FIRE DEPARTMENT • CITY OF NEW YORK

CERTIFICATE OF FITNESS

STUDY MATERIAL

FOR

W-27 Supervision of Stationary Energy Storage Systems (ESS) in Group R-3 Occupancies (citywide)

This book is provided to the public for free by the FDNY.

All applicants are required to apply and pay for an exam online before arriving at the FDNY. It can take about 30 minutes to complete.

Simplified instructions for online application and payment can be found here:

http://www1.nyc.gov/assets/fdny/downloads/pdf/business/fdny-business-cof-individuals-short.pdf

Create an Account and Log in to:

http://fires.fdnycloud.org/CitizenAccess

ALSO INCLUDED IN THIS BOOKLET YOU WILL FIND THE FOLLOWING:
NOTICE OF EXAMINATION (NOE

ATTENTION

If you already hold a B-28/W-28 COF, you can waive the W-27 exam and only pay the application fee to obtain a W-27 COF.

Table of Contents

EXAM SPECIFIC INFORMATION FOR W-27 CERTIFICATE OF FITNESS

Save time and submit application online!

All applicants are required to apply and pay for an exam online before arriving at the FDNY. It can take about 30 minutes to complete.

Simplified instructions for online application and payment can be found here:

http://www1.nyc.gov/assets/fdny/downloads/pdf/business/fdny-business-cof-individuals-short.pdf

Create an Account and Log in to:

http://fires.fdnycloud.org/CitizenAccess

REQUIREMENTS FOR CERTIFICATE OF FITNESS APPLICATION

General requirements:
Review the General Notice of Exam:

https://www1.nyc.gov/assets/fdny/downloads/pdf/business/general-notice-of-exam-cof.pdf

Special requirements for W-27 Certificate of Fitness:

(1) W-27 COF applicants need to submit the Battery System Training Verification Letter. Applicant must present an affidavit from the battery system owner, manufacturer or the installer of the battery system stating that this applicant has been trained and is knowledgeable with the battery system he/she will supervise. The sample of this verification letter is provided on the following pages or the following link: https://www1.nyc.gov/assets/fdny/downloads/pdf/business/w27-verification-letter.pdf

(2) W-27 COF applicants need to submit the Employer Recommendation Letter. Sample recommendation letter is provided on the following pages or the following link: https://www1.nyc.gov/assets/fdny/downloads/pdf/business/w27-sample-letter.pdf

Application fee (Cash is NO LONGER ACCEPTED):

Pay the **$25** application fee online or in person by one of the following methods:

- Credit card (*American Express, Discover, MasterCard, or Visa*)
- Debit card (*MasterCard or Visa*)

- In person: Personal or company check or money order (*made payable to the New York City Fire Department)*

A convenience fee of 2% will be applied to all credit card payments.

For fee waivers submit: ***(Only government employees who will use their COF for their work- related responsibilities are eligible for fee waivers.)***

- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; ***AND***
- Copy of identification card issued by the agency

REQUIREMENTS FOR ALTERNATIVE ISSUANCE PROCEDURE (AIP)

No AIP available. This certificate of fitness can only be obtained by passing the computer exam at the FDNY Headquarters.

EXAM INFORMATION

The **W-27** exam will consist of **40 multiple-choice questions**, administered on a "touch screen" computer monitor. You will have **62 minutes** to complete the test. A passing score of at least 70% is required in order to secure a Certificate of Fitness.

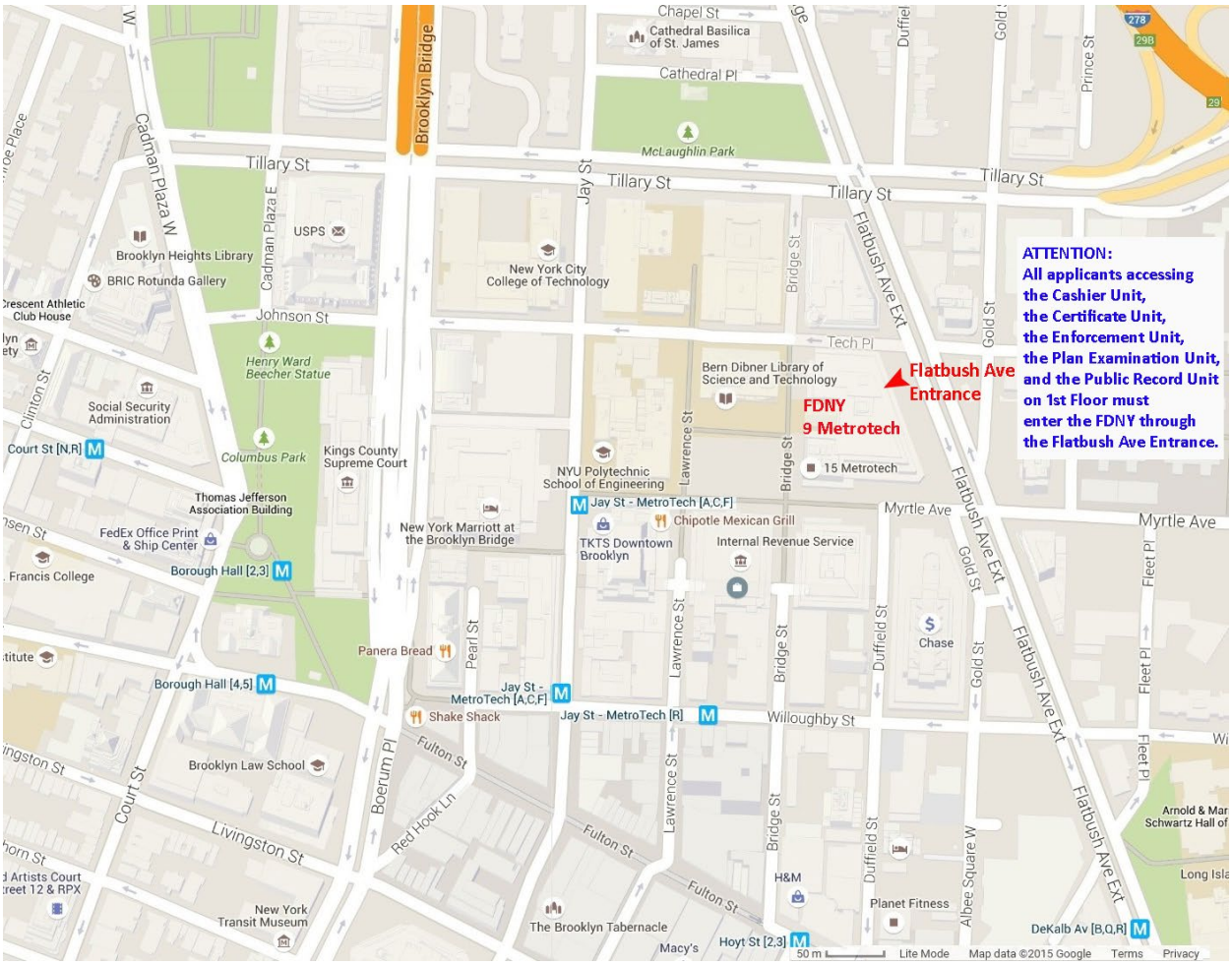
Special material provided during the test:

The reference material in Appendix A will be provided when you take the test at Metro Tech. However, this booklet will not be provided to you during the test.

Call (718) 999-1988 for additional information and forms.

Please always check for the latest revised booklet at FDNY website before you take the exam.
http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-w27-study-material.pdf

Exam site: **FDNY Headquarters,** 9 MetroTech Center, Brooklyn, NY. Enter through the **Flatbush Avenue entrance (between Myrtle Avenue and Tech Place)**.



RENEWAL REQUIREMENTS

General renewal requirements:

Review the General Notice of Exam:
https://www1.nyc.gov/assets/fdny/downloads/pdf/business/general-notice-of-exam-cof.pdf

Special renewal requirements.

W-27 Certificate of Fitness must be renewed every two ***YEARs***. The renewal fee is **$10**. FDNY also reserves the right to require the applicants to take a re-examination upon submission of renewal applications.
You may receive a courtesy notice of renewal, by email, 90 days before the expiration date. However, it is your responsibility to renew your Certificate. It is very important to renew your COF before it expires. Renewals submitted 90 days after (up to one year) the expiration date will incur a $25 penalty in addition to the renewal fee. Certificates expired over one year past expiration date will not be renewed. New exams will be required.

The FDNY strongly recommends the W-27 COF holders to renew the COF on-line. The COF holder must upload an affidavit listing all premises location and ESS information that the COF holder is currently responsible for supervising.

Sample of the affidavit:

http://www1.nyc.gov/assets/fdny/downloads/pdf/business/w27-renew-affidavit.pdf

Read the Quick Renewal Guide for FLSD, Expeditors or Fee Exempt Applicants to learn the procedure:

http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-renewal-short.pdf

QUESTIONS?

FDNY Business Support Team: For questions, call 311 and ask for the FDNY Customer Service Center or send an email to FDNY.BusinessSupport@fdny.nyc.gov.

W27 Energy Storage System (ESS) Training Verification Letter

Please **print** or **type** the information below. **This form must be NOTARIZED.**

This letter is to verify that _____(Name of Applicant) has been trained in the energy storage system installed and used for the Group R-3 occupancies (e.g. Buildings that do not contain more than two dwelling units) that the applicant will supervise.

I am ☐ the manufacturer of the battery system (need to upload/attach a company letter to support this statement)
☐ the manufacturer authorized/certified installer of the battery system (need to upload/attach a manufacturer issued certification to support this statement)
☐ a B-28 COF holder (COF #:_____) with 2 years of working experience (The B-28 COF card must be issued 2 years before the notarized date on this form)

I affirm that I have the comprehensive knowledge and required material to administer the training for the applicant that listed in this letter

The size of the energy storage system (ESS) is _____ kWh and the type of the energy storage system (ESS) is (check the one that applies)

☐ Lithium-ion
☐ Nickel cadmium
☐ Nickel metal hydride
☐ Flooded (Vented) Lead acid
☐ Valve-Regulated Lead Acid (VRLA)
☐ Other: _____ (please specify)

The remote monitoring company of this energy storage system's Energy Storage Management System (ESMS) or Battery Management System (BMS) is _____ (company name) and its contact phone number is: _____.

Section B - Energy Storage System (ESS) Training Verification

I, _____, hereby certify that the applicant has been trained and obtained the following information related to the energy storage system that he/she will supervise. (All items below must be marked "Yes" or "N/A" to proceed)

Information	
The type, size of the battery systems	☐ Yes
The possible hazards of the energy storage system	☐ Yes
The area that the energy storage system serves and the impact of shutting down the entire system	☐ Yes
Safety Data Sheets (SDS) of the energy storage system	☐ Yes
The Emergency Management Plan	☐ Yes
Commissioning plan	☐ Yes
Decommissioning plan (end-of-life decommissioning plan and emergency decommissioning plan)	☐ Yes
The type of fire extinguishing systems will be installed and designed hold time (if applicable, refer to the section 5.1 of this booklet)	☐ Yes ☐ N/A, there is no fire extinguishing systems.
Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions	☐ Yes
Procedure for notification in need of maintenance or service	☐ Yes
Procedure for notifications in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions	☐ Yes
Contact information of the ESMS/BMS monitoring facility and the SMEs	☐ Yes
The general function of the ESMS/BMS including how this system monitors or manages the energy storage performance and status of health, safe operation, notifications, etc.	☐ Yes
Standoff distances for electrical hazards and explosion hazards	☐ Yes
Procedures for inspection/testing/maintenance	☐ Yes
The planned/actual location of:	
Required signs	☐ Yes
Disconnect switches (i.e. "lock-out, tag-out")	☐ Yes
The deflagration vents and/or exhaust outlets	☐ Yes ☐ N/A, there is no deflagration venting/explosion prevention system.

On this _____ day of _____, in the year _____, I have hereunto affixed my signature and I affirm that all statements made on this application are true under the penalties of perjury. I understand that:

- any intentional falsification of this letter can be grounds for the denial, non-renewal, suspension or revocation of the Certificate of Fitness as applies to the applicant;
- all statements made in connection with the application are subject to investigation and verification;
- the FDNY representative may ask the W-27 Certificate of Fitness holder without prior notice to demonstrate the required knowledge listed in this verification letter to verify his/her proficiency in supervising the energy storage system upon inspection.

_____ _____

Printed Name of owner, manufacturer or installer Job Title

_____ Signature of owner, manufacture or installer (**Sign only before a Notary**)	_____ Signature of Notary	**NOTARY PUBLIC: [Notary Seal]** **My commission expires: ___/___/____**

W-27 Sample Recommendation Letter

COMPANY NAME
BUSINESS ADDRESS

Fire Department
Bureau of Fire Prevention
9 Metro Tech Center
Brooklyn, NY 11201-3857

Date: _____

Dear Sir/Madam:

I am pleased to recommend my employee _____ (Name of Applicant) to apply for the W-27 Certificate of Fitness to supervise the stationary energy storage system (ESS) installed in Group R-3 occupancies.

He/she has _____ (Years/Months) of relevant experience and has obtained all required training regarding the energy storage system mentioned in the Energy Storage System Training Verification Letter from the qualified personnel. I confirm that this candidate has been trained and is capable in supervising the energy storage system and providing required information to the first responders during a fire or non-fire emergency incident. This applicant is of good character and is physically able to perform the functions required by this Certificate of Fitness.

