# NYC ENERGY STORAGE

## Stakeholder's Roundtable: Progress, Planning, and Input

*20 November 2019*

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

CUNY SMART DG HUB

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*With key technical assistance from* UL

# The Big Picture: Shared Goals

**NYC Energy Storage Goal**
Original: 100MWh by 2020
Updated: 500 MW by 2025

**Con Edison Program Goal**
300 MW by 2030

**NYS Energy Storage Goal**
3 GW by 2030

**Market growth**
Falling costs, rising need

# The Big Picture: Multiple Strategies and Stages

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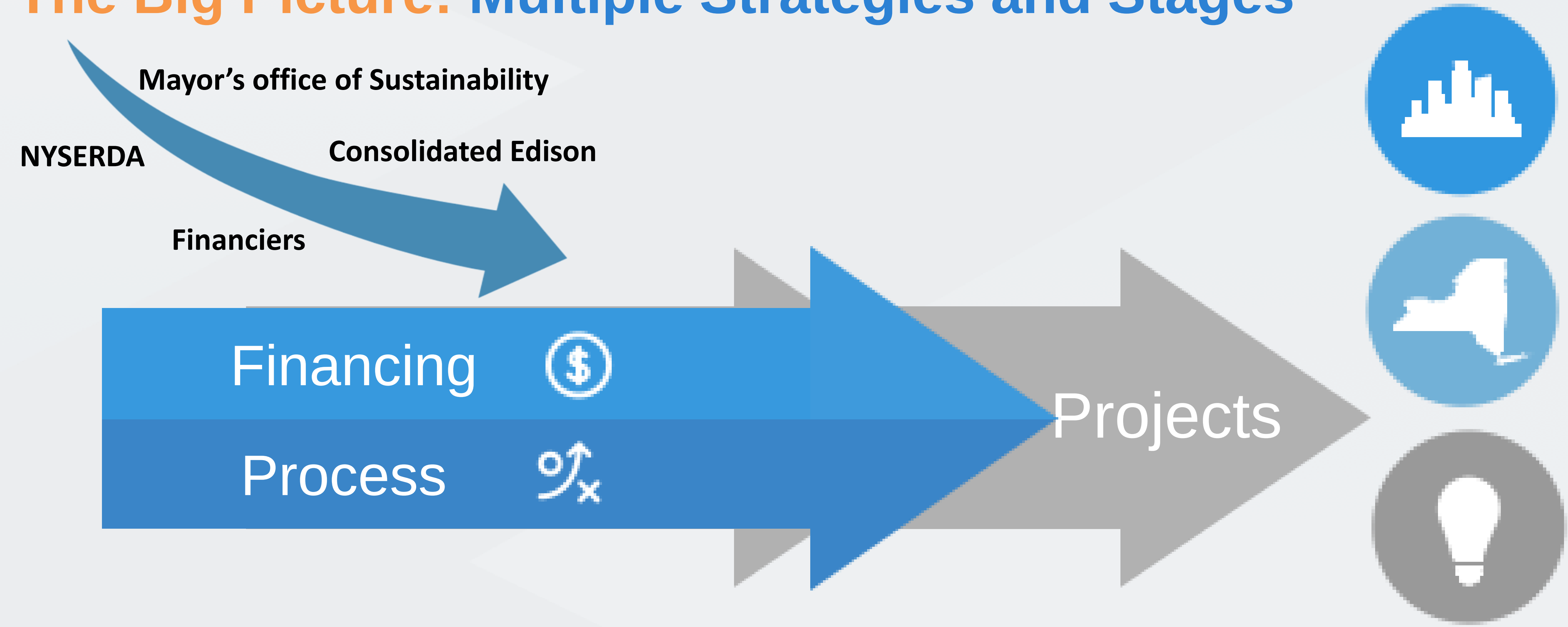


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# The Big Picture: Multiple Strategies and Stages


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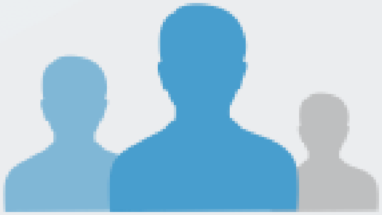
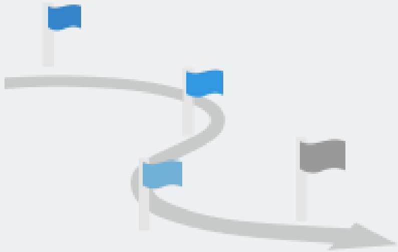
# The Big Picture: Success Through Partnership

## ENGAGEMENT OF STAKEHOLDERS




## PATHWAYS TO PROGRESS



# Timeline: Where We Came From → Where We Are Going

**September 2016**
New York City 100 MWh by 2020 goal set

**December 2016**
NYSERDA Soft Costs initiative

**February 2017**
First DG Hub / NYSERDA / FDNY / DOB meeting for permitting initiative

**Feb - Dec 2017**
Weekly meetings with AHJs on guidelines

**August 2017**
IFC 2018 published

**October 2017**
NFPA 855 first draft

**Nov 2017**
UL 9540A 1st edition

**January 2018**
UL 9540A 2nd edition

**April 2018**
NYC outdoor permitting guidelines published

**June 2018**
UL 9540A 3rd edition

**July 2018**
NFPA 855 second draft

**September 2018**
DOB 1st storage bulletin

**November 2018**
UL flow charts developed

**December 2018**
NY State energy storage target set

**January 2019**
DOB 2nd storage bulletin

**January 2019 – present**
UL 9540A data analysis guide meetings

**July 2019**
NYS emergency rule published

**July 2019**
ConEd Bulk Storage RFP issued

**August 2019**
NFPA 855 published

**August 2019**
NYSERDA Guidebook published

**September 2019**
DOB storage zoning bulletin

**October 2019**
FDNY storage rule published

**Nov 2019**
Stakeholder feedback

**December 2019**
Updated NYC Permitting Guidelines

**2020**
Process improvement
Expanded installs
Technical assistance

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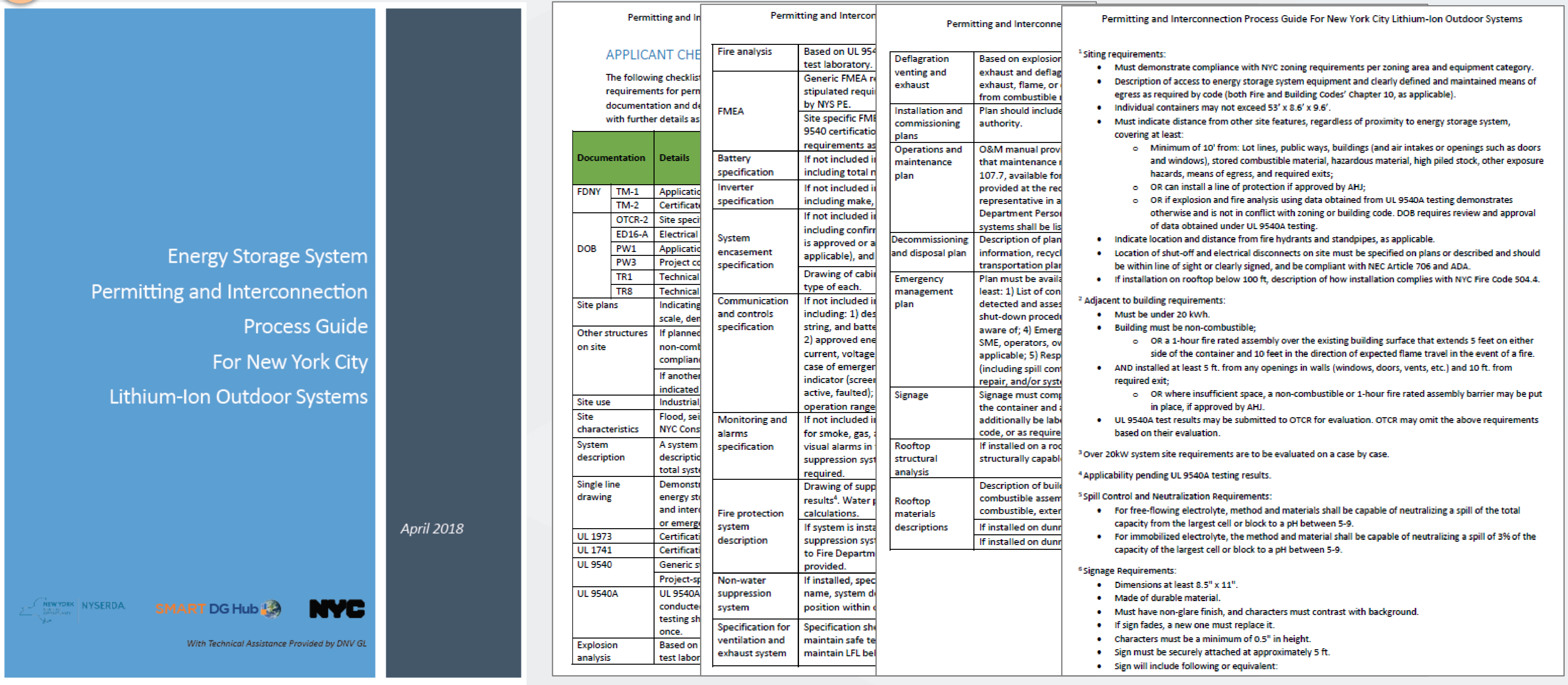
# Smart DG Hub: Outdoor Guidelines



Energy Storage System
Permitting and Interconnection
Process Guide
For New York City
Lithium-Ion Outdoor Systems

*April 2018*

NEW YORK STATE OF OPPORTUNITY. NYSERDA SMART DG Hub NYC

*With Technical Assistance Provided by DNV GL*

Permitting and In

APPLICANT CHE

The following checklist
requirements for perm
documentation and de
with further details as

| Documentation | | Details |
|---|---|---|
| FDNY | TM-1 | Applicatio |
| | TM-2 | Certificate |
| DOB | OTCR-2 | Site speci |
| | ED16-A | Electrical |
| | PW1 | Applicatio |
| | PW3 | Project co |
| | TR1 | Technical |
| | TR8 | Technical |
| Site plans | | Indicating scale, den |
| Other structures on site | | If planned non-comb complian |
| | | If another indicated |
| Site use | | Industrial |
| Site characteristics | | Flood, sei NYC Cons |
| System description | | A system descriptio total syste |
| Single line drawing | | Demonstr energy st and interc or emerge |
| UL 1973 | | Certificati |
| UL 1741 | | Certificati |
| UL 9540 | | Generic s |
| | | Project-sp |
| UL 9540A | | UL 9540A conducte testing sh once. |
| Explosion analysis | | Based on test labor |

Permitting and Intercon

| | |
|---|---|
| Fire analysis | Based on UL 954 test laboratory. |
| FMEA | Generic FMEA re stipulated requi by NYS PE. |
| | Site specific FME 9540 certificatio requirements as |
| Battery specification | If not included i including total n |
| Inverter specification | If not included i including make, |
| System encasement specification | If not included i including confir is approved or a applicable), and |
| | Drawing of cabi type of each. |
| Communication and controls specification | If not included i including: 1) des string, and batte 2) approved ene current, voltage case of emergen indicator (scree active, faulted); operation range |
| Monitoring and alarms specification | If not included i for smoke, gas, visual alarms in suppression syst required. |
| Fire protection system description | Drawing of supp results[4]. Water p calculations. |
| | If system is insta suppression syst to Fire Departm provided. |
| Non-water suppression system | If installed, spec name, system d position within |
| Specification for ventilation and exhaust system | Specification sh maintain safe te maintain LFL bel |

Permitting and Interconne

| | |
|---|---|
| Deflagration venting and exhaust | Based on explosion exhaust and deflag exhaust, flame, or from combustible |
| Installation and commissioning plans | Plan should include authority. |
| Operations and maintenance plan | O&M manual provi that maintenance 107.7, available for provided at the req representative in a Department Perso systems shall be lis |
| Decommissioning and disposal plan | Description of plan information, recycl transportation plan |
| Emergency management plan | Plan must be availa least: 1) List of con detected and asses shut-down procedu aware of; 4) Emerg SME, operators, ov applicable; 5) Resp (including spill con repair, and/or syst |
| Signage | Signage must comp the container and additionally be lab code, or as require |
| Rooftop structural analysis | If installed on a roo structurally capabl |
| Rooftop materials descriptions | Description of buil combustible assem combustible, exter |
| | If installed on dunn |
| | If installed on dunn |

Permitting and Interconnection Process Guide For New York City Lithium-Ion Outdoor Systems

[1] Siting requirements:

- Must demonstrate compliance with NYC zoning requirements per zoning area and equipment category.
- Description of access to energy storage system equipment and clearly defined and maintained means of egress as required by code (both Fire and Building Codes' Chapter 10, as applicable).
- Individual containers may not exceed 53' x 8.6' x 9.6'.
- Must indicate distance from other site features, regardless of proximity to energy storage system, covering at least:
    - Minimum of 10' from: Lot lines, public ways, buildings (and air intakes or openings such as doors and windows), stored combustible material, hazardous material, high piled stock, other exposure hazards, means of egress, and required exits;
    - OR can install a line of protection if approved by AHJ;
    - OR if explosion and fire analysis using data obtained from UL 9540A testing demonstrates otherwise and is not in conflict with zoning or building code. DOB requires review and approval of data obtained under UL 9540A testing.
- Indicate location and distance from fire hydrants and standpipes, as applicable.
- Location of shut-off and electrical disconnects on site must be specified on plans or described and should be within line of sight or clearly signed, and be compliant with NEC Article 706 and ADA.
- If installation on rooftop below 100 ft, description of how installation complies with NYC Fire Code 504.4.

[2] Adjacent to building requirements:

- Must be under 20 kWh.
- Building must be non-combustible;
    - OR a 1-hour fire rated assembly over the existing building surface that extends 5 feet on either side of the container and 10 feet in the direction of expected flame travel in the event of a fire.
- AND installed at least 5 ft. from any openings in walls (windows, doors, vents, etc.) and 10 ft. from required exit;
    - OR where insufficient space, a non-combustible or 1-hour fire rated assembly barrier may be put in place, if approved by AHJ.
- UL 9540A test results may be submitted to OTCR for evaluation. OTCR may omit the above requirements based on their evaluation.

[3] Over 20kW system site requirements are to be evaluated on a case by case.

[4] Applicability pending UL 9540A testing results.

[5] Spill Control and Neutralization Requirements:

- For free-flowing electrolyte, method and materials shall be capable of neutralizing a spill of the total capacity from the largest cell or block to a pH between 5-9.
- For immobilized electrolyte, the method and material shall be capable of neutralizing a spill of 3% of the capacity of the largest cell or block to a pH between 5-9.

[6] Signage Requirements:

- Dimensions at least 8.5" x 11".
- Made of durable material.
- Must have non-glare finish, and characters must contrast with background.
- If sign fades, a new one must replace it.
- Characters must be a minimum of 0.5" in height.
- Sign must be securely attached at approximately 5 ft.
- Sign will include following or equivalent:

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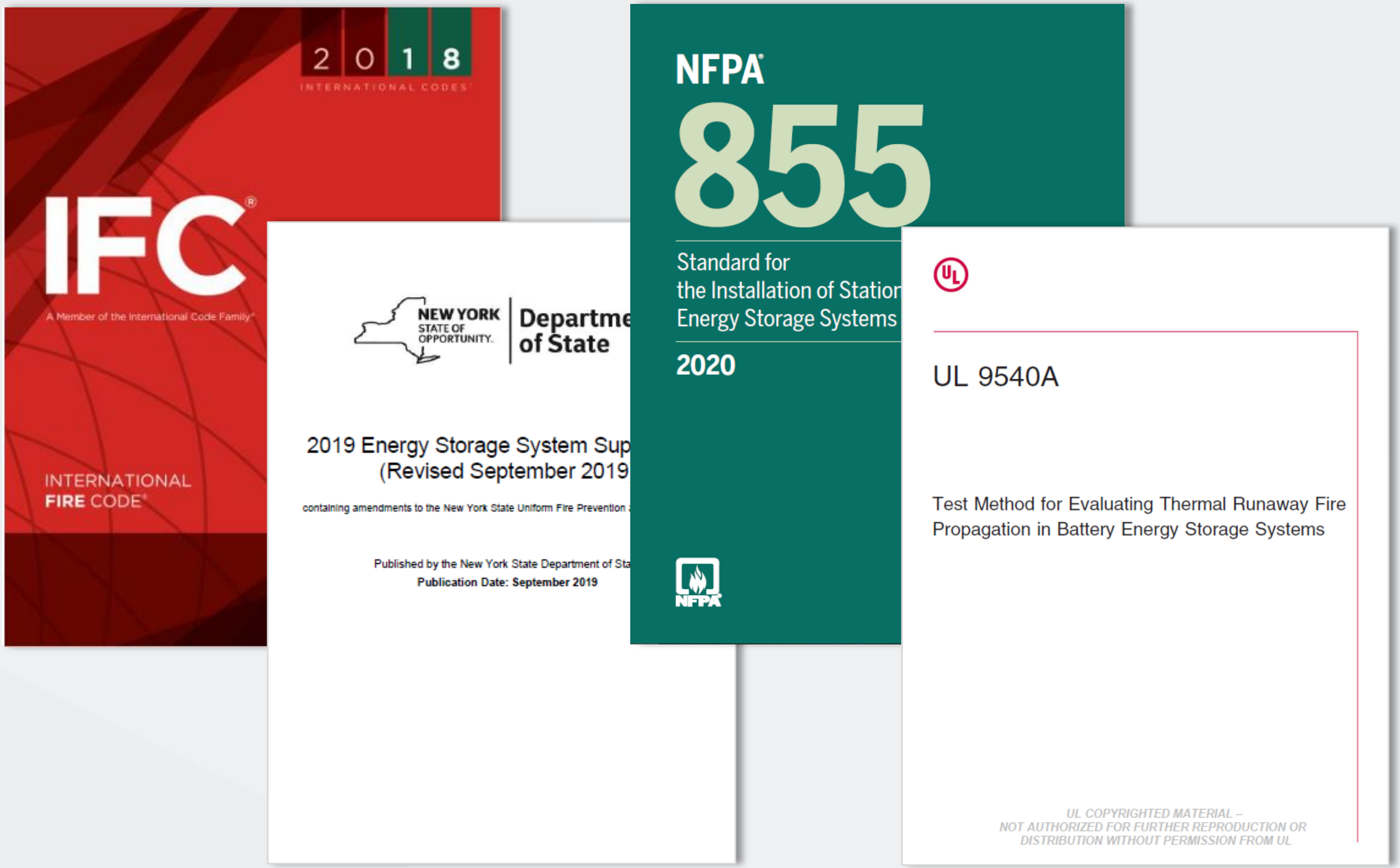
# Smart DG Hub: Outdoor Guide

- Published in 2018, with detailed input and discussion with stakeholders
- Addressed the ConEd, DOB, and FDNY application processes
- Created a checklist for critical permitting requirements, prior to the adoption of code, addressing:
  - Sizing
  - Siting
  - Testing / certifications
  - Signage
  - Submission details (forms and documentation requirements)
  - Costs
- Since publication, adoption of new bulletins and rules, as well as new data, necessitates updates

# General Overview: Standards Development

- **NFPA 855**
- **IFC 2018 (and draft 2021)**
- **UL Standards**
  - UL 1642 (cell)
  - UL 1973 (module)
  - UL 1741 (inverter)
  - UL 9540 (system)
  - UL 9540A (test method)
- **NY and NYC rules**




*With key technical assistance from*

# UL: Standards Development

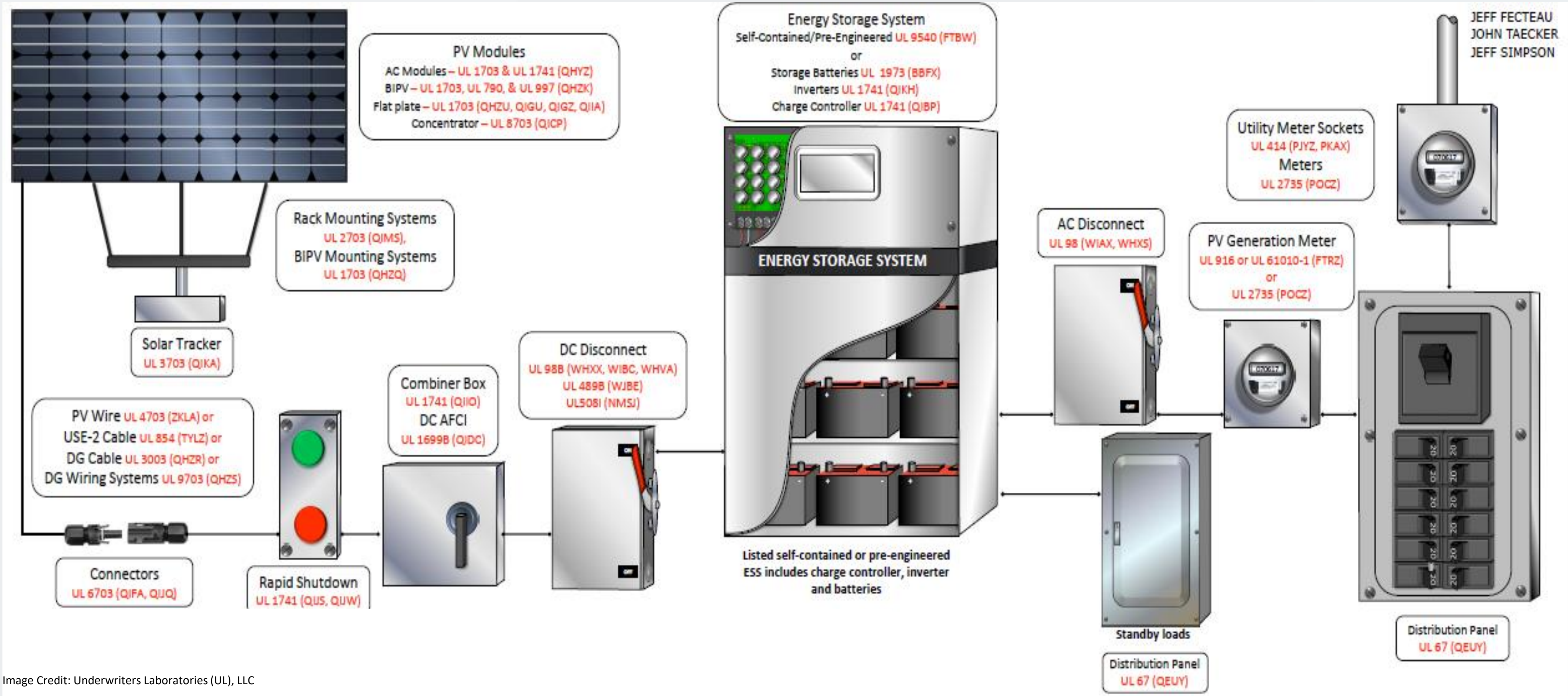
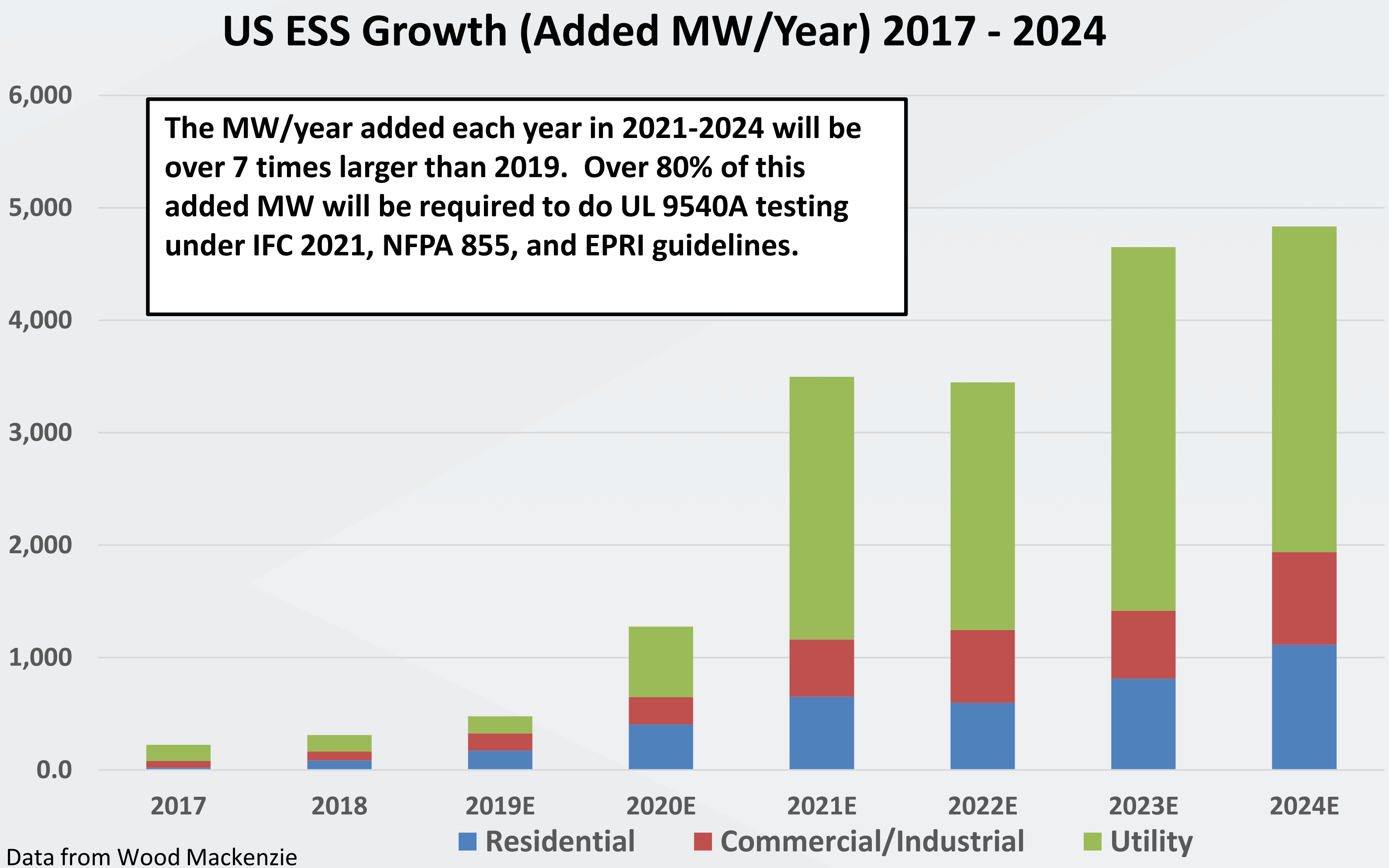



Image Credit: Underwriters Laboratories (UL), LLC

From SPI, “Energy Storage System Installation Codes” presented by J. Fecteau, J.Taecker, J.Simpson

# UL: Standards Development




Data from Wood Mackenzie
3Q19 Energy Storage Report

# UL: Standards Development

U.S. front-of-the-meter energy storage pipeline by requested commissioning date (MW)

| Market | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2 |
|---|---|---|---|---|---|---|---|
| Arizona | 0 | 171 | 225 | 836 | 1,940 | 60 | |
| California | 51 | 3,415 | 5,836 | 12,920 | 9,254 | 1,856 | 1 |
| Colorado | 0 | 200 | 0 | 275 | 0 | 0 | |
| Florida | 0 | 22 | 409 | 0 | 0 | 0 | |
| Hawaii | 14 | 120 | 217 | 45 | 0 | 0 | |
| Massachusetts | 0 | 0 | 312 | 416 | 1,000 | 0 | |
| Nevada | 0 | 0 | 100 | 1,870 | 940 | 0 | |
| New Jersey | 49 | 55 | 116 | 116 | 0 | 0 | |
| New York | 26 | 675 | 1,105 | 2,609 | 857 | 100 | |
| PJM (Excl. NJ) | 25 | 580 | 1,151 | 1,191 | 339 | 0 | |
| Texas | 84 | 929 | 2,306 | 100 | 380 | 600 | |
| All others | 10 | 2,781 | 1,550 | 1,698 | 3,031 | 0 | |
| **Total** | **259** | **8,947** | **13,327** | **22,077** | **17,741** | **2,616** | **1** |

- 2022 represents the largest anticipated pipeline delivery year, as some projects with a COD of 2019 and 2020 were delayed.
- Interconnection queue requests are clustered in the 2020-2023 time frame, driving most pipeline numbers.

