

Tutorial 3: Worst Case Scenario - What if systems fail?

Learning Objectives

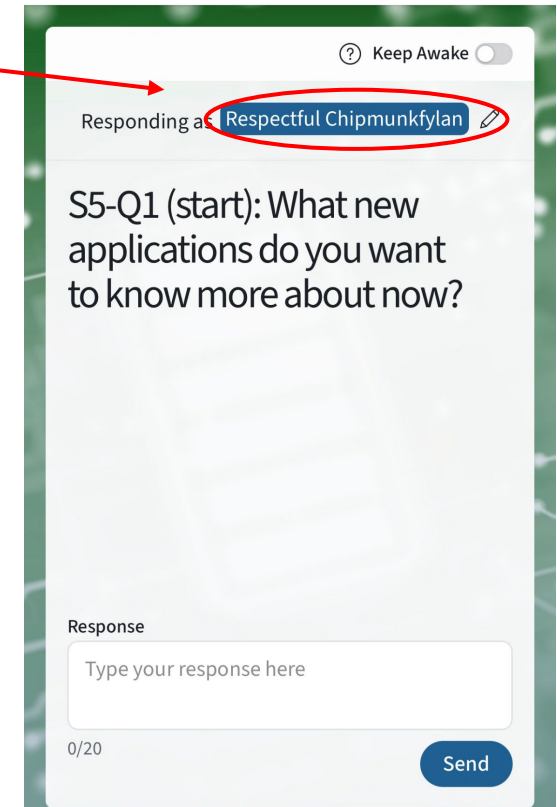
- Attendees will learn about working with AHJ's, best practices for emergency planning response, and unique decommissioning case studies.



Poll Questions

Please visit Poll Everywhere via the **QR** code below (mobile) or at **pe.app/essrf** (laptop). If you would like to add your name, please update with the “**pencil**” icon. If not, feel free to remain anonymous

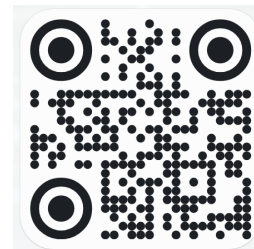
Respond at
pe.app/essrf



Poll:

What are the most common causes of BESS failures?

- a) Cell defects
- b) Integration Workmanship Issues
- c) Water leaks/Intrusions
- d) Operations/controls Failure



Working with AHJ's

- Ensuring knowledge of locally adopted codes
 - Zoning, building, fire
- Early engagement with all stakeholders
 - Education and communication
- Ensure proper use of listed system and components
- Early identification of specific BESS equipment
- **Equipment tested, certified, and installed to the most current edition of NFPA 855**

BESS SDK POWERED BY FRA Codes Tools Resources Contact Login Sign up

New Mexico Battery Energy Storage System Codes

Site Type Indoor / Dedicated [Download PDF](#) Login Required

Applicable Codes

The governing code specifies mandatory requirements. Supporting codes may provide additional requirements.

International Fire Code (2021) ★ +

IBC (2021) + NFPA 70 (2020) +

NFPA 13 (2019) NFPA 72 (2019)

Legend:


- ★ Governing Code
- + With Amendments
- 📍 Refer to Local Codes
- 📄 For Reference Only

Compliance Requirements

A list of code compliance requirement issues and their code sections.

ISSUE	REQUIRED	CODE SECTION	NOTES
Elevation	Yes	1207.5.3	
Fire suppression systems	Yes	1207.5.5	
Fire-resistance-rated separations	Yes	1207.7.4	Note: c
General installation requirements	Yes	1207.4	
Maximum allowable quantities	No	1207.5.2	
Size and separation	Yes	1207.5.1	
Smoke and automatic fire detection	Yes	1207.5.4	Note: d, e
Technology specific protection	Yes	1207.6	

ERP Training

- Emergency Planning & Training required by NFPA 855 (4.3.1)
 - For operations staff as well as responders
- Table-top exercises to simulate various events and coordinate resources. Plan A, B, & C
 - Unified command structure based on ICS
 - Incident based on ERP, modeling from plume models, and other scenario inputs
- Conduct drills across all shifts – **Seldom used skills** 
- Decommissioning plan (planned and unplanned).