I affirm that the applicant has also been or will be trained and is knowledgeable about the requirements listed in the FDNY Certificate of Approval for the energy storage systems that the applicant will supervise.

On this _____ day of _____, in the year _____, I have hereunto affixed my signature, and I affirm that all statements made on this form are true under the penalties of perjury.

I understand that

- all statements made in connection with the application are subject to investigation and verification
- any intentional falsification of this letter can be grounds for the denial, non-renewal, suspension or revocation of the W-27 Certificate of Fitness as applies to the applicant
- FDNY representative may question the W-27 Certificate of Fitness holder as to the required building or site information listed above to verify their knowledge during inspection.

_____	_____	_____
(Printed name of Employer)	(Employer's title)	(Signature of Employer)

NOTE: ***The recommendation letter should be on employer's letterhead. If not on employer's letterhead, signature must be notarized.***

STUDY MATERIAL AND TEST DESCRIPTION

About the Study Material

This material will help you prepare for the examination for the Certificate of Fitness for Supervision of Stationary Energy Storage System installed in the Group R3 occupancies. The exam covers this entire booklet. **It will not be provided to you during the test. It is critical that you read and understand this booklet to help increase your chance of passing this exam. The reference material will be provided to you during exam.** The study material does not contain all of the information you need to know to supervise the energy storage system (ESS). It is your responsibility to become familiar with all applicable rules and regulations of the City of New York, even if they are not covered in this study material. In order to properly prepare for this exam, you need to be familiar with the 2022 New York City Fire Code sections FC608, FC901.6, and FC907, Fire Department Rules 3RCNY 608-01 and 3RCNY 907-01, and NFPA 855 (2019 Ed.).

About the Test

The W-27 exam consists of 40 multiple choice questions, administered on a "touch screen" computer monitor. It is a time-limited test. Only one answer is correct for each question. If you **DO NOT** answer a question or mark more than one alternative, your answer will be scored as incorrect. A score of 70% is required on the examination in order to obtain a Certificate of Fitness. Read each question carefully before marking your answer. There is no penalty for guessing.

Sample Questions

The following questions represent the "format" of the exam questions, not the content of the real exam.

1. Which of the following are allowed to be used/displayed while taking a Certificate of Fitness examination at 9 Metro Tech Center?

I. cellular phone
II. Study material booklet
III. Reference material provided by the FDNY
IV. Mp3 player

A. III only
B. I, II, and III
C. II and IV
D. I only

Only reference material provided by the FDNY is allowed to be used during Certificate of Fitness examinations. Therefore, the correct answer would be A. You would touch "A" on the computer terminal screen.

2. If you do not know the answer to a question while taking an examination, whom should you ask for help?

A. the person next to you
B. the firefighters
C. the examiner in the testing room
D. you should not ask about test questions since FDNY staff cannot assist applicants

You should not ask about examination questions or answers since FDNY staff cannot assist applicants with their tests. Therefore, the correct answer would be D. You would touch "D" on the computer terminal screen.

3. If the screen on your computer terminal freezes during your examination, whom should you ask for help?

A. the person next to you
B. the firefighters
C. the examiner in the testing room
D. the computer help desk

If you have a computer related question, you should ask the examiner in the testing room. Therefore, the correct answer would be C. You would touch C. You would touch "C" on the computer terminal screen.

INTRODUCTION

This study material will help you prepare for the written examination for the W-27 Certificate of Fitness (COF) for Supervision of Energy Storage Systems (ESS) in the Group R-3 occupancies.

W-27 Certificate of Fitness holders should be aware that they may be required to demonstrate their knowledge and proficiency in their duties related to their Certificate at the time of original and renewal applications, and at any time Fire Department representatives are conducting an inspection of a premises. The Fire Department (FDNY) can deny, not renew, suspend or revoke a Certificate of Fitness for misconduct, which would include the failure of the Certificate of Fitness holder to properly fulfill their duty for any reason.

The Certificate of Fitness holder must keep the Certificate of Fitness readily available for inspection by any representative of the Fire Department and at all times while operating or supervising an energy storage system (ESS) facility for which the Certificate of Fitness is required.

In addition to any other penalties provided by law, misconduct on the part of an applicant or holder of a Certificate of Fitness must be grounds for denial, non-renewal, suspension or revocation of a certificate, and denial of an application for a certificate or the opportunity to take a certificate examination. Such misconduct includes, but is not limited to:

- The failure of Certificate of Fitness holders to properly fulfill their duties
    - i.e. COF holders will be held accountable when they fail to report a spill, fire, excessive smoking/vaporizing or smoldering, or any other hazardous condition, and they may have their Certificate of Fitness revoked for such failure.
- Any false and fraudulent conduct in connection with an application for a certificate or the duties of a certificate holder, including:
    - False or fraudulent statements or submissions
    - Unauthorized changes or use of a Certificate of Fitness or possession of a fraudulent Certificate of Fitness
    - Cheating on Certificate of Fitness examination
    - Impersonating another person or allowing oneself to be impersonated
- The failure of Certificate of Fitness holders to promptly notify the Fire Department of any change in the applicant’s or Certificate of Fitness holder’s residence address, or work location
- Any other conduct that decreases the integrity or reliability of an applicant or Certificate of Fitness holder
- Compromising the integrity or confidentiality of a Fire Department examination

PURPOSE OF FIRE CODE 608

The Fire Code 608 govern all energy storage systems, including emergency power, standby power, uninterruptible power and mobile systems.

PURPOSE OF RULE 3 RCNY 608-01

The rule 3 RCNY 608-01 was adopted to establish standards, requirements and procedures for the design, installation, operation, inspection, maintenance, and decommissioning of outdoor/rooftop stationary storage energy storage systems and mobile energy storage systems. All outdoor/rooftop stationary energy storage systems or mobile energy storage systems must comply with this Rule requirements.

PURPOSE OF THE STUDY MATERIAL

The study material includes information taken from the 2022 NYC Fire Code, NYC Fire Department Rules, and various NFPA standards.

This study material covers:

Indoor or outdoor stationary storage systems installed in Group R-3 occupancies that use various types of new energy storage technologies, including lithium-ion, nickel-cadmium and nickel metal hydride batteries.

This study material does NOT cover:

All other indoor/outdoor stationary storage systems installed in occupancies other than Group R-3.

DEFINITIONS

Abnormal Conditions. When one or more parameters that govern the operation of a system are outside their control limits.

Alarm Signal. A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

Ampere-Hour (Ah). Ah is an abbreviation for ampere-hour, or amp-hour. This describes the charge capacity of a battery, or how much current can be delivered at a constant rate as the battery is depleted over the course of one hour.

Approved. Acceptable to the Fire Commissioner. In reference to construction documents, the determination by the Fire Department after full examination that submitted construction documents comply with NYC Fire Code and other applicable laws and rules. In reference to materials, the determination by the commissioner that material is acceptable for its intended use.

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

Automatic. As applied to fire protection devices, any device, equipment or system that initiates system function as a result of a predetermined temperature rise, rate of temperature rise, or combustion products, without the necessity for human intervention.

Battery Module. A module consists of number of cells generally connected in either series or parallel.

BMS (Battery Management System). Any electronic system that manages a rechargeable battery (cell or battery pack) by facilitating the safe usage and a long life of the battery in practical scenarios while monitoring and estimating its various states (such as state of health and state of charge), calculating secondary data, reporting that data, controlling its environment, authenticating or balancing it.

Battery String. A battery string or bank comprises a number of cells/batteries connected in. series to produce a battery or battery string with the required usable voltage/potential e.g. 6V, 12V, 24V, 48V, 110V. Ah.

ESMS (Energy Storage Management System). A system that monitors, controls, and optimizes performance of an individual or multiple battery modules in an energy storage system and has the ability to control the disconnection of the module(s) from the system in the event of abnormal conditions. This system can be completely independent of the Energy Storage Management System.

Battery Rack. A device used to vertically store battery modules.

Cell. A single connection between the plates and electrolyte which produces a specific voltage (i.e. one AA battery has one cell). In battery systems there are multiple cells in order to provide enough voltage and energy for the entire load.

Central Station. A facility that receives alarm signals from a protected premises and re-transmits or otherwise reports such alarm signals to the Fire Department.

Certificate of Approval. A written statement issued by the FDNY commissioner, certifying that an article, device or equipment, or type, class or kind thereof, has been examined, tested and approved for a specific purpose or use in conformity with the requirements of the construction codes, the Fire Code or the Fire Department Rules.

Commissioning of the System. A systematic process that provides documented confirmation that the stationary storage battery system and all associated fire protection systems function according to the intended design criteria set forth in the project documents and satisfy the operator and/or owner's operational needs, including compliance with applicable laws, regulations, codes, and standards.

Converters. Convert the voltage of an electric device, usually alternating current (AC) to direct current (DC).

Decommissioning of the System. A process that verifies and documents that the energy storage system has been completely and safely removed from service and the hazardous components properly disposed of in accordance with minimum code requirements, applicable regulations and manufacturer's instructions. Decommissioning can be Emergency Decommissioning; required when the ESS suffers a thermal runaway or other failure or Planned Decommissioning; which occurs when maintenance is required (see Recommissioning) or at the expected termination of the ESS when it reaches the end of its useful life.

Dedicated Use Building. A building housing a stationary energy storage system that 44 allows human entry (walk-in) but is not designed or used for human occupancy.

Deflagration. Propagation of a rapid combustion zone creating over-pressure at a velocity that is less than the speed of sound in the unreacted medium, which may be caused by a thermal runaway condition. (NFPA 68-2018: Standard on explosion Protection by Deflagration Venting.)

Disconnect Switch. The purpose of this switch is to electrically isolate the ESS from the utility grid and provide a physical break in the electrical circuit. *(See e-stop).*

Direct Current. As opposed to alternating current or AC which is commonly found in homes and business batteries produce direct current or DC. Note: Non-contact voltage testers will NOT detect direct current. These devices were designed to detect alternating current as the devices can see the alternating wave form of AC.

E-Stop. An emergency device used to stop an energy storage system from charging. ***Note:*** It will NOT deplete the energy already stored within the batteries associated with the system. (*See disconnect switch*).

Energy Storage Systems (ESS), Stationary.

A rechargeable system for the storage of electrochemical energy, designed as a stationary installation (including mobile systems) and consisting of one or more interconnected storage batteries, capacitors, inverters and other electrical equipment. A stationary energy storage system is typically used to provide electrical power and includes associated fire protection, explosion mitigation, ventilation and/or exhaust systems. Stationary energy storage systems include the following types of systems:

- **Indoor System.** A stationary energy storage system installed inside a building.

- **Mobile System.** A stationary energy storage system mounted on a trailer or otherwise installed for mobile use.
- **Outdoor System.** A stationary energy storage system installed outdoors, including mobile systems and systems installed on a rooftop.

One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time to the local power loads, to the utility grid, or for grid support.

Fire Alarm Signal. A signal initiated by a fire alarm-initiating device such as a manual fire alarm box, automatic fire detector, water-flow switch, or other device whose activation is indicative of the presence of a fire or fire signature.

Fire Alarm System. Any system, including any interconnected fire alarm sub-system, of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices.

Fire Apparatus Access Road. A road that serves to provide access for fire apparatus from a public street to the frontage space of one or more buildings not directly fronting on a public street. A fire apparatus access road includes any road that serves such purpose whether denominated as a driveway, parking lot lane, private road or private street.

Fire Department Connections (FDC). A connection, normally on the exterior of the building, through which the Fire Department can pump supplemental water into the sprinkler system, standpipe, or other system furnishing water for fire extinguishment to supplement existing water supplies (**formerly known as a Siamese connection).**

Fire Detector, Automatic. A device designed to detect the presence of a fire signature and to initiate action.

Fire Extinguishing System. An approved system of devices and equipment which detects a fire and discharges an approved fire extinguishing agent onto or in the area of a fire. Such term includes automatic systems and, where such systems are authorized by this code or the Building Code, manually activated systems.

Fire Protection System. Approved devices, equipment and systems or combinations of systems used to detect a fire, activate an alarm, extinguish or control a fire, control or manage smoke and products of a fire or any combination thereof, including fire extinguishing systems, fire alarm systems, sprinkler systems and standpipe systems.

Gas Detection System. A system or portion of a combination system that utilizes one or more stationary sensors to detect the presence of a specified gas at a specified concentration and initiate one or more responses required by this code, such as notifying a responsible person, activating an alarm signal, or activating or deactivating equipment. A self-contained gas detection and alarm device is not classified as a gas detection system.

General Supervision. Supervision by the holder of any department certificate who is responsible for performing the duties of the Certificate of Fitness holder but need not be personally present on the premises at all times.

Heat Detector. A fire alarm device designed to respond when the convected thermal energy of a fire increases the temperature of a heat sensitive element.

Inverters. Convert direct current (DC) to alternating current (AC).

Immediately. Without any delay, but up to a maximum of 15 minutes.

Kilowatt-Hour (kWh). A measurement of electrical energy. KWh is an abbreviation for kilowatt hour. If energy is transmitted or used at a constant rate (power) over a period of time, the total energy in kilowatt hours is equal to the power in kilowatts multiplied by the time in hours. The kilowatt hour is commonly used as a billing unit for energy delivered to consumers by electric utilities.

Listed. A material, device, equipment or system included on a list published by a nationally recognized testing laboratory or other approved organization performing product evaluations that maintains periodic inspection of production of such listed material, device, equipment or system, and whose listing indicates compliance with nationally recognized standards and designates suitable usage.

