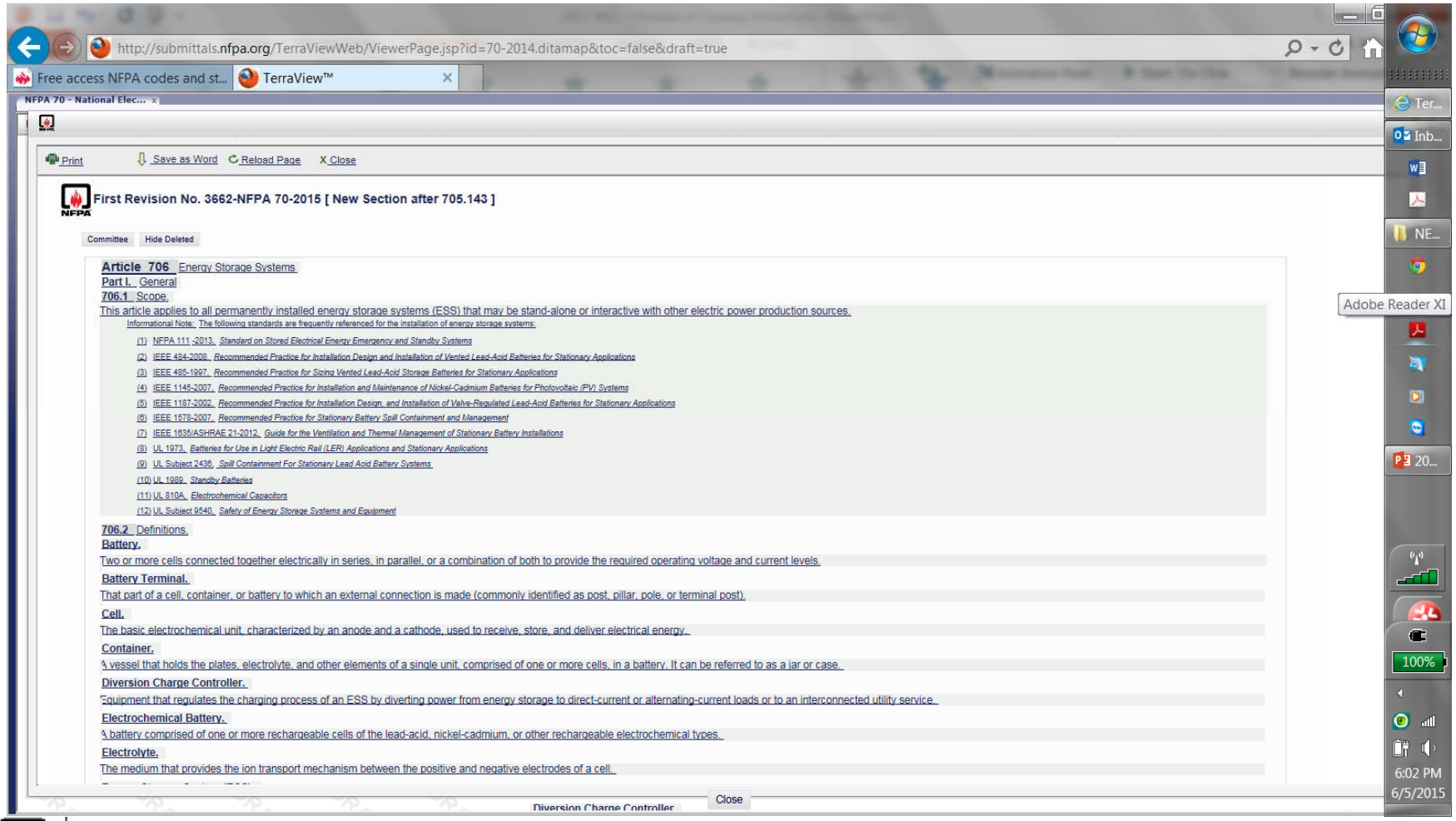
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First Revision No. 3662-NFPA 70-2015 [New Section after 705.143]
Committee
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Container.
A vessel that holds the plates, electrolyte, and other elements of a single unit, comprised of one or more cells, 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.
Electrochemical Battery.
A battery comprised of one or more rechargeable cells of the lead-acid, nickel-cadmium, or other rechargeable electrochemical types.
Electrolyte.
The medium that provides the ion transport mechanism between the positive and negative electrodes of a cell.
Diversion Charge Controller
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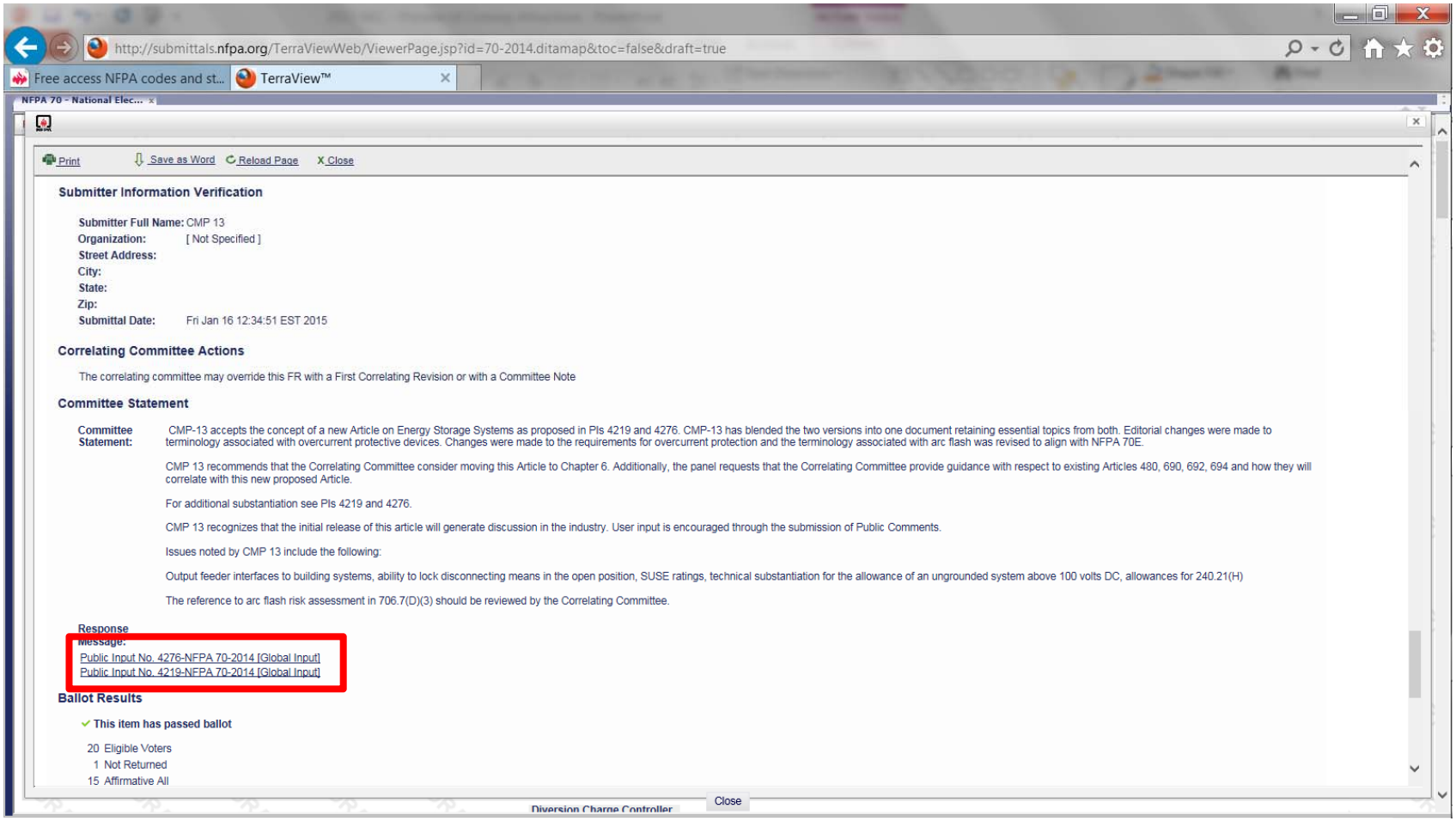
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Submitter Full Name: CMP 13
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 16 12:34:51 EST 2015
Correlating Committee Actions
The correlating committee may override this FR with a First Correlating Revision or with a Committee Note
Committee Statement
Committee Statement: CMP-13 accepts the concept of a new Article on Energy Storage Systems as proposed in PIs 4219 and 4276. CMP-13 has blended the two versions into one document retaining essential topics from both. Editorial changes were made to terminology associated with overcurrent protective devices. Changes were made to the requirements for overcurrent protection and the terminology associated with arc flash was revised to align with NFPA 70E.
CMP 13 recommends that the Correlating Committee consider moving this Article to Chapter 6. Additionally, the panel requests that the Correlating Committee provide guidance with respect to existing Articles 480, 690, 692, 694 and how they will correlate with this new proposed Article.
For additional substantiation see PIs 4219 and 4276.
CMP 13 recognizes that the initial release of this article will generate discussion in the industry. User input is encouraged through the submission of Public Comments.
Issues noted by CMP 13 include the following:
Output feeder interfaces to building systems, ability to lock disconnecting means in the open position, SUSE ratings, technical substantiation for the allowance of an ungrounded system above 100 volts DC, allowances for 240.21(H)
The reference to arc flash risk assessment in 706.7(D)(3) should be reviewed by the Correlating Committee.
Response Message:
Public Input No. 4276-NFPA 70-2014 [Global Input]
Public Input No. 4219-NFPA 70-2014 [Global Input]
Ballot Results
This item has passed ballot
20 Eligible Voters
1 Not Returned
15 Affirmative All
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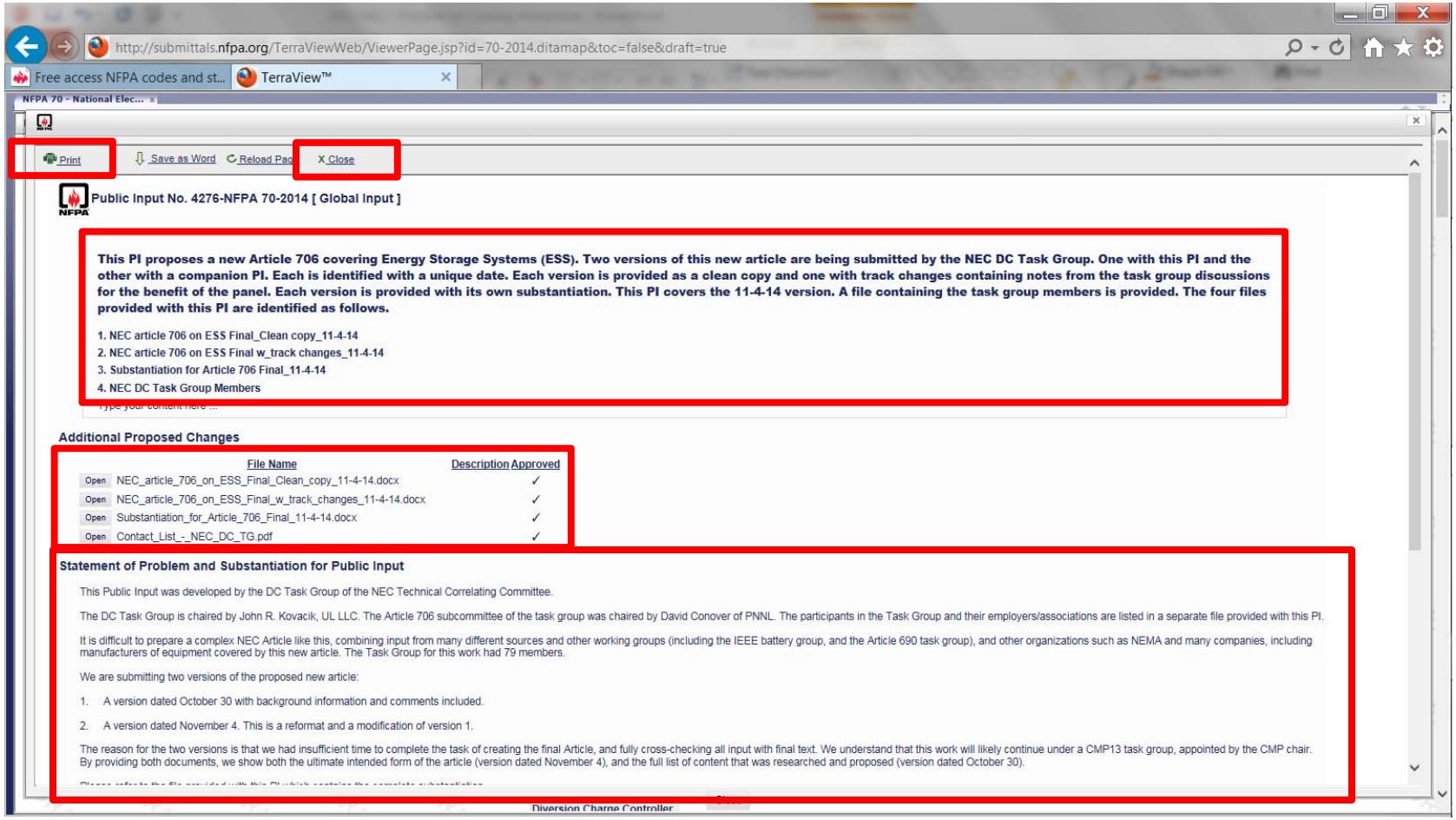