Data from Wood Mackenzie
3Q19 Energy Storage Report

# UL: Standards Development

## ENERGY STORAGE FIRE SAFETY STANDARDS

**Installation Codes**

**NEC:** National Electric Code (NFPA 70)

**NFPA 855:** Standard for the Installation of Stationary Energy Storage Systems

**IFC 2018/2021:** The International Fire Code

**Battery Safety Certification**

**UL 1642:** Lithium Batteries

**UL 1973:** Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

**UL 9540:** Energy Storage Systems and Equipment

**Testing for Performance**

**UL 9540A:** Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

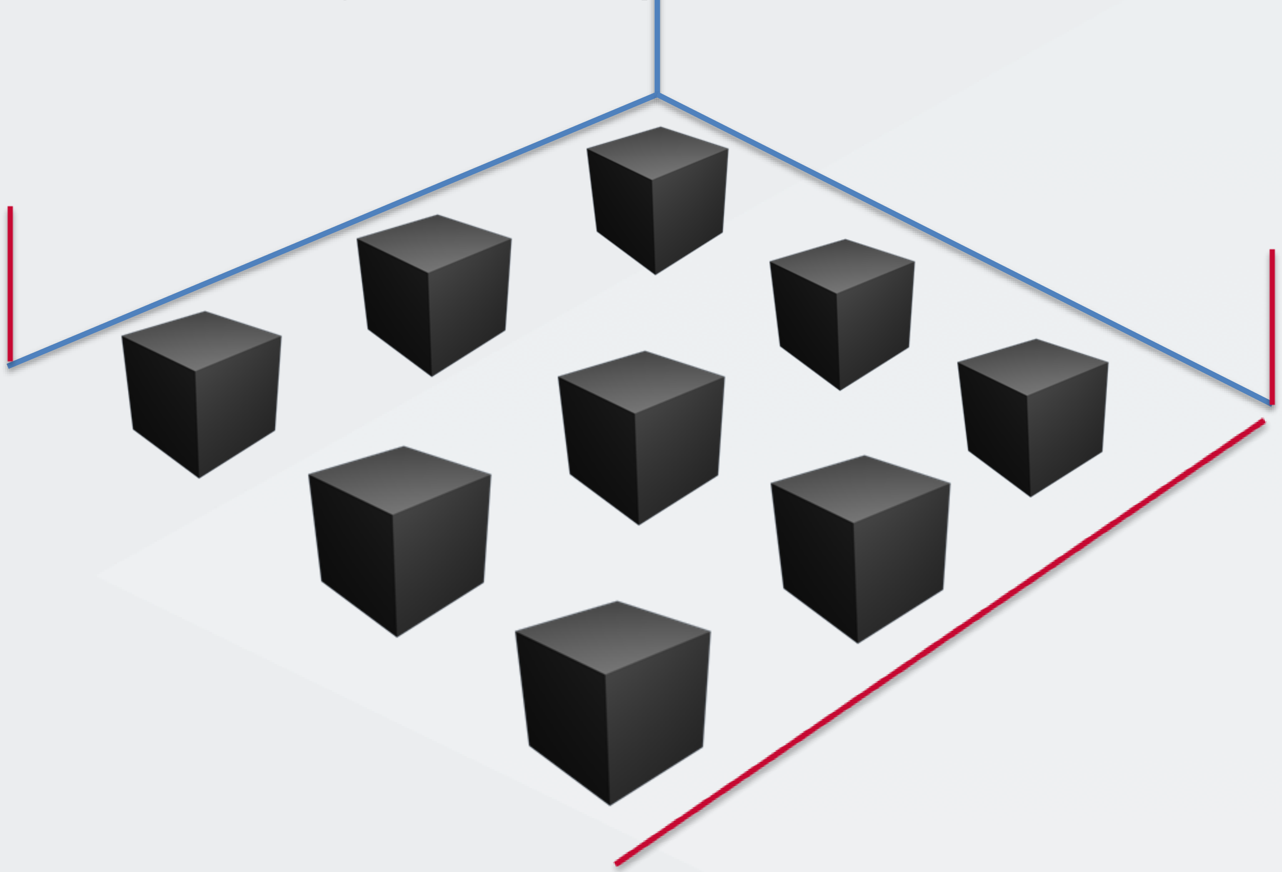
# UL: Standards Development

- UL 9540A, 4th Edition: Test Method for Evaluating Thermal Runaway Fire Propagation In Battery Energy Storage Systems (12 November 2019)
  - Cell level test
  - Module level test
  - Unit (rack) level test
  - Installation level test (including mitigative systems)
- UL 9540A 4th Edition versus 3rd Edition
  - Adjusted test set up and requirements
  - Performance criteria
  - More installation types
  - More system types

# UL: Standards Development

IFC 2021 / NFPA 855

Listing, Size, Separation, MAQ



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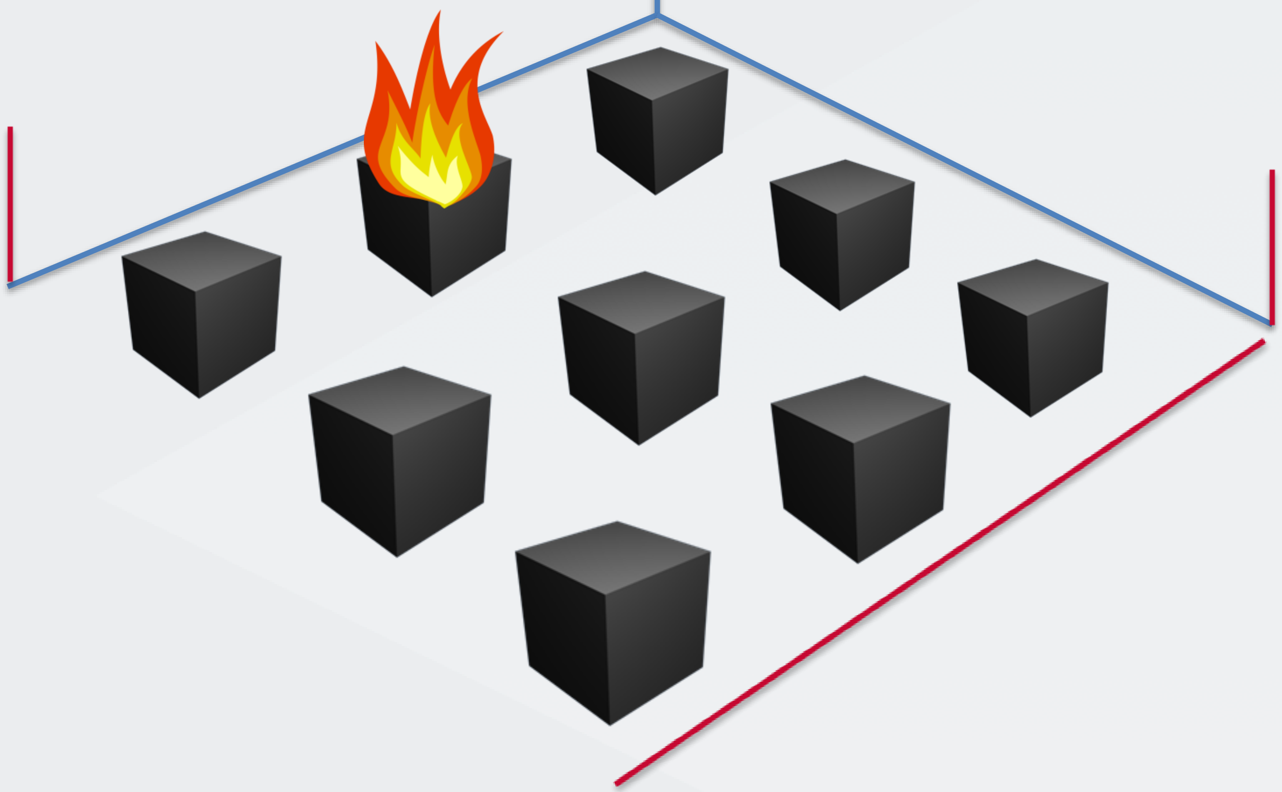

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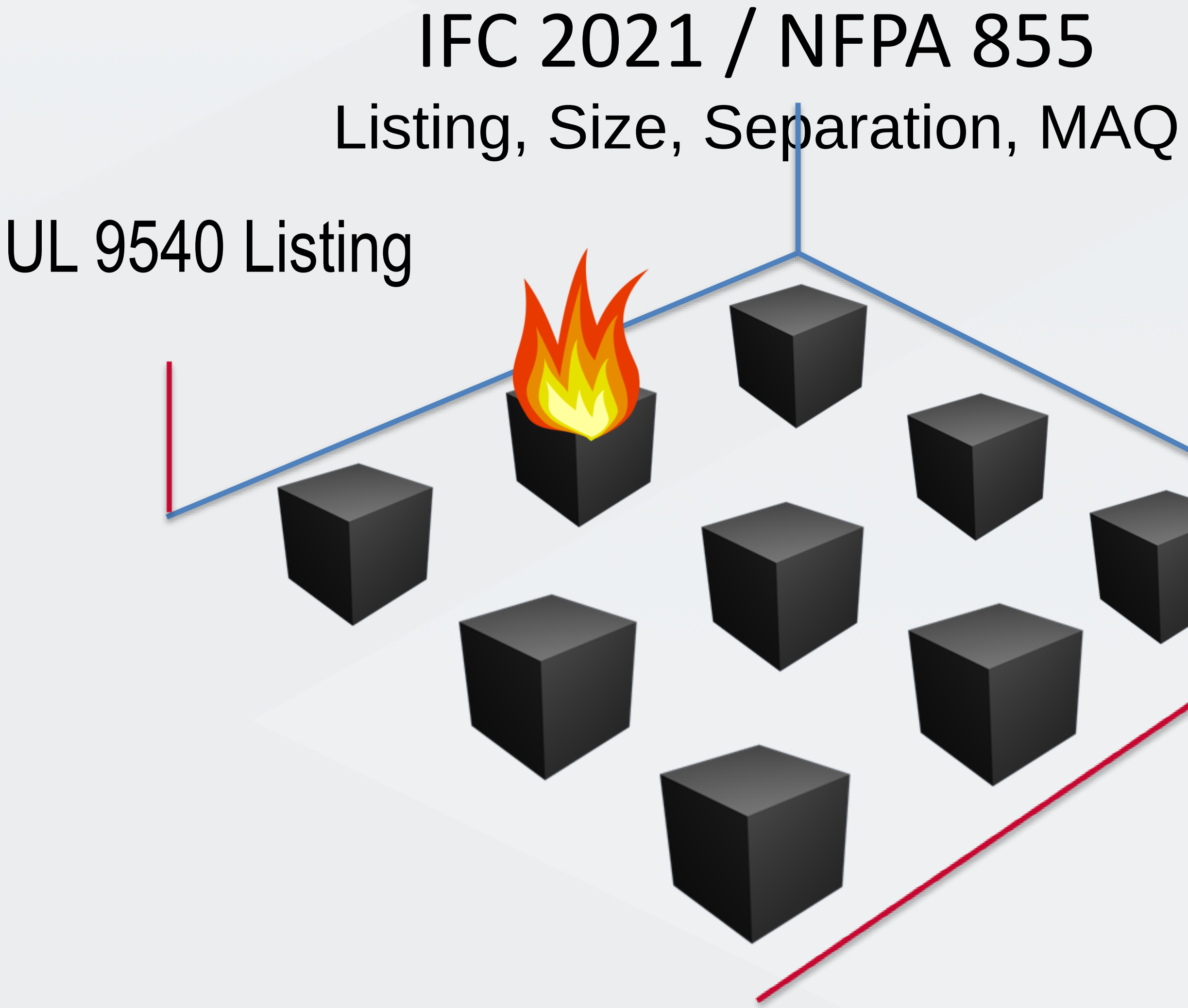

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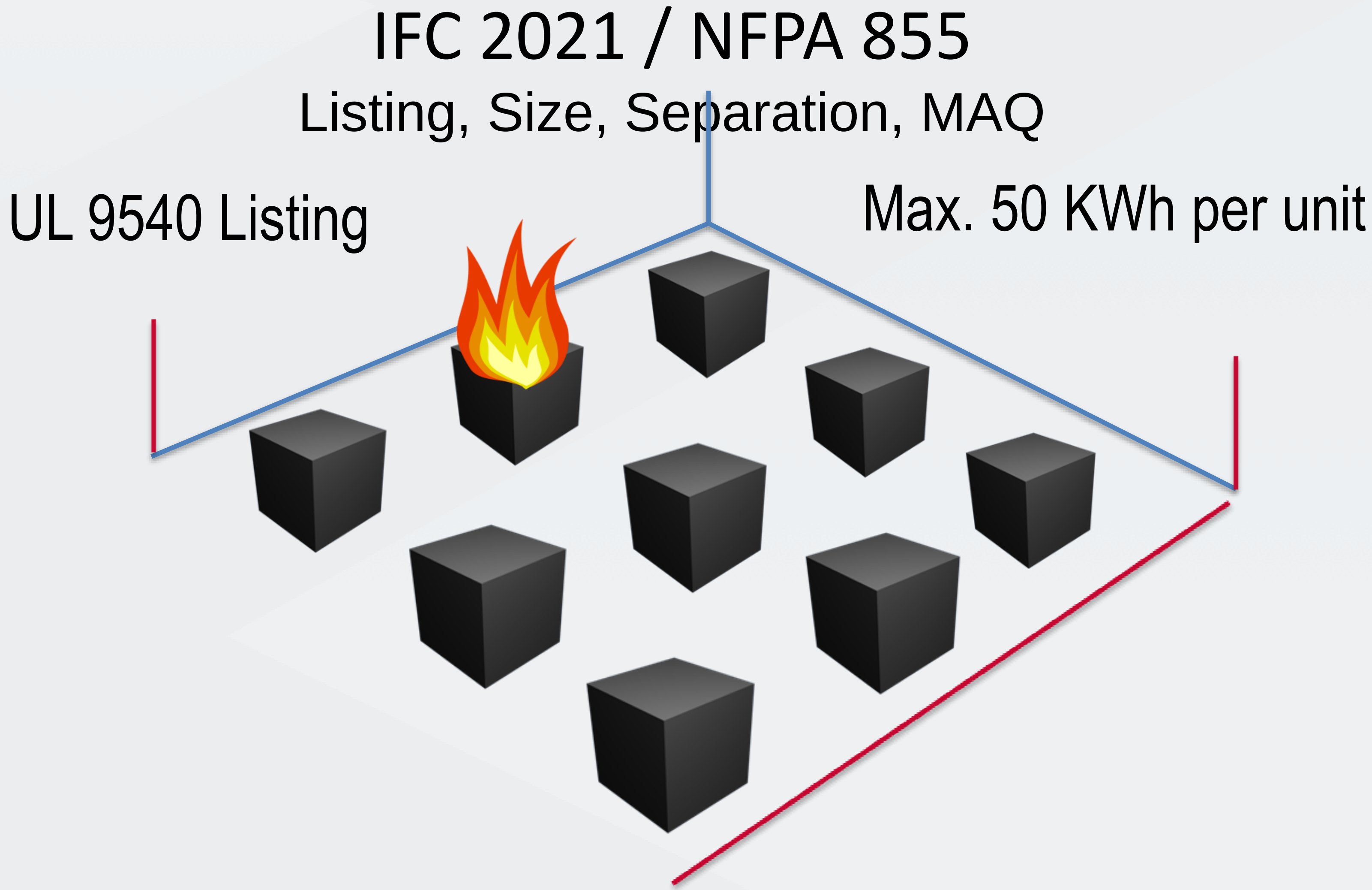


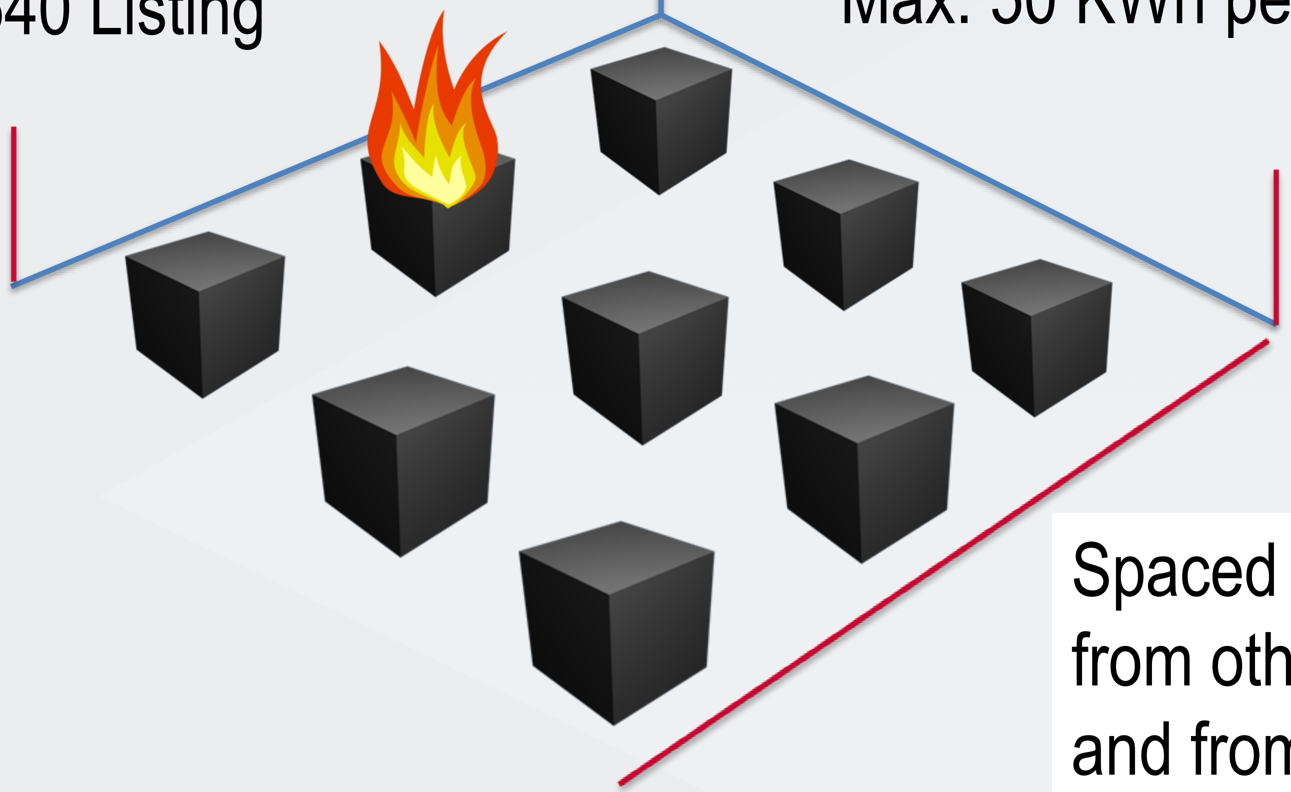
# UL: Standards Development

## IFC 2021 / NFPA 855

Listing, Size, Separation, MAQ

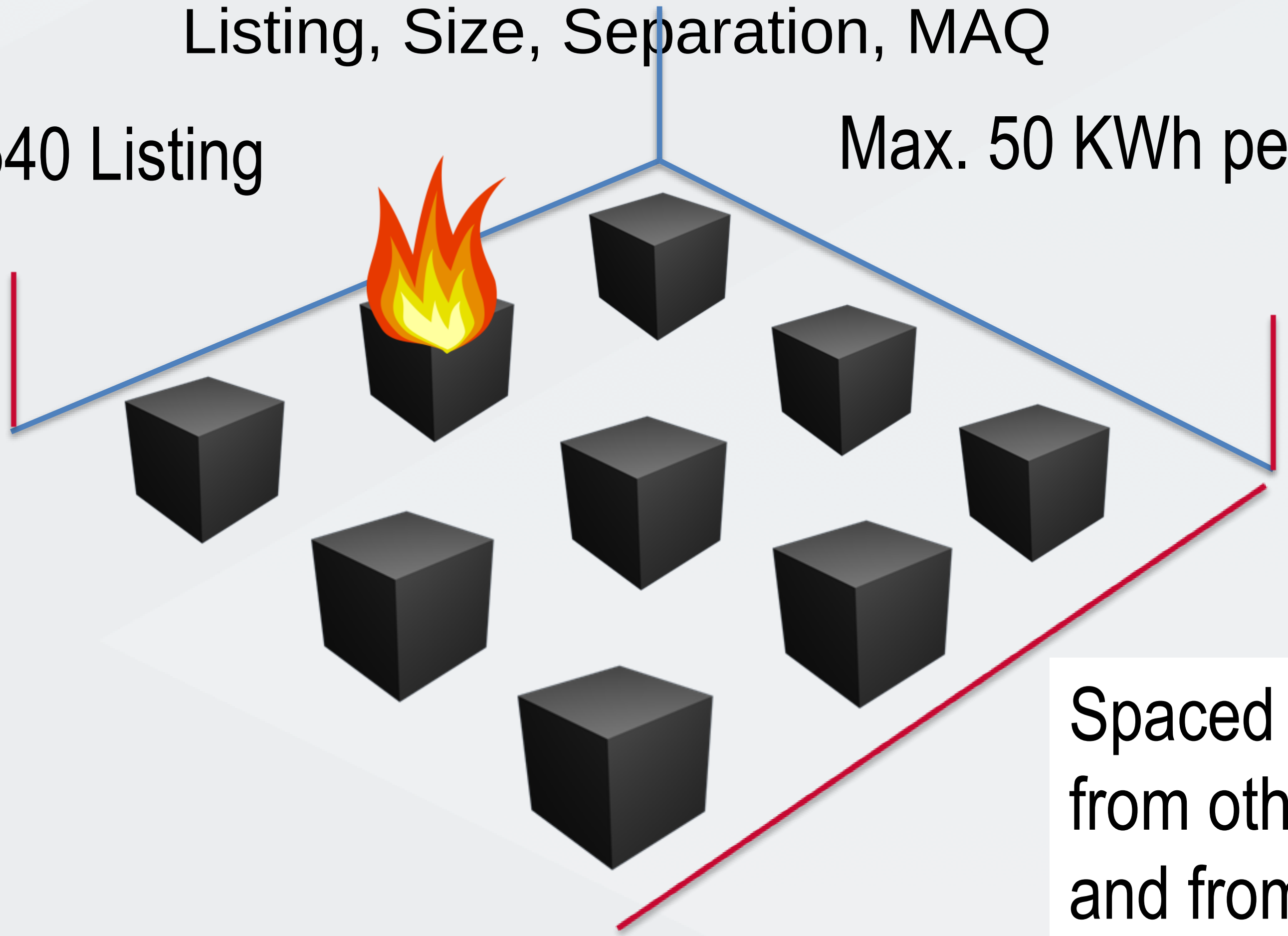
UL 9540 Listing

Max. 50 KWh per unit



Spaced min. 3 ft.
from other arrays
and from walls

# UL: Standards Development



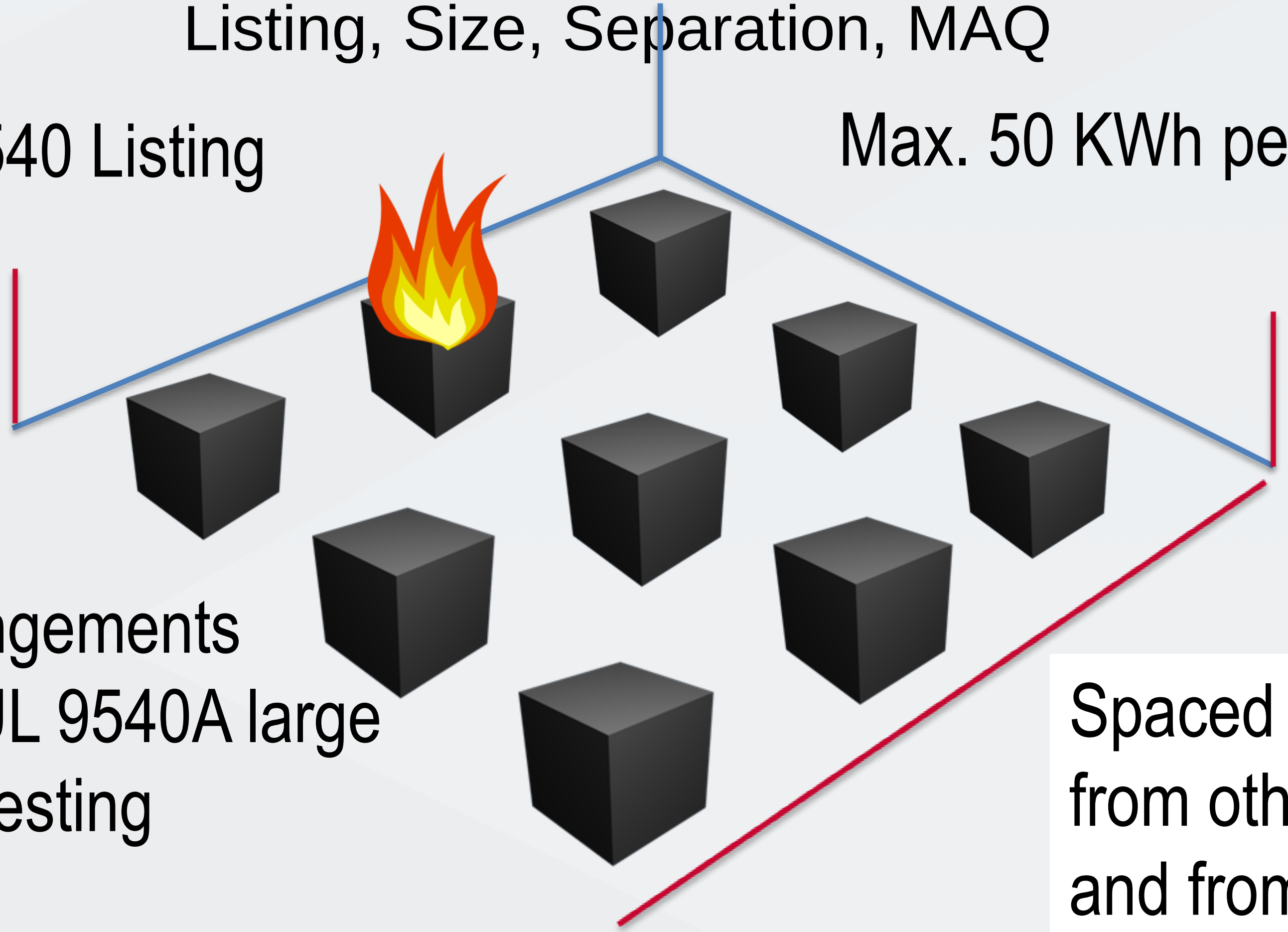
# UL: Standards Development

## IFC 2021 / NFPA 855

Listing, Size, Separation, MAQ

UL 9540 Listing

Max. 50 KWh per unit



Other arrangements based on UL 9540A large scale fire testing

Spaced min. 3 ft. from other arrays and from walls

Max. 600 KWh aggregate/fire area

# UL: Standards Development

## UL 9540A Testing Methodology

**Cell Level Test**
- Whether cell can exhibit thermal runaway
- Thermal runaway characteristics
- Gas composition (flammability)