Megawatt Hours (MWh). A measurement of electrical energy.

Out-of-Service System. A fire protection system that is not fully functional; or whose operation is impaired or is otherwise not in good working order.

Photovoltaic (PV). The conversion of light into electricity using semiconducting materials.

Photovoltaic System (PV). An electric power system designed to supply usable solar power by means of photovoltaics. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to convert the output from direct to alternating current, as well as mounting, cabling, and other electrical accessories to set up a working system.

Recommissioning of an Existing System. A process that verifies and documents that a repaired or reconditioned energy storage system functions in accordance with its initial commissioning and according to minimum code requirements, listing requirements and manufacturer's published instructions.

Residential Group R Occupancies.

Group R-1 occupancies containing sleeping units where the occupants are primarily transient in nature, including:

Boarding houses (transient) with more than 10 occupants

Congregate living facilities (transient) with more than 10 occupants

Hotels/Motels (transient)

Group R-2 occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent in nature, including:

Apartment houses

Congregate living facilities (non-transient) with more than 16 occupants, including boarding houses (non-transient), convents, dormitories, fraternities and sororities, monasteries

Hotels/Motels (non-transient)

Vacation timeshare properties

Group R-3 occupancies where the occupants are primarily permanent in nature.

Safety Data Sheet (SDS). A document prepared in accordance with the regulations of the United States Department of Labor, as set forth in 29 CFR Part 1910.1200 or a federally approved state OSHA plan which sets forth information concerning a hazardous material. An SDS is a standardized document that contains important occupational safety and health data for workers and emergency first responders.

Smoke Detector. A listed device that senses visible or invisible particles of combustion.

Standpipe System. Piping installed in a building or structure that serves to transfer water from a water supply to hose connections at one or more locations in a building or structure for fire-fighting purposes.

Storage Battery. An electrochemical device, equipment or system designed to store and generate electrical energy.

Storage Battery Types

Flow battery. A storage battery that stores and generates an electrical current by ion exchange through a membrane separating liquid electrolytes.

Lead acid battery. A storage battery that is comprised of lead electrodes immersed in sulfuric acid electrolyte, including vented (flooded) or valve regulated lead acid (VRLA) batteries.

Valve-regulated lead-acid (VRLA) battery. A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount. In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).

Vented (flooded) lead-acid battery. A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte. Flooded lead-acid batteries have a provision for the user to add water to the cell and are equipped with a flame-arresting vent that permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell.

Lithium-ion (Li-ion) battery. A storage battery in which an electrical current is generated by lithium ions embedded in a carbon graphite or nickel metal-oxide substrate placed in a high-viscosity carbonate mixture or gelled polymer electrolyte.

Lithium Metal Polymer Battery. A storage battery in which an electrical current is generated by the interaction between lithiated positive active material electrically separated from metallic lithium or lithiated negative active material, and nonaqueous liquid or polymerized electrolytes.

Nickel Cadmium (Ni-Cd) Battery. An alkaline storage battery in which the positive active material is nickel oxide, the negative active material contains cadmium, and the electrolyte is potassium hydroxide.

Nickel Metal Hydride (NiMH) Battery. An alkaline storage battery in which the positive active material is nickel oxide, the negative active material is a hydrogen- absorbing alloy, and the electrolyte is potassium hydroxide.

Nonrecombinant Battery. A storage battery in which, under conditions of normal use, 26 hydrogen and oxygen gases created by electrolysis are vented into the air outside of the battery.

Recombinant Battery. A storage battery in which, under conditions of normal use, hydrogen 29 and oxygen gases created by electrolysis are converted into water inside the battery instead of 30 venting into the air outside of the battery.

Stationary storage battery. A storage battery designed for use in a stationary installation, in which electrochemical cells are interconnected to supply a nominal voltage of direct current power. The nominal voltage rating of a stationary storage battery is a function of the number of cells connected in a series, and the discharge capacity is a function of the size of the cells. Stationary storage batteries are characterized by their ability to be restored to a fully charged condition by reversing the flow of the electric current after discharge.

Storage Battery Unit. A storage battery system in the configuration in which it was tested and listed to Underwriters Laboratories Standard 9540 (UL Standard 9540), including any cabinet or other enclosure.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Subject Matter Expert (SME). A person who has accumulated great knowledge in a particular field or topic and this level of knowledge is demonstrated by the person's degree, licensure, and/or through years of professional experience with the subject.

Thermal Imaging Camera (TIC). A thermographic camera that converts infrared light emitted from surfaces to visible light, displayed by the camera’s viewing screen. Such cameras allow firefighters to see areas of heat or thermal energy through smoke, darkness, or heat-permeable barriers. Thermal imagers also enable the inspection of equipment for abnormal operation (e.g., loose connections, overloaded components, loss of coolant, moisture intrusion, etc.)

Thermal runway. The condition when an electrochemical battery cell increases its temperature through self-heating in an uncontrollable fashion. The thermal runaway progresses when the cells generation of heat is at a higher rate than the heat it can dissipate. Thermal runaway may lead to off-gassing, fire and deflagration.

Unnecessary Alarm. An alarm signal transmitted by a fire alarm system which functioned as designed, but for which a Fire Department response proved unnecessary. An example of an unnecessary alarm is an alarm triggered by smoke from a lit cigarette in a non-smoking area, when the presence of such smoke does not implicate fire safety concerns.

Unwarranted Alarm. An alarm signal transmitted by a fire alarm system which failed to function as designed because of improper installation, improper maintenance, malfunction, or other factor. Examples of unwarranted alarms are alarms resulting from improper smoke detector placement, improper detector setting for installed location, lack of system maintenance, and control panel malfunction.

Exhaust or Mechanical Ventilation System. Such ventilation systems shall be adequate to exhaust any flammable or other gases generated during the normal operation and/or failure of the stationary energy storage system

CHAPTER 1. CASE STUDIES

The case studies mentioned below are for illustrative purposes to address some issues that may be involved in energy storage system accidents. The case studies do not necessarily reflect the overall incidents.

Garage Battery Fire (Cedar City, UT, USA, 2020)

The fire is believed to have started inside the garage, where a bank of batteries charged by solar panels overheated. No injuries were reported. The damage was estimated at approximately $30,000.

Garage Battery Fire (San Jose, CA, USA, 2020)

A 10kWh Li-ion ESS was ignited. Fire extended to rafters and into wall cavity behind ESS.

The ESS must be installed in accordance with the manufacturer's instructions and their listing, if applicable, and must not be installed within the habitable space of a dwelling unit.

CHAPTER 2. HOME STATIONARY ENERGY STORAGE SYSTEMS

Home (one- or two-family houses) energy storage system is becoming more popular in these years. Many house owners have installed solar systems and energy storage systems to store solar energy generated during the day for use any time. These home ESSs may be installed in attached/detached garages, on exterior walls, on the ground of yard, or in enclosed utility spaces. The home energy storage system may also be designed to store energy from the grid.

Although the capacity of these home energy storage systems is not as high as the energy storage systems used in the large residential or commercial buildings, there are still hazards and risks.

The 2022 Fire Code requires home ESS must be under general supervision of a W-27 Certificate of Fitness holder to ensure that the installation, commissioning, decommissioning, maintenance, and testing are in compliance with the Fire Code and related regulations.

2.1 Five Types of Energy Storage Technologies

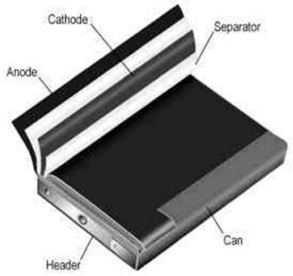
This study material focuses on the stationary energy storage systems that uses the following types of new energy storage technologies:

- Lithium-ion batteries
- Lithium metal polymer
- Flow batteries
- Nickel cadmium
- Nickel metal hydride
- Lead acid (Flooded and VRLA)

In the future, the study material may be updated with the new technologies or battery chemistries that may become available.

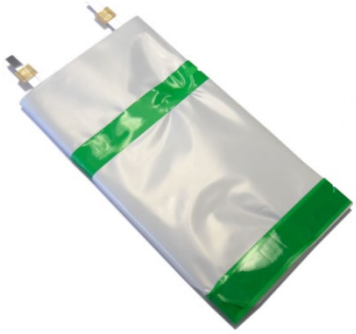
2.1.1 Lithium-ion (Li-ion) batteries

LITHIUM-ION PRISMATIC



LITHIUM-ION PRISMATIC

LITHIUM-ION POUCH



LITHIUM-ION POUCH

LITHIUM-ION CELL (18650)
CYLINDRICAL

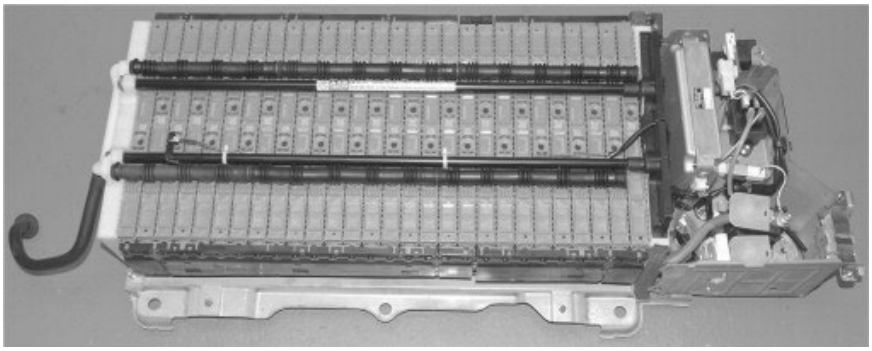
LITHIUM-ION CELL
CYLINDRICAL

LITHIUM-ION RACK
(MULTIPLE MODULES)

2.1.2 Lithium Metal Polymer batteries

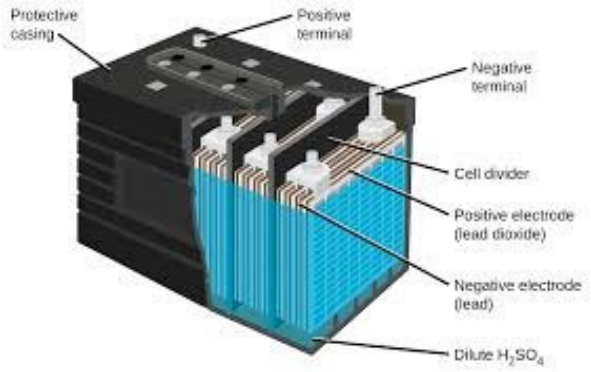
2.1.3 Nickel cadmium batteries

2.1.4 Nickel metal hydride (Ni-MH) batteries



2.1.5 Lead acid batteries

(a) Flooded



(b) VRLA

2.2 Different Battery Energy Storage Systems Benefits and Hazards

2.2.1 Benefits of different Battery Energy Storage Systems

Technology	Benefits
Lithium Ion **(most commonly used)**	• Low maintenance • high cycle life • Due to popular demand, this technology is continually evolving • Fast power response rate
Nickel Cadmium (Ni-Cad)	• Good load performance • Forgiving if abused
Nickel-Metal Hydride	• Memory degradation but less prone to memory than Ni-Cad, can be long usage life • More environmentally friendly
Flooded (Vented) Lead Acid	• Require a refill with distilled water • Low risk of thermal runaway • Well understood causes and remedies for thermal runaway
Valve-Regulated Lead-Acid (VRLA)	• No electrolyte to fill • Low risk of thermal runaway • Well understood causes and remedies for thermal runaway
	•

2.2.2 Hazards of different Battery Energy Storage Systems

(For detailed information, refer to NFPA 855, Annex B. Battery Energy Storage System Hazards)

Technology	Potential Hazards	Potential Hazards Under Normal Conditions	Potential Hazards Under Emergency/Abnormal Conditions
Lithium Ion (Li-ion)	Fire/explosion hazards	Latent defects within the cells or design issues: • Flammable gas concentrations • Thermal runaway	• Flammable gas concentrations • Thermal runaway
	Chemical hazards	N/A.	• Off-gassing of flammable or toxic vapors
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Risk of electric shock during manual suppression • Ground paths altered and unexpected shock hazards
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance	• Stranded energy may present electric shock hazards during disassembly
	Physical hazards	• Lifting hazards due to the weight of the battery	• Overheating • Heavy system components • The guards of moving hazardous parts (e.g. fans) might be missing
Nickel Cadmium (Ni-Cad)	Fire hazards	If not properly vented: Flammable gas concentrations	• Flammable gas concentrations •
	Chemical hazards	• Corrosive/caustic potassium hydroxide electrolyte	• Corrosive/caustic potassium hydroxide electrolyte • Toxic vapors
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Risk of electric shock during manual suppression • Ground paths altered and unexpected shock hazards
	Stranded or stored energy hazards	Stranded or stored energy hazards during maintenance	• Stranded energy may present electric shock hazards during disassembly
	Physical hazards	Lifting hazards due to the weight of the battery	• Overheating • Heavy system components
	Fire hazards	• N/A	• Flammable gas concentrations Thermal runaway

Nickel-Metal Hydride (Ni-MH)	Chemical hazards	• N/A	• Corrosive electrolyte • Off-gassing of toxic vapors
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Electric shock
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance	• Stranded energy may present electric shock hazards during disassembly
	Physical hazards	• N/A	• Overheating • The guards of moving hazardous parts (e.g. fans) might be missing
Flooded (Vented) Lead-Acid	Fire hazards	If not properly vented: Flammable gas concentrations	• Flammable gas concentrations •
	Chemical hazards	Sulfuric acid electrolyte	• Corrosive sulfuric acid electrolyte •
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance.	• Stranded energy may present electric shock hazards during disassembly
	Physical hazards	Lifting hazards due to the weight of the battery	• Overheating • Heavy system components
Valve-Regulated Lead-Acid (VRLA)	Fire hazards	• N/A	• Flammable gas concentrations Thermal runaway
	Chemical hazards	• N/A.	Corrosive electrolyte (minor)
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Risk of electric shock during manual suppression • Ground paths altered and unexpected shock hazards
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance	• Stranded energy may present electric shock hazards during disassembly
	Physical hazards	• Lifting hazards due to the weight of the battery	• Overheating • Heavy system components
			•

			•
		•	•
		•	•
		•	•

2.3 Battery Systems Size Thresholds (only applies to outdoor/rooftop stationary)

Outdoor/rooftop stationary energy storage systems are classified by size - small, medium or large, as set forth in Table 1 of this booklet. The size of the stationary energy storage system is based on the energy storage/generating capacity of such system, as rated by the manufacturer, and includes all energy storage units operating as a single system. Table 1 is not applicable to multiple battery systems operating independently at a single premise, which are subject to the Section 2.4 “Multiple battery system” of this booklet.