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Public Input No. 4276-NFPA 70-2014 [Global Input]
This PI proposes a new Article 706 covering Energy Storage Systems (ESS). Two versions of this new article are being submitted by the NEC DC Task Group. One with this PI and the other with a companion PI. Each is identified with a unique date. Each version is provided as a clean copy and one with track changes containing notes from the task group discussions for the benefit of the panel. Each version is provided with its own substantiation. This PI covers the 11-4-14 version. A file containing the task group members is provided. The four files provided with this PI are identified as follows.
1. NEC article 706 on ESS Final_Clean copy_11-4-14
2. NEC article 706 on ESS Final w_track changes_11-4-14
3. Substantiation for Article 706 Final_11-4-14
4. NEC DC Task Group Members
Additional Proposed Changes
File Name
Description
Approved
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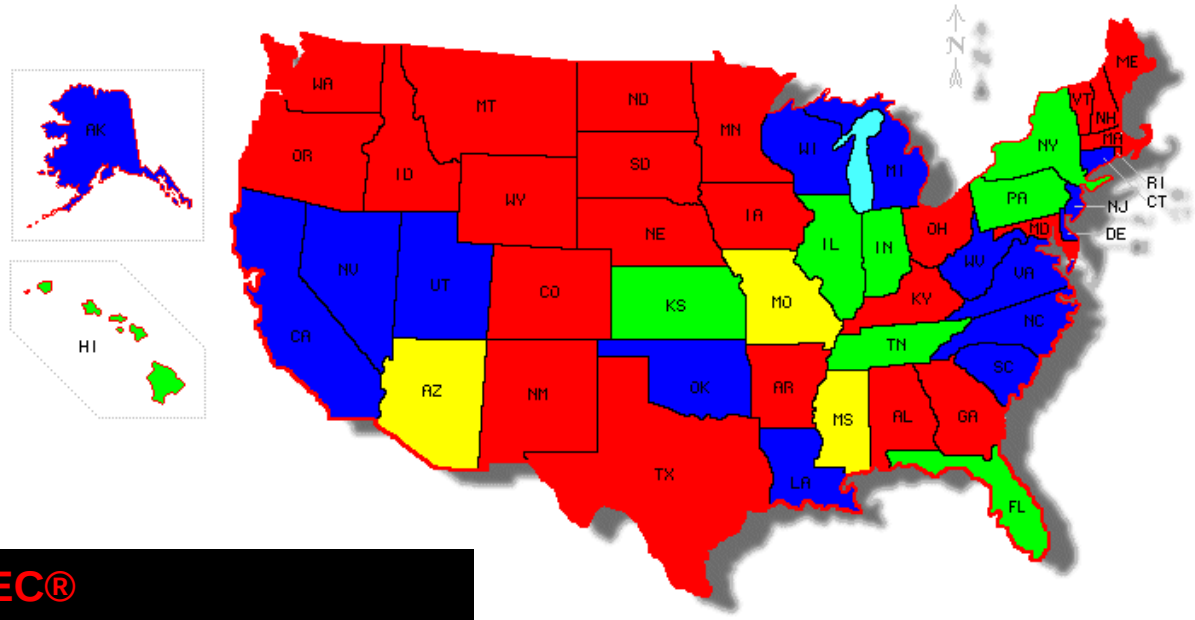
Open NEC_article_706_on_ESS_Final_w_track_changes_11-4-14.docx ✓
Open Substantiation_for_Article_706_Final_11-4-14.docx ✓
Open Contact_List_-_NEC_DC_TG.pdf ✓
Statement of Problem and Substantiation for Public Input
This Public Input was developed by the DC Task Group of the NEC Technical Correlating Committee.
The DC Task Group is chaired by John R. Kovacik, UL LLC. The Article 706 subcommittee of the task group was chaired by David Conover of PNNL. The participants in the Task Group and their employers/associations are listed in a separate file provided with this PI.
It is difficult to prepare a complex NEC Article like this, combining input from many different sources and other working groups (including the IEEE battery group, and the Article 690 task group), and other organizations such as NEMA and many companies, including manufacturers of equipment covered by this new article. The Task Group for this work had 79 members.
We are submitting two versions of the proposed new article:
1. A version dated October 30 with background information and comments included.
2. A version dated November 4. This is a reformat and a modification of version 1.
The reason for the two versions is that we had insufficient time to complete the task of creating the final Article, and fully cross-checking all input with final text. We understand that this work will likely continue under a CMP13 task group, appointed by the CMP chair. By providing both documents, we show both the ultimate intended form of the article (version dated November 4), and the full list of content that was researched and proposed (version dated October 30).
Diversion Charge Controller