**Module Level Test**
- Propensity for propagation of thermal runaway
- Heat and gas release rates (severity/duration)
- Flaming/deflagration hazards

**Unit Level Test**
- Evaluation of fire spread
- Heat and gas release rates (severity/duration)
- Deflagration hazards
- Re-ignition hazards

**Installation Level Test**
- Effectiveness of fire protection system(s)
- Heat and gas release rates (severity/duration)
- Deflagration hazards
- Re-ignition hazards

**Challenge – AHJ needs to evaluate the test results**

# UL: Standards Development

## Thermal Runaway - 25 Lithium-ion Cells

Let's do the math…

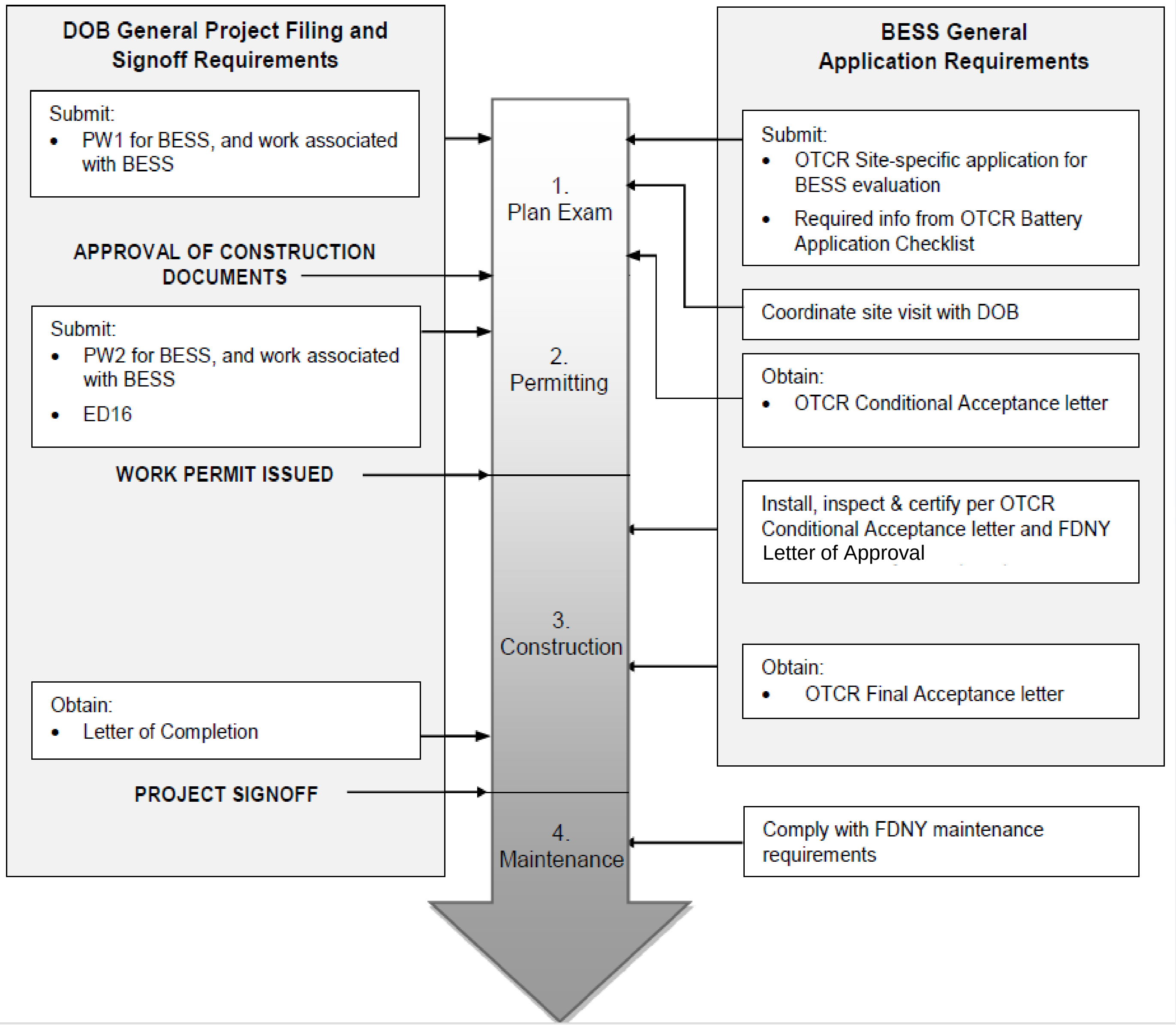
- A single 18650 Li-Ion cell is ~ 10 WH
- 25 cells is ~ 250 WH
- A typical ESS module has 3,100 WH
- A typical rack has 10 modules for 31,000 WH
- This typical rack has over 120 times more energy than the 25 cell example in the video

# Consolidated Edison: Incentives and Installations

- **Current grid needs:**
  - Resiliency
  - Response to changing demand levels and shape
  - Retirement of generation and peaker facilities
- **ConEd programs to address need:**
  - UL 9540A testing incentive
  - Bulk storage RFP summary
    - Timeline
    - Applications
    - Totals moving forward

# Department of Buildings: Bulletin 2019-002

- **Effective date: January 30, 2019**
- **Applicable to:**
  - Lithium ion, flow batteries, lead acid, and valve regulated lead acid
  - All system sizes
  - All installation types
- **Key takeaways / steps**
  - Complete a PW1 and submit all site-specific data required in the OTCR application checklist
  - Schedule site visit with DOB
  - Submit PW2 and ED16
  - Install, inspect, and Certify per OTCR Conditional acceptance
  - OTCR Final Acceptance Letter for BESS must be obtained prior to project signoff



# Department of Buildings: Bulletin 2019-007

- **Issuance Date: September 26, 2019**
- **Independent Systems:**
  - Fuel Cells
  - Battery Energy Storage Systems (BESS)
  - OTCR Review - Exceed Power Output FGC 633.1 (BB 2019-002 w/other reqs)
- **Key takeaways:**

  Electric/Gas Utility Substation (ZR 32-15: Use Group 6D)
    - Comply with ZR (yards, fencing)
    - Energy provided to Grid
    - Open or Enclosed
    - Site - 10,000 sf limit Fuel Cells - Natural Gas, 15 psig max
    - Fuel Cells - Sound Studies (AC 24 Chapter 2)

  Otherwise, Use Group 17 C “Public Utility Substation Open or Enclosed with no Limit on Size”

NYC Buildings

NYC Department of Buildings
280 Broadway
New York, NY 10007

Melanie La Rocca, Commissioner

**BUILDINGS BULLETIN 2019-007**
**Zoning**

**Supersedes:** None

**Issuer:** Keith L. Wen, R.A.
Assistant Commissioner, Code and Zoning Interpretation

**Issuance Date:** September 26, 2019

**Purpose:** This bulletin clarifies the applicable zoning use group and limitation when establishing facilities for non-accessory fuel cell systems and battery energy storage systems.

**Related Code/Zoning Section(s):** ZR 32-15, ZR 37-20, AC Title 24 Chapter 2, FGC 633.1, BC 1206.2

**Subject(s):** Fuel cell; Fuel cell installation; Fuel cell facility; Use group, fuel cell; Battery energy storage systems; Battery installation; Battery energy storage system facility; Use group, battery energy storage; Zoning Use Group classification (UG), Use Group 6D

I. **Background**

One of the strategies outlined in the New York City's Roadmap to 80 x 50[1] is to promote clean, distributed energy resources at a community scale. Distributed energy resources (DERs), which include renewable energy sources, energy efficient technologies and strategies, and energy storage, will play an important role in increasing the amount of clean energy and in reducing demand on the grid and providing resiliency benefits. This bulletin clarifies the applicable zoning use group and limitation when establishing facilities for non-accessory fuel cell systems and battery energy storage systems, which are types of DERs.

A. **Battery energy storage systems (BESS).** BESS store energy through electrochemical means to supply electrical energy at a future time, and provide electrical energy for other uses. Batteries are charged when energy can be produced with lower carbon emissions or when renewable energy is available, and discharged when it is more convenient, economic, or when energy is not available from the grid or other distributed generation sources. Battery energy storage systems may employ lithium-ion, lead acid, flow batteries or other approved types of technology. The systems' components may include equipment for charging, discharging, storage, communication, control and protection of the equipment, fuel, containment and other equipment used to properly operate the system.

B. **Fuel cell technology.** Fuel cells are a type of distributed generation (DG) technology that provides energy to customers at the community level and/or to support the existing electricity grid, where it is necessary to mitigate aging and inadequate energy distribution infrastructure. Fuel cells are commonly connected to natural gas, which produces hydrogen gas through reforming. The hydrogen is then passed through the cell to produce electricity via an electro-chemical reaction. Fuel cells generally operate at efficiency levels higher than traditional combustion generators.

# Bulletin 2019-007: DG Hub Matrix Interpretation

| | | | | Standard Permitting Requirements | | Special Permits/Other Requirements | |
|---|---|---|---|---|---|---|---|
| **Battery type/category** | **Use Cases** | **Zoning District** | **Use Group** | **FDNY** | **DOB** | **BSA / CPC** | **Other (CEQR, Cert of Occ)** |
| **Accessory Use (Building/Site Support)*** | **This use case includes projects that primarily supply power to the existing building on a site. They may or may not be physically connected to the electric grid, but do not function primarily as a grid-supporting asset.* Example Projects:<br>-ESS on roof of a 1-4 family home storing surplus solar generation<br>-ESS on warehouse property providing demand response and peak management for the building** | R | N/A | Permits/requirements as outlined in FDNY RCNY 608.1, unless sited on property outside of NYC AHJ jurisdiction*** | Permits/requirements as outlined in DOB Bulletin 2019-002, unless sited on property outside of NYC AHJ jurisdiction*** | N/A | N/A |
| | | C | N/A | | | | |
| | | M | N/A | | | | |
| **Non-Accessory (Grid Support) ≤ 10,000 sf**** | **This use case would include projects that function primarily as grid-supporting assets, owned and operated by a utility or other third party in order to provide grid support/optimization services.<br>Example Projects:<br>-Con-Ed owned and operated ESS that connects directly to the grid for peak load support<br>-Generator-owned ESS providing ancillary services such as frequency regulation and spinning reserves** | R | 6D | Permits/requirements as outlined in FDNY RCNY 608.1, unless sited on property outside of NYC AHJ jurisdiction*** | Permits/requirements as outlined in DOB Bulletin 2019-002, unless sited on property outside of NYC AHJ jurisdiction*** | BSA special permit | CEQR and new/amended Cert of Occupancy |
| | | C | 6D | | | N/A for zones C1, C2, C4, C5, C6 (except C6-1A), and C8.<br><br>For zones C3, C6-1A, and C7, use group 6D is not allowed as of right. | N/A |
| | | M | 6D | | | N/A | N/A |
| **Non-Accessory (Grid Support) > 10,000 sf** | **This use case would include large projects that provide grid support and/or peak power supply, owned and operated by a utility or other third party. Example Projects:<br>-Generator-owned ESS that replaces a closing fossil-powered peaker plant and connects directly to the grid** | R | 17C or other | Permits/requirements as outlined in FDNY RCNY 608.1, unless sited on property outside of NYC AHJ jurisdiction*** | Permits/requirements as outlined in DOB Bulletin 2019-002, unless sited on property outside of NYC AHJ jurisdiction*** | CPC special permit (if 17/17C) | CEQR and new/amended Cert of Occupancy (if 17/17C) |
| | | C | 17C or other | | | BSA special permit (if 17/17C, 10,000-40,000sf)<br><br>CPC special permit (if 17/17C, >40,000sf) | CEQR and new/amended Cert of Occupancy (if 17/17C) |
| | | M | 17C or other | | | N/A | N/A |

# Fire Department of New York: 3 RCNY 608-01

- **Effective Date: October 1, 2019**
- **Key differences between Rule and previous Permitting Guide**
  - Permit for Medium/Large systems
  - Requirements for all battery types (VRLA, NICAD, Flow)
  - Manual exhaust override
  - Design procedures for explosion mitigation
  - Certificate of Approval – Equipment for City-Wide Use
- **Important information to Applicants – Site Selection**
  - Water supply availability – Hydrants and main ≥ 8 inches
  - Redundant Fire Department Connections (FDC)
  - FDCs at safe distance from hazard zone, with e-stop and exhaust switch available there

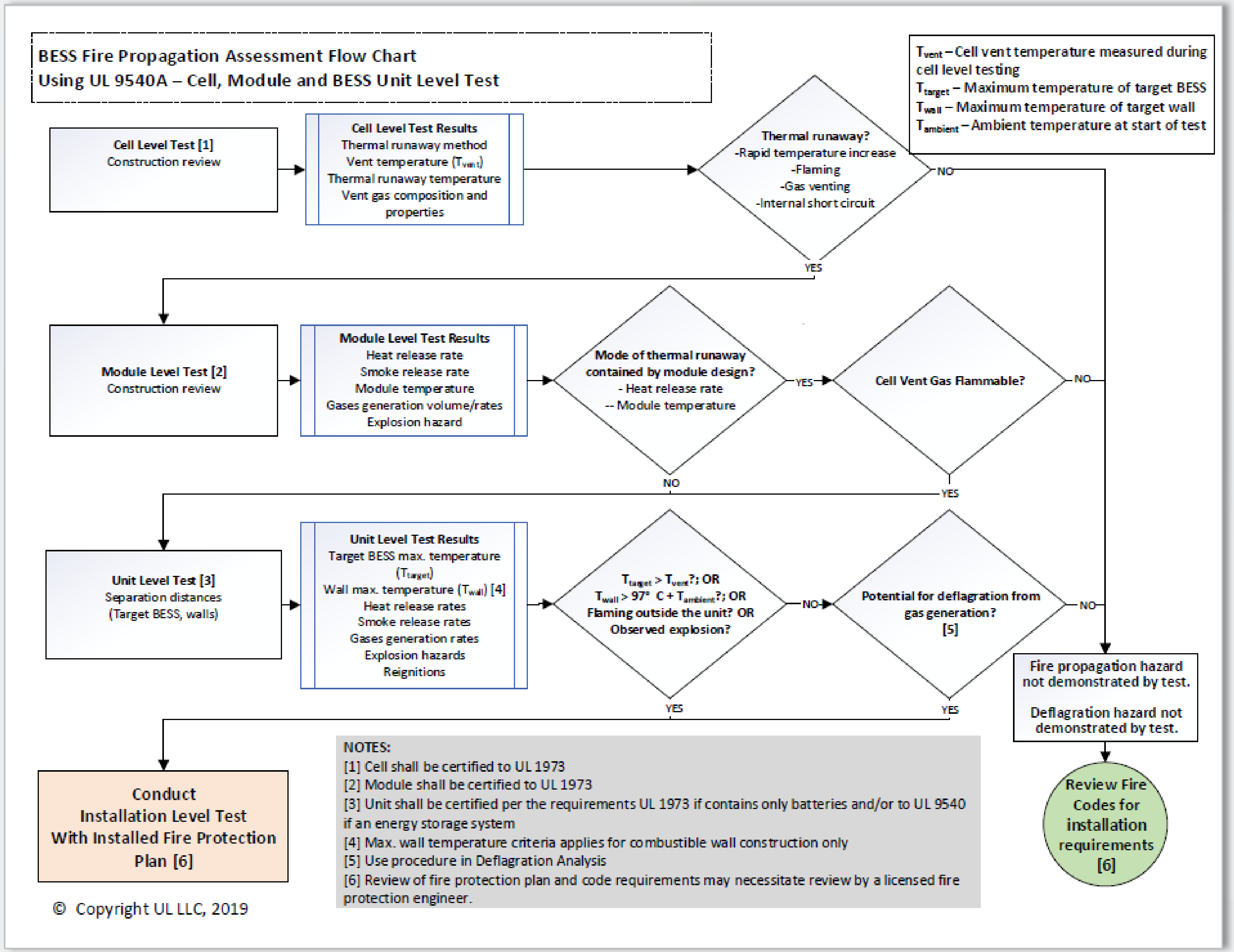
Available on the Fire Department's Website and NYCRULES

# Working group: Processing UL 9540A Data

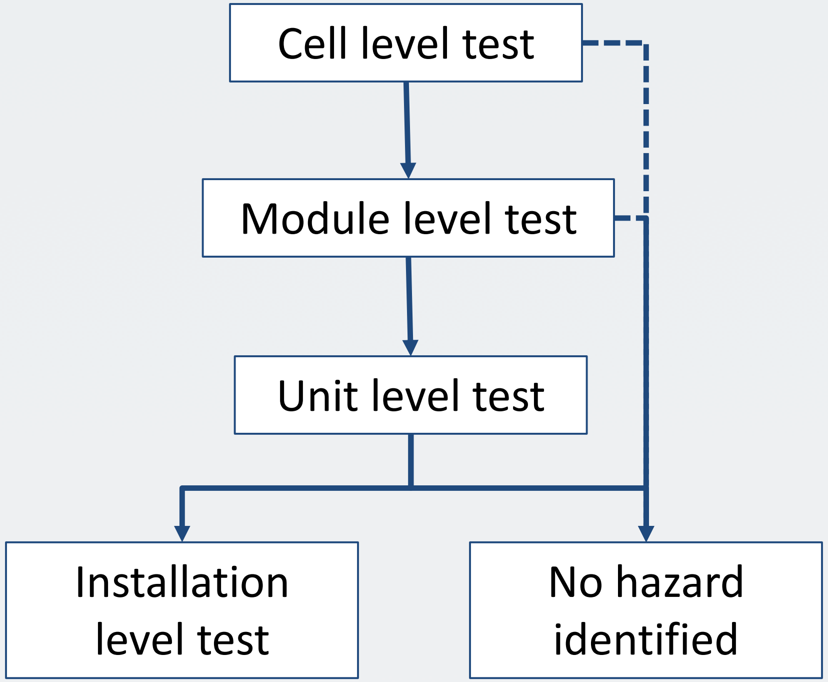
- **Learnings from last year's stakeholder roundtable:**
  - Clarity needed on what to do with UL 9540A data
  - Documentation of process, including roles and responsibilities, lacking
  - Engagement of subject matter experts necessary

- **Based on this input, over the last year:**
  - UL developed flow charts for the basic steps to gather and assess the data
  - DG Hub hosted weekly meetings with subject matter experts to provide insight to stakeholders into best available thinking on this topic
  - NYC-specific intricacies identified

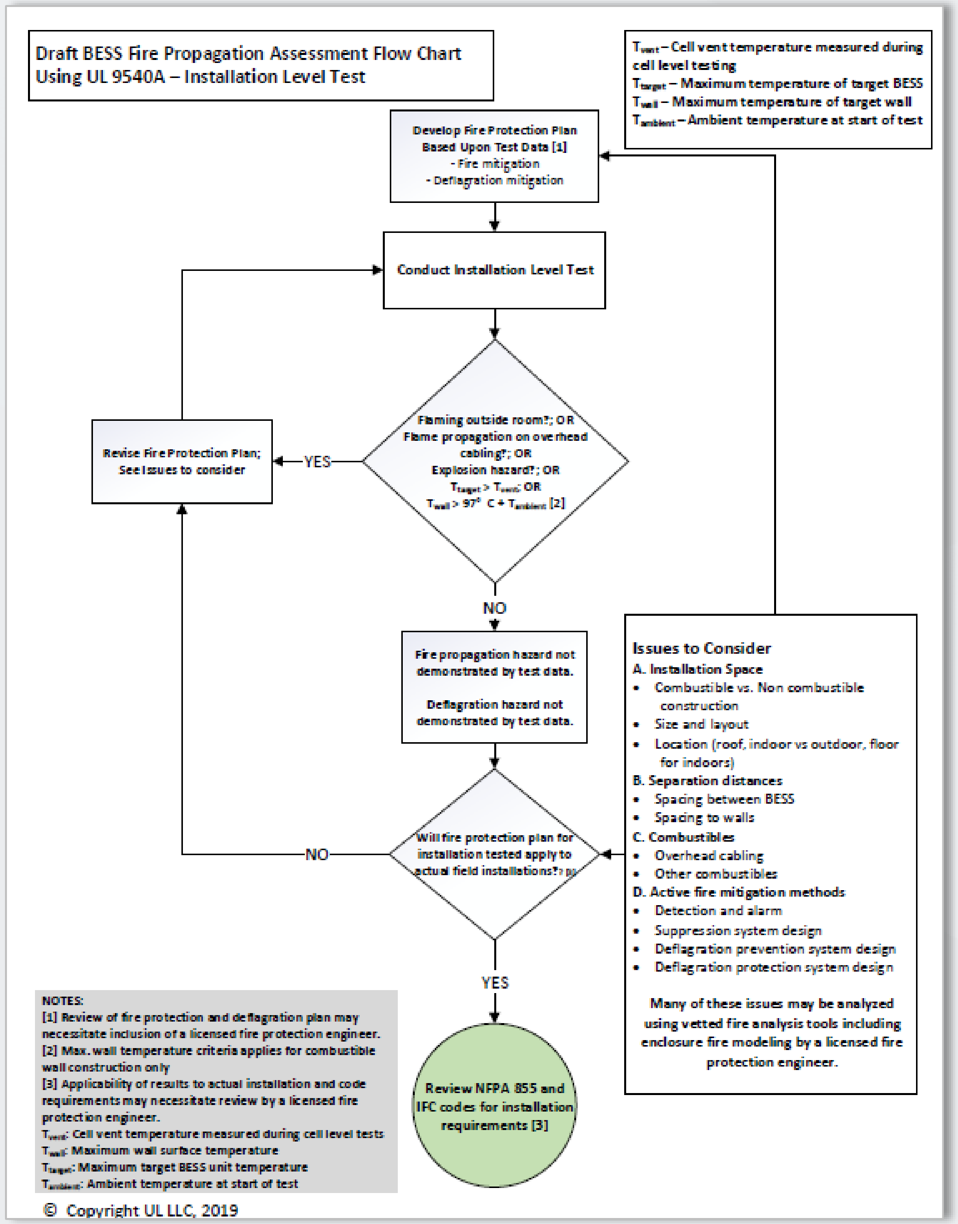
# Working group: Processing UL 9540A Data



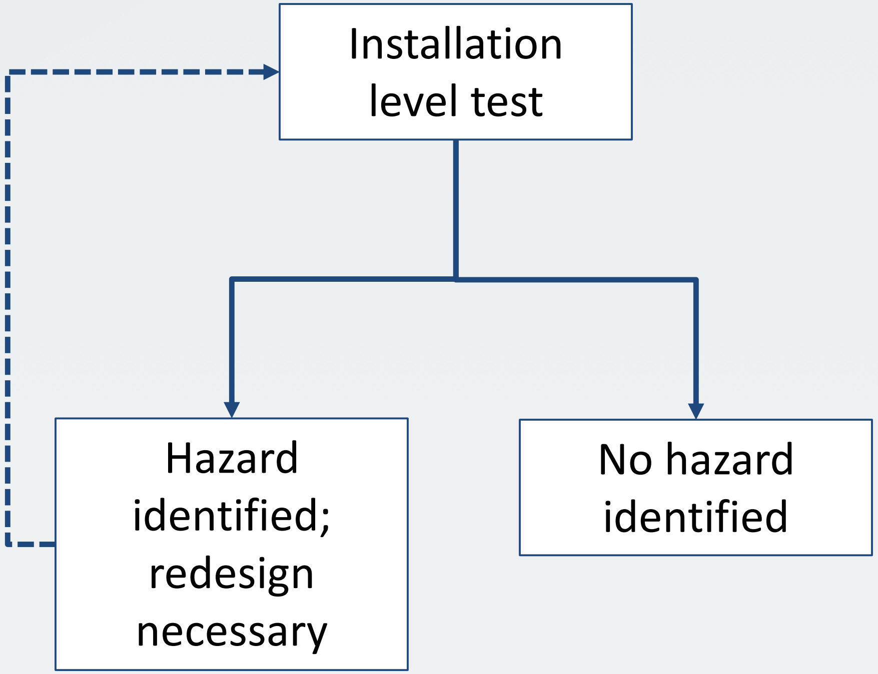

***Fire propagation assessment – cell, module, and unit level***



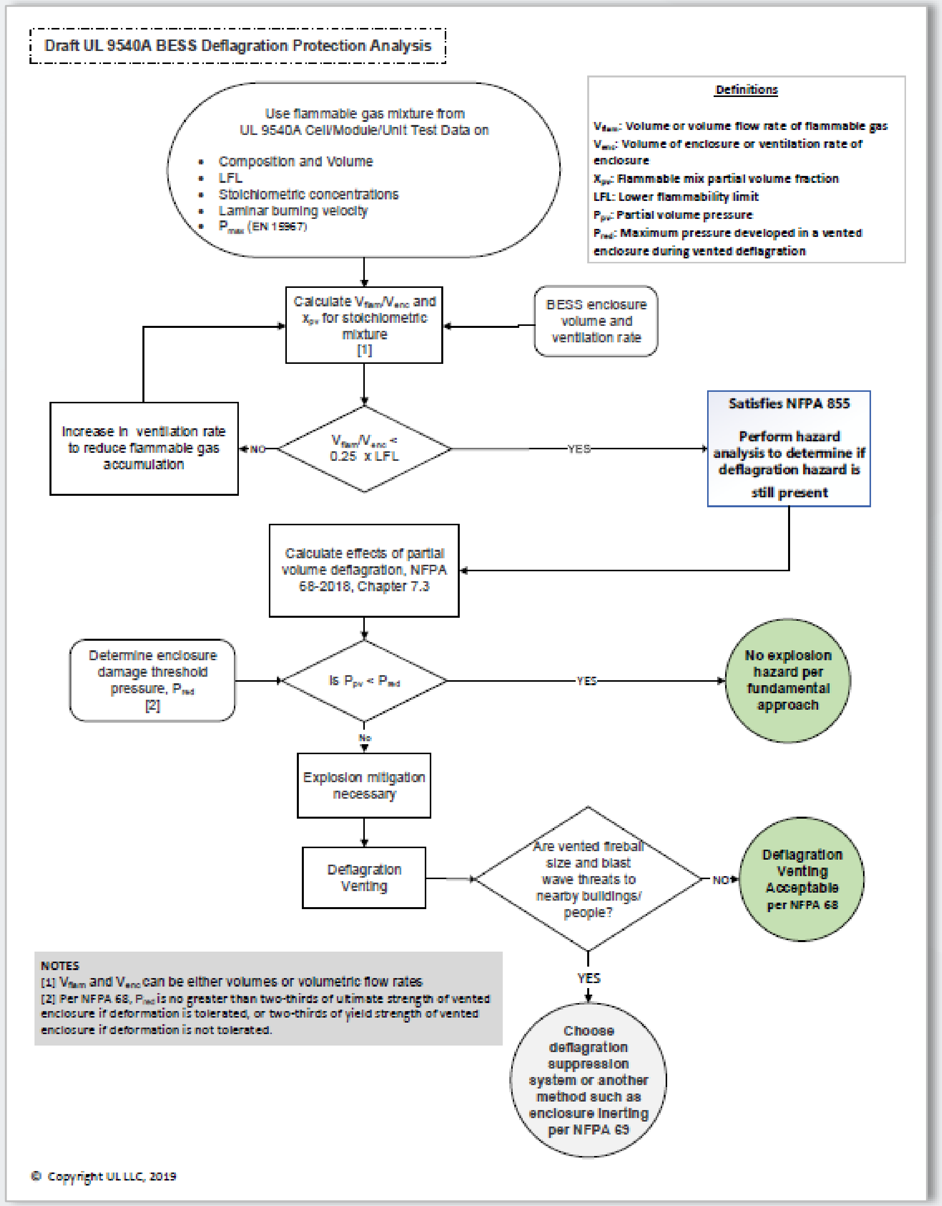
# Working group: Processing UL 9540A Data