Table 1. Stationary Energy storage System Size Thresholds

Battery Technology	**Aggregate Rated Energy Capacity**		
	Small	**Medium**	**Large**
Lead Acid Battery	>2 kWh and ≤70 kWh	Not allowed*	Not allowed*
Ni-Cd Battery	>2 kWh and ≤70 kWh	Not allowed*	Not allowed*
NiMH Battery	>2 kWh and ≤70 kWh	Not allowed*	Not allowed*
Li-ion Battery	>2 kWh and ≤20 kWh	>20 kWh and ≤ 250 kWh	Not allowed*
Flow Battery	>2 kWh and ≤20 kWh	>20 kWh and ≤ 500 kWh	Not allowed*

*This size is not allowed in the Group- R3 occupancies

Ampere-Hour Conversion:

If the energy capacity is rated in amp-hours, the W-27 COF holder should know how to convert the rating to kWh:

KWh must equal rated voltage times amp-hour rating divided by 1000:

(voltage x amp-hours)/1000 = kWh

Calculation Example:

The size of a battery system is labeled as 2500 amp-hours at 12 volts. To convert it to kWh:

(12*2500)/1000=30 kwh

Stationary energy storage systems must comply with all requirements applicable to the type of installation as specified in the Appendix A.

2.4 Multiple Battery Systems

(may not apply to small outdoor/rooftop stationary energy storage systems, see below for details)

More than one energy storage system may be installed on a single site or premises. These sites will be subject to additional or alternative requirements.

Multiple small outdoor/rooftop stationary energy storage systems are not subject to this requirement if they:

- are not part of a single installation or installed in a single enclosure; and
- operate independently of each other and are not interconnected with other small, medium or large battery systems.

If there are multiple battery systems installed on a single site or premises, it is important for the COF holder to know how many battery systems are co-located on the site, how they are separated, how they are electrically interconnected, and their total size.

CHAPTER 3. PERMITS, ROLES AND RESPONSIBILITIES

3.1 Permits

3.1.1 DOB work permit/approval

The work permits/approvals issued by the Department of Buildings (DOB) are issued to authorize construction work. It is the owner's responsibility to contact the Department of Building to comply with the DOB work permit/approval requirements. The information regarding application process can be obtained from the following document:

https://www1.nyc.gov/assets/buildings/bldgs_bulletins/bb_2019-002.pdf

Currently, no Fire Department Permits are required.

3.2 Obligations of Owner and Operator

(applies to all battery storage systems)

Both the owner of the premises at which the stationary energy storage system has been installed, and the business responsible for the battery system's operation, if any, is responsible for compliance with all battery system installation, operational and maintenance requirements, including the lawful and proper removal and disposal of the battery system (decommissioning).

3.3 W-27 Certificate of Fitness Holder's General Duties

All stationary energy storage systems must be under the general supervision of a trained and knowledgeable person holding a Fire Department Certificate of Fitness.

"General supervision" is a defined term in the Fire Code (see FC202). In the present context, it refers to the person holding a Fire Department W-27 Certificate of Fitness who is responsible for the safe operation and maintenance of an ESS at a specific site location. A person providing general supervision does not have to be present on the premises when the ESS is in operation, but is responsible for ensuring that it is installed, operated and maintained in accordance with the NYC Fire Code and other applicable laws, rules and regulations.

A Certificate of Fitness requirement helps ensure that installers and other businesses involved in stationary energy storage systems – who may be new to New York City – are familiar with New York City regulatory requirements, and the W-27 Certificate of Fitness holder can serve as a point of contact with the Fire Department. The required emergency management plan should be developed by manufacturers, installers and, in some cases, by property owners, to address how such situations would be handled.

W-27 COF holder must:

- be trained and knowledgeable in the installation and operation of the battery system;
- possess the manufacturer's installation and operating specifications for each battery system and

any associated fire protection and deflagration mitigations systems present;

- ensures that installers and other businesses involved in stationary energy storage systems are familiar with regulatory requirements;
- ensure the fire and gas detection systems, fire extinguishing systems and smoke/gas purge systems, if applicable, are approved by the FDNY;
- be present during commissioning of the system and authorize the activity after confirming that the battery system is in good working order and operating in accordance with manufacturer's specifications;
- inspect the battery system as often as necessary to ensure that it is continuing to operate in a safe and lawful manner;
- ensure that all associated systems, if applicable, on site (e.g. fire detection systems, ventilation systems, fire extinguishing, deflagration mitigation, ventilation and smoke/gas purge system, etc.) are properly maintained by certified and licensed personnel;
- be familiar with the required procedures for impairment situations with any associated systems on site, if applicable;
- be familiar with the notification procedures for different conditions (e.g. maintenance issue, emergency, etc);
- coordinate communication between ESMS/BMS monitor facility staff, Subject Matter Expert (SME) and FDNY during any emergency condition;
- be reachable by the Fire Department to provide technical support immediately within 15 minutes (via phone is acceptable), and physically present on scene within 2 hours for any emergency condition affecting a battery system;
- provide technical assistance to the Fire Department about the stationary energy storage system installation in coordination with the energy storage management system (ESMS) or battery management system (BMS) monitoring facility, SMEs who can provide technical assistance about the battery's design and performance in the event of an emergency condition affecting the battery system;
- understand how other systems on premises affect the ESS and their sequences in case of emergency (other COF holders have to be available for specific systems that are on the premises);
- be familiar with the emergency standardized operating procedures, which may include assigned actions (alarming neighboring tenants, securing the area, etc.);
- ensure that the scene is properly protected after an emergency;
- be present during all decommissioning to ensure the decommissioning is conducted in accordance with manufacturer's specifications and the system is lawfully transported and disposed of in accordance with *USDOT* hazardous materials regulations and other applicable laws, rules and regulations;
- maintain logbooks, emergency contacts, as well as list of all system personnel. Ensure that information is updated when necessary and it is current and up to date.

3.4 Subject Matter Experts (SMEs)

The SMEs are completely knowledgeable and proficient on the specific battery system, know how this system works and how the system will likely behave under normal as well as emergency conditions. SMEs work with the W-27 COF holders to provide system/site specific technical information to the Fire Department during an emergency situation involving the ESS. They are representative of the manufacturer and/or installer. The SMEs understand the specific chemistry of the battery system and they are fully trained by the manufacturer of the system.

The SME must:

- have technical understanding of the system and be knowledgeable and proficient on reading and understanding the system ESMS/BMS signals and indicators.
- know how to remotely monitor, interpret and explain ESS system performance data as provided by the ESMS/BMS.
  - Interpret location and timing of detection signals (smoke (photo/ion), CO, H_2, VOC, THC, VESDA, etc.)
  - Identify the condition of the fire suppression system(s), if applicable (clean agent, inert gas, water, etc. (discharged/not discharge, malfunctions, etc.))
  - Understand the condition of any other fire/deflagration mitigation systems (deflagration vents,
  - Identify the condition of existing system(s) (e.g. the HVAC system or any mechanical/exhaust ventilation system.)
  - Estimate the quantity of system involved in thermal runaway.
- be familiar with the Emergency Management Plan of the battery system.
- be reachable for technical support immediately (via phone is acceptable).
- work with the W-27 COF holder to assist first responders.
- understand the specific chemistry of the battery system and be fully trained by the manufacturer of the system.
- deal directly with battery manufacturer on emergency operation and decommissioning of the system.
  - Knowledgeable in arc flash hazards and PPE
  - Identify potential ground paths
  - Develop work plan to account for voltage hazards
- have access to real-time ESMS/BMS data and work with COF holder to assist first responders as needed.
- at the site or has remote access to the site.

The SME's knowledge plays an important role in helping the first responders to correctly understand the nature and severity of the emergency and provide technical information essential for making correct decisions regarding the safe mitigation of the emergency. If the SME is knowledgeable to provide the technical support and suggestions for the emergency operation, the first responders will not only be able to control and extinguish the fire but also mitigate the damages to the entire battery system. However, if the SME cannot provide the sufficient information, the first responders will focus

on controlling the fire/deflagration and protecting public safety but not on reducing any potential damage to the ESS.

3.5 ESMS/BMS monitoring facility staff

The designated ESMS/BMS monitoring facility staff must be trained and knowledgeable, retained by the manufacturer or installer of the battery system. The ESMS/BMS monitoring facility personnel may also be the SMEs or they may be different. In order to address any potential emergency, the ESMS/BMS monitoring facility staff must either be personally present in the monitoring facility to constantly monitor the ESMS/BMS or be able to receive the immediate notifications from the ESMS/BMS device that is constantly monitored. In the event the battery system exceeds or appears likely to exceed operating conditions at which fire, deflagration or other serious adverse consequences may result, the staff must immediately make the required notifications to the FDNY (by emailing: tech.mgt@fdny.nyc.gov), Certificate of Fitness holder and SME(s) representing the manufacturer.

CHAPTER 4. GENERAL DESIGN AND INSTALLATION REQUIREMENTS

4.1 Listing and Full-scale testing standards

(applies to all stationary energy storage systems)

All stationary energy storage systems must be tested and listed by a nationally recognized testing laboratory to the standards provided in FC 608.4.1 (Listing standards) and FC 608.13 (Stationary energy storage systems installed in or on the premises of Group R-3 occupancies (indoor and outdoor systems).

Stationary energy storage systems must be subjected to full-scale testing (referred to as "large-scale testing" in NFPA 855).

➢ W-27 COF holder's responsibilities

W-27 Certificate of Fitness holder must verify if all components of the systems are approved for use in NYC.

4.2 Equipment Approval (Certificate of Approval)

(Applies to all battery storage systems.)

The manufacturer of the energy storage unit must obtain a Certificate of Approval issued from the FDNY prior to installation.

Special requirements for any energy storage systems will be listed on the Certificate of Approval. The COF holder must ensure the installation, operation and maintenance of the system also comply with the Certificate of Approval.

➢ W-27 COF holder's responsibilities

Before commissioning, W-27 Certificate of Fitness holder must verify if the Certificate of Approval has been issued to the energy storage system and all requirements listed on the Certificate of Approval are met.

4.3 Maximum Aggregate Rated Energy Capacity for Group R-3 Occupancies

The maximum rated energy capacity of any storage battery in an energy storage system installed in such a dwelling, attached garage or detached garage or mounted outdoors on an exterior wall thereof, must not exceed 20 kWh, and the maximum aggregate rated energy capacity of such energy storage system must not exceed the following amounts:

- in any such dwelling, 20 kWh per dwelling unit, except as may be approved by the department; or
- in any such attached garage, or when mounted outdoors on an exterior wall of such a dwelling or attached garage, 40 kWh, provided that there is an approved two-hour fire

barrier separating such indoor system or wall mounted installation from the dwelling, or other approved measure based on the testing results of the energy storage systems; or

- in any such detached garage, or mounted on an exterior wall thereof, 40 kWh.

➢ W-27 COF holder's responsibilities

W-27 Certificate of Fitness holder must ensure that the maximum rated energy capacity of the ESS does not exceed the approved capacity.

4.4 DOB and FDNY Approval

The design and installation of any ESS must comply with the requirements of the Department of Buildings. The installation application must include the FDNY equipment approval for each battery system unit proposed.

➢ W-27 COF holder's responsibilities

- Ensure that the Certificate of Approval (equipment approval) is obtained from the FDNY.

4.5 Location and Construction

1. Fire Department access and Fire Protection System water supply

A direct, unobstructed pathway must be provided from the battery system installation to the public street or fire apparatus access road on which the premises fronts. Stationary energy storage systems located more than 250 feet from a fire hydrant must be provided with a private hydrant or other approved water supply for firefighting operations.

2. Separation distances**

Stationary energy storage systems must be located a minimum of 10 feet from the following exposures, except where lesser or greater distances are required by the equipment approval or installation approval based on full-scale testing data that indicate that a battery system fire will or will not adversely impact one or more of the following exposures:

(1) Lot lines;

(2) Public streets, fire apparatus access road, public walkways and other public ways;

(3) Any vehicle parking;

(4) Any building entrance door, openable window, or ventilation intake;

(5) Any exit discharge opening or other means of egress opening from a building or outdoor area;

(6) Any outdoor hazardous materials or combustible materials storage facility or area;

(7) Any outdoor storage facility or area for high-piled combustible materials or other combustible items;

(8) Overhead power lines or other aboveground electrical installation, measured from the boundary of the utility easement or, if there is no easement, from the vertical plane of the installation at its widest point; and

(9) Any adjacent or overhead public utility or transportation infrastructure.