2014 NEC Adopted as of 6/1/2015



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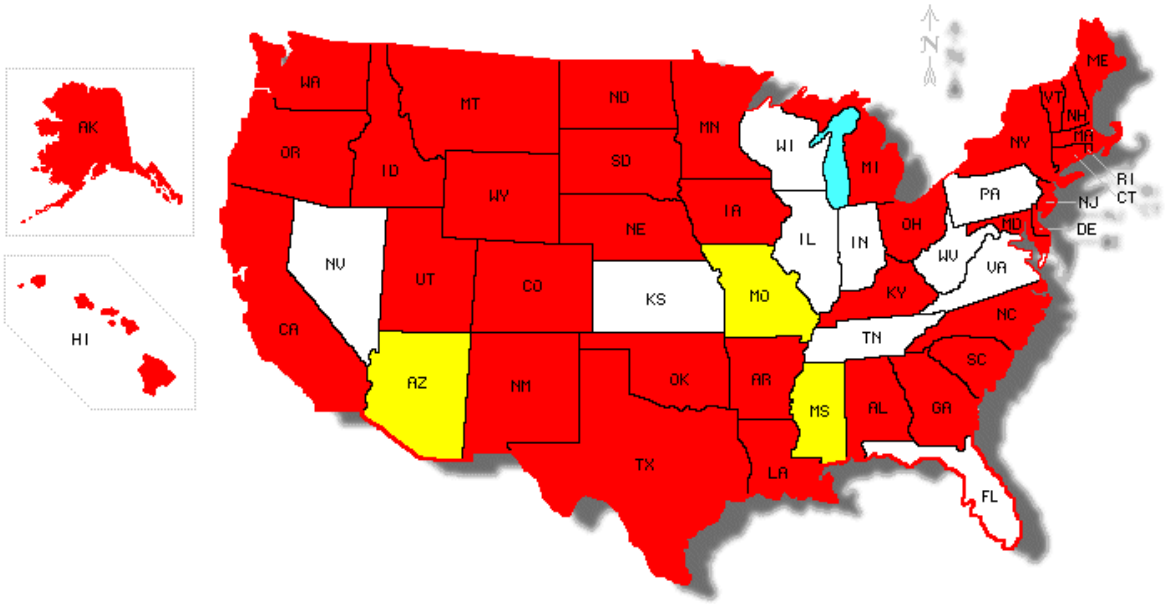

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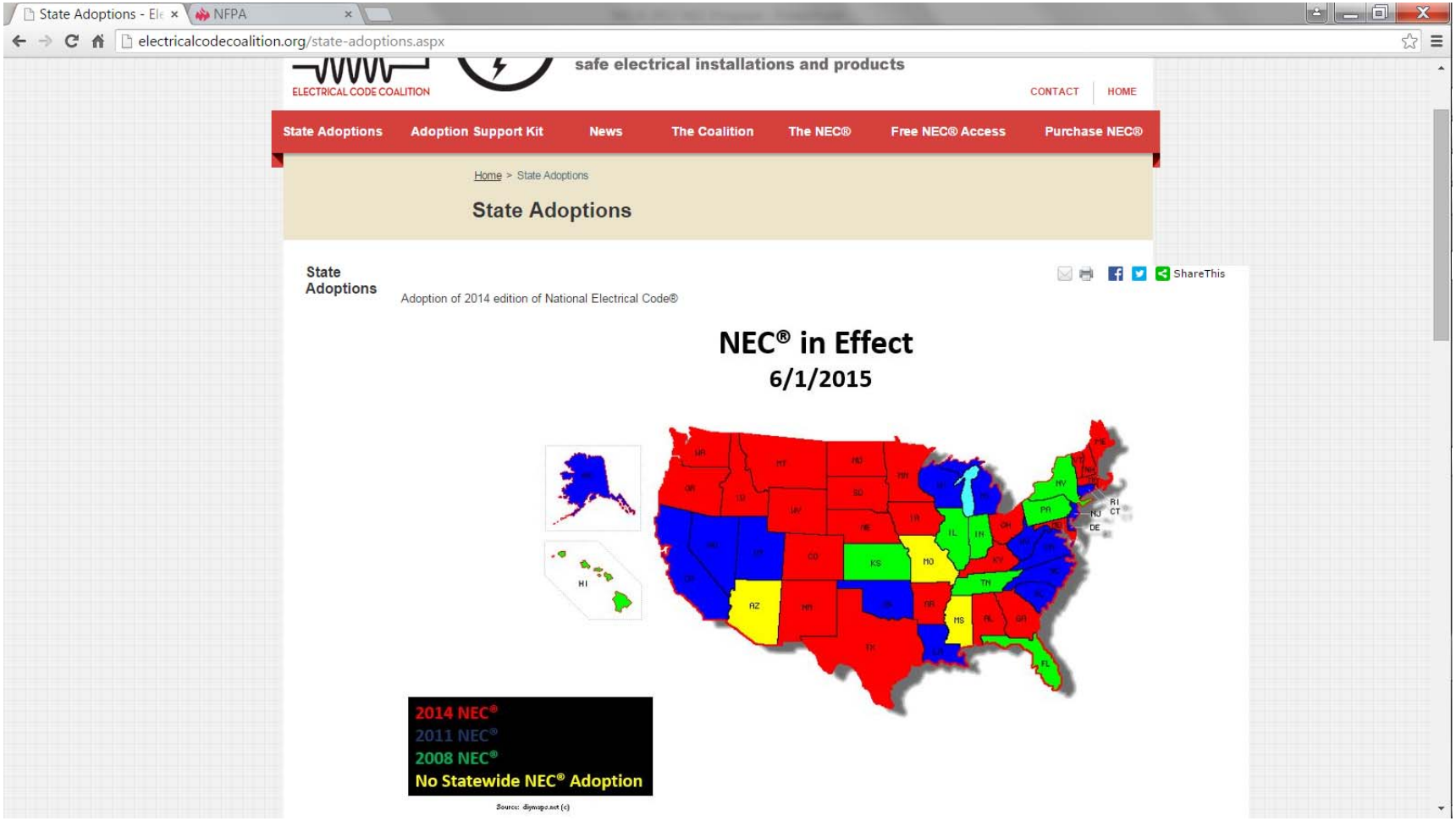