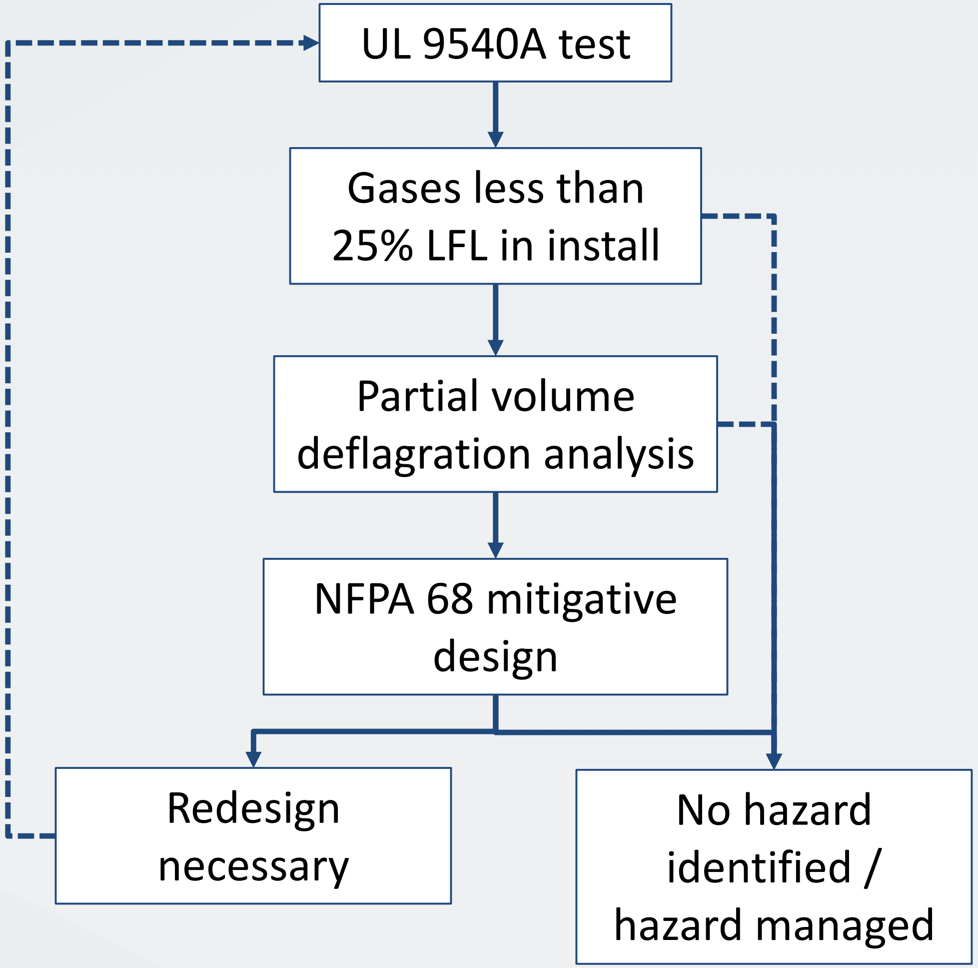

***Fire propagation assessment – installation level analysis***



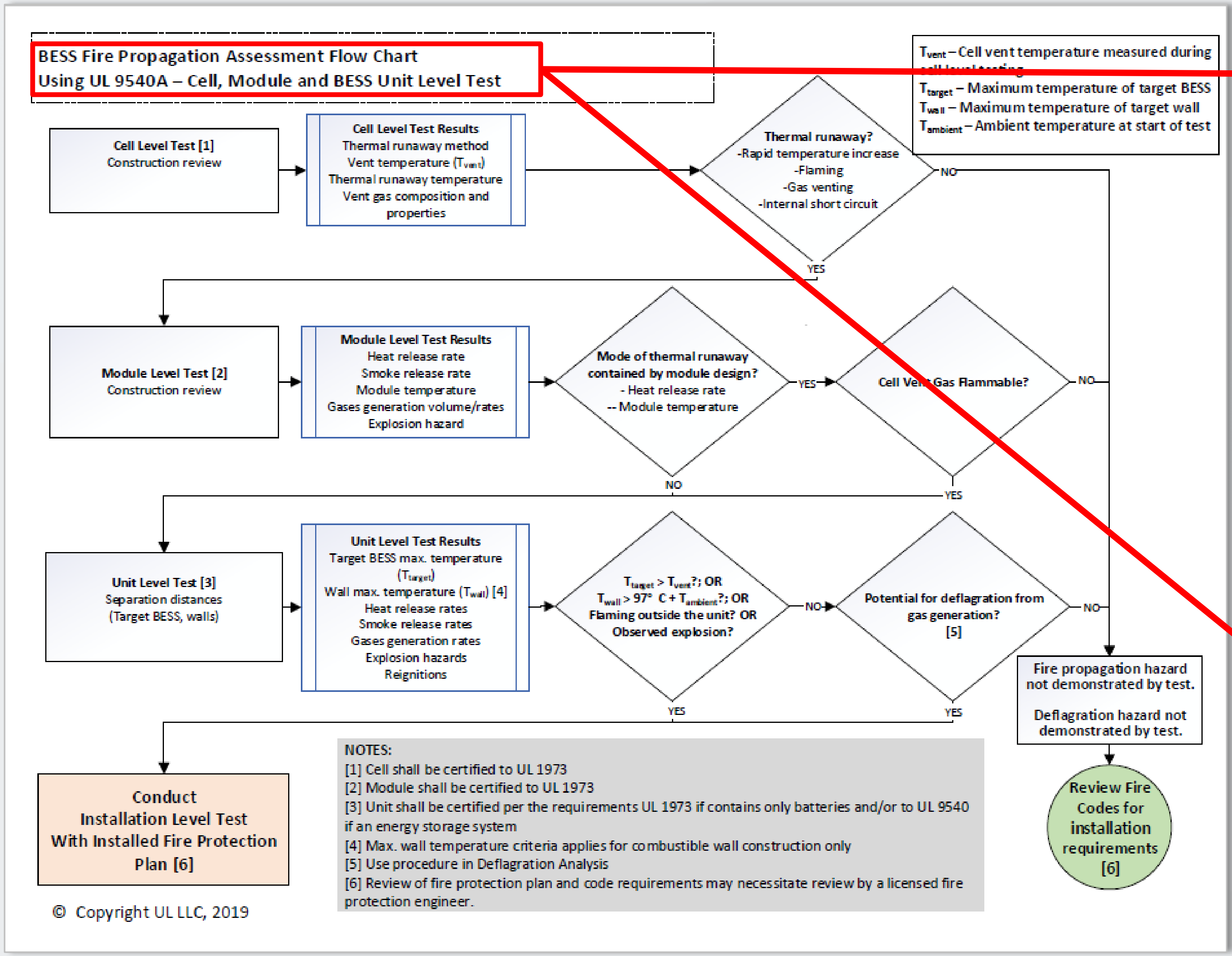
# Working group: Processing UL 9540A Data




## *Deflagration protection analysis*



# Working group: Processing UL 9540A Data in NYC

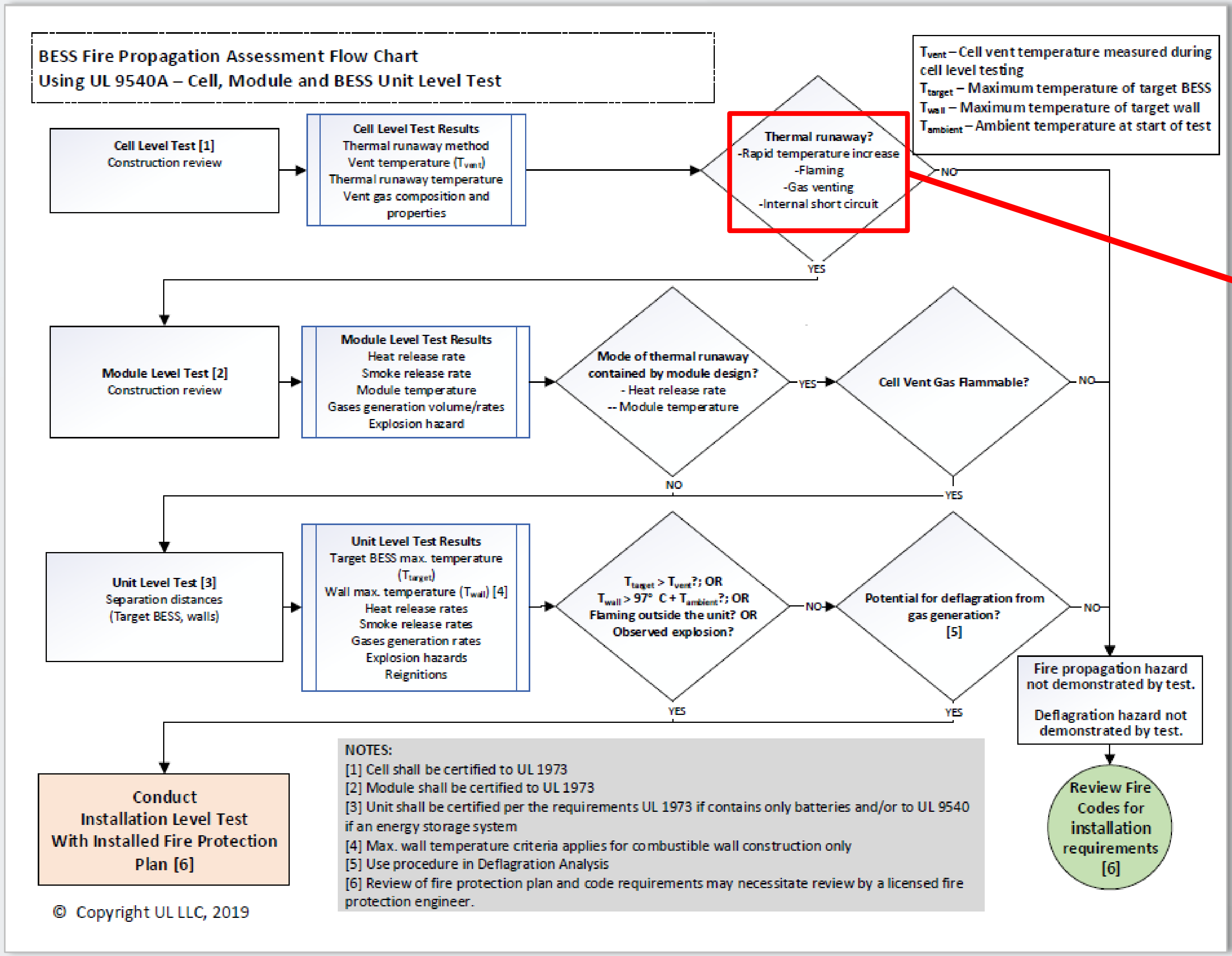



Until accredited labs available, testing data can be provided by any lab which is accredited to conduct UL 9540 or UL 1973.

Contents of UL 9540A test report:

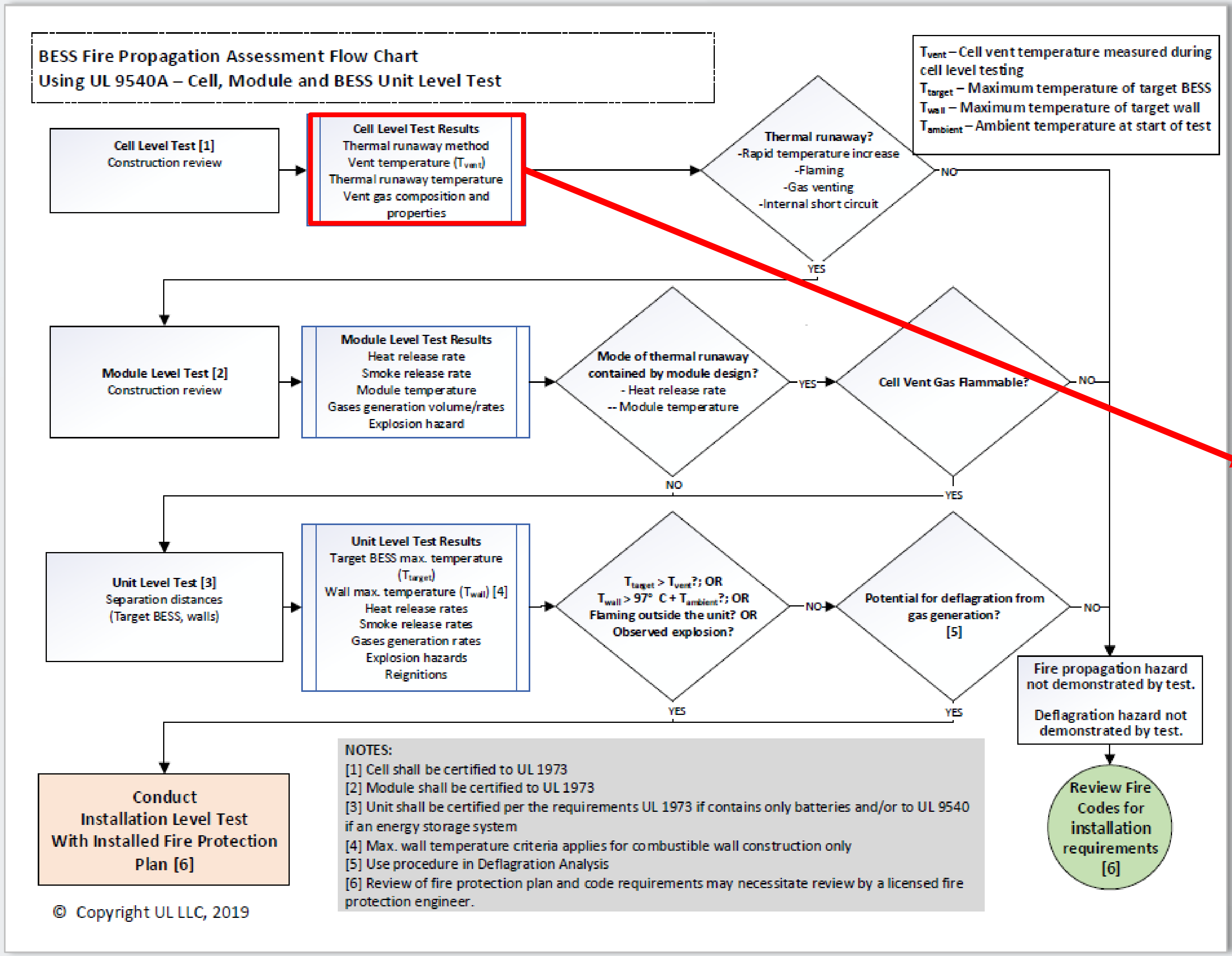
- Executive summary
- Laboratory
- Date of test
- Edition of test method
- Description of energy storage equipment
- Description of layout and mitigative systems
- Description of test set up
- Summary of results
- Raw test data may be requested

# Working group: Processing UL 9540A Data in NYC




Applicable to all system types, sizes, and installation locations, e.g., no exceptions granted for the test.

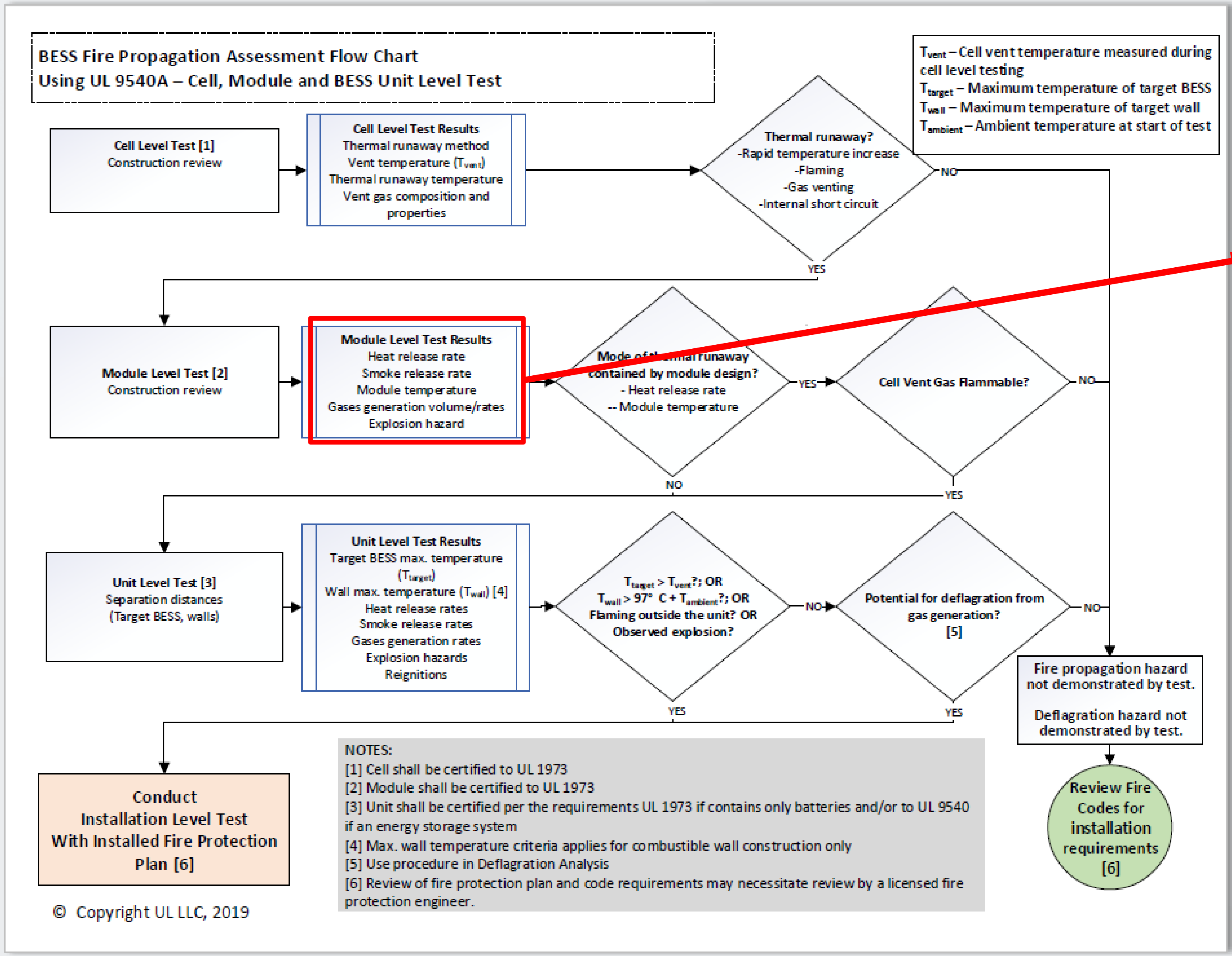
# Working group: Processing UL 9540A Data in NYC




**Cell test measurements:**

- Thermal runaway initiation method
- Cell surface temperature at gas venting
- Cell surface temperature at thermal runaway
- Gas volume
- Gas composition (CO, CO2, H2, total hydrocarbons)
- Lower flammability limit (LFL)
  - Determined through secondary test, via the method outlined in ASTM 918 or ASTM E681
- Deflagration pressure (Pmax)
  - Determined through secondary test, via the method outlined in EN 15967
- Burning velocity (cm/s)
  - Determined through secondary test, via the method outlined in ASHRAE 34 or ISO 817

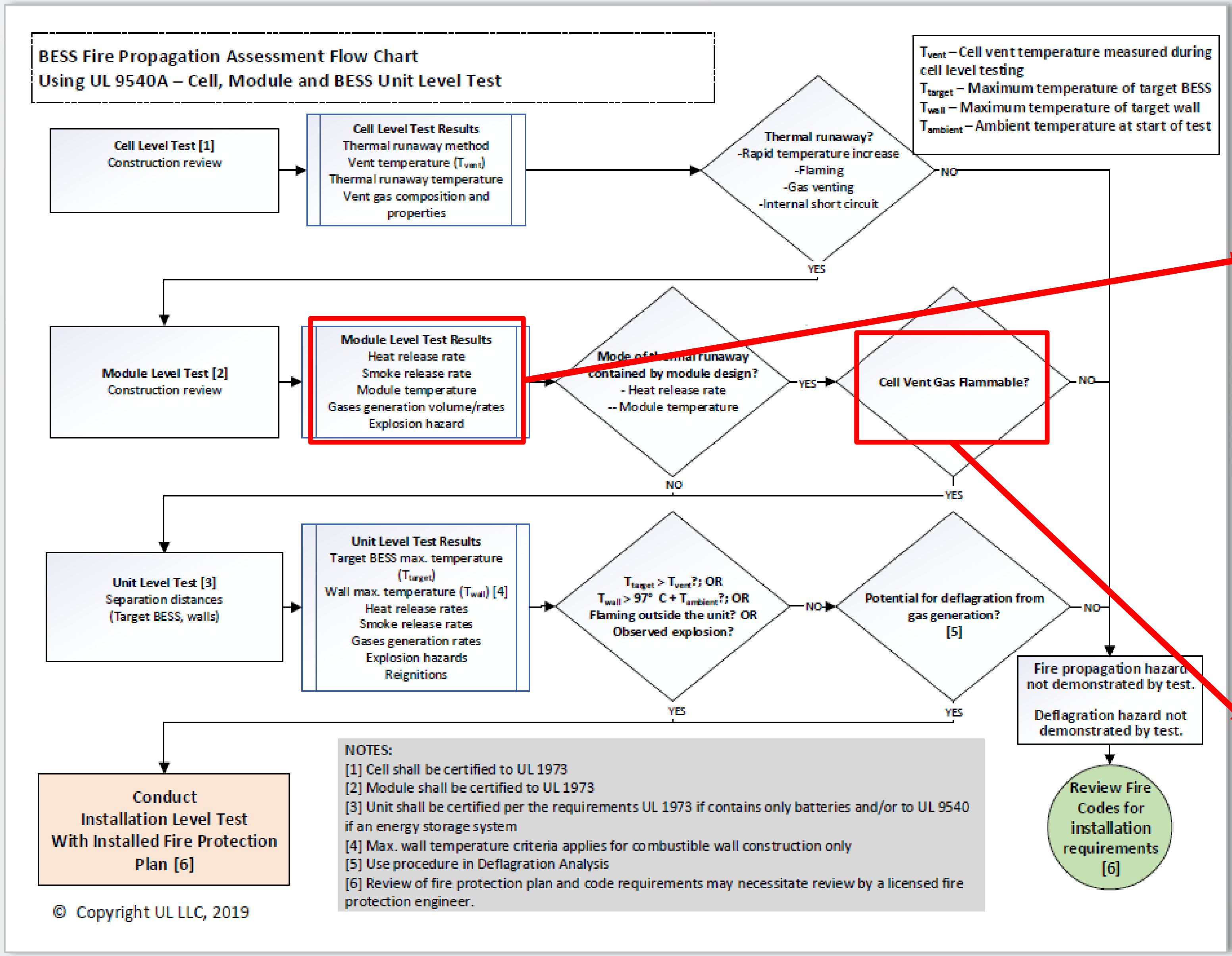
# Working group: Processing UL 9540A Data in NYC




**Module level measurements:**

- Propagation of thermal runaway
- External flaming
- Locations of flame venting
- Flying debris
- Peak heat release rate (HRR)
- Re-ignitions
- Surrounding temperatures
- Gas composition pre-flaming
- Gas composition post-flaming

# Working group: Processing UL 9540A Data in NYC

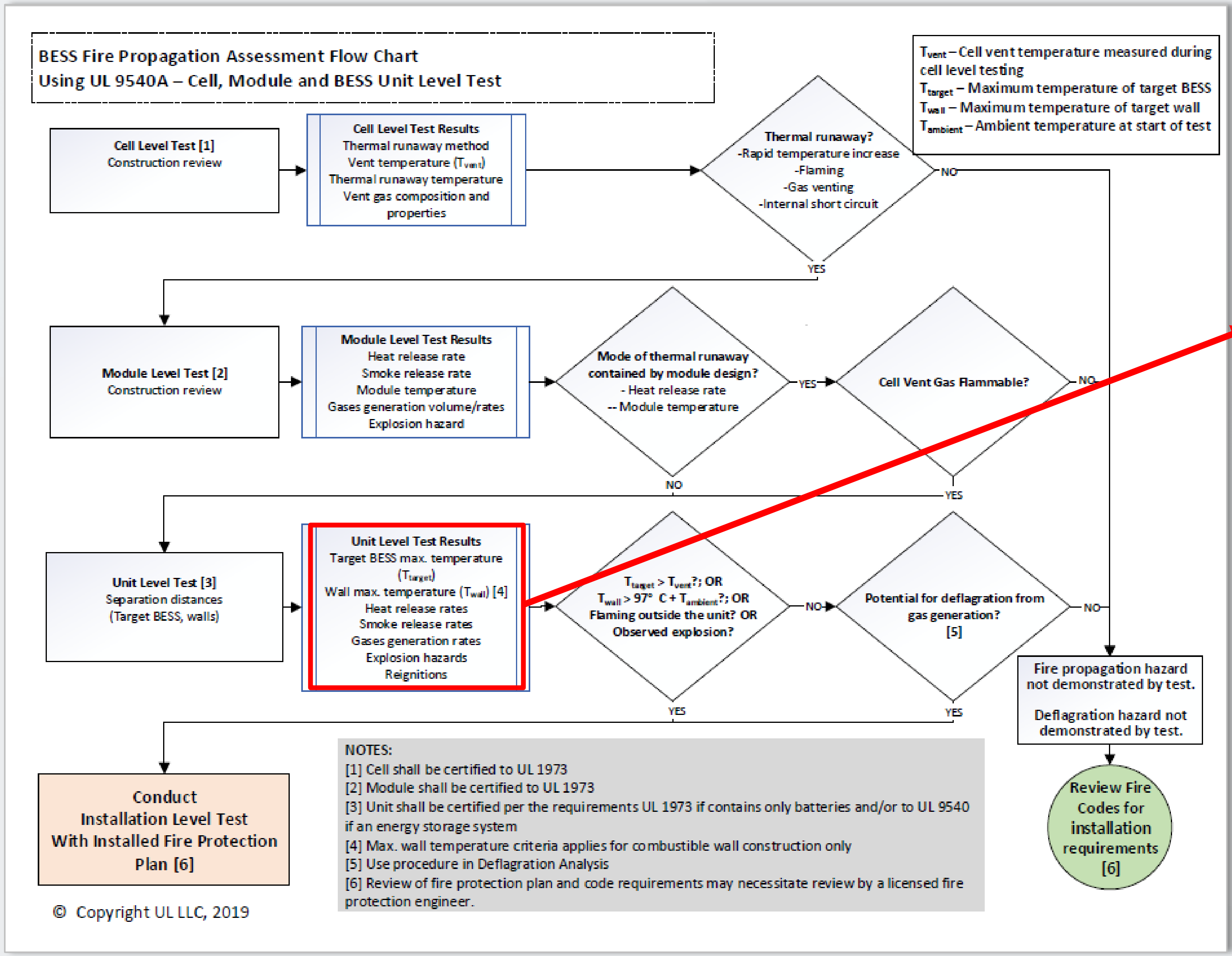



**Module level measurements:**

- Propagation of thermal runaway
- External flaming
- Locations of flame venting
- Flying debris
- Peak heat release rate (HRR)
- Re-ignitions
- Surrounding temperatures
- Gas composition pre-flaming
- Gas composition post-flaming

**Continuation to unit level test determined by results of module level test.** If the module level test demonstrates the heat released outside of the module under thermal runaway conditions does not exceed Tvent, then the unit level test is not required.