** Unless otherwise approved by Rule, DOB or Tech Management Bulletin**

3. Rooftop locations

Stationary energy storage systems installation on rooftops must be authorized by the FDNY Certificate of Approval (COA). Although the original installation will be performed by the manufacture or authorized representative and allowed d by the FDNY COA, the COF holder must ensure any modification or renovation of the rooftop must also comply with the Fire Department Rule requirements, such as:

(1) Proper clearances and no obstructions:

Rooftop battery system installations, including structural support, enclosures/roof covering the ESS, electrical or other associated equipment, must not obstruct the rooftop access and clear path for buildings 100 feet or less in height.

(2) Valve-regulated lead-acid (VRLA) batteries may not be installed on rooftops unless the applicant demonstrates to the satisfaction of the Department that the hazardous materials used in such systems can be safely stored and used on a rooftop, and the application adequately addresses leak detection, spill containment and the movement of such hazardous materials into and out of the building.

(3) Any dunnage or other structural support for the battery system installation must have a proper fire rating, based on the size of the system.

(4) The building roof covering or roofing system, or other approved material placed underneath the rooftop battery system installation, must be noncombustible for a distance of five (5) feet from such installation.

4. Physical Protection

Stationary energy storage system installations must be protected from damage in accordance with the following requirements:

(1) **Temperature.** The storage battery or battery system must be designed for operation throughout the entire expected range of ambient temperature, in accordance with manufacturers' specifications, or provided with appropriate protection from damage from extreme ambient temperatures.

(2) **Vehicle impact protection**. Where the battery system is subject to impact by a motor vehicle or other motorized equipment, such as a fork lift or other powered industrial trucks, vehicle impact protection must be provided.

(3) **Security**. The battery system installation must be secured against unauthorized entry. All battery system enclosures must be securely locked and, where appropriate, safeguarded by a chain link fence or other approved barrier.

➢ W-27 COF holder's responsibilities

- Ensure that the ESS protected from any damage listed above.
- Ensure that proper clearances and "no obstruction" are maintained.
- Ensure that the ESS is properly protected by the approved functional fire protection systems when required by the Certificate of Approval.

*Notify FDNY <tech management email> within _ days after installation (Check rule)

4.6 Remote monitoring

All stationary energy storage systems must be designed to transmit ESMS/BMS data regarding battery system status and temperature to a remote monitoring facility.

4.7 Electrical components

The electrical components of stationary energy storage systems must comply with UL Standards 9540, be designed to operate safely during normal operating conditions, and installed in accordance with the NYC Fire Code requirements.

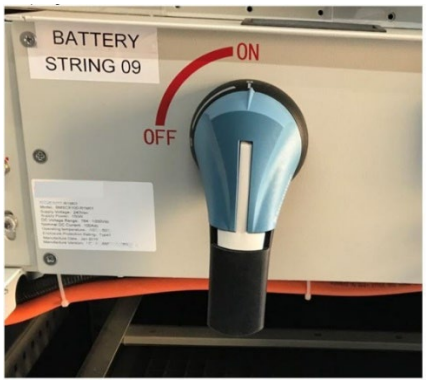
4.7.1 Disconnect switch and Lockout/Tagout Procedure

A disconnect switch (or "load break switch") serves multiple purposes, but its primary uses are to function as a disconnect means for a service entrance and disconnect switch and fault protection for motors (heavy machinery). The switch is used to disconnect equipment from its power source. It is also used for a variety of reasons, including:

- Repairs
- Maintenance
- Emergency stoppage (E-stop) NFPA 79

Fused disconnect switch

Unfused disconnect switch



Battery string disconnect switch

Battery container disconnect switch

Disconnect switches are reliable and provide safety to the battery system and personnel in addition to providing:

- Protection against overcurrent
- Protection against circuit overloads
- Protection against short circuiting
- Protection against heat-generated damage

Safety switches are designed to interrupt the power in the event of a single fault in the circuit.

Disconnect switch may also shut off auxiliary power to other systems, such as the Photovoltaic System (PV) system. As a COF holder, you must know what system(s) will be disconnected from its electrical supply when you open the disconnect switch.

Lockout-Tagout refers to the OSHA recognized safety procedure used in industry and research settings to ensure that dangerous machines have been properly shutdown and is incapable of being started up again prior to the completion of maintenance or servicing work. It requires that all hazardous energy

sources have been (1) identified; (2) isolated; and (3) rendered inoperative to prevent the release of potentially hazardous energy prior to the start of any repair or maintenance procedure. This is accomplished through the locking and tagging of all energy sources and their control devices. Some common forms of energy isolation include electrical circuit breakers, disconnect switches, ball or gate valves, blind flanges, and blocks. Lockout/Tagout procedures are required for ensuring that electrical or mechanical equipment is rendered safe by placing switches or controls in the "off" position and using approved measures to physically prevent the switches from operation while in "lockout" mode.

Push buttons, e-stops, selector switches and control panels are not considered proper points for energy isolation.

Lockout is the placement of a lockout device on an energy isolation apparatus (circuit breaker, slide gate, line valve, disconnect switch, etc.) to ensure that the energy isolating device and equipment being controlled cannot be operated until the lockout device is removed. A lockout device utilizes a positive means such as a lock (key or combination type) to hold an energy-isolating device in a safe position and prevent the energization of a machine or equipment. The lockout device must be substantial enough to prevent removal without use of excessive force or unusual techniques.

Tagout is the placement (a tag or other prominent warning device and a means of attachment on an energy isolation device to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

In general, Lockout/Tagout typically involves signage ("tagout") at the control switches and includes employee procedures about how, when and who can remove such signage; locking devices and return switches to the "on" position.

➢ W-27 COF holder's responsibilities

- Must know the location of the disconnect switch, and when the disconnect switch should be used.
- Must know how to open the disconnect switch.
- Must know how the disconnect switch functions and how it may affect the ESS and other related systems. For example, the COF holder must know what system(s) will be disconnected from its electrical supply when the disconnect switch is opened.
- Must know the lockout/tagout procedure.
- Must ensure that the proper PPE are provided.

CHAPTER 5. COMMISSIONING AND DECOMMISSIONING

5.1 Commissioning

Stationary energy storage systems must be installed by trained and knowledgeable persons in accordance with manufacturer's specifications.

Once an Energy Storage System (ESS) has been installed and all fire protection/life-safety systems related to the system are approved and operational, the commissioning process can begin. Commissioning ensures that the Energy Storage System (ESS) is evaluated for proper operation by the system owner or their designated agent.
Approved fire protection, smoke control and smoke purge, and hazard mitigation systems and measures installed to protect the system must also be inspected and tested by a person holding the qualifications required by this code, the construction codes and/or the Electrical Code, and any required acceptance testing conducted, prior to activation of the system.

Notification
For all ESSs, notice must be given to the Fire Department, so Fire Department firefighters or other representatives can, if they wish, attend the commissioning to familiarize themselves with these installations. The required notification procedures are detailed in Section 8.1 of this booklet.

➢ W-27 COF holder's responsibilities

Upon completion of the installation, the COF holder assuming responsibility for supervision of the ESS must authorize it to be activated, after confirming that the battery system is in good working order and operating in accordance with manufacturer's specifications.

Make the required notification to the FDNY by emailing tech.mgt@fdny.nyc.gov. (Refer to the Section 8.1 of this booklet)

5.1.1 Commissioning Plan

The system owner or their designated agent must prepare a written commissioning plan that details the commissioning process developed specifically for the ESS to be installed and a description of the activities to be conducted. The plan must be submitted with the FDNY permit application. The small outdoor ESS in Group R-3 must follow the COA requirement to develop the plan.

NFPA 855 and the Fire Code indicate that the commissioning plan must include, but not be limited to, the following information:

(1) An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted;
(2) Roles and responsibilities for all those involved in the design, commissioning construction, installation, or operation of the system(s);
(3) Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s);

(4) Plans and specifications necessary to understand the installation and operation of the ESS and all associated operational controls and safety systems;
(5) A detailed description of each activity to be conducted during the commissioning process, who will perform each activity, and at what point in time the activity is to be conducted;
(6) Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems;
(7) Testing for any required fire detection or suppression and thermal management, ventilation, or exhaust systems associated with the installation and verification of proper operation of the safety controls;
(8) Guidelines and format for a commissioning checklist and relevant operational testing forms and necessary commissioning logs and progress reports;
(9) Means and methods whereby facility operating and maintenance staff will be trained on the system;
(10) Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system;
(11) A decommissioning plan (refer to section 6.2 of this booklet) that covers the removal of the system from service and from the facility in which it is located and information on disposal of materials associated with each ESS

5.2 Decommissioning

5.2.1 Decommissioning plan

Prior to decommissioning, the owner, or their designated agent(s) (e.g. manufacturer, installer, hazardous materials carrier or other party responsible for removal, transportation and/or disposal of the stationary energy storage system) must prepare a written decommissioning plan that provides the organization, documentation requirements and methods and tools necessary to indicate how the safety systems required by this standard and the ESS and its components will be decommissioned and the ESS removed from the site. The plan must be submitted with the FDNY permit application. The small outdoor ESS in Group R-3 must follow the COA requirement to develop the plan.

A decommissioning plan will vary depending on the system size, manufacturer, and intended use. The NFPA 855 and the Fire Code indicate that the decommissioning plan must include the following information:

(1) An overview of the decommissioning process developed specifically for the ESS that are to be decommissioned;
(2) Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site;
(3) Means and methods whereby the decommissioning plan will be made available at a point in time corresponding to the decision to decommission the ESS;
(4) Plans and specifications necessary to understand the ESS and all associated operational controls

and safety systems, as built, operated, and maintained;

(5) A detailed description of each activity to be conducted during the decommissioning process and who will perform that activity and at what point in time;

(6) Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned;

(7) Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports;

(8) A description of how any changes to the surrounding areas and other systems adjacent to the ESS, such as but not limited to structural elements, building penetrations, means of egress, and required fire detection and suppression systems, will be protected during decommissioning and confirmed as being acceptable after the system is removed.

Additional Information that must be included in the decommissioning plan would include, but not be limited to the following*:

(1) An identification of all energy sources (batteries, connected batteries in other enclosures or structures), inverters [also known as power conversion systems (PCS)], DC bus pre-charge power supplies, UPS, support equipment with batteries, and AC or DC auxiliary power equipment and distribution systems;

(2) Information about personal protection equipment (PPE) and requirements for use as needed (site dependent), noting that each electrical equipment cabinet should already have shock and arc flash warning labels applied as per NFPA 70E;

(3) A notification that the ESS should be discharged to its safe state of charge (SOC) prior to removal or transport;

(4) Assurance that during the decommissioning process, critical support equipment such as, but not limited to, fire detection and suppression equipment, emergency lighting, electrical circuits to facilitate decommissioning, and so forth, remain operational to the extent possible;

(5) A warning not to disconnect any ESS grounding until all energy sources are isolated and follow locked out/tag out safety procedures;

(6) A warning notification to disconnect and shut down all batteries and support or auxiliary equipment associated with the system or its component parts;

(7) Isolation of all energy sources, starting with those with highest fault energy, by isolating the ac point of interconnection, then isolating strings, then isolating the individual battery modules;

(8) The need to mechanically uninstall battery trays and place them into original or equivalent packing materials or protect terminals;

(9) Information on disposal material associated with each ESS.

*As applicable

In addition, the owner, manufacturer or installer of stationary energy storage systems must have an emergency management plan or protocol that includes procedures for notifications and technical assistance (refer to section 8.1 and 8.3 of this booklet) and all other actions necessary for mitigation and decommissioning (or restoration to normal operation). The procedures of decommissioning vary,

and instructions of decommissioning are to be followed from the manufacturer.

5.2.2 Decommissioning Process

For all ESSs, notification of decommissioning to the FDNY must be made. The notification requirement for decommissioning should be referred to Section 8.1 of this booklet.

➢ W-27 COF holder's responsibilities

The W-27 COF holder supervising a stationary energy storage system must be responsible for its decommissioning. The deactivation, de-energizing, dismantling and removal of the stationary energy storage system must be conducted by trained and knowledgeable persons in accordance with manufacturer's specifications. The owner, manufacturer, installer, hazardous materials carrier or other party responsible for removal, transportation and/or disposal of the stationary energy storage system must ensure that the battery system is lawfully decommissioned, transported and disposed of in accordance with DOTn hazardous materials regulations and other applicable laws, rules and regulations.

The decommissioning process must be in accordance with the decommissioning plan. In general, the Certificate of Fitness holder should the ensure:

1. **Proper Isolation**
   ESS remains electrically and mechanically isolated through the use of the E-Stop and disconnect switches until the affected batteries have been removed.
2. **Removal of all damaged/end of useful life batteries**

   All the damaged batteries and any battery that reaches end of life have been removed the ESS.

   Heat compromises the performance virtually all electronics, and can be particularly harmful to battery electrolyte operation. If any battery that was/is exposed to the temperature that exceeds the normal temperature setting, the battery should be removed from service and disposed of.