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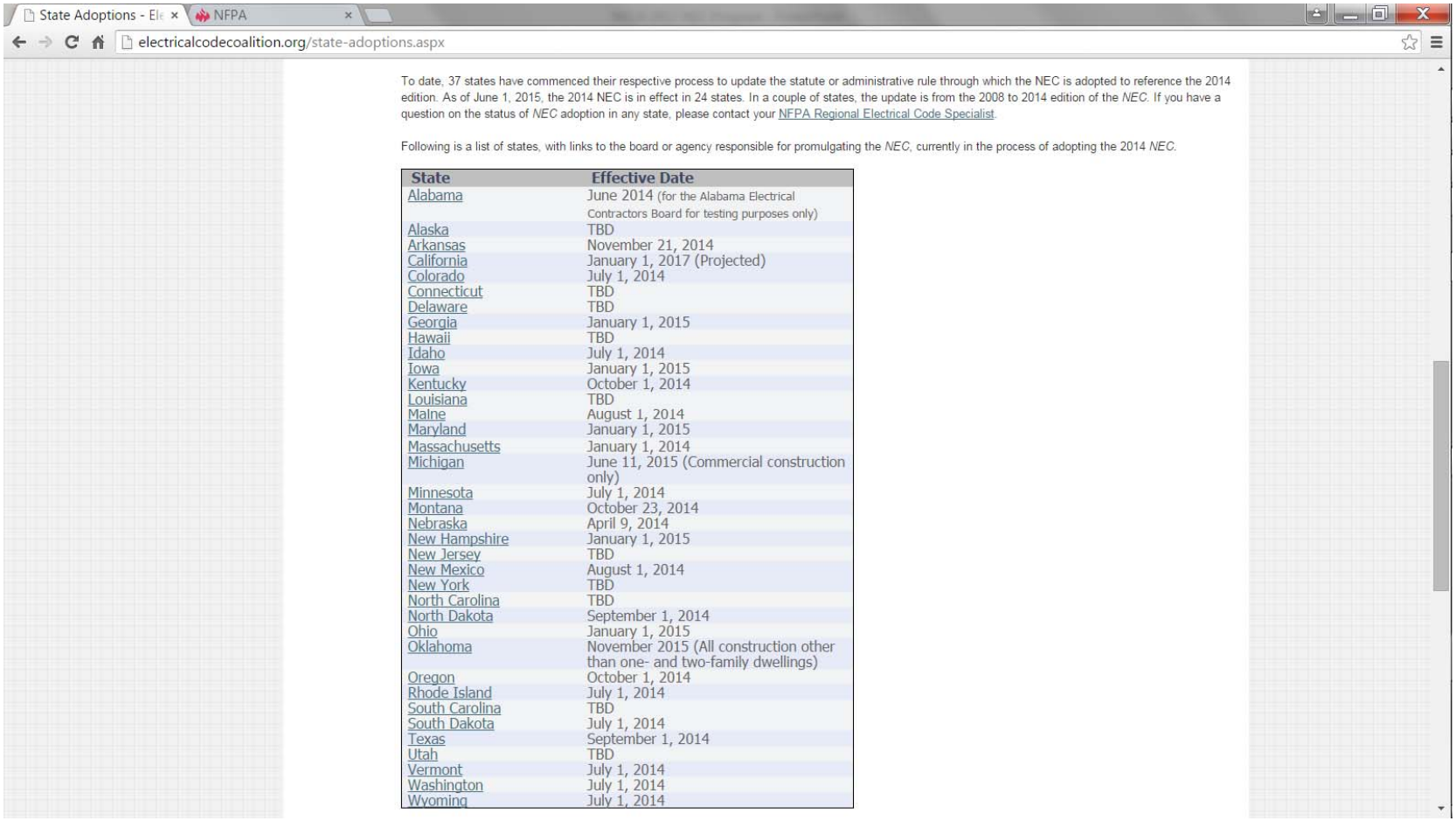

To date, 37 states have commenced their respective process to update the statute or administrative rule through which the NEC is adopted to reference the 2014 edition. As of June 1, 2015, the 2014 NEC is in effect in 24 states. In a couple of states, the update is from the 2008 to 2014 edition of the *NEC*. If you have a question on the status of *NEC* adoption in any state, please contact your NFPA Regional Electrical Code Specialist.

Following is a list of states, with links to the board or agency responsible for promulgating the *NEC*, currently in the process of adopting the 2014 *NEC*.

State	Effective Date
Alabama	June 2014 (for the Alabama Electrical Contractors Board for testing purposes only)
Alaska	TBD
Arkansas	November 21, 2014
California	January 1, 2017 (Projected)
Colorado	July 1, 2014
Connecticut	TBD
Delaware	TBD
Georgia	January 1, 2015
Hawaii	TBD
Idaho	July 1, 2014
Iowa	January 1, 2015
Kentucky	October 1, 2014
Louisiana	TBD
Maine	August 1, 2014
Maryland	January 1, 2015
Massachusetts	January 1, 2014
Michigan	June 11, 2015 (Commercial construction only)
Minnesota	July 1, 2014
Montana	October 23, 2014
Nebraska	April 9, 2014
New Hampshire	January 1, 2015
New Jersey	TBD
New Mexico	August 1, 2014
New York	TBD
North Carolina	TBD
North Dakota	September 1, 2014
Ohio	January 1, 2015
Oklahoma	November 2015 (All construction other than one- and two-family dwellings)
Oregon	October 1, 2014
Rhode Island	July 1, 2014
South Carolina	TBD
South Dakota	July 1, 2014
Texas	September 1, 2014
Utah	TBD
Vermont	July 1, 2014
Washington	July 1, 2014
Wyoming	July 1, 2014

National Fire Protection Association
The authority on fire, electrical, and building safety

An Industry on the Move

9 New Articles Proposed for 2017 NEC

- Article 425 - Fixed Resistance and Electrode Industrial Process Heating Equipment
- Article 691 - Large-Scale Photovoltaic (PV) Electric Supply Stations
- Article 706 - Energy Storage Systems (ESS)
- Article 712 - Direct Current Microgrids
- Article 369 - Metal Enclosed Busduct
- Article 395 - Low Voltage Underfloor Power Distribution Systems
- Article 554 - Residential Docks
- Article 672 - Industrial Equipment in Mobile Structures
- Article 710 - Microgrids

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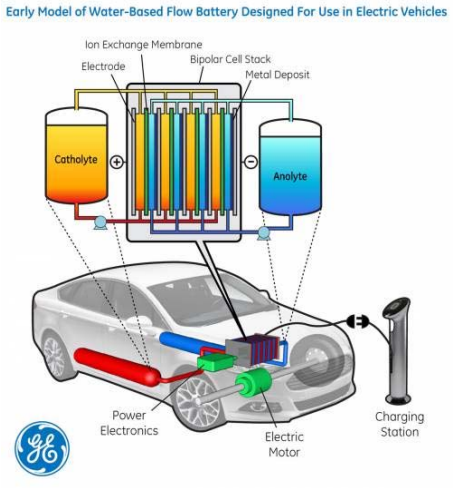
- Article 425 - Fixed Resistance and Electrode Industrial Process Heating Equipment
- Article 691 - Large-Scale Photovoltaic (PV) Electric Supply Stations
- Article 706 - Energy Storage Systems (ESS)
- Article 712 - Direct Current Microgrids
- Article 369 - Metal Enclosed Busduct
- Article 395 - Low Voltage Underfloor Power Distribution Systems
- Article 554 - Residential Docks
- Article 672 - Industrial Equipment in Mobile Structures
- Article 710 - Microgrids

Article 706 Energy Storage Systems (EES)

- Defined a device or more than one device assembled together capable of storing energy for use at a future time.
- Applies to all permanently installed energy storage systems (stand-alone or interactive).
- ESS(s) include electrochemical storage devices (e.g., batteries), flow batteries, capacitors, and kinetic energy devices (e.g., flywheels and compressed air).

Article 706 Energy Storage Systems (EES)

Article 706 Energy Storage Systems (EES)



Why Article 706?

- Public input developed by the NEC CC Direct Current Task Group
- Batteries currently addressed several NEC articles including Articles 480 and 690
- This has been appropriate over time with the article historically covering lead-acid batteries and the latter recently added to address the application of batteries in general, not just lead acid, to PV systems
- The current state of energy storage technology, which includes batteries, and anticipated evolution of energy storage supports the need for a singular set of requirements in the NEC covering such systems

Why Article 706?

- If this is not accomplished in the 2017 NEC and available to serve as a singular foundation for needed changes in the future, the provisions covering such systems will continue to reside in different places within the NEC and likely evolve to attach themselves as parts to existing criteria throughout the NEC. To foster the safe application of energy storage systems and facilitate the application and use of the NEC by technology proponents as well as those who install and inspect such systems there should be a singular article in the NEC on energy storage systems.

- As covered in the *DOE/EPRI 2013 Electricity Storage Handbook in Collaboration with NRECA* the portfolio of electricity storage technologies can be considered for providing a range of services to the electric grid and can be positioned around their power and energy relationship.

Why Article 706?

- IEEE and UL standards developed for new battery technolgy and other energy storage devices
- NFPA 111 has covered stored electrical energy emergency power systems since 2001

What's in Article 706?

- Parts
  - I – General
  - II – Circuit Requirements
  - III – Electrochemical Energy Storage Systems
  - IV – Flowing Electrolyte Energy Storage Systems
  - V – Kinetic Energy Storage Systems

What's in Article 706?

706.1 Scope. This article applies to all permanently installed energy storage systems (ESS) which may be stand-alone or interactive with other electric power production sources.

Informational Note No. 1. Operating voltages and power ratings for self-contained energy storage systems are typically found on the equipment nameplate data.

What's in Article 706?

706.2 Definitions

Energy Storage System (ESS).

- Device or more than one device assembled together capable of storing energy for use at a future time
- Include but are not limited to electrochemical storage devices (batteries), flowing electrolyte batteries, capacitors, and kinetic energy devices (flywheels and compressed air)
- 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 devices 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.

What's in Article 706?
Part I – General

706.2 Definitions

Energy Storage System, Pre-engineered of Matched Components.

- Provided as separate components of a system by a singular entity that are matched and intended to be assembled as an energy storage system at the system installation site

Energy Storage System, Other.

- Individual components assembled as a system

What's in Article 706?
Part I – General

- Additional Definitions in 706.2
  - **Battery**
  - **Battery Terminal**
  - **Cell**
  - **Container**
  - **Diversion Charge Controller**
  - **Electrochemical Battery**
  - **Electrolyte**
  - **Flowing Electrolyte Battery**
  - **Intercell Connector**
  - **Intertier Connector**
  - **Inverter Input Circuit**
  - **Inverter Output Circuit**
  - **Inverter Utilization Output Circuit**
  - **Nominal Voltage (Battery or Cell)**
  - **Sealed Cell or Battery**

What's in Article 706?
Part I – General

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 705.14, 705.16, 705.32 and 705.143 shall apply.