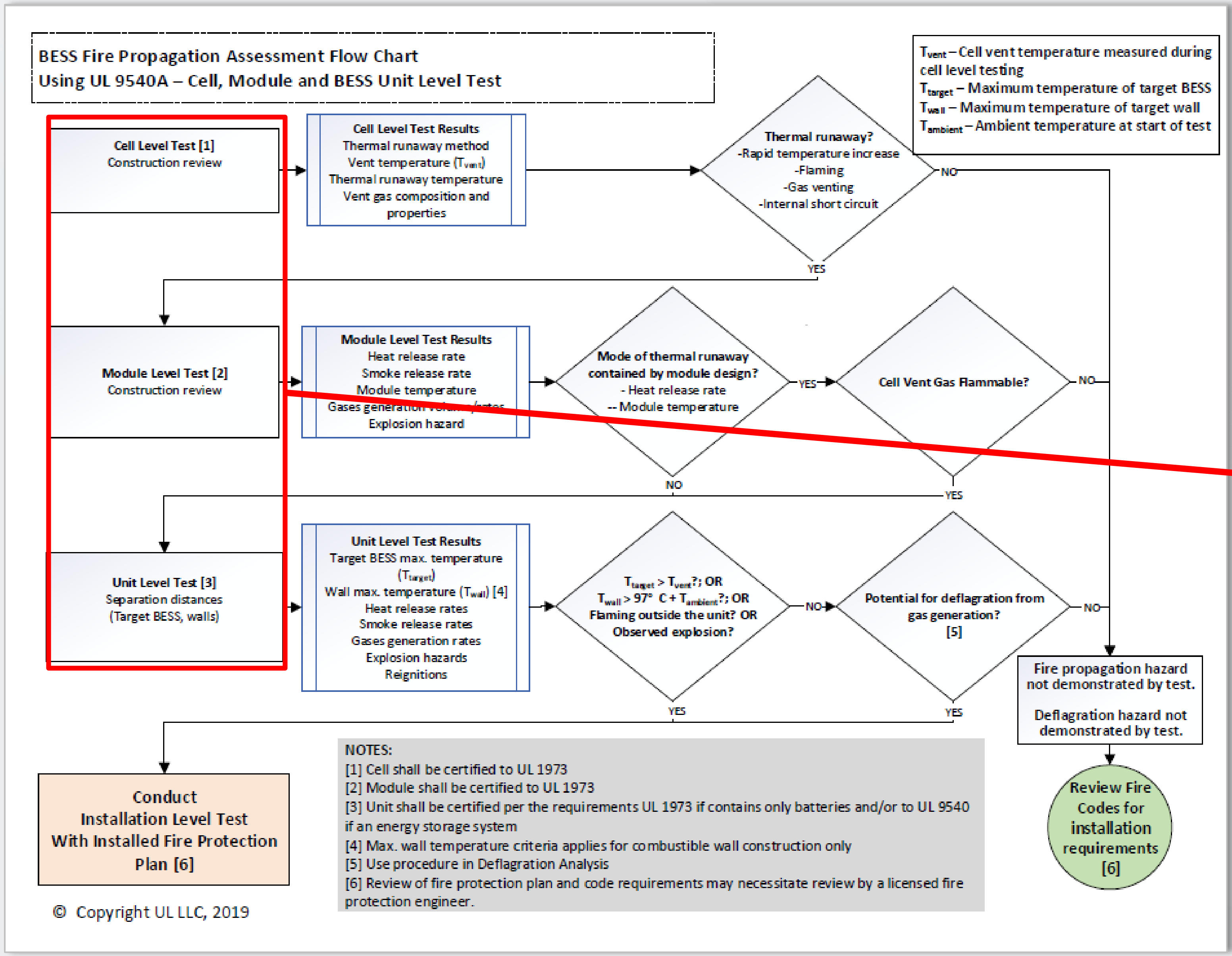
# Working group: Processing UL 9540A Data in NYC




**Unit level test measurements:**

- Test configuration
- Fire protection systems within unit
- Thermal runaway propagation
- External flaming
- Locations of flame venting
- Flying debris
- Peak HRR
- Re-ignitions
- Max. target BESS temperature
- Max. wall surface temperature
- Gas composition pre-flaming
- Gas composition post-flaming

# Working group: Processing UL 9540A Data in NYC



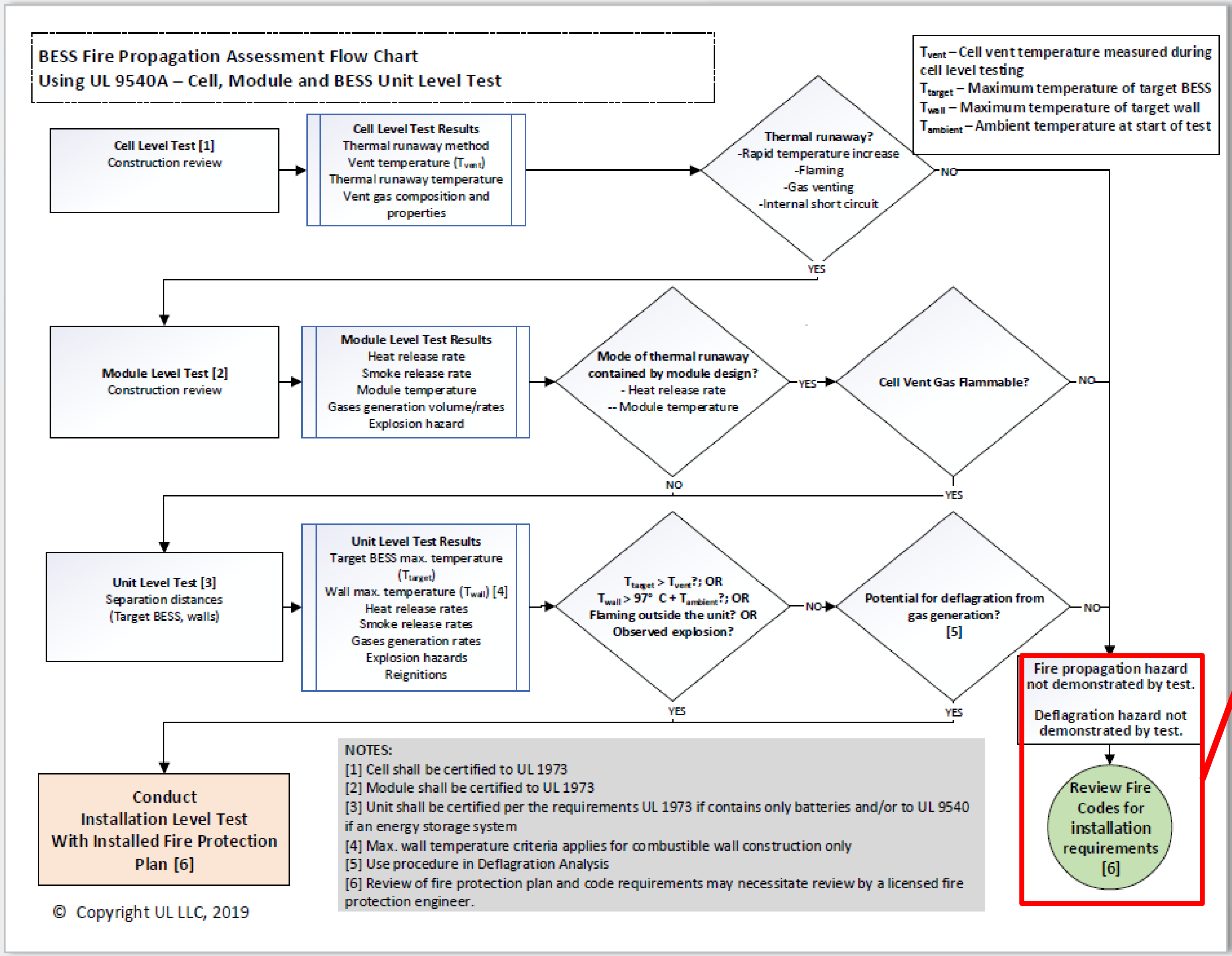

**Construction review standards are not stipulated,** but may consider features like:

- Chemistry
- Energy density
- Packaging materials
- System design/spacing

**Use of identical data to the system installed is not mandatory**, as long as the 'worst case scenario' system is tested and that data is used, based on approved test lab formal construction review. Review must be provided with application.

“Scaling down” results must be demonstrated as appropriate through testing by an approved lab. **Models and assumptions to “scale data” are not currently acceptable.**

# Working group: Processing UL 9540A Data in NYC

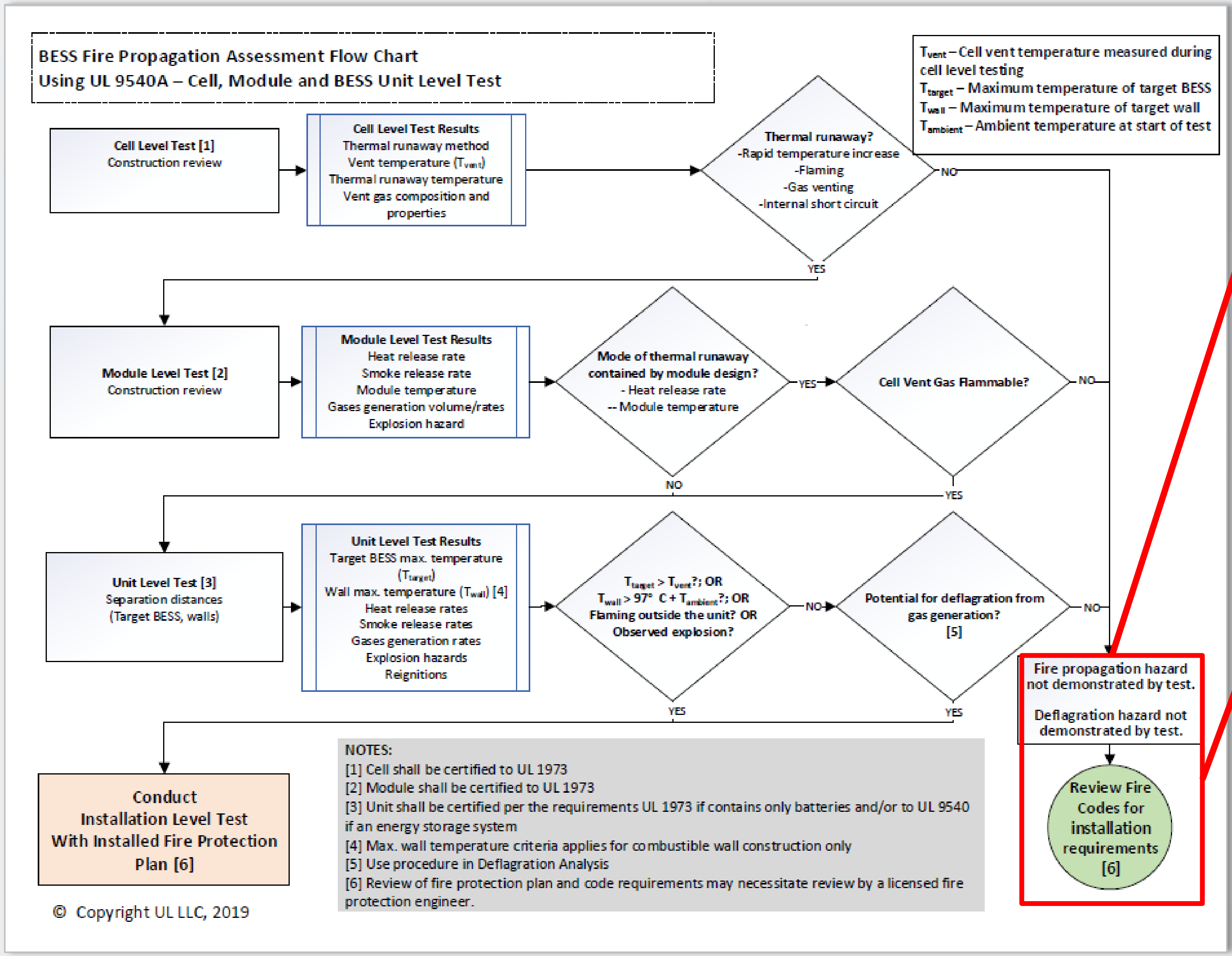



**A site specific risk analysis is necessary,** signed and stamped by a NYS PE, including:

- Identification of hazards
- Severity and likelihood assessment
- Modes and mitigations analysis
- Gap analysis

(Reference ISO 31010 for guidance)

# Working group: Processing UL 9540A Data in NYC



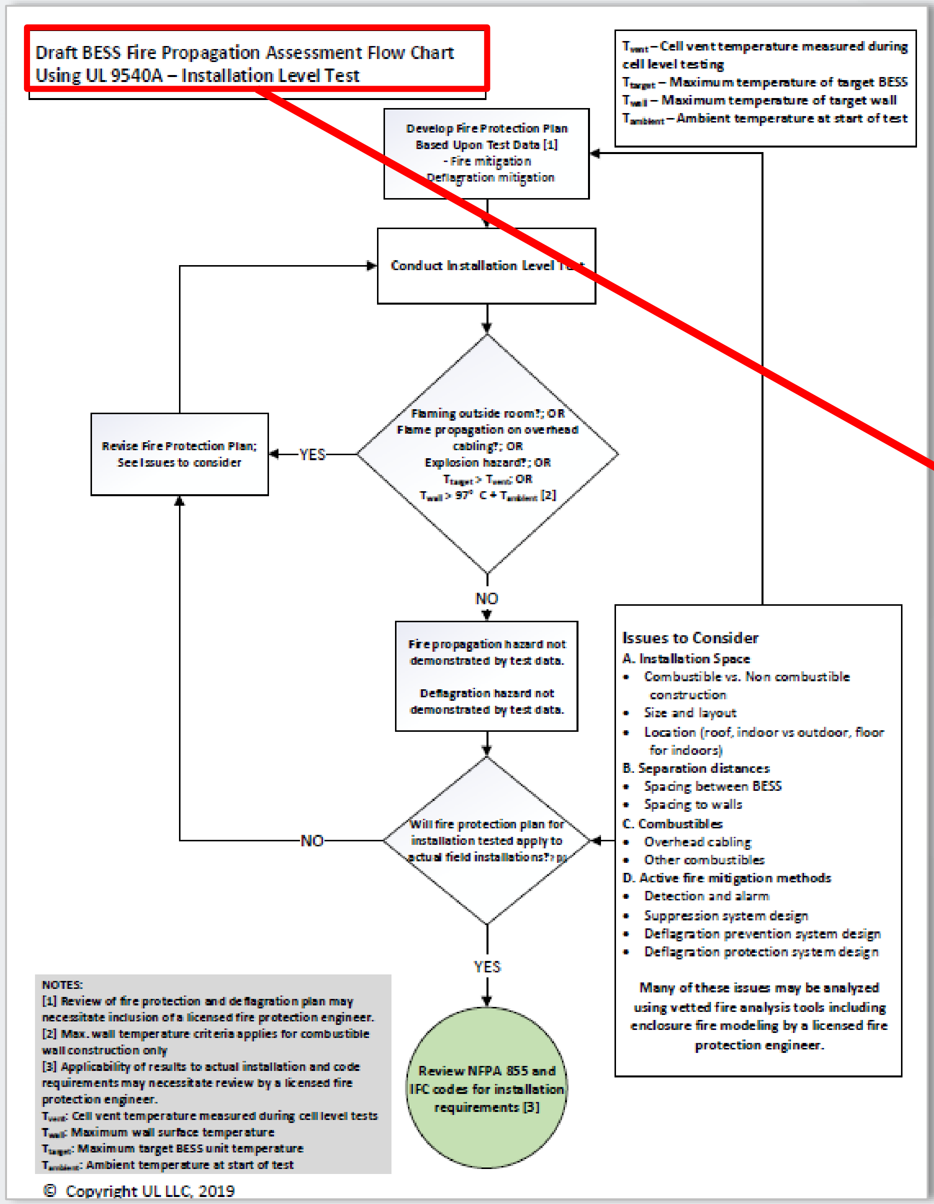

**Toxicity analysis/modeling is not required for outdoor sites.** Appropriate PPE should be identified for first responders, and prescriptive egress requirements must be followed. Indoor sites may require gas detection.

**A site specific risk analysis is necessary,** signed and stamped by a NYS PE, including:

- Identification of hazards
- Severity and likelihood assessment
- Modes and mitigations analysis
- Gap analysis

(Reference ISO 31010 for guidance)

# Working group: Processing UL 9540A Data in NYC

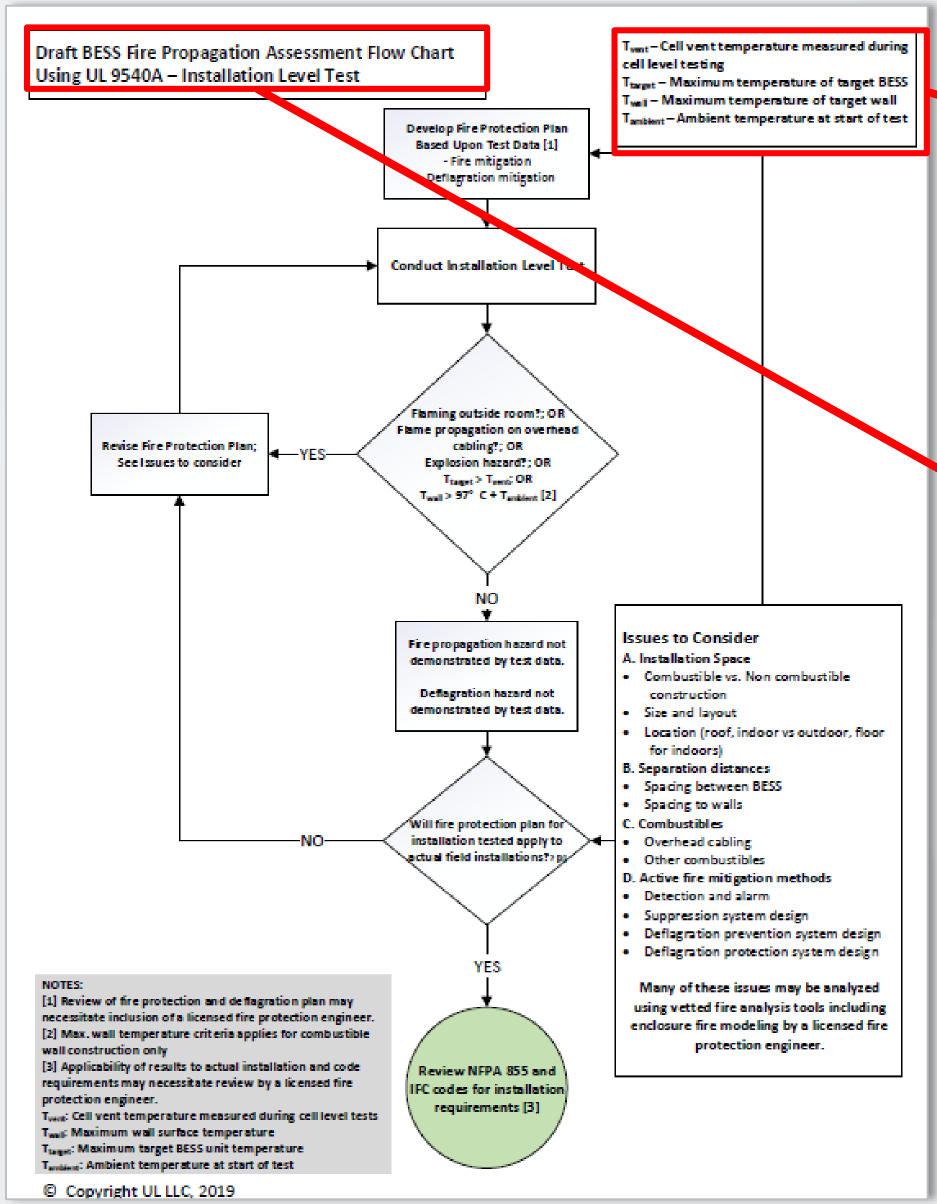



**Reporting requirements**

Any submitted fire spread analysis must include the following:

- Executive summary
- Methodology used (UL 9540A results or heat transfer calculations)
- Data input
- Result output
- Calculations and assumptions
- If model used, validation documentation
- Sign off on final design by NYS PE

# Working group: Processing UL 9540A Data in NYC




**Conservative criteria are assessed in order to account for edge cases.**

Cell vent temperature ≠ thermal runaway temperature, but, if no mitigative actions are taken, indicates thermal runaway *potential*.

**Reporting requirements**

Any submitted fire spread analysis must include the following:

- Executive summary
- Methodology used (UL 9540A results or heat transfer calculations)
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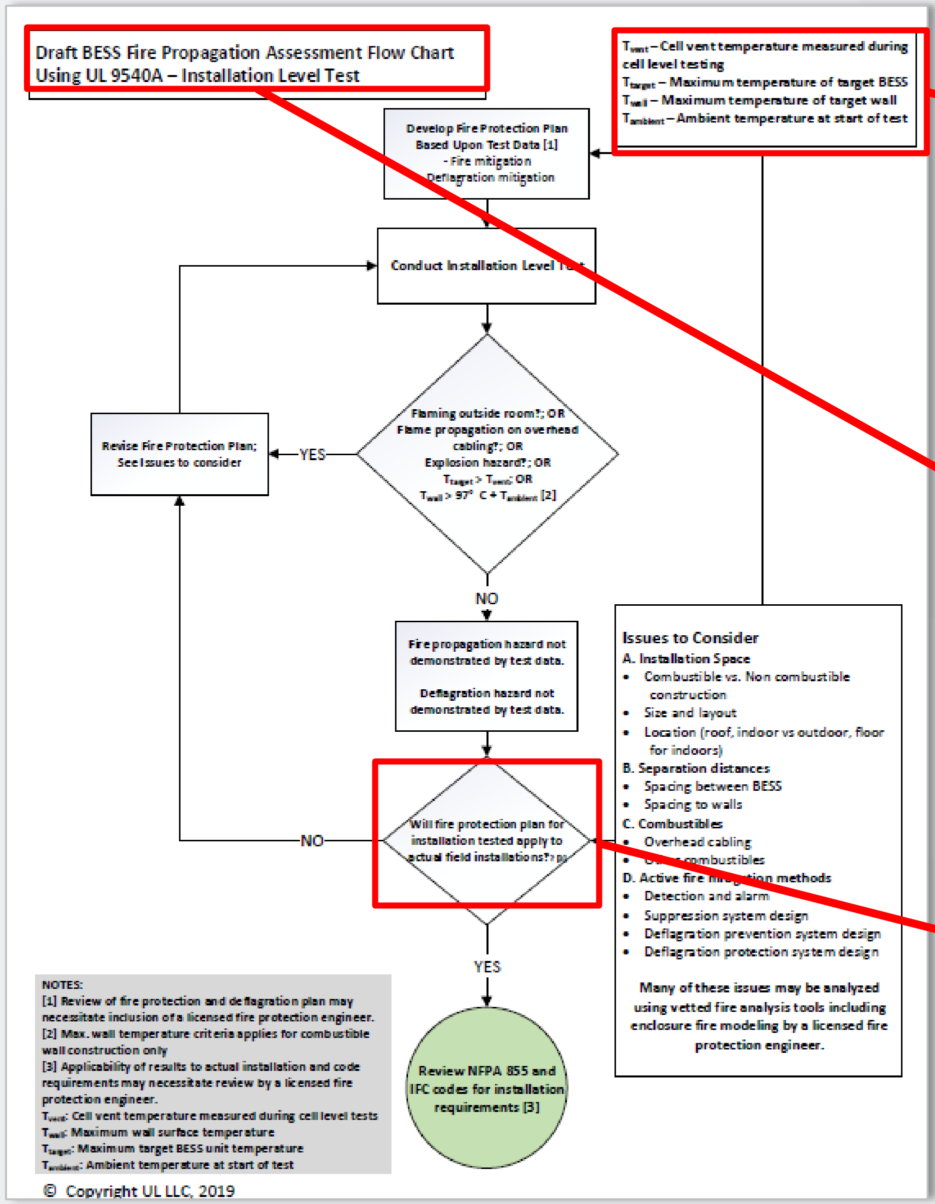



**Conservative criteria are assessed in order to account for edge cases.** Cell vent temperature ≠ thermal runaway temperature, but, if no mitigative actions are taken, indicates thermal runaway *potential*.