3. **Qualified Hazardous Waste Management Company will handle the disposal and transportation of the battery waste properly**

   Specific management standards for batteries include containing any battery that shows evidence of leakage, spillage, or damage that could cause leakage. The container must be closed, structurally sound, and compatible with the batteries. Batteries or battery packs may be sorted, mixed, discharged, regenerated, disassembled into individual batteries, or removed from products as long as the individual battery cell is not breached. Cells may be opened to remove electrolyte from the battery, but must be closed again immediately. Electrolyte or any other material generated by the handler must be evaluated to determine if it is a hazardous waste and, if so, managed appropriately under 40 CFR part 262 regulations.

   The person transporting the waste must comply with the transportation standards in 40 CFR part 273 subpart D of the universal waste regulations. These standards prohibit disposal or treatment of the universal wastes and cover management standards, complying with DOT regulations, storage time limits, responding to releases, and exports.

The hazardous waste management company must comply with all local, state and federal laws. Hazardous waste information is maintained in the Resource Conservation and Recovery Act Information (RCRAInfo), a national program management and inventory system of hazardous waste handlers. You can use the RCRAInfo Search (https://www3.epa.gov/enviro/facts/rcrainfo/search.html) to determine identification and location data for specific hazardous waste handlers. You can also find a wide range of information on treatment, storage and disposal facilities (TSDFs) regarding permit and closure status, compliance with federal and state regulations, and cleanup activities. You can specify a facility using any combination of facility name, geographic location (e.g., zip code) and facility industrial classification (EPA ID).

Decommissioning of malfunctioning battery system (emergency decommissioning) should comply with additional requirements; refer to Chapter 9 of this booklet.

CHAPTER 6. OPERATION AND MAINTENANCE

6.1 Remote Monitoring of Energy Storage Management System (ESMS)/Battery Management System (BMS) and Reporting

The Fire Department requires that all stationary energy storage systems must be designed with an energy storage management system (ESMS)/battery management system (BMS) that transmits data regarding energy storage system status and temperature to a remote monitoring facility or other approved location.

The Fire Department requires that all stationary energy storage systems will be designed with an energy storage management system (ESMS) /battery management system (BMS) which monitors, controls, and optimize performance of the battery system and has the ability to control the disconnection of the module(s)/containers from the system.

The primary functions of ESMS/BMS are to monitor the status of the battery health and provide notification to the SMEs if there are any abnormalities of the ESS. The ESMS/BMS protects the batteries from being over-charge/over-discharged, tracks how much energy goes in and out of the batteries and monitors cell voltages; and constantly monitors for shorts, loose connections, breakdowns in wire insulation, and weak or defective battery cells that need to be replaced. It may also monitor the temperature of the battery systems and provide real-time information and values, etc. The ESMS/BMS can also isolate the individual batteries in cases of emergency. ESMS/BMS is an essential tool to provide early warning of any malfunction of the batteries.

The owner of a stationary energy storage system must arrange for data transmissions from the battery system's ESMS/BMS to be continuously monitored (on a 24/7 basis) by a remote monitoring facility staffed by trained and knowledgeable persons (ESMS/BMS monitoring facility staff) retained by the manufacturer or installer of the battery system. If unstaffed, the facilities must be designed to make immediate automatic notifications to the designated facility staff who can address the potential emergency.

The ESMS/BMS system monitors and responds to a variety of normal and off-normal conditions associated with the battery system. Many of the conditions are associated with non-emergency conditions, such as the energy efficiency and monitoring voltage fluctuations. Off-normal condition can also signal the need for maintenance and service, or in some cases shut down of the ESS until the

condition can be evaluated by a trained and knowledgeable personnel. If the monitoring staff notice there is any deterioration in cell performance that need appropriate maintenance actions, the staff should notify the qualified manufacturer technician, SME(s) or W-27 COF holder to take a proper action to ensure the state of health of the battery system and to prevent unexpected battery failure or severe accidents, such as thermal runaway.

Such remote monitoring ensures the monitoring staff or automatic notifications can provide timely notifications to the Fire Department, Certificate of Fitness holder and manufacturer of the battery if the stationary energy storage system exhibits abnormal behavior that may lead to a serious malfunction that will cause fire, explosion or other serious adverse consequences.

The ESMS/BMS monitoring facility staff (or the persons who receive notifications from an automated facility) should be able to provide information about battery readings and what they indicate about battery status, especially as the ESMS/BMS is monitoring battery performance for purposes other than emergency notifications. If they are not sufficiently knowledgeable to address more technical questions about the battery's likely performance and the actions that should be taken to render it safe, the ESMS/BMS monitoring facility should maintain a notification tree for emergency notifications by which they can reach out to a subject matter expert (SME) on a 24/7 basis and arrange for a direct communication with the on-scene FDNY incident commander.

Prompt provision of technical assistance will protect the owner's investment. In the absence of timely, accurate information, the Fire Department may determine to flood (and may permanently damage) a battery system that, for example, is releasing smoke, when no action or more limited action may be warranted by the ESMS/BMS data or after the ESMS/BMS monitoring facility has remotely shut down the malfunctioning units.

The W-27 Certificate of Fitness holder must additionally be notified, as a response to the premises will be required if the battery system has failed and/or caught fire. Lithium-ion battery systems, for example, have been known to reignite, so appropriate precautions should be taken to de-energize the battery system and/or safely remove the battery system or the damaged components from the premises. The Certificate of Fitness holder would be expected to manage the situation pursuant to its Emergency Management Plan, once the fire or emergency has been abated by the Fire Department.

The owner of the ESS's operation is responsible for ensuring the remote monitoring of Energy Storage Management System (ESMS)/Battery Management System (BMS) is provided. If the W-27 COF holder is aware of any ESS they supervise is not monitored by a remote ESMS/BMS monitoring facility, the W-27 COF holder must notify the owner to comply with the Fire Code requirements and report this non-compliance situation to the FDNY Technology Management (+email). The enforcement action will be taken for any stationary energy storage system that is not compliant with the FDNY requirements.

6.2 Signage

The following signs (or FDNY approved equivalent markings) must be durably posted for each *stationary energy storage system*, at the locations indicated:

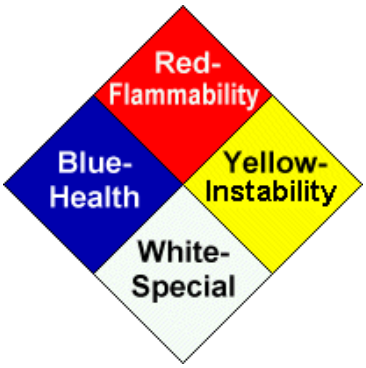
(A) Warning signs.

The following warning signs must be posted on the exterior of medium and large battery systems or battery system enclosure:

(1) "Danger: High Voltage," or equivalent signage complying with the requirements of the *Electrical Code*; and

(2) NFPA 704 Hazard identification sign.

The sign provides a readily recognized for identifying specific hazards and their severity. The system is characterized by the "diamond shape". It identifies the hazards of a material and the degree of severity of the health, flammability, and instability (reactivity) hazards. In addition, a special precaution symbol may be used if necessary. Hazard severity is indicated by a numerical rating that ranges from 0 indicating a minimal hazard, to 4 indicating a severe hazard. The hazards are color coded (blue for health, red for flammability, and yellow for instability or reactivity) and arranged spatially as follows:



The six o'clock position on the symbol represents special hazards and has a white background. The special hazards in use are ~~**W**~~, which indicates unusual reactivity with water and is a caution about the use of water in either firefighting or spill control response, and **OX**, which indicates that the material is an oxidizer.

(B) Identification, emergency contact and emergency shut-down signs.

The following signs must be posted at utility connection or other approved, conspicuous outdoor location on the premises that is accessible to emergency response personnel and that is a reasonable distance (**but not less than 10 feet**) from the stationary energy storage system installation.

If the location of the signage would not be readily apparent to emergency response personnel, a sign with large lettering (not less than 3 inches high) must be posted on or adjacent to the battery installation indicating the location of the following signage:

(1) **Equipment specifications**. The manufacturer and model number of the battery system and electrical rating (voltage and current).

(2) **Installation identification**. The number or other unique identifier used by the energy storage management system remote monitoring facility to identify the installation, which firefighters or other Department representatives can reference in communications with the monitoring facility.

(3) **Monitoring facility contact information**. The telephone number of the energy storage management system remote monitoring facility.

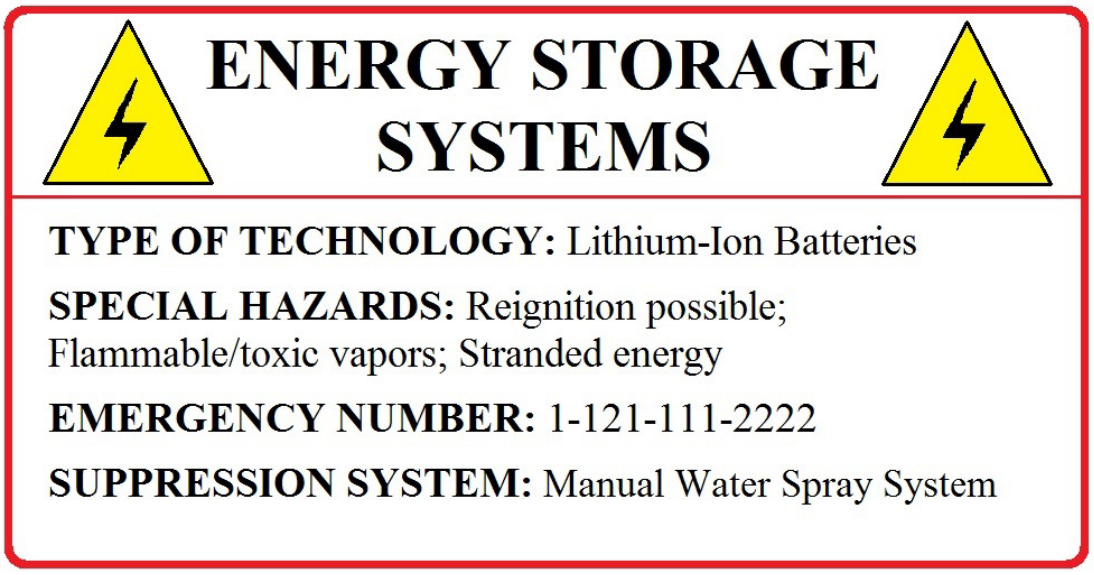
(4) **Certificate of fitness contact information.** The name and telephone number of the certificate of fitness holder responsible for the battery system.

(5) **Emergency shutdown procedures**. Emergency shutdown procedures for the battery energy storage system must be posted at the battery system emergency shut down (e-stop) control and at any attended on-site location.

NFPA 855 also provides recommendations for signage. It suggests that there should be a signage posted in approved locations near entrances to ESS rooms/enclosures. The recommended signage should include the following information:

(1) “Energy Storage Systems” with symbol of lightning bolt in a triangle
(2) Type of technology associated with the ESS
(3) Special hazards associated as identified by the manufacture.
(4) Type of suppression system installed in the area of the ESS
(5) Emergency contact information:
- The W-27 COF holder’s contact number (required)
- Manufacturer’s emergency contact number (optional)

Example of the NFPA 855 <u>suggested</u> signage:



➢ W-27 COF holder's responsibilities

The W-27 COF holder must ensure all required signs are posted at the correct locations.

6.3 Maintenance

The owner must ensure that stationary energy storage systems are periodically inspected, tested, serviced and otherwise maintained in accordance with manufacturer's specifications and the requirements of this section by a person trained and knowledgeable in the specific battery system.

6.3.1 Periodic inspection

➢ W-27 COF holder's responsibilities

The W-27 should ensure that an owner's manual is provided to the homeowner. The homeowner should know the inspection/testing/service frequency of the energy storage systems.

If the owner notices any situation related to the ESS requiring attention, correction, or additional maintenance, the homeowner should notify the W-27 Certificate of Fitness holder or the installer.

Once the W-27 COF holder is aware of any possible issue related to the energy storage system, the W-27 COF holder must ensure the issue is timely addressed and/corrected by a qualified installer. The W-27 COF holder is responsible to ensure the system meets the standards for safe operation.

6.3.2 Replacement components

Any replacement storage battery units or other battery system components must be designed for the same storage battery technology and/or chemistry and be compatible with the existing battery system installation. In-kind replacement of existing components (consistent with the listing for the storage battery unit or energy storage system) constitutes maintenance and does not require Fire Department review and approval.

FDNY review and approval, and, as applicable, Department of Buildings review and approval, is required in the same manner as an application for a new stationary energy storage system installation for replacement of existing components that effect an alteration of the energy storage system, including:

- replacement of components included in the storage battery unit listing, or that could otherwise affect the results of the full-scale testing of the battery storage unit;
- replacement components that use different battery technologies or chemistries (including the electrolyte chemistry in a flow system); and
- replacement components that change the storage/generating capacity or other functionality of the stationary energy storage system.

➢ W-27 COF holder's responsibilities

The W-27 should ensure that an owner's manual is provided to the homeowner to inform that the owner should notify the W-27 COF holder regarding any replacement is conducted. Once the W-27 COF holder is aware of the modifications, the W-27 COF holder must ensure that the homeowner understand that any replacement must be done by qualified installer and must keep the W-27 COF updated with any new changes. The W-27 COF holder must also document all the replacement activities and detail the components that have been replaced in the record. If the replacement of components is significant, the new FDNY and DOB approval must be obtained.

6.3.3 Combustible waste and vegetation or storage of combustible materials

Stationary energy storage system installations must be kept free from the accumulation of combustible waste and combustible vegetation.