706.4 System Classification. ESS shall be classified as one of the types described in (A), (B) or (C).

- Self-contained ESS.
- Pre-engineered of matched components ESS intended for field assembly as a system.
- Other ESS.

What's in Article 706?
Part I – General

706.5 Equipment. Monitors and controls, switches and breakers, power conversion systems, inverters and transformers, energy storage devices and other components of the energy storage system shall be listed for the intended application as a part of an energy storage system. Alternatively, prepackaged self-contained systems shall be permitted to be listed for the intended application as a complete energy storage system. Only inverters listed and identified as interactive shall be permitted on interactive systems.

706.6 Multiple Systems. Multiple ESS(s) shall be permitted to be installed in or on a single building or structure.

What's in Article 706?
Part I – General

706.7 Disconnecting Means

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

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.

Busway. Where a DC busway system is installed, the disconnecting means shall be permitted to be incorporated into the busway.

What's in Article 706?
Part I – General

706.7 Disconnecting Means

Notification. The disconnecting means shall be legibly marked in the field. A label with the marking shall be placed in a conspicuous location near the ESS if a disconnecting means is not provided. The marking shall be of sufficient durability to withstand the environment involved and shall include the following:

- Nominal ESS voltage
- Maximum available short-circuit current derived from the ESS
- Arc flash derived from the terminals of the ESS
- Date the calculation was performed

What's in Article 706?
Part I – General

Partitions and Distance. Where energy storage device 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:

- A disconnecting means and overcurrent protection shall be provided at the energy storage device end of the circuit. Fused disconnecting means or circuit breakers shall be permitted to be used.
- Where fused disconnecting means are used, the line terminals of the disconnecting means shall be connected toward the energy storage device terminals.
- Overcurrent devices or disconnecting means shall not be installed in energy storage device enclosures where explosive atmospheres can exist.
- 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.
- Where the energy storage device disconnecting means is not within sight of the ESS disconnecting means, placards or directories shall be installed at the locations of all disconnecting means indicating the location of all disconnecting means.

What's in Article 706?
Part I – General

706.8 Connection to other energy sources.

Connection to other energy sources shall comply with the requirements of 705.12.

- **Load Disconnect.** A load disconnect that has multiple sources of power shall disconnect all energy sources when in the off position.
- **Identified Interactive Equipment.** Only inverters and ac modules listed and identified as interactive shall be permitted on interactive systems.
- **Loss of Interactive System Power.** An inverter in an interactive energy storage system shall automatically de-energize its output to the connected electrical production and distribution network upon loss of voltage in that system and shall remain in that state until the electrical production and distribution network voltage has been restored. A normally interactive energy storage system shall be permitted to operate as a stand-alone system to supply loads that have been disconnected from electrical production and distribution network sources.
- **Unbalanced Interconnections.** Unbalanced connections between an energy storage system and electric power production sources shall be in accordance with 705.100.
- **Point of Connection.** The point of connection between an energy storage system and electric power production sources shall be in accordance with 705.12.

What's in Article 706?
Part I – General

706.10 Energy Storage System Locations

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.

Guarding of live parts. Guarding of live parts shall comply with 110.27.

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.

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.

Illumination. Illumination shall be provided for working spaces associated with ESS and their equipment and components. Lighting outlets shall not be controlled by automatic means only. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source.

What's in Article 706?
Part I – General

706.11 Directory

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

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

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.

What's in Article 706?
Part II – Circuit Requirements

706.20 Circuit sizing and current.

The maximum current for the specific circuit shall be calculated in accordance with:

- **Nameplate Rated Circuit Current**
- **Inverter Output Circuit Current**
- **Inverter Input Circuit Current**
- **Inverter Utilization Output Circuit Current**
- **DC to DC Converter Output Current**

What's in Article 706?
Part II – Circuit Requirements

706.20 Circuit sizing and current.

- **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).

- **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.

What's in Article 706?
Part II – Circuit Requirements

706.21 Overcurrent protection.

- **Circuits and Equipment.** Energy storage circuit conductors and equipment shall be protected in accordance with the requirements of Article 240. Protection devices for ESS circuits shall be in accordance with the requirements of 706.11(B) through (F). Circuits shall be protected at the source from overcurrent.
- **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 706.10(A).
- **Direct Current Rating.** Overcurrent devices, either fuses or circuit breakers, used in any dc portion of an ESS shall be listed and shall have the appropriate voltage, current and interrupt ratings.
- **Prime Movers.** Overcurrent protection shall not be required for conductors from an ESS with a nominal voltage of 50 volts or less if these conductors provide power for starting, ignition, or control of prime movers. Section 300.3 shall not apply to these conductors.

What's in Article 706?
Part II – Circuit Requirements

706.21 Overcurrent protection.

- **Current limiting.** A listed, current-limiting, overcurrent device shall be installed in each circuit adjacent to the ESS where the available short-circuit current from an energy storage device exceeds the interrupting or withstand ratings of other equipment in the circuit .
- **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.

What's in Article 706?
Part II – Circuit Requirements

706.22 Wiring from and equipment supplied by energy storage systems. Wiring and equipment supplied from ESS(s) and system components shall be subject to the applicable provisions of this Code applying to wiring and equipment operating at the same voltage, unless otherwise permitted by this Article.

What's in Article 706?
Part II – Circuit Requirements

706.23 Charge Control

- **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.
- **Diversion charge controller.**
  - **Sole Means of Regulating Charging.**
  - **Circuits with Diversion Charge Controller and Diversion Load.**
  - **Energy Storage Systems Using Utility-Interactive Inverters.**
- **Charge controllers and DC converters.** When charge controllers and other dc power converters that increase or decrease the output current or output voltage with respect to the input current or input voltage are installed 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, and 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.

What's in Article 706?
Part III – Electrochemical Energy Storage Systems

Part III of this article applies to ESS(s) that are comprised of sealed and non-sealed cells or batteries or system modules that are comprised of multiple sealed cells or batteries.

706.30 Installation of batteries. Storage batteries associated with an ESS shall be installed in accordance with the provisions this Article.

- **Dwelling Units.**
- **Storage system nonconductive cases and conductive racks.**
- **Disconnection of Series Battery Circuits.**
- **Storage system maintenance disconnecting means.**
- **Storage systems of more than 100 volts.**

What's in Article 706?
Part III – Electrochemical Energy Storage Systems

706.31 Battery and cell terminations.

- **Corrosion Prevention.**
- **Intercell and Intertier Conductors and Connections.**
- **Battery Terminals.**

706.32 Battery interconnections.

706.33 Accessibility.

706.34 Battery Locations.

- **Live Parts.**
- **Top Terminal Batteries.**
- **Gas piping.**

What's in Article 706?
Part III – Electrochemical Energy Storage Systems

706.35 Vents.

- **(A) Vented Cells.**
- **(B) Sealed Cells.**

What's in Article 706?
Part IV – Flowing Electrolyte Energy Storage Systems

The provisions Part IV apply to ESS(s) composed of or containing flowing electrolyte 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, flowing electrolyte ESS shall comply with the applicable provisions of Article 692.

706.41 Electrolyte Classification.

706.42 Electrolyte Containment.

706.43 Flow controls.

706.44 Pumps and other fluid handling equipment.

What's in Article 706?
Part V – Kinetic Energy Storage Systems

The provisions of Part V apply to ESS(s) composed of or containing kinetic devices intended to store energy mechanically 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, kinetic ESS shall comply with the applicable provisions of Part III of Article 705.

Informational Note: The energy storage device itself can be considered similar to a generator as covered in Article 445, with respect to the inputs to and outputs from the system.