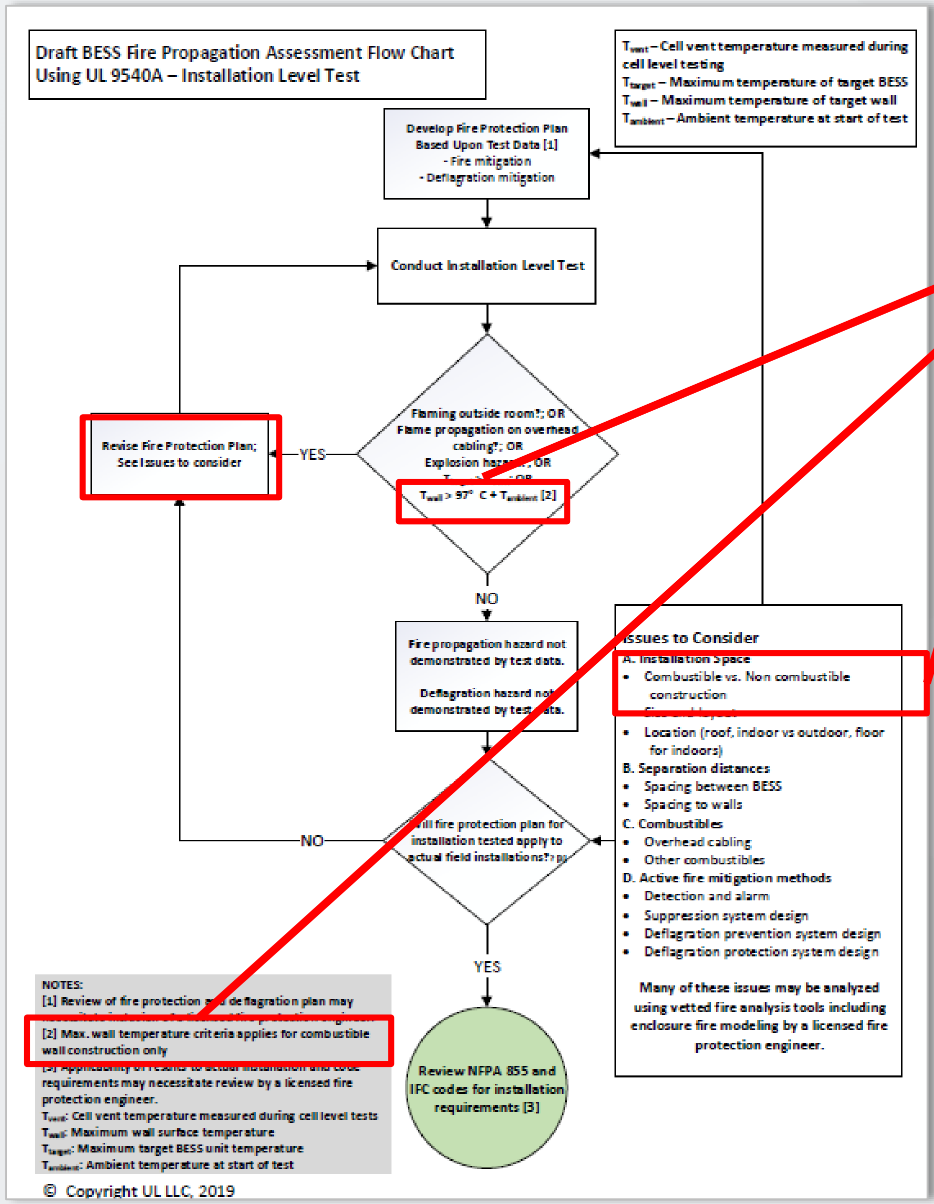
**Reporting requirements**

Any submitted fire spread analysis must include the following:

- Executive summary
- Methodology used (UL 9540A results or heat transfer calculations)
- Data input
- Result output
- Calculations and assumptions
- If model used, validation documentation
- Sign off on final design by NYS PE

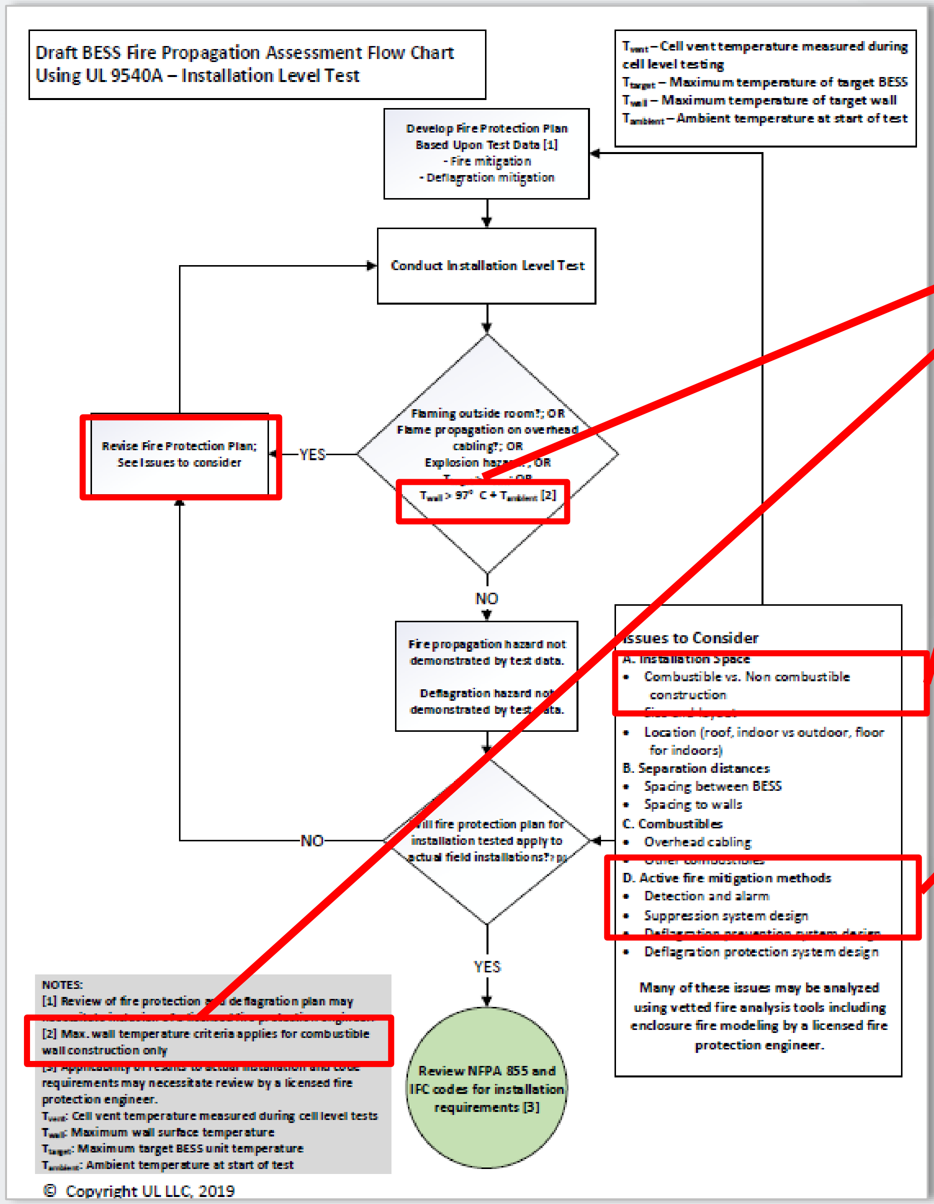
**Minor differences between test set up and actual installation are expected and permitted.** A NYS PE will be required to sign off on any differences, and comment on the test's applicability.

# Working group: Processing UL 9540A Data in NYC




**Fire rated materials' effectiveness are not directly tested in UL 9540A.** As such, a site specific determination of necessary maximum temperatures on back of wall shall be indicated, with expected impact of materials taken into consideration and signed off on by a NYS licensed PE. It is recommended that autoignition temperatures and fire resistant materials ratings are taken into consideration.

# Working group: Processing UL 9540A Data in NYC

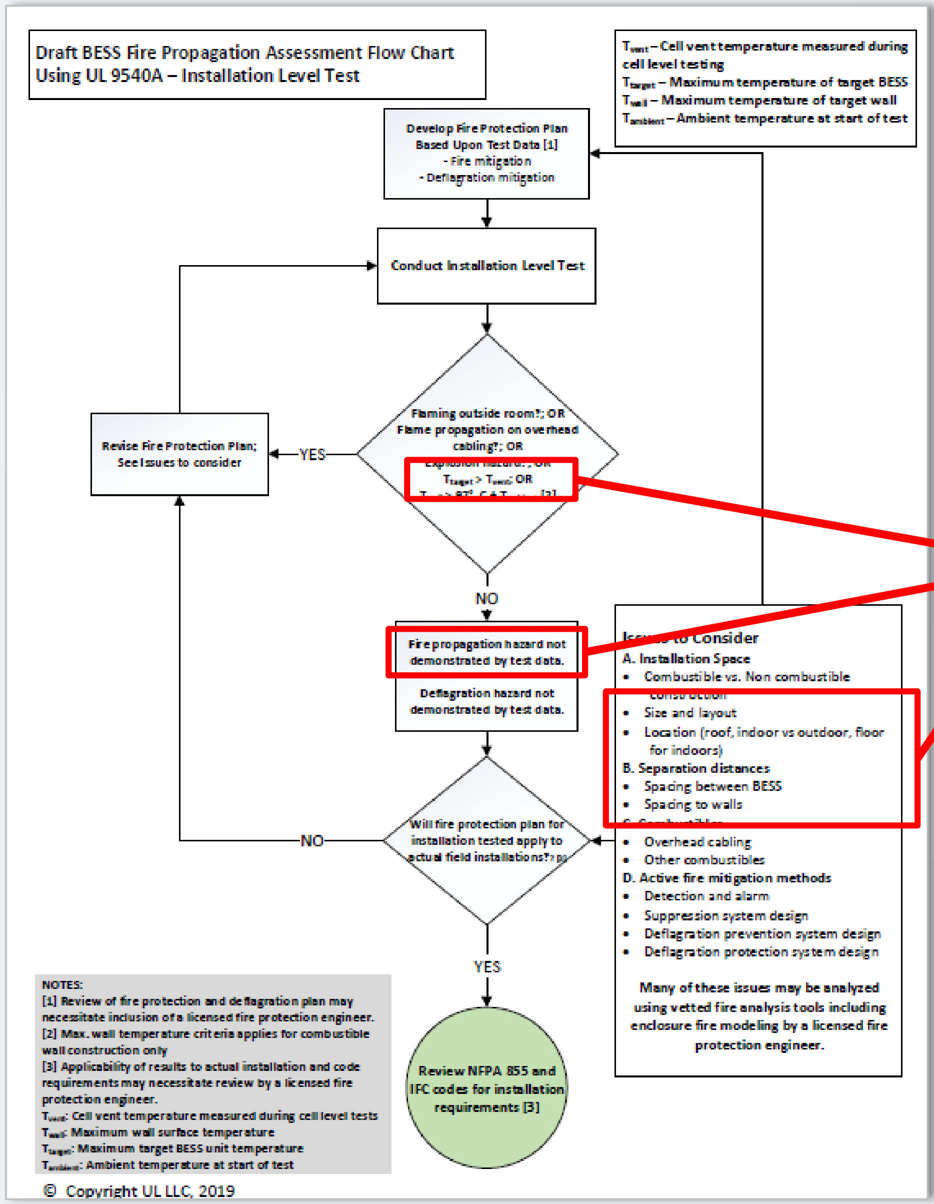



**Fire rated materials' effectiveness are not directly tested in UL 9540A.** As such, a site specific determination of necessary maximum temperatures on back of wall shall be indicated, with expected impact of materials taken into consideration and signed off on by a NYS licensed PE. It is recommended that autoignition temperatures and fire resistant materials ratings are taken into consideration.

**NFPA 15 should be referenced for "dry pipe" water-based suppression systems, with 0.5 GPM/ft2 as the prescriptive requirement.**

- *Small system (Li ion, 0 – 20 kWh):* No NFPA 15 requirement; DOB prescriptive requirements
- *Medium system (Li ion, 20 – 250 kWh):* No NFPA 15 requirement unless demonstrated as necessary by UL 9540A
- *Large system (Li ion, 250 kWh+):* Required unless demonstrated by UL 9540A as not necessary (variance process).

# Working group: Processing UL 9540A Data in NYC

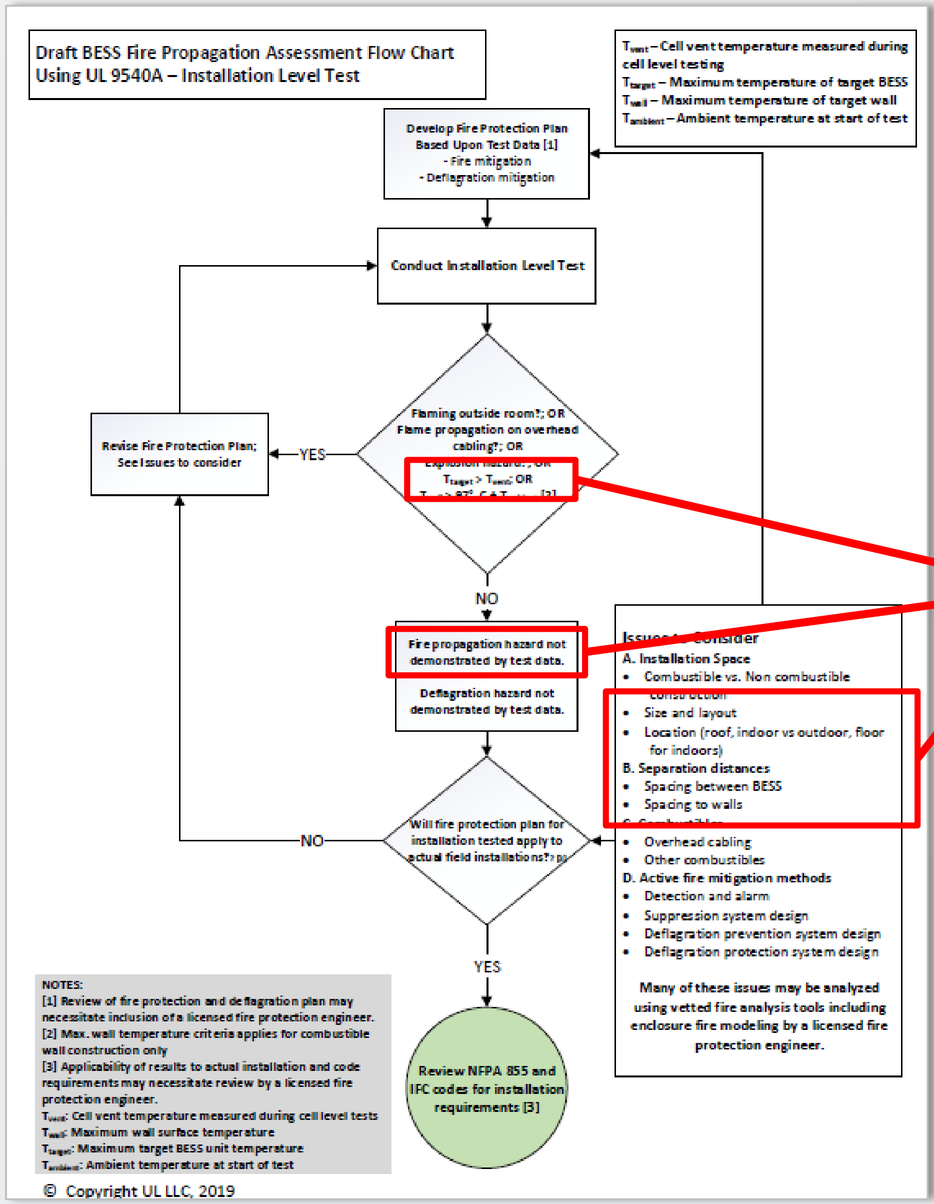



**Fire threat should be assessed and documented by the NYS PE, but guidance for its definition and related minimum expectations include:**

- **To buildings:** The temperature at which the building will be affected beyond that deemed acceptable for the performance group (Ref: ICC 2009), with consideration for materials of and in building

| Magnitude of event | Increasing level of performance → Performance Group I | Performance Group II | Performance Group III | Performance Group IV |
|---|---|---|---|---|
| **Very large** (very rare) | Severe | Severe | High | Moderate |
| **Large** (rare) | Severe | High | Moderate | Mild |
| **Medium** (Less frequent) | High | Moderate | Mild | Mild |
| **Small** (Frequent) | Moderate | Mild | Mild | Mild |

# Working group: Processing UL 9540A Data in NYC

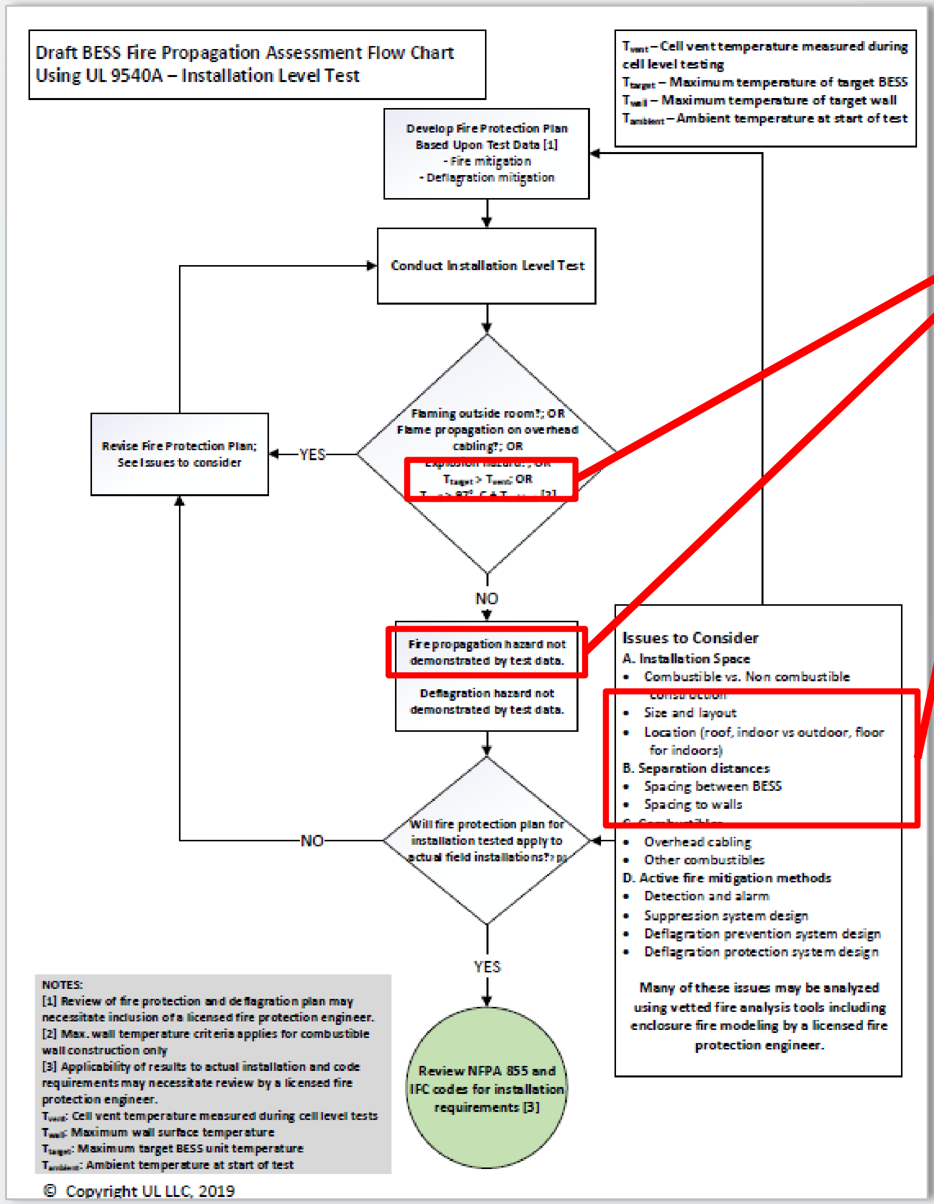



**Fire threat should be assessed and documented by the NYS PE, but guidance for its definition and related minimum expectations include:**

- **To first responders:** The heat flux at the fire department connection (FDC) should be demonstrated, through testing and analysis, as less than 2.5 kw/m2 based on the proposed siting (Ref: SFPE Handbook). ) The FDC shall be in no case less than 10 ft from the system.

| Approximate Radiant Heat Flux ($kW/m^2$) | Comment or Observed Effect |
|---|---|
| 170 | Maximum heat flux as currently measured in a postflashover fire compartment. |
| 80 | Heat flux for protective clothing Thermal Protective Performance (TPP) Test.[a] |
| 52 | Fiberboard ignites spontaneously after 5 seconds.[b] |
| 29 | Wood ignites spontaneously after prolonged exposure.[b] |
| 20 | Heat flux on a residential family room floor at the beginning of flashover.[c] |
| 20 | Human skin experiences pain with a 2-second exposure and blisters in 4 seconds with second-degree burn injury.[d] |
| 15 | Human skin experiences pain with a 3-second exposure and blisters in 6 seconds with second-degree burn injury.[d] |
| 12.5 | Wood volatiles ignite with extended exposure[e] and piloted ignition. |
| 10 | Human skin experiences pain with a 5-second exposure and blisters in 10 seconds with second-degree burn injury.[d] |
| 5 | Human skin experiences pain with a 13-second exposure and blisters in 29 seconds with second-degree burn injury.[d] |
| 2.5 | Human skin experiences pain with a 33-second exposure and blisters in 79 seconds with second-degree burn injury.[d] |
| 2.5 | Common thermal radiation exposure while fire fighting.[f] This energy level may cause burn injuries with prolonged exposure. |
| 1.0 | Nominal solar constant on a clear summer day.[g] |

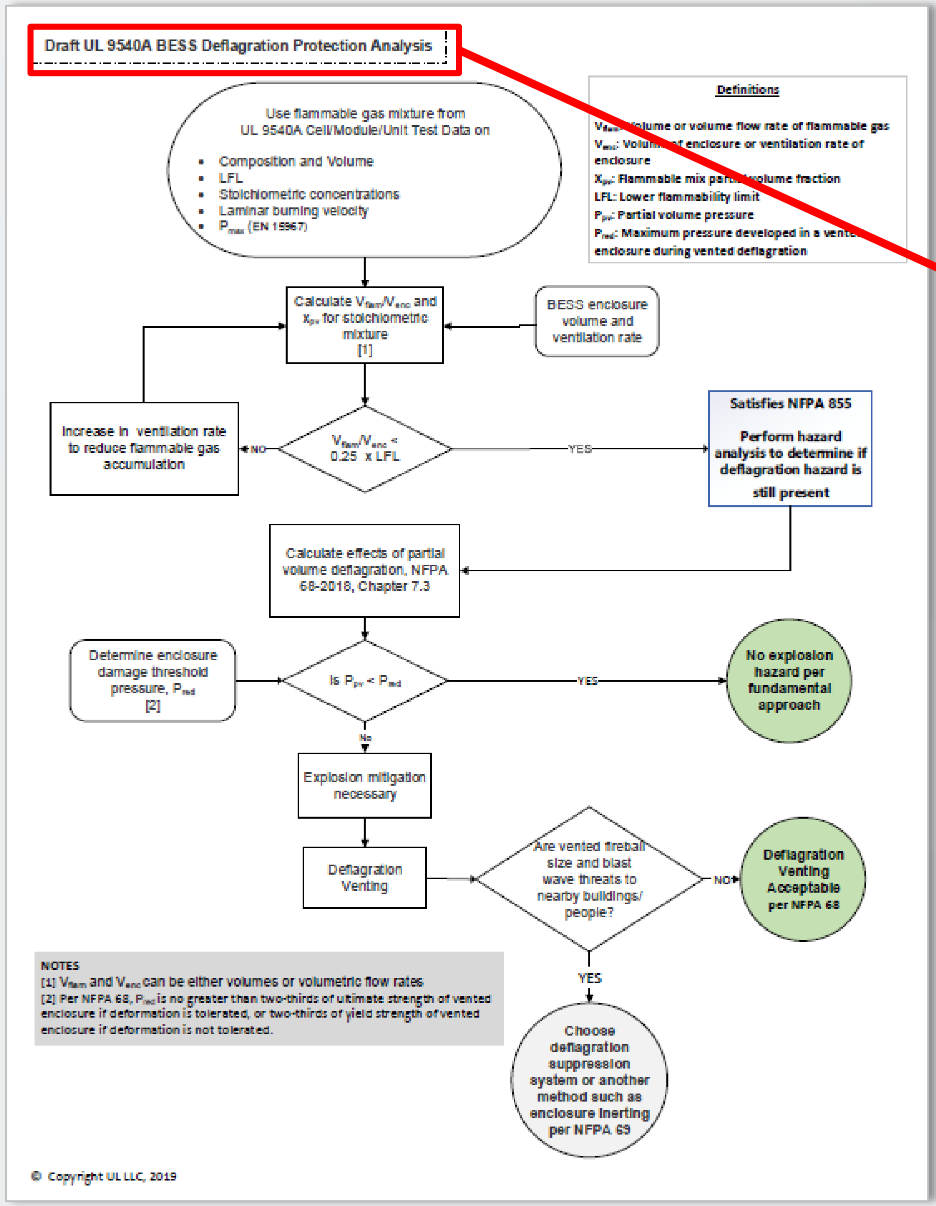
# Working group: Processing UL 9540A Data in NYC




**Fire threat should be assessed and documented by the NYS PE, but guidance for its definition and related minimum expectations include:**

- **To bystanders:** Egress pathways are determined through prescriptive requirements, with 10 ft of spacing required between system and egress pathway.