Weeds, grass, vines, brush or other vegetation that is capable of being ignited must be regularly pruned or cleared and removed for a distance of 10 feet from any building or system.

➢ W-27 COF holder's responsibilities

W-27 COF holder must ensure that the owner's manual is provided to inform the homeowner that the ESS must be kept free from the accumulation of combustible waste and combustible vegetation/materials.

7 Requirements for Impairment Situation

All impairment situations must be documented in written records and maintained for at least 3 years.

When the Energy Storage Management System is out of service, the W-27 COF holder must ensure the operation of the affected ESS components is stopped.

➢ W-27 COF holder's responsibilities

If the W-27 COF holder is notified by the ESMS/BMS monitoring facility or the owner regarding any impairment situation, he/she must inform the owner to contact the qualified installer to address and fix this issue.

CHAPTER 7. CAUSES OF BATTERY FAILURES AND EMERGENCY MANAGEMENT PLAN

7.1 Root Causes of Energetic Cell and Battery Failures

(Information contained in this section is cited from the NFPA report for lithium-ion batteries hazard and use assessment published in July 2011)

Batteries can fail in energetic mode. Typical energetic failure mode is thermal runaway. Cell thermal runaway refers to rapid self-heating of a cell derived from the exothermic chemical reaction of the highly oxidizing positive electrode and the highly reducing negative electrode; it can occur with batteries of almost any chemistry. In a thermal runaway reaction, a cell rapidly releases its stored energy. The more energy a cell has stored, the more energetic a thermal runaway reaction will be.

Generally, the root causes of energetic cell and battery failures can be classified into:

- Thermal abuse;
- Mechanical abuse;
- Electrical abuse;
- Poor cell electrochemical design; and internal cell faults associated with cell manufacturing defects.

7.1.1 Thermal abuse

The most direct way to exceed the thermal stability limits of a battery cell is to subject it to external heating. Acute exposure of a cell to high temperatures will readily induce thermal runaway in that cell. Typically, if an internal cell fault is sufficient to cause thermal runaway in a single cell of a multi-cell battery pack, heat transfer from the faulting cell will cause thermal runaway in neighboring cells of the battery pack. Thus, the thermal runaway reaction will propagate through a battery pack.

The COF holder should ensure the ventilation system of the battery system, if applicable, is in a good working order to keep the enclosure under a proper ambient temperature. In addition, if the ESMS/BMSsystem indicates any abnormal temperature change of the battery system, the COF holder and/or the SME should be notified to address this issue.

7.1.2 Mechanical abuse/damage

Mechanical abuse/damage of cells can cause shorting between cell electrodes, leading to localized cell heating that propagates to the entire cell and initiates thermal runaway. The mechanical abuse includes mechanical shock, drop, crush, immersion (e.g. flooding), vibration, structure collapse, etc.

Flooding can induce electrical damage to ESS that should be taken into consideration after water has receded. Systems experience severe vibrations might be prone to fire if cells have been mechanically damaged or power electronics are damaged and operating improperly, leading to electrical overcharge or other abuse conditions that can cause fire.

Mobile energy storage system may be subject to more mechanical damages/impacts because of frequent transportations, W-28 COF holders must follow the precautions outlined by the manufacture/installer to protect the system from the mechanical damages/impacts.

The COF holder should ensure the installation of the battery systems will prevent the systems from the mechanical abuse/damage. If the COF holder is aware of any cell/pack that have suffered mechanical abuse, the cell/pack must be evaluated by the SMEs or the manufacturer technicians to ensure the damage did not induce a defect likely to cause any problem, or the cell/pack should be disposed of by the trained and knowledgeable personnel.

7.1.3 Electrical abuse

There are a number of ways in which battery cells can be abused electrically, leading to cell thermal runaway reactions. Some of these mechanisms are described are overcharge, external short circuit (may be caused by flooding) and over-discharge. The functional ESMS/BMS should eliminate these situations.

7.1.4 Poor design and manufacturing defects

The majority of thermal runaway failures in the field are still caused by internal cell faults related to cell manufacturing defects. The COF holder must ensure all the components of the stationary energy storage systems are tested and listed by a nationally recognized testing laboratory by checking the equipment approval letter issued by the FDNY before commissioning.

7.1.5 Other possible causes for lead-acid batteries

Sulfation is a buildup of lead sulfate crystals and is the number one cause of early battery failure in lead-acid batteries. Sulfation occurs when a battery is deprived of a full charge, it builds up and remains on battery plates. When too much sulfation occurs, it can impede the chemical to electrical conversion. A buildup of sulfates can cause dramatically shorter battery life and complete battery failure. All lead acid batteries will accumulate sulfation in their lifetime as it is part of the natural chemical process of a battery. Sulfation builds up and causes problems when the battery is overcharged, stored above 75 degrees or stored without a full charge. Swelling of a case can indicate potential improper charging voltage of the cell for the ambient temperature of the site.

7.2 Emergency Management Plan

The owner, manufacturer and/or installer of a stationary energy storage system must have an emergency management plan or protocol that includes procedures for notifications, provision of technical assistance to the FDNY, mitigation of hazardous conditions, and decommissioning or restoration to normal operation. The FDNY may require that a representative of the stationary energy storage system manufacturer or other subject matter expert with technical knowledge of the system and its operation be available in a timely manner to provide technical assistance to the Fire Department during an emergency involving or affecting the system.

The plan must be updated when conditions that affect the response considerations and procedures change.

The plan should be readily available for use by facility operations and maintenance personnel.

The FDNY requires the Emergency Management Plan including the following information:

- Size and the type of the ESS
- Type of the fire extinguishing system(s) installed, if applicable
    - If clean agent fire suppression system is installed, the designed hold time information
- The type of the occupancy that the energy storage system serves
- Procedure for notifications in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions.
- Procedures for inspection and testing of associated alarms, interlocks, and controls
- Contact information: Name and telephone number of
    - the ESMS/BMS remote monitoring facility
    - the SMEs
    - the COF holder
    - the premises owner
- Procedures for safe shutdown, de-energizing, or isolation of equipment and ESS under emergency conditions to reduce the risk of fire, electric shock, and personal injuries, and for safe start-up following cessation of emergency conditions
- Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment including:
    - what kinds of hazards may be related to this type of the system (under normal condition and during fire emergency)?
    - What kinds of flammable/corrosive/toxic gases maybe generated by the system
- Decommissioning of malfunctioning battery system procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility.
- The locations of
    - Required signs
    - E-Stops
    - Disconnect switches (i.e. “lockout, tagout”)

  - Fire Department Connection (FDC) locations,
  - The vent and the manual activation switch of the smoke/gas purge system
  - Fire extinguishing system manual activation (if applicable)
  - Standpipe (if applicable)
  - Hydrants (if applicable)
  - The deflagration vents and/or exhaust outlets (if applicable)
- Standoff distances for electrical hazards and explosion hazards

The Certificate of Fitness holder must be familiar with their site Emergency Management plan and would be expected to manage the situation pursuant to the plan.

CHAPTER 8. NOTIFICATIONS AND EMERGENCY RESPONSES

➢ W-27 COF holder's responsibilities

W-27 COF holder must be familiar with all the following notification and emergency procedures.

8.1 Commissioning and Decommissioning Notification

The Fire Department Rule requires notification to the Fire Department in connection with the commissioning and decommissioning of these stationary energy storage systems. Notice of the commissioning and decommissioning of stationary energy storage systems must be given to the Fire Department, and the removal of a malfunctioning system coordinated with the Fire Department, as follows:

a. **Small outdoor/rooftop energy storage systems and stationary energy storage systems**
The owner or certificate of fitness holder must notify the Fire Department of the commissioning or decommissioning of a small stationary energy storage system, by emailing to tech.mgt@fdny.nyc.gov no later than two (2) business days after installation, the battery type, manufacturer and rated energy capacity, and the name and certificate of fitness number of the certificate of fitness holder who will be, or is no longer, responsible for supervision of the system.

b. **Decommissioning of a malfunctioning energy storage system**

The removal and transportation of any ESS that has given abnormal temperature or gas emission readings as a result of physical damage, exposure to fire or other actual or potential cause of damage, must be coordinated with the Hazardous Materials Unit of the Fire Department's Bureau of Operations, who may send representatives to monitor the decommissioning process. The Hazardous Materials Unit must be notified two (2) business days prior to the scheduled action, or in as timely a manner as circumstances allow, by calling the Fire Department Communications Office in the borough in which the energy storage system is located.

Manhattan (212) 999-2222

Bronx (212) 999-3333

Brooklyn (718) 999-4444

Queens (718) 999-5555

Staten Island (718) 999-6666

8.2 Remote monitoring and reporting

The ESMS/BMS monitoring facility staff (or the persons who receive notifications from an automated facility) must, without delay, make the following notifications in the event an energy storage system

installed in New York City exceeds or appears likely to exceed thresholds at which fire, explosion or other serious adverse consequences may result:

(A) Notify the Fire Department by calling the Communications Office in the borough in which the energy storage system is located, to alert the Fire Department to the unsafe condition;

(B) Notify the Certificate of Fitness holder responsible for the energy storage system, in a pre-arranged manner, to alert such individual to be ready to provide technical assistance to the Fire Department and/or respond to the incident location; and

(C) Notify the manufacturer of the energy storage system to make a qualified representative available to provide technical assistance to the Fire Department.

The ESMS/BMS monitoring facility staff (or the persons who receive notifications from an automated facility) should be able to provide information about battery readings and what they indicate about battery status, especially as the ESMS/BMS is monitoring battery performance for purposes other than emergency notifications.

8.3 Technical Assistance and Emergency Management

Once the Certificate of Fitness holder is notified by the ESMS/BMS monitoring facility staff in case of the energy storage system has failed and/or other emergencies, the Certificate of Fitness holder must manage the situation pursuant to its emergency management plan including providing technical assistance and emergency management to the Fire Department.

8.3.1 Technical assistance

Upon request of the Fire Department, both the COF holder responsible for the ESS and the energy storage system manufacturer must make available to the Fire Department a representative with technical knowledge of the ESS and its operation. Such representative must be made available immediately.

8.3.2 Emergency Management

Upon request of the Fire Department, the COF holder responsible for the ESS and an authorized representative of the owner of the premises upon which the ESS is installed must respond to the location of the installation, as soon as possible but in any event within two (2) hours of notification, to assist the Fire Department in addressing a fire or other emergency involving or affecting the ESS, and to take all other actions necessary for mitigation and decommissioning of the ESS, or restoration to normal operation.

8.4 Interaction with First Responders

8.4.1 Incident Command System (ICS)

The Incident Command System (ICS) is a management system designed to enable effective and efficient domestic incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure.

Incident Command System allows personnel from a variety of agencies to meld rapidly into a common management structure. It ensures that resources are deployed where most needed. It provides the logistical and administrative support to ensure that operational staff can meet incident objectives.

The Incident Commander (IC) has overall responsibility for managing the incident. The IC must be fully briefed and should have a written delegation of authority. Initially, assigning tactical resources and overseeing operations will be under the direct supervision of the Incident Commander. The incident commander will designate the command staff. The command staff are responsible to provide information, safety and liaison service for the ICS. IT is critical in any type of fire that W-27 COF holder and SME share information describing the specific battery installation with incident commander.

The Incident Sequence created by the NYC Emergency Management Department is provided in the Appendix D of this booklet.

The COF holder, the SMEs and the ESMS/BMS monitoring facility staff (if applicable) and all energy storage system related personnel must comply with the orders of the incident commander and the command staff.

8.4.2 Information that may be required by the first responders

The COF holder, the SMEs and the ESMS/BMS monitoring facility staff (if applicable) and all energy storage system related personnel must comply with the orders of FDNY firefighting personnel. The COF holder and/or the SME(s) must quickly provide FDNY firefighting personnel the following information:

- The nature of the emergency
- Type, size of the energy storage systems
- Location(s) of the energy storage systems
- Hazards of the energy storage systems:
    - What kinds of hazards may be related to this type of the system (under normal condition and during fire emergency)?
    - What kinds of flammable/corrosive/toxic gases maybe generated by the system
- Emergency Management Plan
- Critical information from the ESMS/BMS:

  - Is ESMS/BMS still working?
  - What part(s) of the system may cause this issue?
  - Is it battery fire or other fire (e.g. cable fire)?
  - What are the real time readings of the battery system that could know the status of the system?
  - What is the battery/module/system temperature trend during this incident?
  - What is the potential stranded energy (state of charge) in the battery system?
- Type of fire protection/extinguishing systems installed (if applicable):
  - What kind of water-based fire extinguishing system is installed and what is its coverage?
  - If applicable, what kind of non-water-based fire extinguishing system is installed and what is its coverage?
- The location of:
  - Disconnect switches (i.e. “lock-out, tag-out”)
  - Fire Department Connection locations (if applicable),
  - The vent and the manual activation switch of the smoke/gas purge system (if applicable)
  - Suppression system pull stations (if applicable)
  - Standpipe (if applicable)
  - Hydrants (if applicable)
  - The deflagration vents and/or exhaust outlets (if applicable)
- Who are the premises owner, system owner and system manufacturer?
- Actions that should be taken to render as safe as possible (if applicable):
  - When to use of smoke/gas purge system (if clean agent fire suppression system is installed, the designed hold time information should be provided to the first responders)
  - Minimum standoff distances for electrical hazards and explosion hazards

8.5 Post-Fire Consideration and Restoration to Service

Any energy storage system that undergoes a serious failure, including one that results in a fire, release of flammable or toxic gas, and/or physical damage to system components, must be removed from service forthwith. The energy storage system must not be restored to service until it has been evaluated and, if necessary, repaired or replaced, by a trained and qualified person, and recommissioned by the Certificate of Fitness holder responsible for the system.