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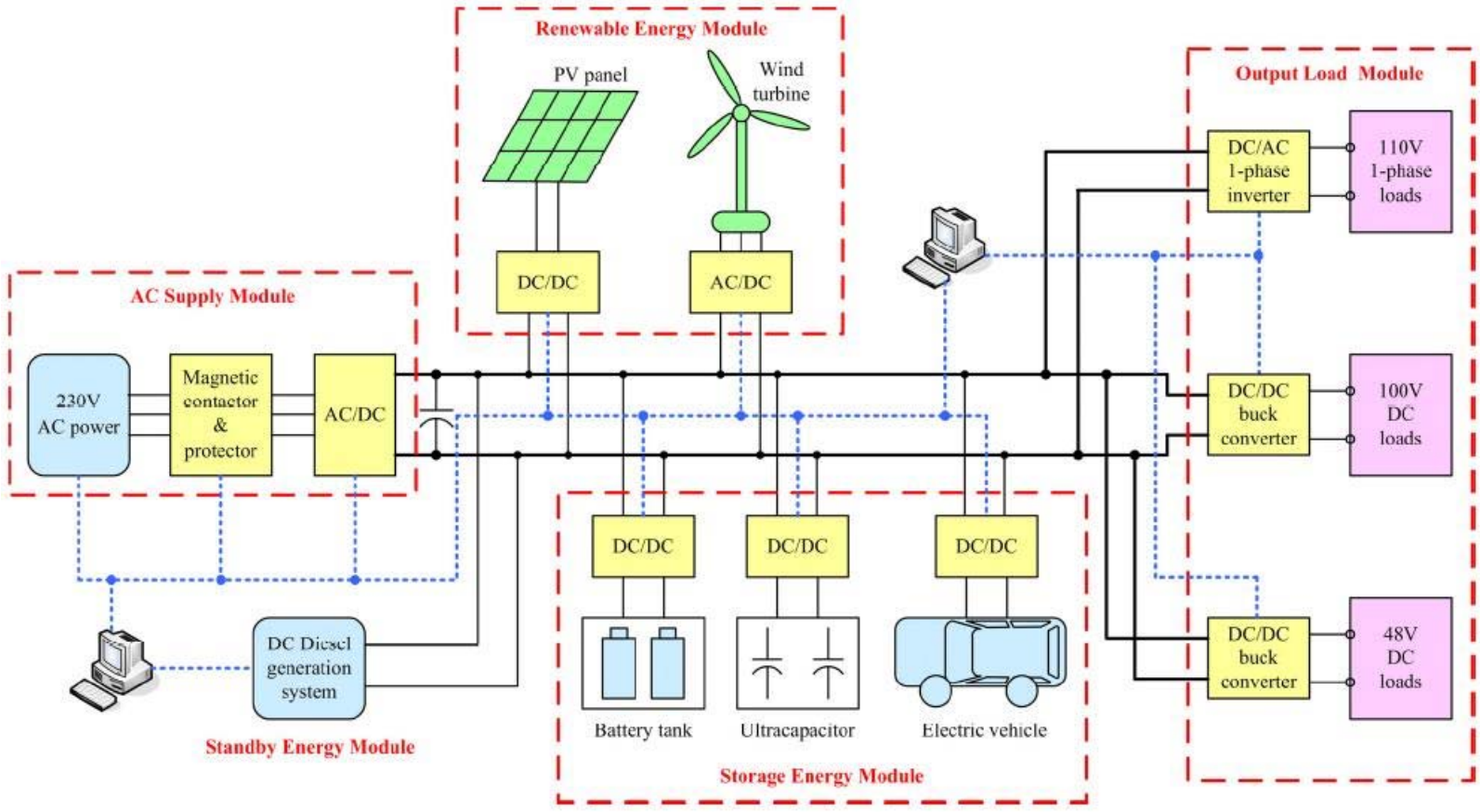
CMP Voting

- 15 affirmative all
- 3 affirmative w/comment
- 1 negative w/comment
- Negative comment:
  - Brady, Brian B. (M-Cummins Power Generation) We do not see a clear constructive need for an entirely new article on Energy Storage Systems. In its present form it appears be substantially a rehash of content already addressed in other existing articles of the Code. Battery systems have their own article which was debated earlier in the CMP meetings before this was brought before the Panel. Flow battery installations are already covered with other fuel cells and addressed by another CMP and flywheel systems should be addressed by adding whatever additional requirements that are need into Art 455. We feel that having duplicate requirements for these types of equipment in different Articles under different CMP will lead to confusion, duplicated efforts and conflicting interpretations.

Article 712 Direct Current Microgrids

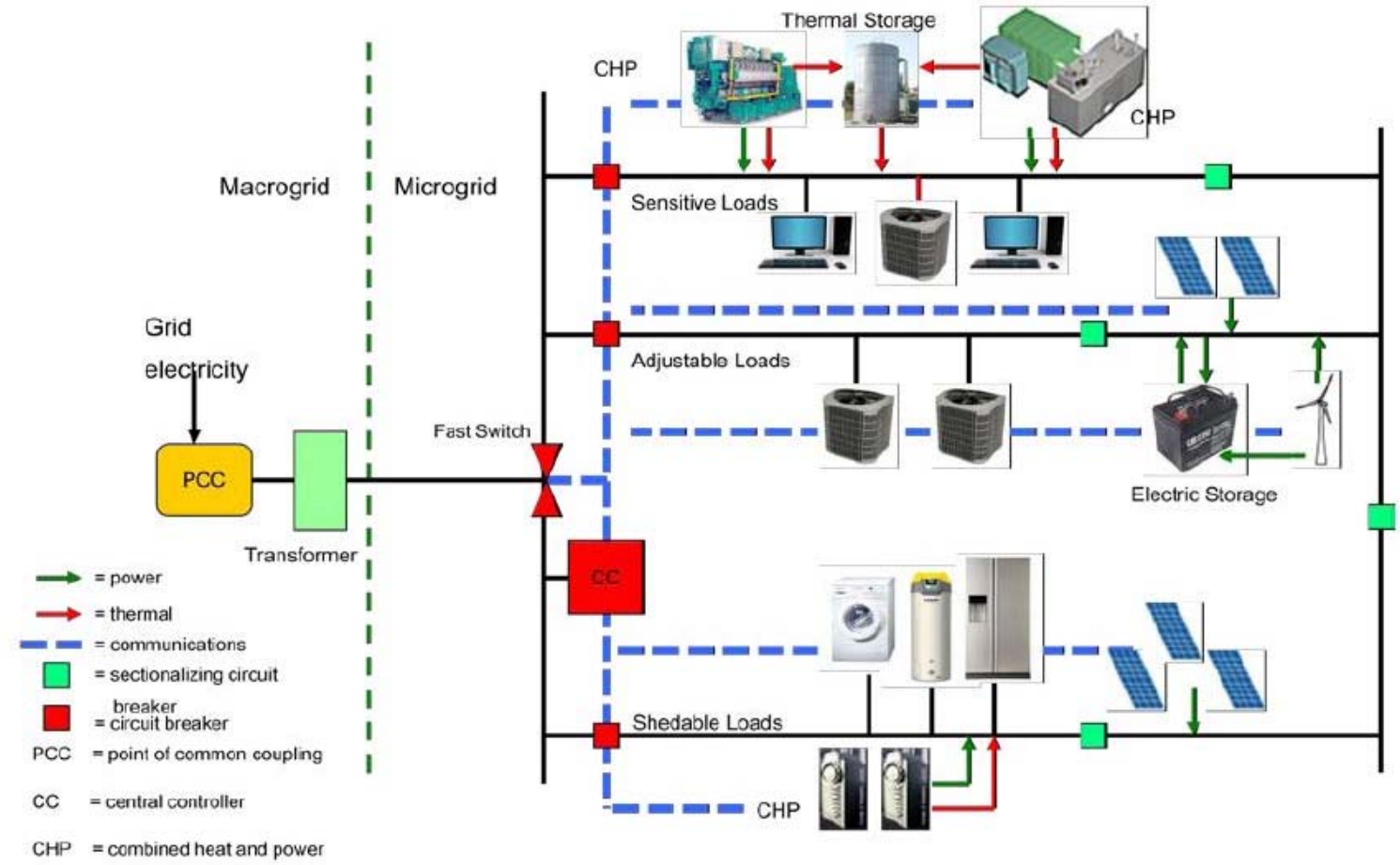
- Direct current power distribution system consisting of one or more interconnected dc power sources, dc-dc converters, dc loads, and ac loads powered by dc-ac inverters.
- DC power sources to direct current loads such as LED lighting, communications equipment, computers & servers, variable-speed motor drives, HVAC equipment, etc.

Article 712 Direct Current Microgrids



Proposed DC micro-grid system.

Article 712 Direct Current Microgrids



Why Article 712?

- Public Input developed by the NEC CC Direct-Current Task Group
- Microgrid Sub-group chaired by Robert Wills, Intergrid, LLC
- Powering utilization equipment directly from dc sources without intervening dc-ac and ac-dc conversion steps, leads to higher efficiencies and potentially smaller and lower-cost equipment than ac-coupled methods
- Need for higher efficiency in telecom and data centers has driven implementation of dc microgrids in hundreds of data centers around the world. Worldwide, data centers use about 30 GW of electrical power, with the USA using about 10 GW
- US and international community developing standards for dc microgrids for data centers.

Why Article 712?

- DC microgrids with energy storage offer inherent resilience and security from failure of primary power sources
- Simpler interconnection of power sources than ac microgrids, no synchronization equipment needed
- DC microgrids viewed as a return to the time of Thomas Edison when dc distribution was the norm
- Modern applications are driven by
  - the ability to transform dc power using power electronics,
  - the availability of reliable dc energy storage systems, and
  - the low cost and simplicity of on-site dc solar electricity generation.