# Working group: Processing UL 9540A Data in NYC

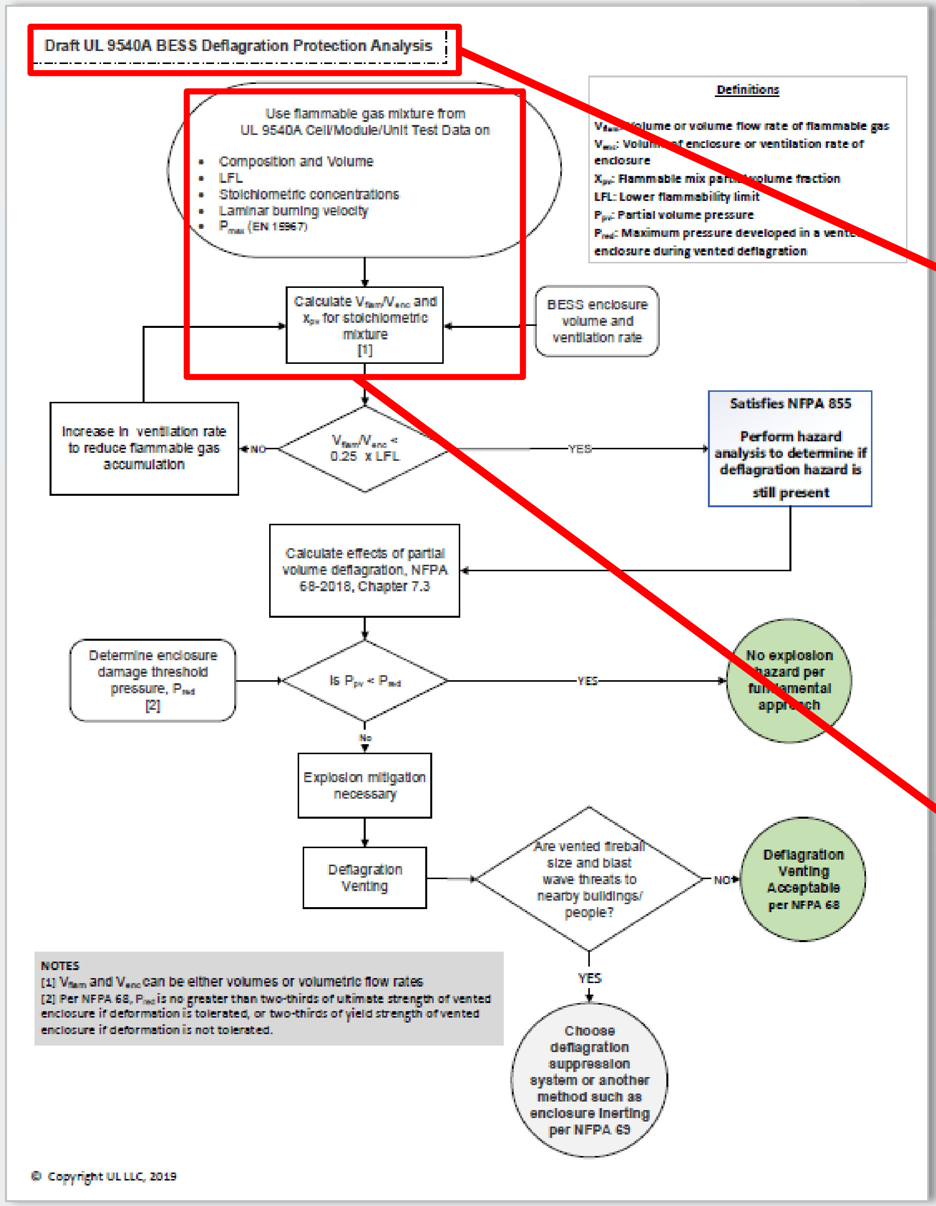



**Reporting requirements**

Any submitted explosion analysis must include the following:

- Executive summary
- Methodology used (NFPA 68, NFPA 69, or equivalent)
- Data input
- Result output
- Calculations and assumptions
- If model used, validation documentation
- Sign off on final design by NYS RA or PE

# Working group: Processing UL 9540A Data in NYC




**Reporting requirements**

Any submitted explosion analysis must include the following:

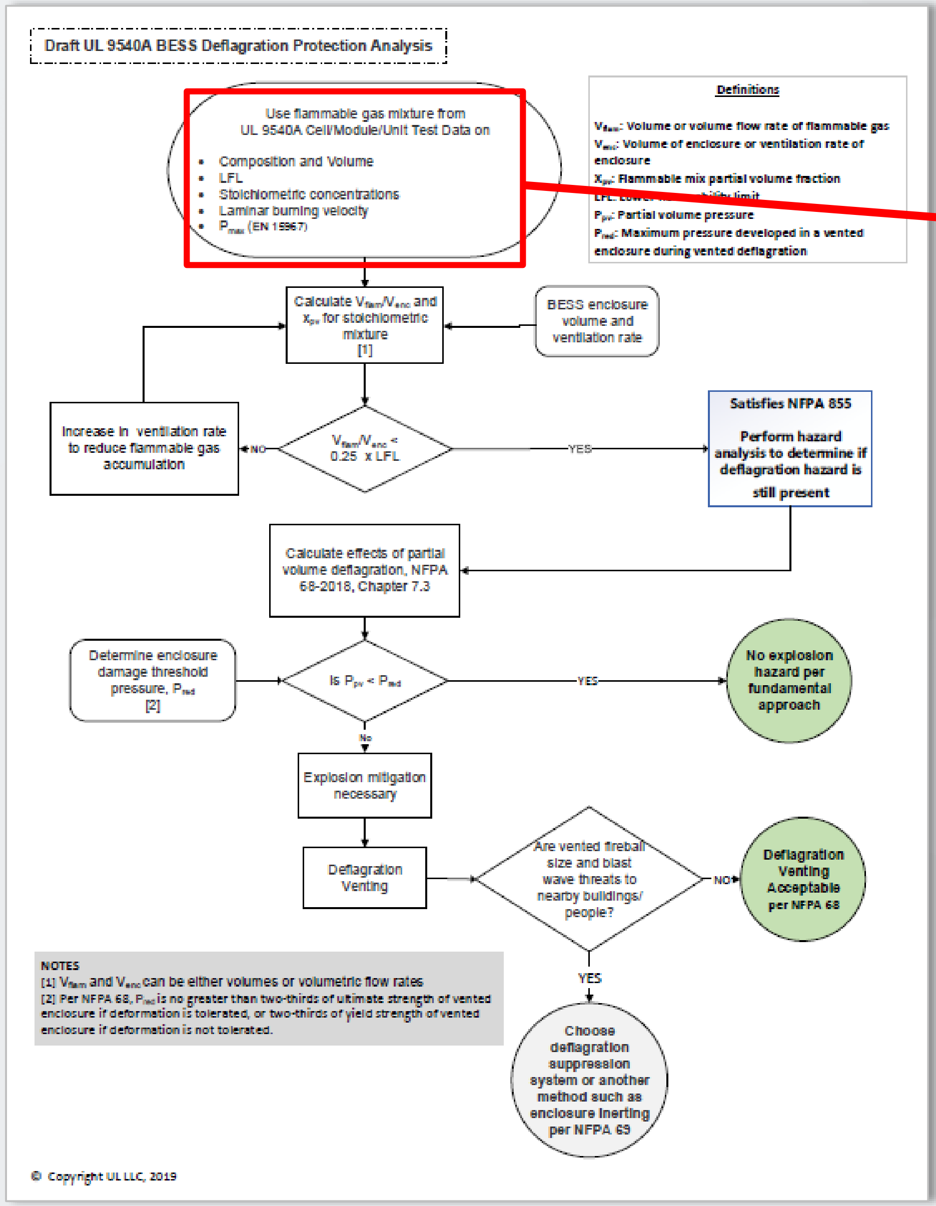
- Executive summary
- Methodology used (NFPA 68, NFPA 69, or equivalent)
- Data input
- Result output
- Calculations and assumptions
- If model used, validation documentation
- Sign off on final design by NYS RA or PE

**Input data for analysis.**

- Cell level gas composition data
  - Pmax (EN 15967)
  - LFL (ASTM 918 or ASTM E681)
  - Burning velocity (ASHRAE 34 or ISO 817)
- Unit level total volume and release rate of *pre-flaming* gas

Cell level gas characteristics should be applied to the unit volumetric release rate, with composition remaining constant (well-mixed).

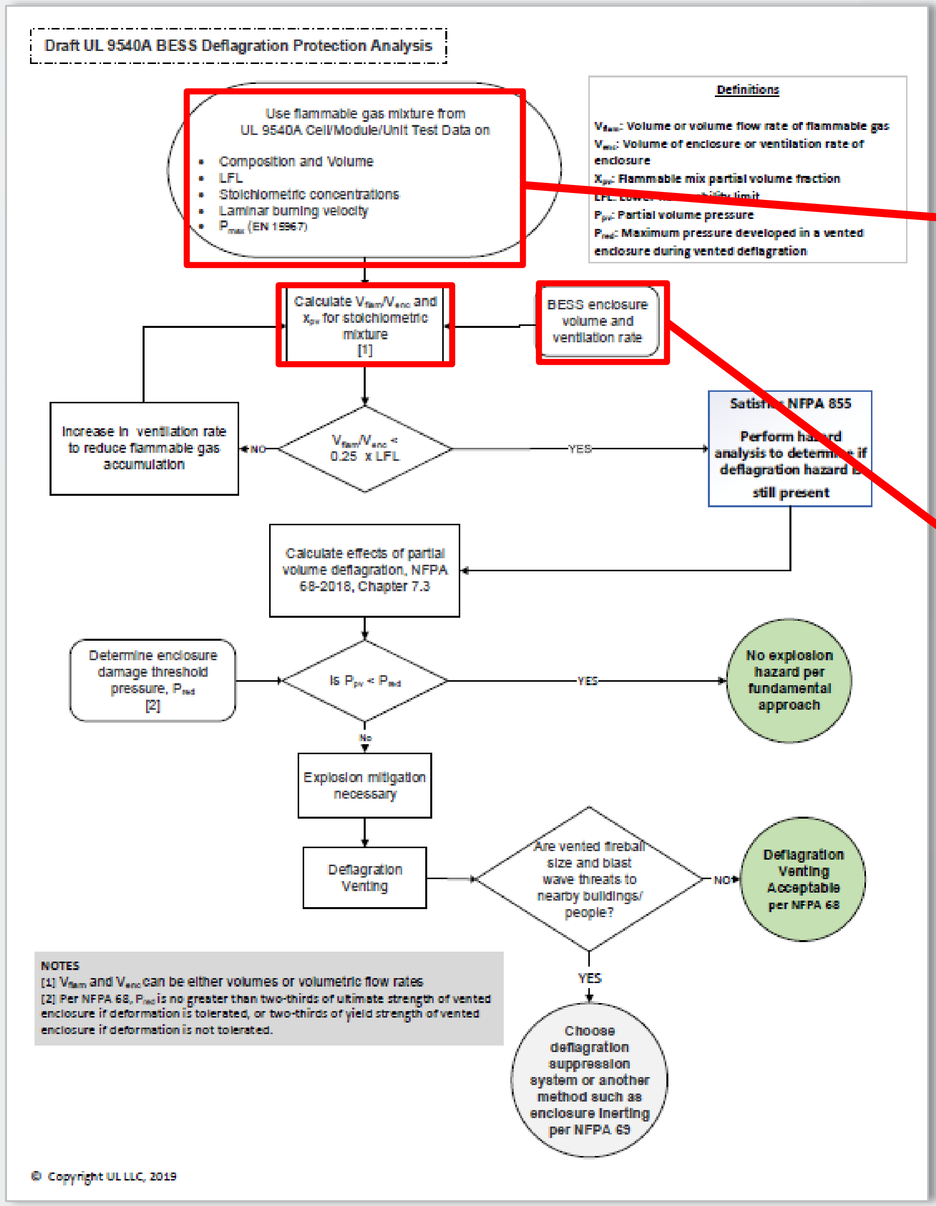
# Working group: Processing UL 9540A Data in NYC




**Test termination does not invalidate results**. Test data may be used for explosion analysis, up to the point the test ended.

**First responder impact may not be considered to impact analysis**, either positively (e.g., application of water prevents further cascading failure) or negatively (e.g., exhaust activation precipitates explosion)

# Working group: Processing UL 9540A Data in NYC

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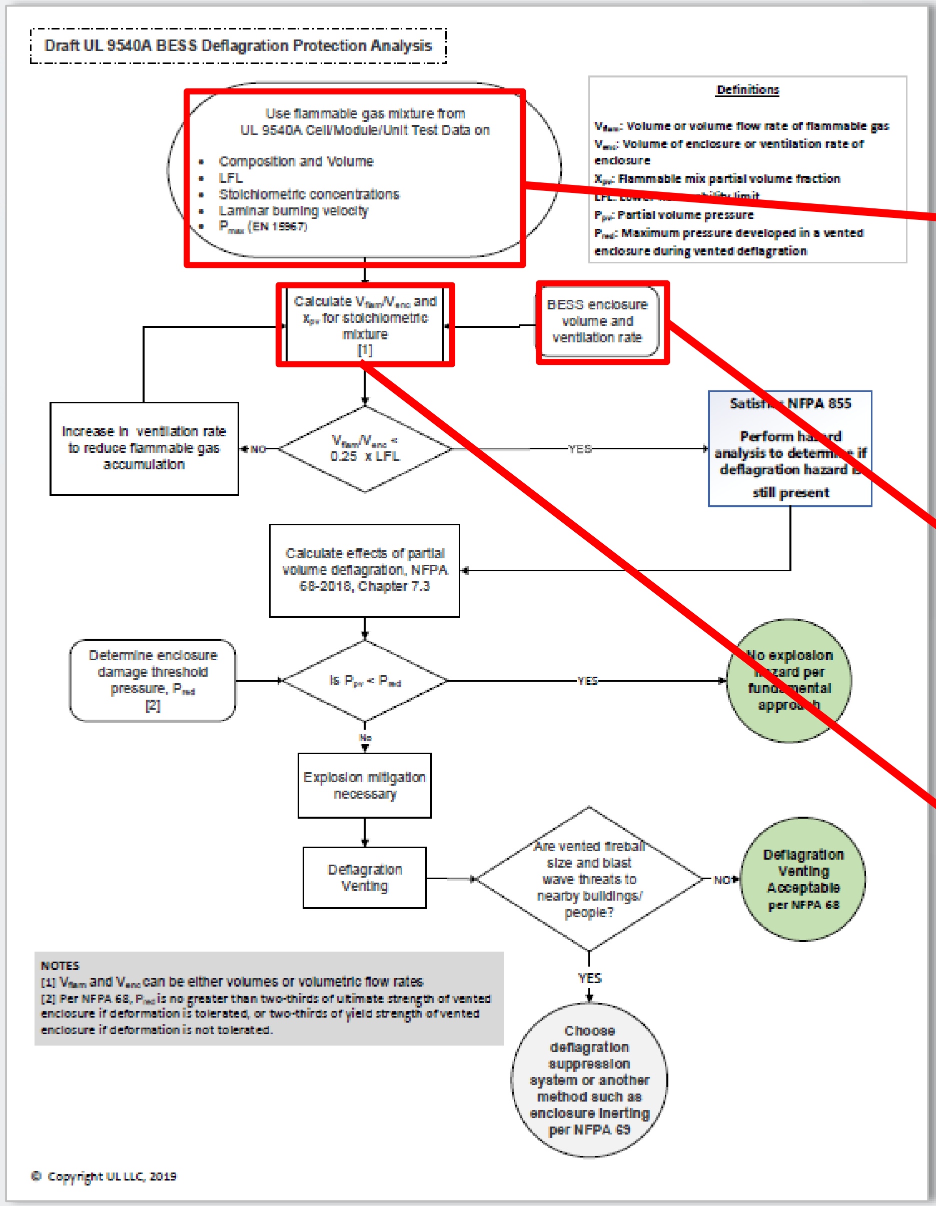
**First responder impact may not be considered to impact analysis**, either positively (e.g., application of water prevents further cascading failure) or negatively (e.g., exhaust activation precipitates explosion)

**Ventilation rate impact is calculated rather than tested,** as the UL 9540A test method includes a vent to gather gas data which will not be present in actual installations. CFD analysis is not required but is accepted as best practices; a simple mass flow calculation can be conducted instead.

# Working group: Processing UL 9540A Data in NYC

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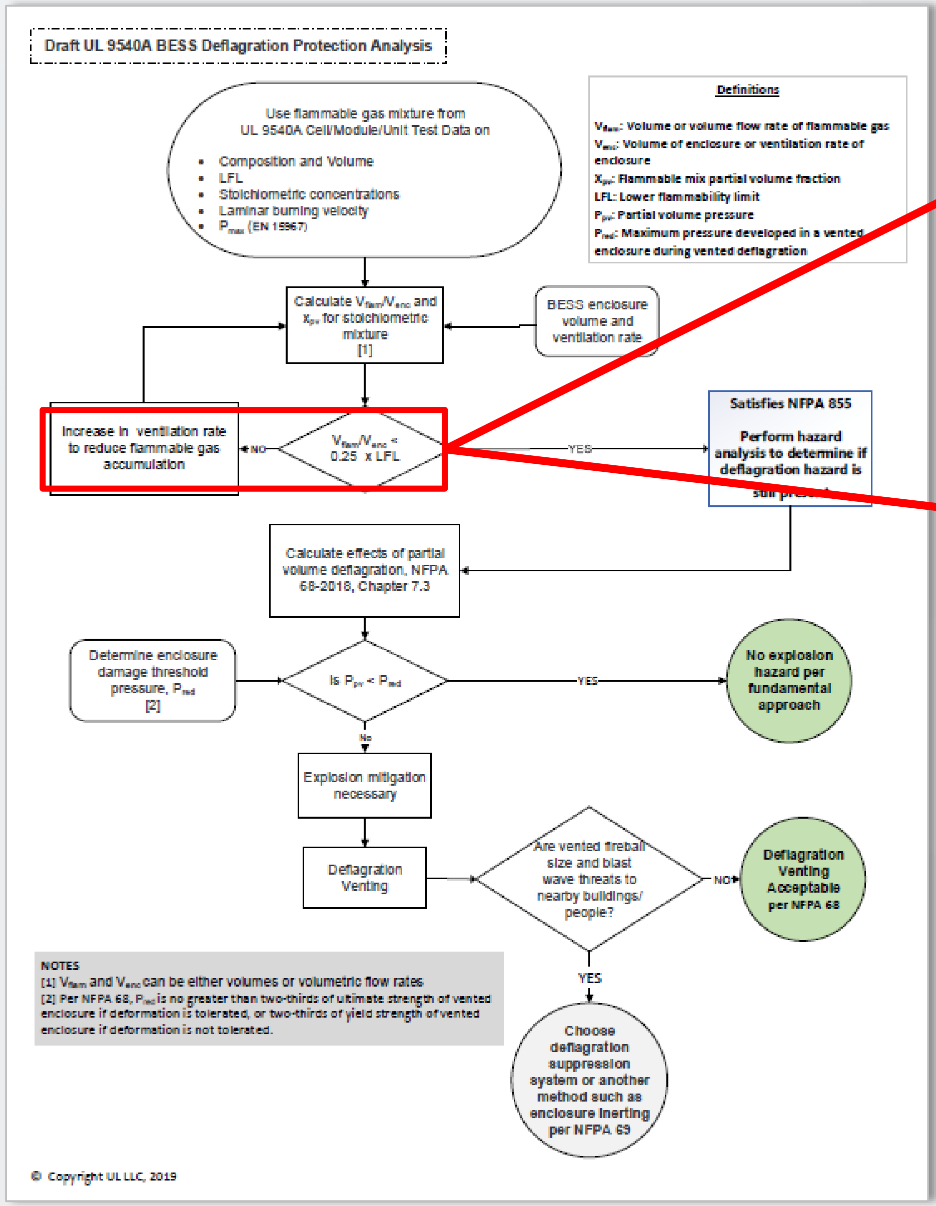
**Ventilation rate impact is calculated rather than tested,** as the UL 9540A test method includes a vent to gather gas data which will not be present in actual installations. CFD analysis is not required but is accepted as best practices; a simple mass flow calculation can be conducted instead.

**Volume of enclosure is defined as:**
Full volume of space minus obstruction volume (e.g., racks). Dead space between cells/modules is included with obstruction volume.

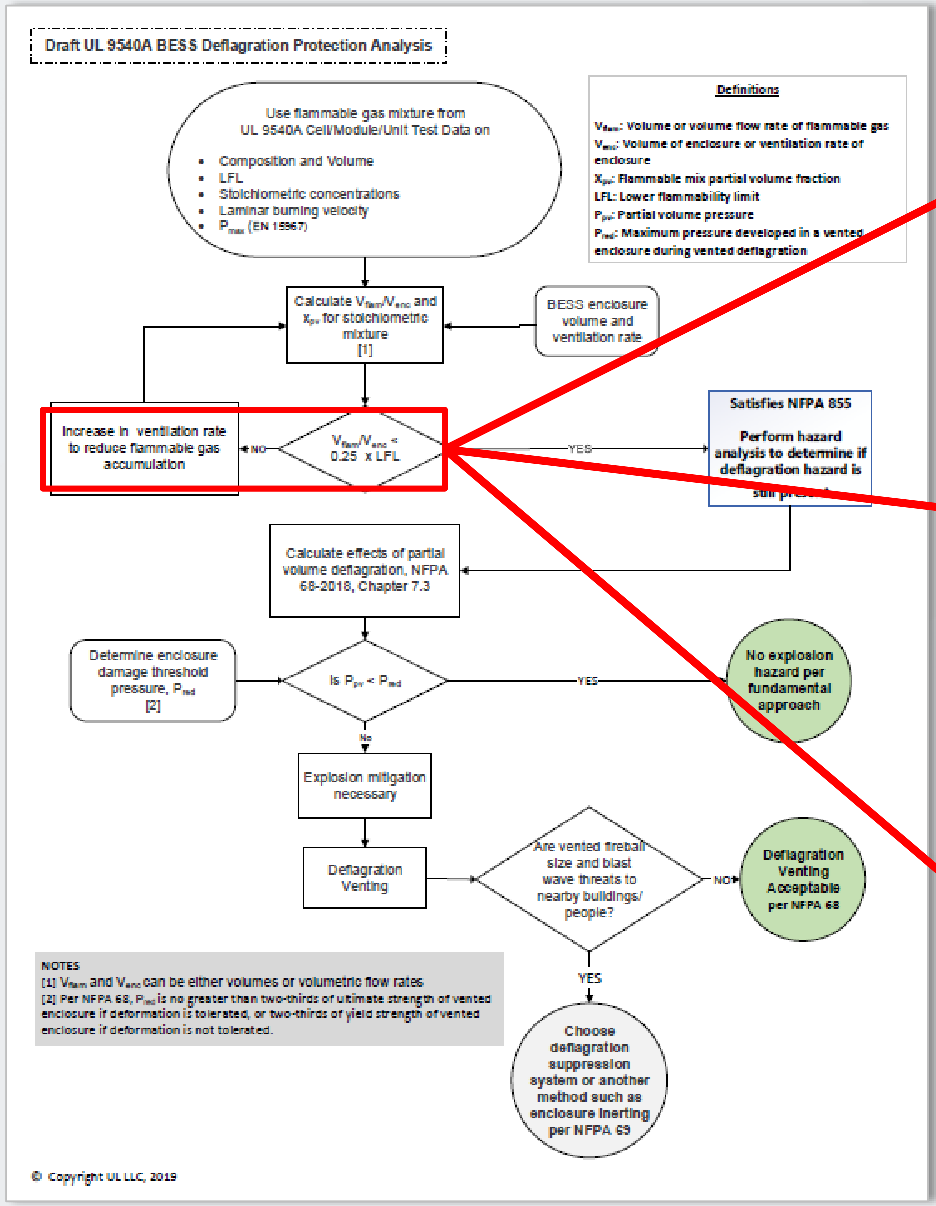
# Working group: Processing UL 9540A Data in NYC




**NFPA 68 or NFPA 69 are both industry accepted for explosion analysis and design.** Currently, NFPA 68 is required by NYC code, while NFPA 69 is optional.

**For energy storage systems which do not output gases under normal conditions (e.g., Li ion), it is not necessary to reduce LFL below 25% if NFPA 69 is not being pursued.** While it is accepted as best practice to reduce the gas concentration to as low as possible through ventilation, but it is recognized that in some scenarios it may not be possible to hit 25% LFL. **Batteries which may generate gases under normal conditions (e.g., lead acid), must comply with the 25% LFL requirement, per code.**

# Working group: Processing UL 9540A Data in NYC

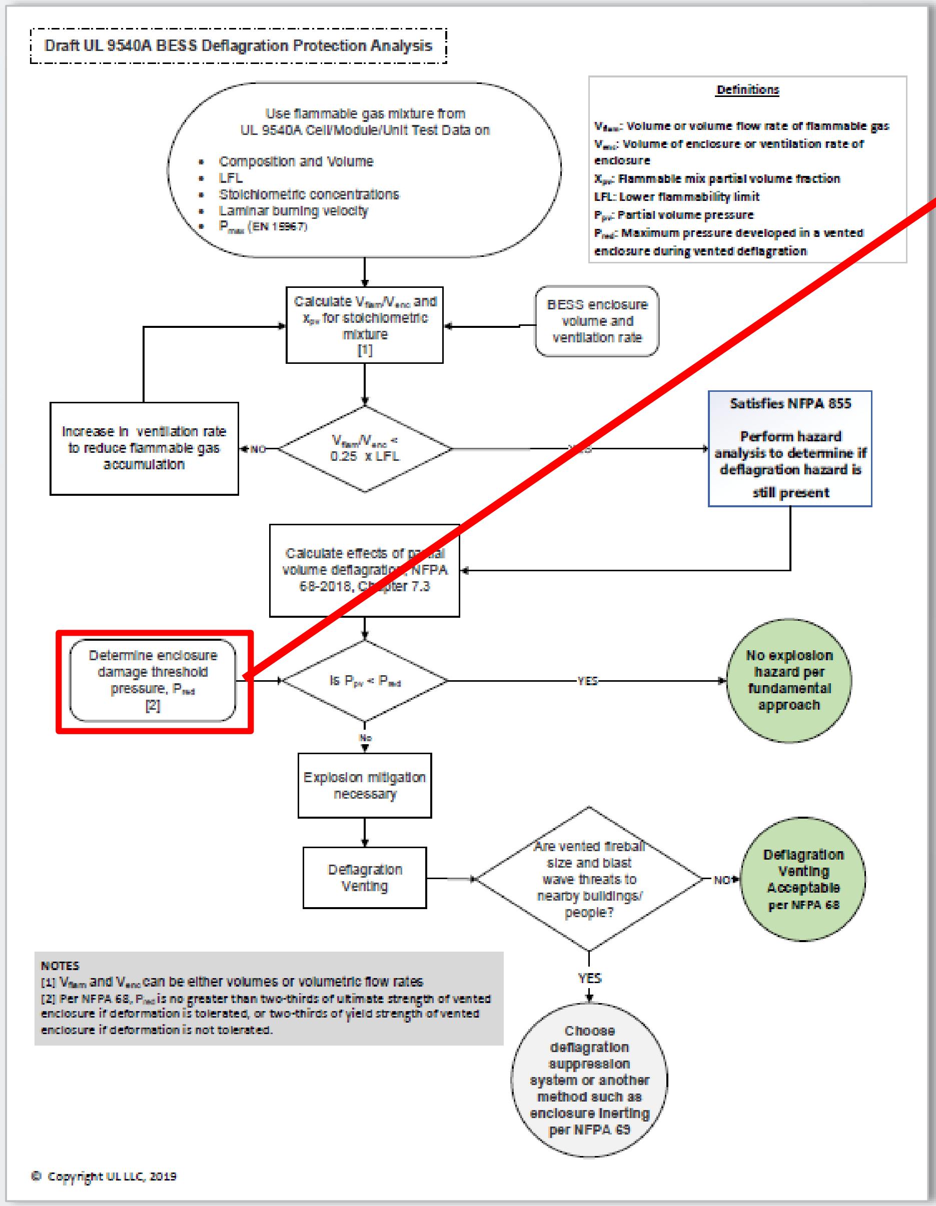



**NFPA 68 or NFPA 69 are both industry accepted for explosion analysis and design.** Currently, NFPA 68 is required by NYC code, while NFPA 69 is optional.