8.5.1 Site security

The post-fire batteries may reignite. The isolation and monitoring of the damaged energy storage system is critical. If possible, the batteries should be monitored for residual heat and temperature, as reignition is a possible in cells that are not sufficiently cooled. No person should be allowed to enter

the ESS enclosure unless the enclosure has been verified that there is no flammable gas accumulation inside. Since the batteries may keep producing flammable gas, the ventilation system, explosion mitigation, and/or smoke purge system should be kept operating.

A qualified technician must ensure the heat has been removed and that the batteries are not at risk of being electrically shorted before the FDNY hands over the fire scene to the owner or responsible party appointed by the owner.

Before decommissioning is completed, no person is allowed re-enter the scene other than qualified/authorized personnel.

8.5.2 Emergency decommissioning

The deactivation, de-energizing, dismantling and removal and transportation of any energy storage system that has given abnormal temperature or gas emission readings as a result of physical damage, exposure to fire or other actual or potential cause of damage. This process must be coordinated with the Hazardous Materials Unit of the Fire Department's Bureau of Operations (FDNY Hazmat), who may send representatives to monitor the decommissioning process. The Hazardous Materials Unit (FDNY Hazmat) must be notified two (2) business days prior to the scheduled action, or in as timely a manner as circumstances allow, by calling the Fire Department Communications Office in the borough in which the energy storage system is located.

The emergency decommissioning should also be in accordance with the decommissioning plan and the decommissioning procedure (refer to Section 6.2 of this booklet). However, since the batteries are exposed to fire, the decommissioning personnel must also understand the procedures for dealing with damaged ESS equipment in a post-fire incident, including the following: recognizing that stranded electrical energy in fire-damaged storage batteries and other ESS has the potential for re-ignition after initial extinguishment. Following the suppression operations by the FDNY, it is important to have a fire watch until decommissioning is complete.

The owner must contact personnel qualified to safely remove damaged ESS equipment from the facility. (The information could refer to Section 6.2.2 of this booklet)

8.5.3 Restoration to Service (re-commissioning)

Upon completion of the repair and retest by the qualified company/individual/installer, after confirming that the energy storage system is in good working order and operating in accordance with manufacturer's specifications, the Certificate of Fitness holder must supervise the re-commissioning of the energy storage system. Re-commissioning is required for restoration.

For small outdoor/rooftop/ mobile ESSs or indoor ESSs, the owner or the Certificate of Fitness holder must notify the Fire Department of the re-commissioning, by emailing to tech.mgt@fdny.nyc.gov **no later than two (2) business days after restoration**, the battery type, manufacturer and rated energy

capacity, and the name and certificate of fitness number of the certificate of fitness holder who will be responsible for supervision of the system.

CHAPTER 9. RECORDKEEPING REQUIREMENTS

9.1 Recordkeeping

The W-27 COF holder must ensure all related approval documents issued by the New York City agencies must be maintained on the premises.

The W-27 COF holder must ensure that the records of the inspections, tests, servicing, and other operations and maintenance required by this code, the rules, the referenced standards and any other required recordkeeping referenced therein, must be maintained on the premises or other approved location for a minimum of 3 years.

9.2 Energy Storage System (ESS) Recordkeeping

A written record of the following information must be maintained at the premises or other approved location by the W-27 Certificate of Fitness holder and by the owner or operator of the stationary energy storage system, except as otherwise prescribed by the Fire Department Rule:

(1) Energy storage system installation and commissioning;

(2) Energy storage system maintenance, including all inspections, servicing and repair (The COF holder must also document all the replacement activities and detail the components that have been replaced in the record);

(3) Energy storage system decommissioning and removal;

(4) Installation and maintenance of energy storage system fire protection systems, including all inspection, testing, servicing and repair; and

(5) Fires or other incidents involving or affecting the energy storage system.

The record must be maintained for a minimum of 3 years. Such records must be made available for inspection by any FDNY representative, and a copy of such records must be provided to the FDNY upon request, without charge.

APPENDIX A: REFERENCE MATERIAL (This Part will be provided to you during the exam)

STATIONARY ENERGY STORAGE SYSTEM COMPLIANCE REQUIREMENTS

Section	Compliance Requirement	Small	Medium
(c)	**General Provisions**		
(c)(5)	Supervision (Certificate of Fitness)	Yes	Yes
(c)(6)	Obligations of Owner and Operator	Yes	Yes
(c)(7)	Listing and Full-Scale Testing Standards		
(c)(7)(A)	• Listing		
	o *Lead Acid Battery*	Yes	Yes
	o *Ni-Cd or NiMH Battery*	Yes	Yes
	o *Li-Ion Battery*	Yes	Yes
	o *Flow Battery*	Yes	Yes
(c)(7)(B)	• Full-Scale Testing		
	o *Lead Acid Battery*	No	No
	o *Ni-Cd Battery*	No	No
	o *NiMH Battery*	No	No
	o *Li-Ion Battery*	Yes	Yes
	o *Flow Battery*	No	No
(c)(8)	• Manufacturer's Requirements	Yes	Yes
(c)(9)	• Multiple Battery System Approval	No[a]	Yes
(d)	• Equipment Approval	Yes[b]	Yes[b]
(f)	• Commissioning and Decommissioning	No[c]	Yes
(g)	**General Design and Installation Requirements**		
(g)(1)	• Location and Construction	Yes	Yes
(g)(2)	• Remote Monitoring	Yes	Yes
(g)(3)	• Electrical Components	Yes	Yes
(g)(3)(C)	o Secondary Power	No	Yes
(h)	**Enclosure Design and Installation Requirements**		
(h)(1)	• Human Occupancy Prohibited	N/A	Yes
(h)(2)	• Racks	N/A	Yes
(h)(3)	• Fire Extinguishing System	No[d]	No[d]
(h)(5)	• Fire Detection	No[d]	Yes
(h)(6)	• Gas Detection		

	o *Lead Acid Battery*	Yes[e]	Yes
	o *Ni-Cd and NiMH Battery*	Yes[e]	Yes
	o *Li-Ion Battery*	No[d]	No[d]
	o *Lead Acid Battery*	Yes	Yes
(h)(7)	• Detector Alarm Notification / Fire Alarm System	No[d]	Yes
(h)(8)	• Ventilation System	No[d]	No[d]
(h)(9)	• Smoke/Gas Purge System	No[d]	No[d]
(i)	**Operational and Maintenance Requirements**		
(i)(1)	• Remote Monitoring of Energy Storage Management System and Reporting	Yes	Yes
(i)(2)	• Central Station Monitoring of Fire Protection System	N/A[d]	Yes
(i)(3)	• Remote Monitoring at Constantly Attended On-Site Location	No	No
(i)(4)	• Technical Assistance	Yes	Yes
(i)(5)	• Emergency Management	Yes	Yes
(i)(6)	• Signage	Yes	Yes
(i)(7)	• Maintenance		
(i)(7)(A)	o Periodic Inspection	No	Yes
	o Restoration to Service After Serious Failure	Yes	Yes
(i)(7)(B)	o Replacement Components	Yes	Yes
(i)(7)(C)	o Combustible Waste	Yes	Yes
(i)(7)(D)	o Storage of Combustible Materials	Yes	Yes
(j)	Recordkeeping	Yes	Yes

a. Except for multiple small battery systems installed in a single enclosure or as part of a single installation.

b. Except for battery systems tested and *listed* by a nationally recognized testing laboratory with installation conditions, as set forth in R608-01(c)(7)(C), or other *approved listing* based on *approved* test data.

c. Except for: (1) notifying the *Department* of the *certificate of fitness* responsible for supervision of the installation; and (2) coordination of removal and transportation of small battery systems experiencing abnormal temperature or gas emission readings, as set forth in R608-01(f)(3)(C).

d. Unless required as a condition of equipment approval based on full-scale testing. The *Department* will assess the results of the full-scale testing to determine whether there are any hazards that are not resolved or mitigated by the equipment or installation design and, if the installation is approved, prescribe appropriate safeguards.

e. Required for equipment approval, as an element of the storage battery unit design, not as part of a battery system enclosure.

f. Limited post-installation review by inspection unit for *Department* permit issuance only.

g. *Approved* test data is required for explosion mitigation measures. If no other *approved* test data is available, test data from UL Test Method 9540A testing will be required.

h. Except project-specific installation designs. Large installations that utilize full-scale tested and *Department*-approved *storage battery units* in non-standard configurations or other project- specific designs may be field-tested in accordance with UL Standard 9540 or other *approved* standard.

Hazards of Different Battery Energy Storage Systems

Technology	Potential Hazards	Potential Hazards Under Normal Conditions	Potential Hazards Under Emergency/Abnormal Conditions
Lithium Ion (Li-ion)	Fire/explosion hazards	Latent defects within the cells or design issues: • Flammable gas concentrations • Thermal runaway	• Flammable gas concentrations • Thermal runaway
	Chemical hazards	N/A.	• Off-gassing of flammable or toxic vapors
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Risk of electric shock during manual suppression • Ground paths altered and unexpected shock hazards
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance.	• Stranded energy may present electric shock hazards during disassembly.
	Physical hazards	• Lifting hazards due to the weight of the battery.	• Overheating • Heavy system components • The guards of moving hazardous parts (e.g. fans) might be missing.
Nickel Cadmium (Ni-Cad)	Fire hazards	If not properly vented: Flammable gas concentrations	• Flammable gas concentrations •
	Chemical hazards	• Corrosive/caustic potassium hydroxide electrolyte	• Corrosive/caustic potassium hydroxide electrolyte • Toxic vapors
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Risk of electric shock during manual suppression • Ground paths altered and unexpected shock hazards
	Stranded or stored energy hazards	Stranded or stored energy hazards during maintenance.	• Stranded energy may present electric shock hazards during disassembly.
	Physical hazards	Lifting hazards due to the weight of the battery.	• Overheating • Heavy system components
Nickel-Metal Hydride (Ni-MH)	Fire hazards	• N/A	• Flammable gas concentrations Thermal runaway
	Chemical hazards	• N/A	• Corrosive electrolyte • Off-gassing of toxic vapors

Technology	Potential Hazards	Potential Hazards Under Normal Conditions	Potential Hazards Under Emergency/Abnormal Conditions
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Electric shock
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance.	• Stranded energy may present electric shock hazards during disassembly.
	Physical hazards	• N/A	• Overheating • The guards of moving hazardous parts (e.g. fans) might be missing.
Flooded (Vented) Lead-Acid	Fire hazards	If not properly vented: Flammable gas concentrations	• Flammable gas concentrations •
	Chemical hazards	Sulfuric acid electrolyte	• Corrosive sulfuric acid electrolyte •
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance.	• Stranded energy may present electric shock hazards during disassembly.
	Physical hazards	Lifting hazards due to the weight of the battery.	• Overheating • Heavy system components
Valve-Regulated Lead-Acid (VRLA)	Fire hazards	• N/A	• Flammable gas concentrations Thermal runaway
	Chemical hazards	• N/A.	Corrosive electrolyte (minor)
	Electrical hazards	• High DC voltage hazards • Arc flash	• High AC and DC voltage hazards • Arc flash, short circuiting • Risk of electric shock during manual suppression • Ground paths altered and unexpected shock hazards
	Stranded or stored energy hazards	• Stranded or stored energy hazards during maintenance.	• Stranded energy may present electric shock hazards during disassembly.
	Physical hazards	• Lifting hazards due to the weight of the battery.	• Overheating • Heavy system components

Benefits of different Battery Energy Storage Systems

Technology	Benefits
Lithium Ion (most commonly used)	• Low maintenance, • High cycle life, • Due to popular demand this technology is continually evolving. • Fast power response rate
Nickel Cadmium (Ni-Cad)	• Good load performance • Forgiving if abused.
Nickel-Metal Hydride	• Memory degradation but less prone to memory than Ni-Cad, can be long usage life • More environmentally friendly
Flooded (Vented) Lead Acid	• Require a refill with distilled water. • Low risk of thermal runaway • Well understood causes and remedies for thermal runaway
Valve-Regulated Lead-Acid (VRLA)	• No electrolyte to fill. • Low risk of thermal runaway • Well understood causes and remedies for thermal runaway.
	•

Outdoor Stationary Energy storage system Size Thresholds

Battery Technology	**Aggregate Rated Energy Capacity**		
	<u>Small</u>	**<u>Medium</u>**	**<u>Large</u>**
Lead Acid Battery	>2 kWh and ≤70 kWh	Not allowed*	Not allowed*
Ni-Cd Battery	>2 kWh and ≤70 kWh	Not allowed*	Not allowed*
NiMH Battery	>2 kWh and ≤70 kWh	Not allowed*	Not allowed*
Li-ion Battery	>2 kWh and ≤20 kWh	>20 kWh and ≤ 250 kWh	Not allowed*
Flow Battery	>2 kWh and ≤20 kWh	>20 kWh and ≤ 500 kWh	Not allowed*

Ampere-Hour Conversion

KWh must equal rated voltage times amp-hour rating divided by 1000:

(voltage x amp-hours)/1000 = kWh

APPENDIX B: INCIDENT COMMAND SYSTEM INCIDENT SEQUENCE