Why Article 712?

- DC microgrids also being implemented in government, academic and commercial test sites. Examples include:
  - The EPRI/LBNL Research Institute test bed (Livermore CA).
  - The Duke Energy data center (Charlotte NC)
  - Calit2 – UC San Diego.
  - Ford Michigan assembly plant (whole building dc microgrid)
  - Intel Rio Rancho campus (Intel Research Labs, New Mexico)
  - The NextEnergy Center (Detroit Michigan – Nextek Power Systems)
  - Fort Belvoir DC Microgrid (Alexandria, VA)
  - Jail in Alameda, CA has microgrid that integrates power from PV, fuel cells, wind turbines and diesel generators.

Why Article 712?

- Basic requirements for wiring methods, overcurrent protection and grounding are specified in other parts of the *Code,* but
- Existing requirements do not address all of the issues created by interconnecting dc multiple sources and dc loads
- New article important first step, and place-holder for future requirements in this rapidly developing area
- First international conference on DC microgrids will be hosted by the IEEE in Atlanta in June 2015

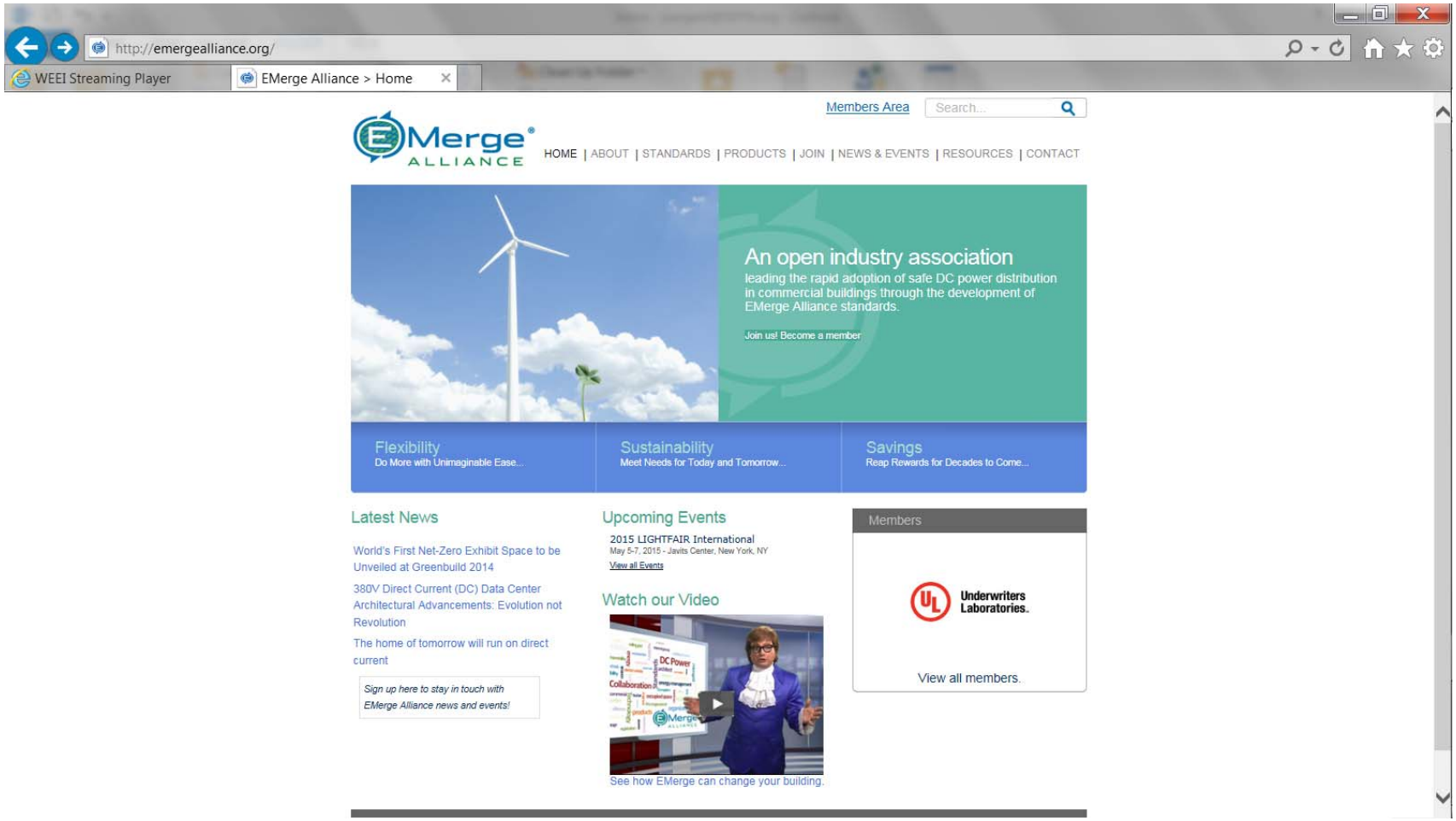
Why Article 712?

- Key issues addressed in Article 712:
  - Higher arcing capability of dc. To prevent arcs and high fault current this leads to the use of:
    - Ungrounded reference-, and resistively-grounded systems
    - Ground-fault and arc-fault detection and rapid de-energization on fault detection.
  - Use of multi-pole circuit breakers for 2 wire utilization circuits.
  - In ungrounded dc systems OCPD will not open under a single equipment ground fault requiring additional ground-fault detection equipment
  - DC breakers and switchgear are often “uni-directional” due to the use of permanent magnets to extinguish arcs, or semiconductor switches.
  - DC circuit have polarity, not phases.

Why Article 712?

- Key issues addressed in Article 712:
  - Hybrid breakers and switches include semiconductor elements.
  - Ground fault detection; safe working requirements
  - Arc-fault detection
  - Residual current circuit protection (RCD)
  - The need for fast acting circuit protection
  - The need for circuit coordination and overall system control.
  - Means of de-energizing dc microgrids for service or building emergencies

Why Article 712?



Why Article 712?

ARTICLE 393
Low-Voltage Suspended Ceiling Power Distribution Systems

I. General

393.1 Scope

This article covers the installation of low-voltage suspended ceiling power distribution systems.

Low-Voltage Suspended Ceiling Power Distribution System. A system that serves as a support for a finished ceiling surface and consists of a busbar and busbar support system to distribute power to utilization equipment supplied by a Class 2 power supply.

Armstrong Inspiring Great Spaces

COMMERCIAL CEILINGS & WALLS | USA & Canada

Home » Products » Suspension Systems » DC FlexZone Systems

DC FlexZone Systems

DESCRIPTION

DC FlexZone offers the ability to distribute safe, low-voltage direct current (DC) power that can significantly improve the flexibility and reuse of interior spaces by enabling easier re-purposing and reconfigurations without the need to re-wire. It is the first ceiling suspension system that provides an infrastructure for the delivery of low-voltage direct current (DC) power based on the Emerge Alliance 24 VDC Occupied Space Standard.Available in two popular Armstrong grid designs – 9/16" Suprafine® T-bar and 9/16" Silhouette® 1/4" reveal – the new system's DC main beams with integrated electrical conductors are available in four different lengths and are designed for use with standard cross tees and conventional suspended ceiling

PERFORMANCE

DOWNLOAD

PRODUCTS OVERVIEW

DC FlexZone™ Suspension System

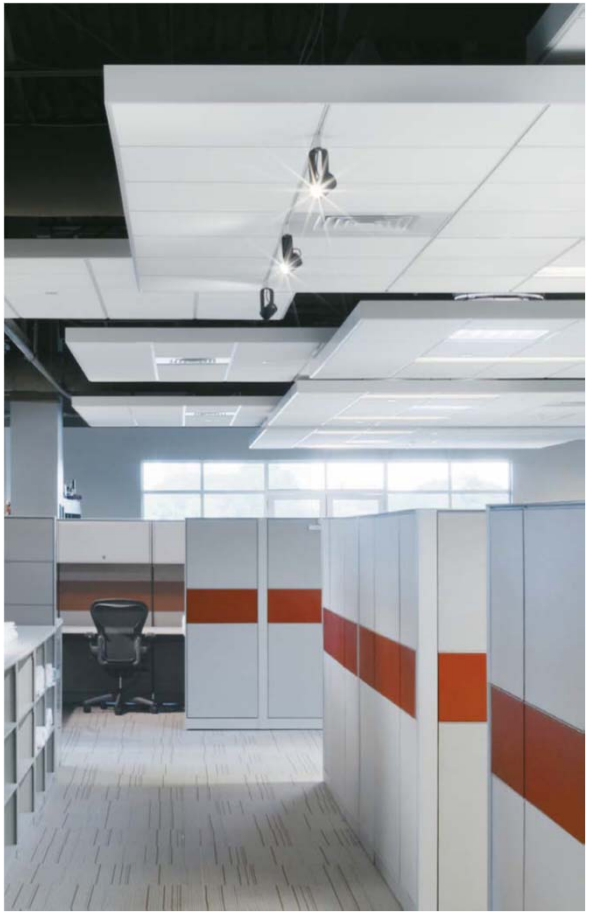
The DC FlexZone Suspension System is a power distribution platform that allows you to distribute safe, low-voltage direct current (DC) electrical power. DC FlexZone can be an integral part of a net zero energy building strategy providing more efficient lighting and direct use of on-site renewable energy. Plus, it gives you plug and play electrical flexibility throughout the building for easier re-purposing of spaces without the need to re-wire.