**For energy storage systems which do not output gases under normal conditions (e.g., Li ion), it is not necessary to reduce LFL below 25% if NFPA 69 is not being pursued.** While it is accepted as best practice to reduce the gas concentration to as low as possible through ventilation, but it is recognized that in some scenarios it may not be possible to hit 25% LFL. **Batteries which may generate gases under normal conditions (e.g., lead acid), must comply with the 25% LFL requirement, per code.**

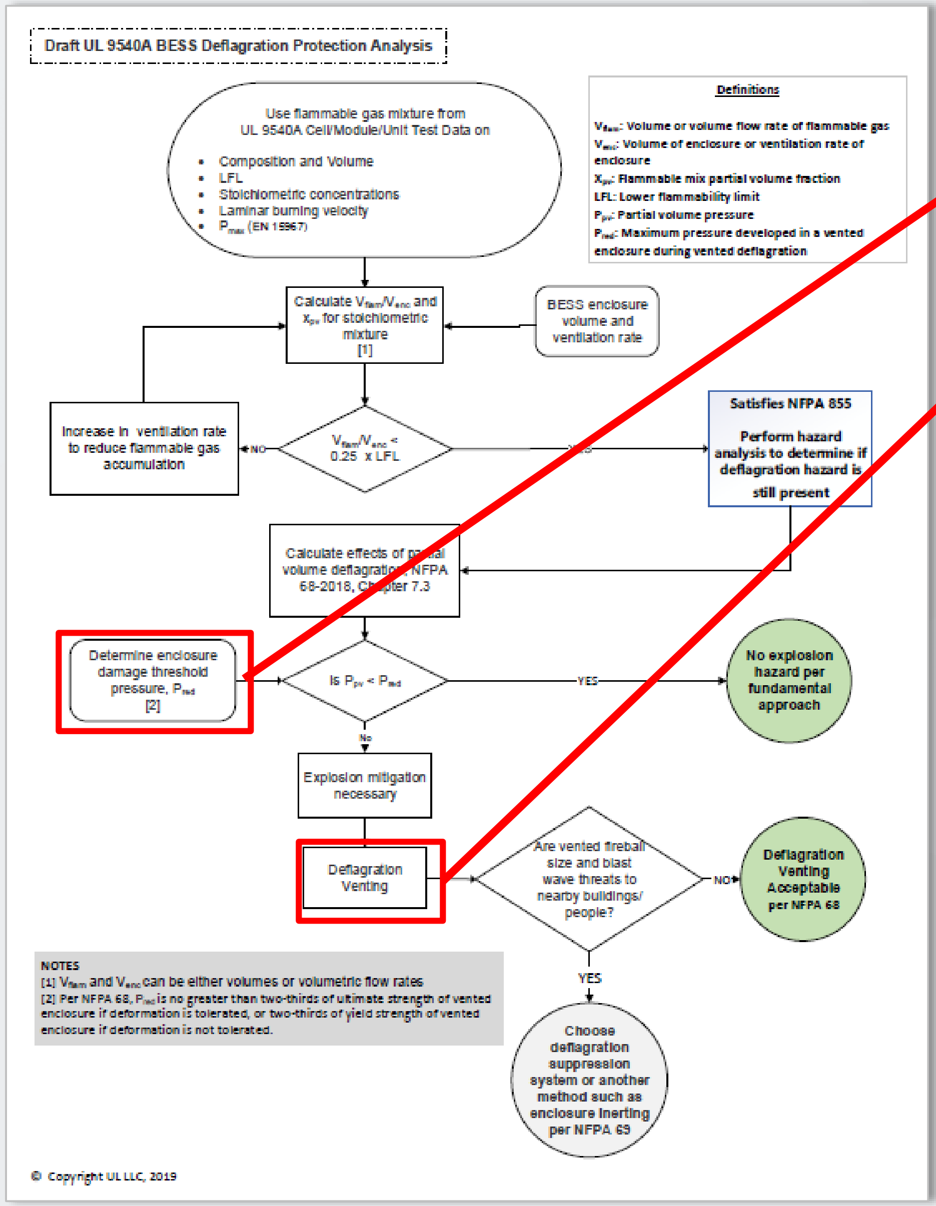
**Generally, gas detection equipment is recognized as non-standardized/not certified for continuous operation during Li-ion failures.** As such, gas detection equipment is not required for outdoor systems. Indoor system gas detection requirements are still under consideration.

# Working group: Processing UL 9540A Data in NYC




**Deformation of containers is permissible.** Strength of the enclosure should be calculated using method described in NFPA 68.

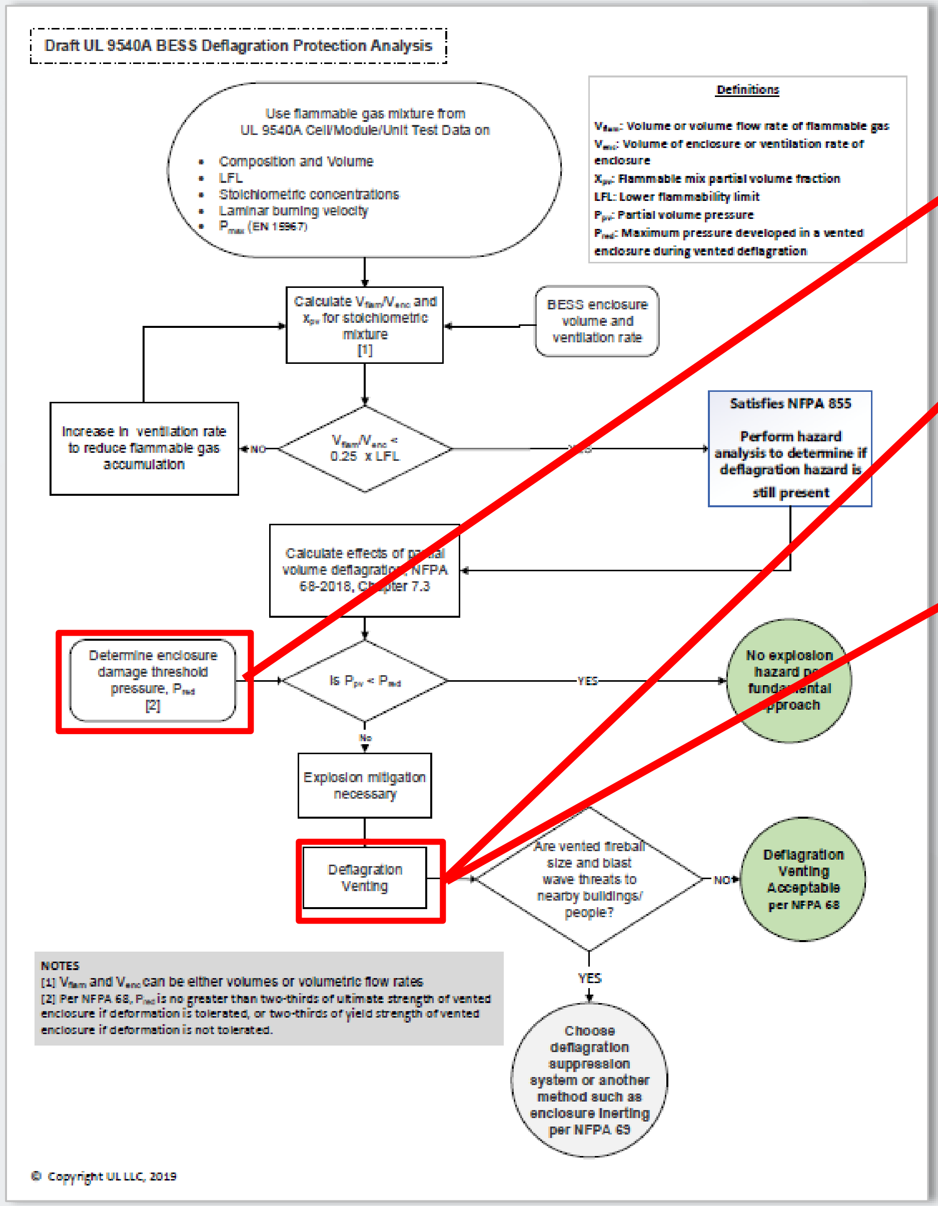
# Working group: Processing UL 9540A Data in NYC




**Deformation of containers is permissible.** Strength of the enclosure should be calculated using method described in NFPA 68.

**Deflagration vents will always be designed with upwards pressure release.**

# Working group: Processing UL 9540A Data in NYC

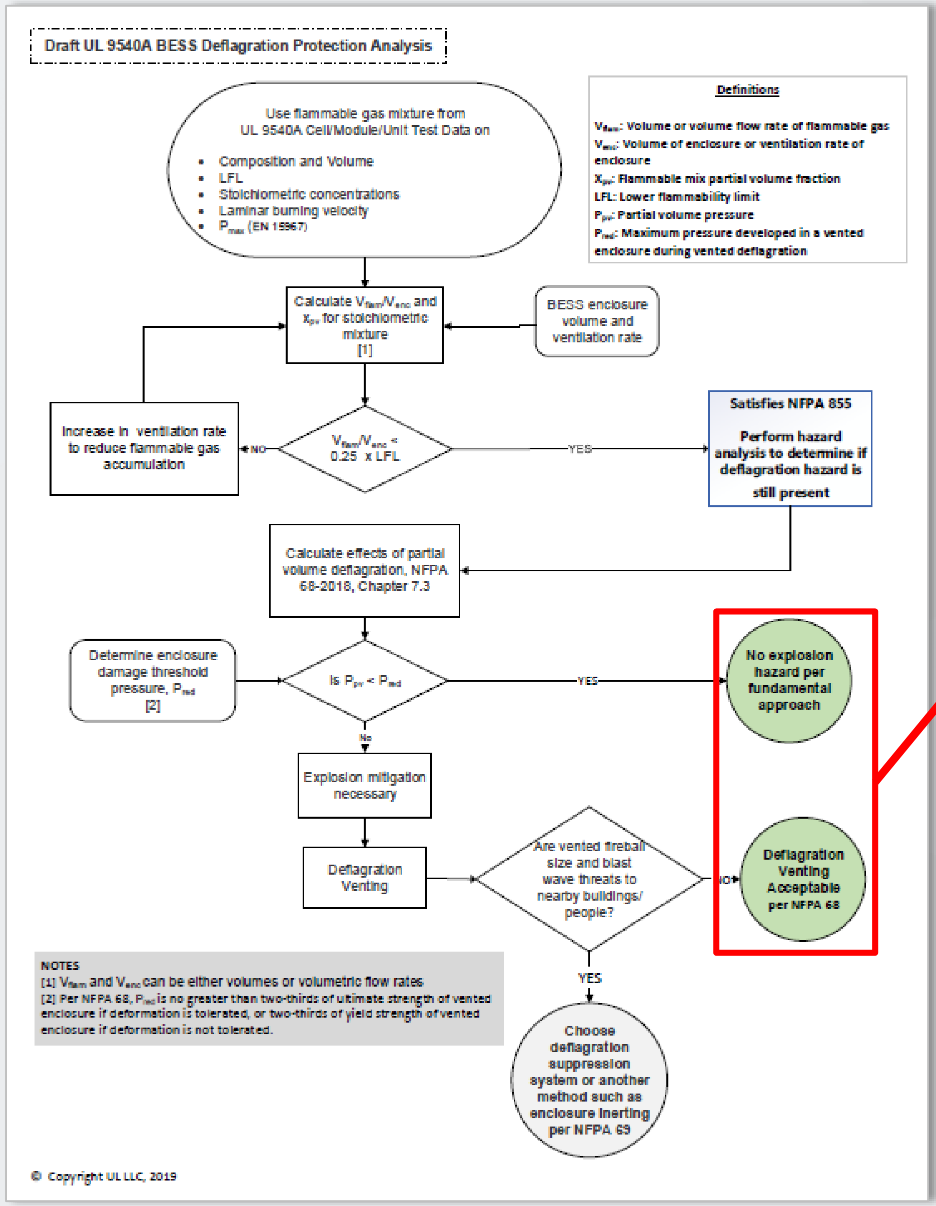



**Deformation of containers is permissible.** Strength of the enclosure should be calculated using method described in NFPA 68.

**Deflagration vents will always be designed with upwards pressure release.**

**Model-based design is permitted.** Design methods which are demonstrated to meet or exceed NFPA 68 are acceptable, given demonstrated through acceptance by a NYS PE and documentation of assumptions/calculations/research or testing support.

# Working group: Processing UL 9540A Data in NYC

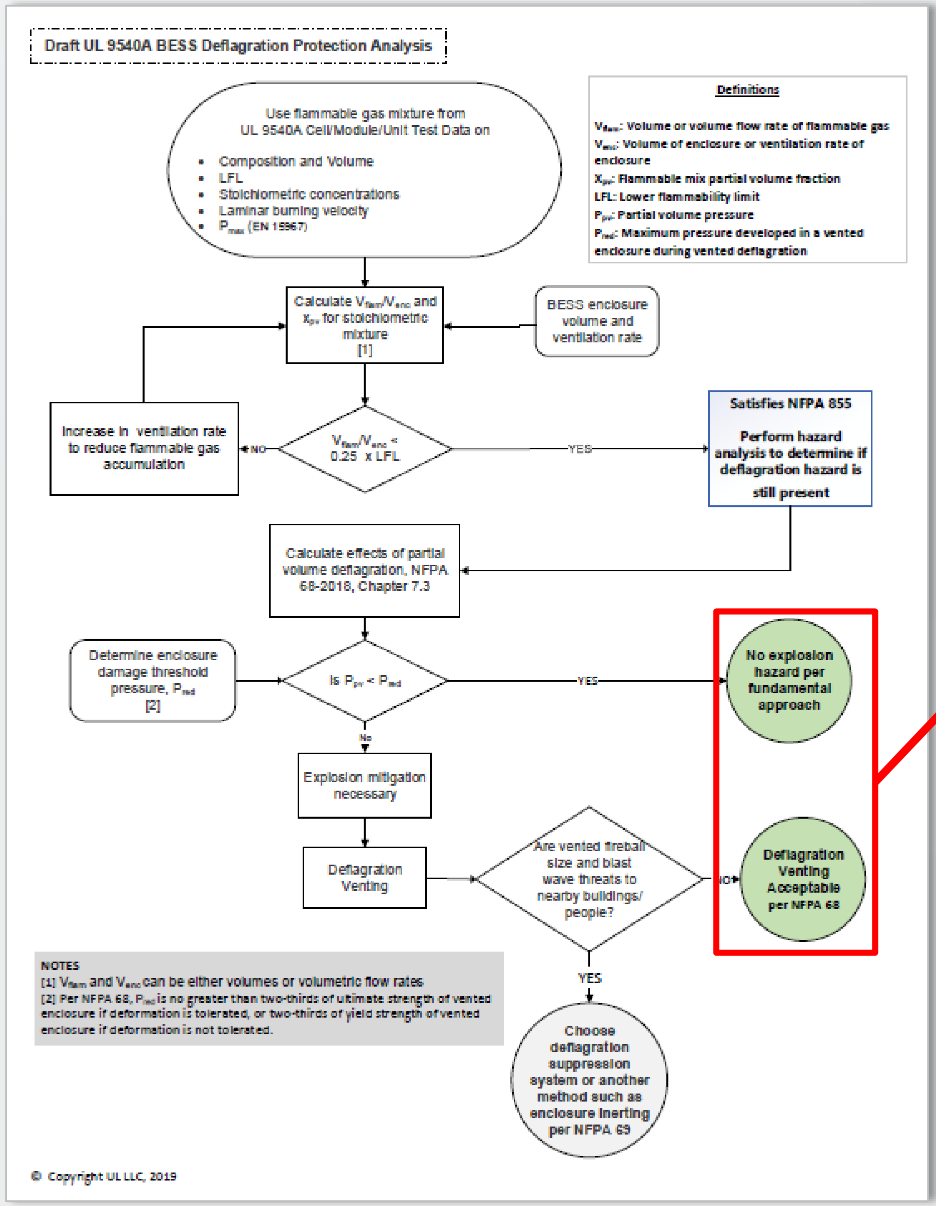



**Pressure waves from explosion threat should be assessed and documented by the NYS PE, but guidance for its definition and related minimum expectations include:**

- **To buildings:** The pressures at which the building will be affected beyond that deemed acceptable for the performance group (Ref: ICC 2009), with consideration for building materials and occupancy

| Magnitude of event | | Increasing level of performance | | | |
|---|---|---|---|---|---|
| | | Performance Group I | Performance Group II | Performance Group III | Performance Group IV |
| | **Very large** (very rare) | Severe | Severe | High | Moderate |
| | **Large** (rare) | Severe | High | Moderate | Mild |
| | **Medium** (Less frequent) | High | Moderate | Mild | Mild |
| | **Small** (Frequent) | Moderate | Mild | Mild | Mild |

# Working group: Processing UL 9540A Data in NYC



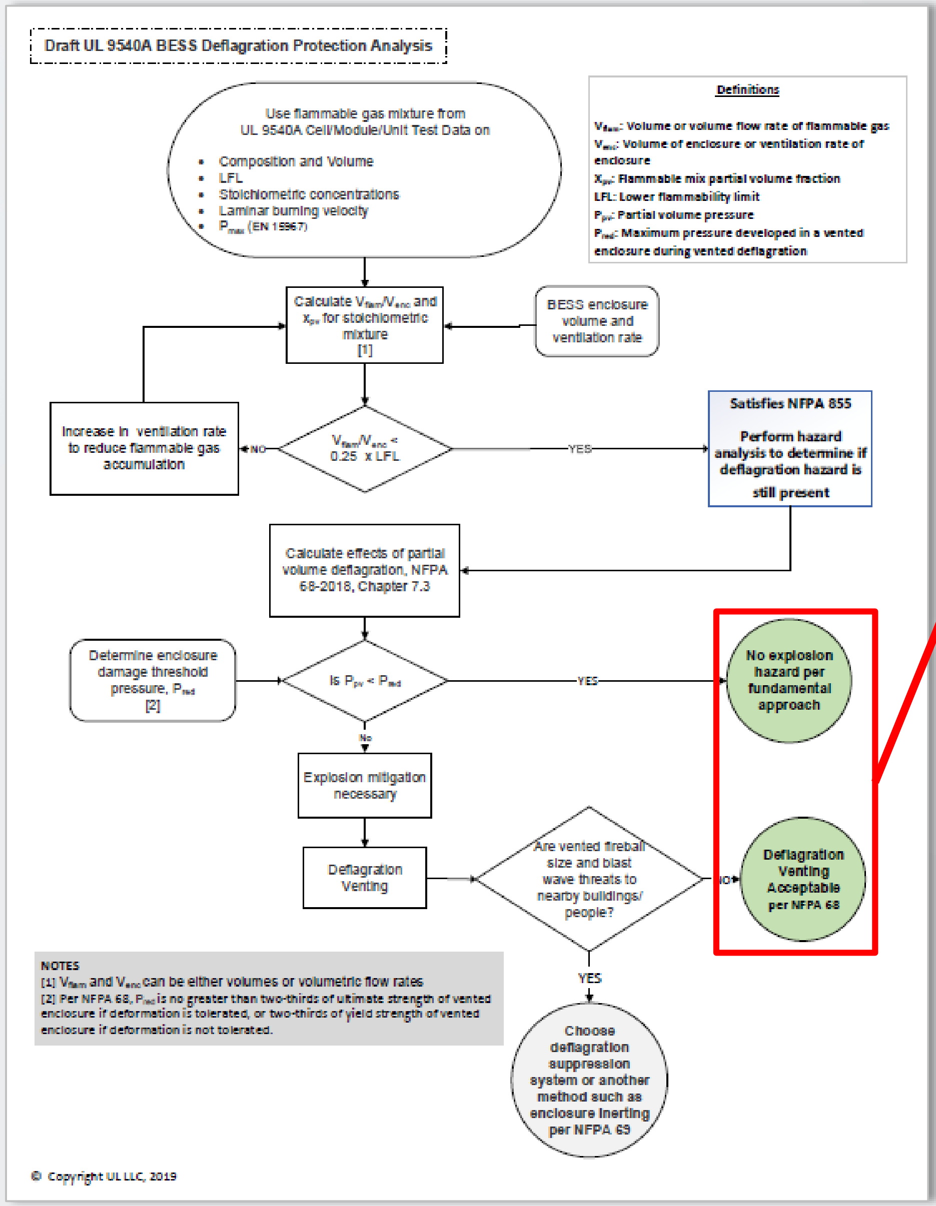

**Pressure waves from the explosion threat should be assessed and documented by the NYS PE, but guidance for its definition and related minimum expectations include:**

- **To first responders:** The overpressure at the fire department connection (FDC) should be demonstrated, through testing and analysis, as less than 1 psig based on the proposed siting (Ref: SFPE Handbook). ) The FDC shall be in no case less than 10 ft from the system.

**Table 5-13.4** ***Explosion Overpressure Damage Estimates***

| Overpressure (psig) | Characteristic damage: To Equipment | Characteristic damage: To People |
|---|---|---|
| 2.5–5 | Heavy damage to buildings and to process equipment | 1% death from lung damage<br>>50% eardrum rupture<br>>50% serious wounds from flying objects |
| 1–2.4 | Repairable damage to buildings and damage to the facades of dwellings | 1% eardrum rupture<br>1% serious wounds from flying objects |
| 0.5–1 | Glass damage | Injury from flying glass |
| 0.15–0.30 | Glass damage to about 10% of panes | Slight injury from flying glass |

# Working group: Processing UL 9540A Data in NYC




**Fireball from the explosion threat should be assessed and documented by the NYS PE based on NFPA 68 method, ensuring that the FDC and building are beyond the "hazard zone".**

**7.6* Fireball Dimensions.**

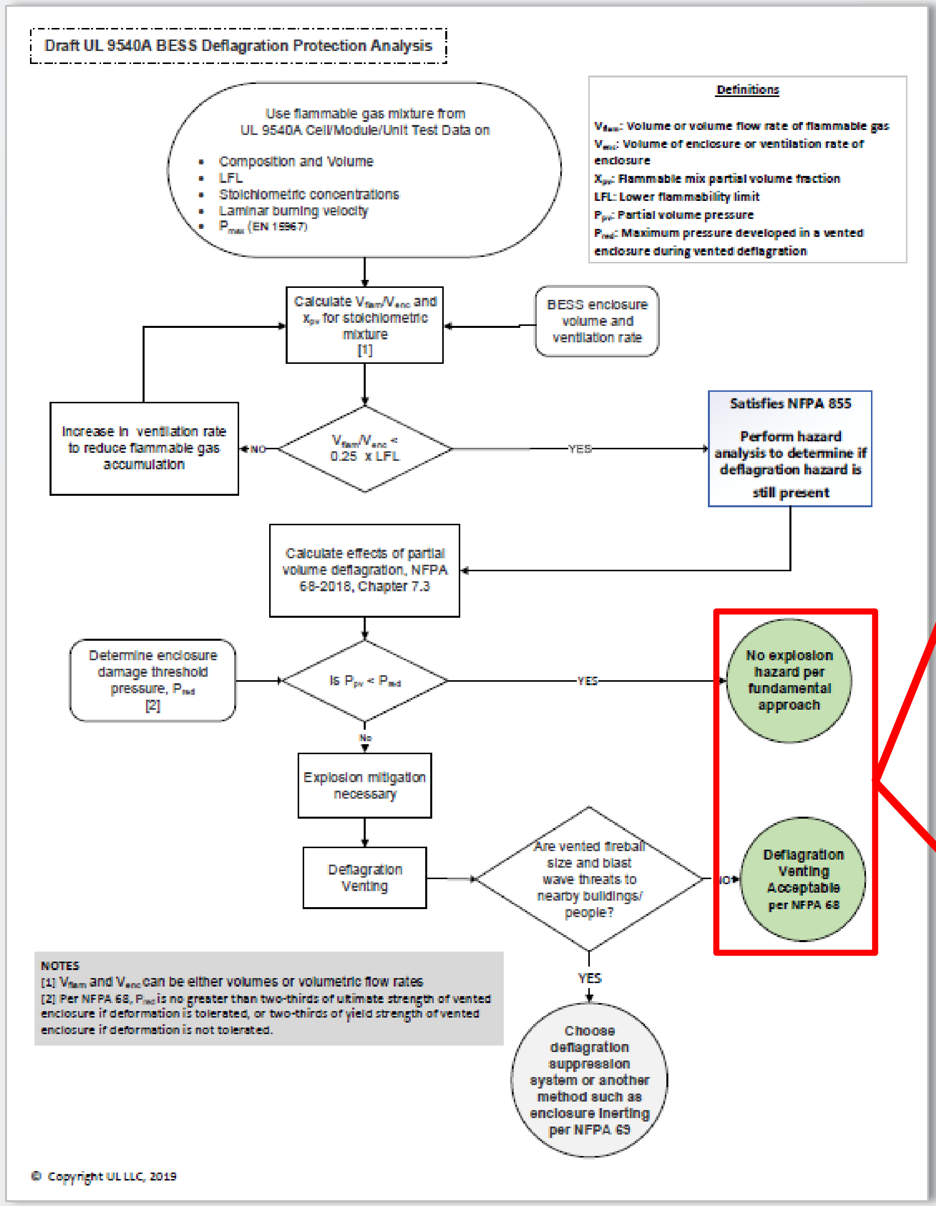
**7.6.1** The hazard zone from a vented gas deflagration shall be calculated by the following equation:

$$D = 3.1 \cdot \left(\frac{V}{n}\right)^{0.402} \qquad [7.6.1]$$

where:
$D$ = axial distance (front-centerline) from vent (m)
$V$ = volume of vented enclosure ($m^3$)
$n$ = number of evenly distributed vents

**7.6.2** The hazard zone measured radially (to the sides, measured from the centerline of the vent) shall be calculated as $0.5D$.

# Working group: Processing UL 9540A Data in NYC




**Fireball from the explosion threat should be assessed and documented by the NYS PE based on NFPA 68 method, ensuring that the FDC and building are beyond the "hazard zone".**

**7.6* Fireball Dimensions.**

**7.6.1** The hazard zone from a vented gas deflagration shall be calculated by the following equation:

$$D = 3.1 \cdot \left(\frac{V}{n}\right)^{0.402} \qquad [7.6.1]$$

where:
$D$ = axial distance (front-centerline) from vent (m)
$V$ = volume of vented enclosure ($m^3$)
$n$ = number of evenly distributed vents

**7.6.2** The hazard zone measured radially (to the sides, measured from the centerline of the vent) shall be calculated as $0.5D$.

**Management of the projectile threat should be done in an NFPA 68 compliant method and ensure no projectiles.**

- UL 9540A requires no projectiles in it's test.
- Only securely mounted equipment is permitted in the energy storage space.
- A design engineer should specify that the deflagration equipment is designed to be tethered or hinged to container.

# Stakeholders group: What's Next?

- Updates to the Outdoor Guide
  - Alignment with DOB bulletins and FDNY rule
  - Clarification on administrative processes
  - Addition of UL 9540A data analysis recommendations
- Process development and on-going support
- Development of templated applications or checklists
- Smart DG Hub as contact for Technical Assistance (TA)
- Training webinars
- Project tracking
- Indoor installation progress
- Example calculations and data consolidation

**Q4 2019 through Q4 2020**
Updated documentation
Process improvement
Expanded installs
Technical assistance

# Thank you!

Questions? Comments?
Contact us at SmartDGhub@cuny.edu
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With key technical assistance from