DC FlexZone - Suprafine® Suspension System

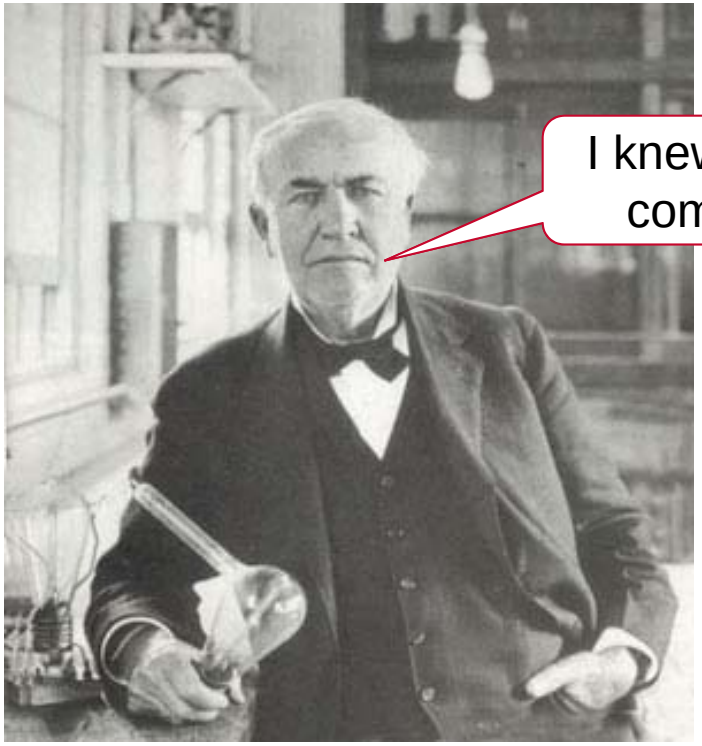
- Offers the same durability and stability of standard Suprafine with the added benefit of one Class 2 "Safe to Touch" electrical circuit integrated into the main beams.
- DC FlexZone – Suprafine main beams come in 4 different lengths, are made from high recycled content steel and meet D, E, F seismic design requirements.

RESOURCES

- DC FlexZone Overview Brochure
- Architectural Overview Brochure
- Architectural Design Guide
- Electrical Design Guide
- DC FlexZone Installation Instructions
- DC FlexZone Acoustical Tip Sheet
- DC FlexZone Electrical Tip Sheet
- CAD Drawings



Why Article 712?



What's in Article 712?

- Parts
  - I – General
  - II – Circuit Requirements
  - III – Disconnecting Means
  - IV – Wiring Methods
  - V – Grounding
  - VI – Marking
  - VII – Systems with Multiple Sources
  - VIII – ?
  - IX – Systems over 1000 V

What's in Article 712?
Part I – General

712.1 Scope

This article applies to direct current microgrids.

712.2 Definitions

Direct Current Microgrid (DC Microgrid).

- Power distribution system consisting of one or more interconnected dc power sources, dc-dc converters, dc loads, and ac loads powered by dc-ac inverters.
- Typically not directly connected to a primary source of electricity, but some dc microgrids interconnect via one or more ac-dc converters or bidirectional inverters.

What's in Article 712?
Part I – General

- Additional Definitions in 712.2:
  - **Grounded Two-Wire DC System**
  - **Grounded Three-Wire DC System**
  - **Nominal Voltage**
  - **Reference-Grounded DC System**
  - **Resistively-Grounded DC System**
  - **Ungrounded DC System**

What's in Article 712?
Part I – General

712.3 Other Articles

Wherever the requirements of other articles of this *Code* and Article 712 differ, the requirements of Article 712 shall apply.

712.4 Labeling and Listing

Any equipment used in a direct-current micro-grid shall be listed or labeled for dc use and for the purpose.

What's in Article 712?
Part II – Circuit Requirements

712.25 Identification of Circuit Conductors.

(A) Circuit conductors in dc microgrids shall be identified according to the requirements of 210.5(C)(2) for branch circuits and 215.12(C)(2) for feeders.

(B) Ungrounded conductors of 6 AWG or smaller shall be permitted to be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means.

712.30 System Voltage

The system voltage of a dc microgrid shall be defined as follows:

(A) the nominal voltage to ground for solidly-grounded systems

(B) the nominal voltage to ground for reference-grounded systems where all conductors are disconnected from power sources when the reference ground is in the high-impedance, faulted state.

(C) the highest nominal voltage between conductors for all other systems.

What's in Article 712?
Part III – Disconnecting Means

712.35 Disconnection of Ungrounded Conductors

In solidly-grounded two and three-wire systems, disconnecting means, overcurrent devices and protective devices such as ground-fault detectors and arc-fault detectors shall open all ungrounded conductors. In ungrounded, resistively-grounded and reference-grounded systems, such devices shall open all current-carrying conductors.

712.37 Directional Current Devices.

Disconnecting means, protective and overcurrent devices that are designed for use in a single current direction shall only be used in the designated current direction.

Informational Note: Examples of directional current devices are magnetically-quenched contactors, and semiconductor switches in overcurrent devices.

What's in Article 712?
Part IV – Wiring Methods

712.40 Wiring Methods.

(A) Wiring methods for dc microgrids shall comply with the requirements of 210.5 for branch circuits and 215.12 for feeders.

(B) Ungrounded conductors of 6 AWG or smaller shall be permitted to be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means.

What's in Article 712?
Part V – Grounding

712.52 System Grounding

(A) Direct-current microgrids shall be grounded in accordance with 250.162.

(B) DC microgrids operating at voltages greater than 300 Vdc shall be reference-grounded or resistively-grounded.

712.55 Ground Fault Protection of Equipment.

(A) DC microgrids operating at greater than 60 Vdc shall have ground fault protection that:

- Detects the fault
- Indicates that a fault has occurred, and
- For solidly-grounded and reference-grounded systems, disconnects power from the faulted equipment.

(B) Ground fault equipment shall comply with **250.167**

What's in Article 712?
Part V – Grounding

712.57 Arc Fault Protection.

DC microgrids with a system voltage of greater than 60V shall be required to have arc fault protection for utilitization circuits. Arc fault protection equipment shall be identified and listed for the purpose.

Informational Note: 90.4 applies when suitable equipment for arc fault protection is not available.

What's in Article 712?
Part VI – Marking

712.62 Panelboards.

Panelboards in dc microgrid systems shall be marked in accordance with 408.3.

712.64 Directory

A permanent plaque or directory, denoting all electric power sources in the dc microgrid shall be installed at all electric power production locations.

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

What's in Article 712?
Part VII – Systems with Multiple Sources

712.72 Interrupting and Short-Circuit Current Rating

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment in dc microgrid systems. Circuit protection devices used within a dc microgrid shall have a rated interrupting capacity greater than the available fault current at the device location.

What's in Article 712?
Part IX – Systems over 1000 V

712.80 General

Systems with a maximum voltage between conductors of over 1000 volts dc shall comply with Article 490 and other requirements applicable to installations rated over 1000 volts.

CMP Voting

- 15 affirmative all
- 2 affirmative w/comment
- 2 negative w/comment
- Negative comments:
  - Brady, Brian B. (M-Cummins Power Generation) We do not see a clear constructive need for an entirely new article on separately derived and/or locally powered DC systems in its present form.
  - Savage, Sr., Michael L. (E-City of Rio Rancho, NM) I believe the requirements of this proposed Section are properly addressed/incorporated into the NEC in Articles 480, 690, 692 and 705. As it was discussed many times in Committee, the user of the code is expected to have the knowledge to navigate through the code for the installation at hand. Additionally, "Chapters 1, 2, 3, and 4 apply generally; Chapters 5, 6, and 7 apply to special occupancies, special equipment, or other special conditions. These latter chapters supplement or modify the general rules. Chapters 1 through 4 apply except as amended by Chapters 5, 6, and 7 for the particular conditions." Therefore the Section is unnecessary and needs to be stricken.

National Fire Protection Association
The authority on fire, electrical, and building safety

Thank You