Decision Making Under Pressure

Risk Frequency Analysis

FREQUENCY

R I S K	High Risk Low Frequency	High Risk High Frequency
	Low Risk Low Frequency	Low Risk High Frequency



Response Best Practices

- ERP based on LSFT to support minimal intervention with expected event duration
 - Pros & Cons of offensive/defensive approaches.
 - Water is a double-edged sword; it absorbs heat, but is conductive and may exacerbate contamination, event duration, and mitigation.
- Early resource requests
 - Hazmat Unit
 - Air/water monitoring onsite & downrange (local/state EPA)
 - Support for shelter/evacuations as needed (LEO)
 - Media outreach (PIO)
 - Owner/Operator mitigation personnel (IFC)



Credit: CBS8



Credit: Hithium



Case Study: Moss Landing/Elkhorn BESS “Successful Failure”



Toxic Emissions

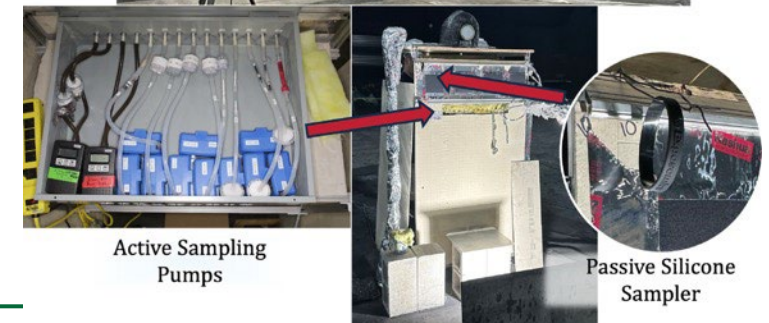
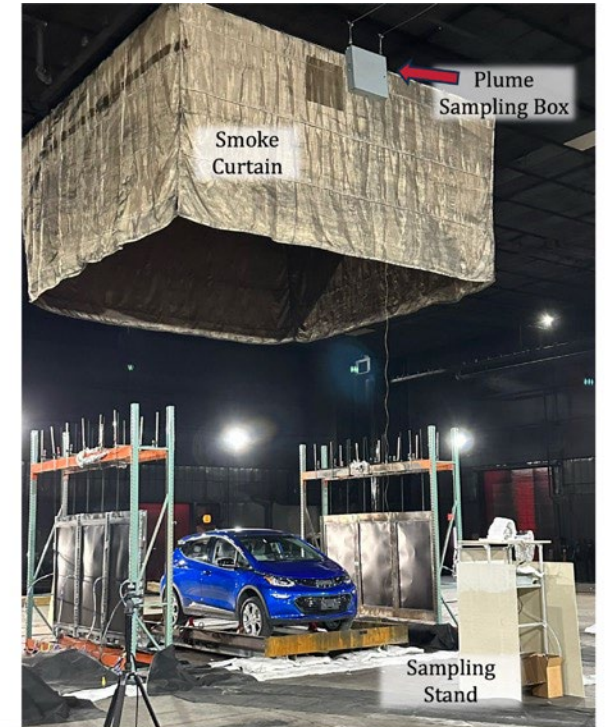


Evaluation of combustion products in air from electric and internal combustion engine vehicles - UL Fire Safety Research Institute

- Fires in both types of vehicles produce inhalation and dermal exposure health hazards.
- Greater concentrations of some heavy metals produced in EV fires.
- Fluoride particulate was detected in higher concentrations than HF in EV fires.
- Fluoride particulate was greater in EV fires than ICE vehicle fires.

HF is extremely reactive and sticky (difficult to measure)

- Richard M. Kesler, Nathaniel Sauer, Adam Barowy. et al. Evaluation of combustion products in air from electric and internal combustion engine vehicles during full-scale fire experiments, Fire Safety Journal, Volume 158, <https://doi.org/10.1016/j.firesaf.2025.104558>.



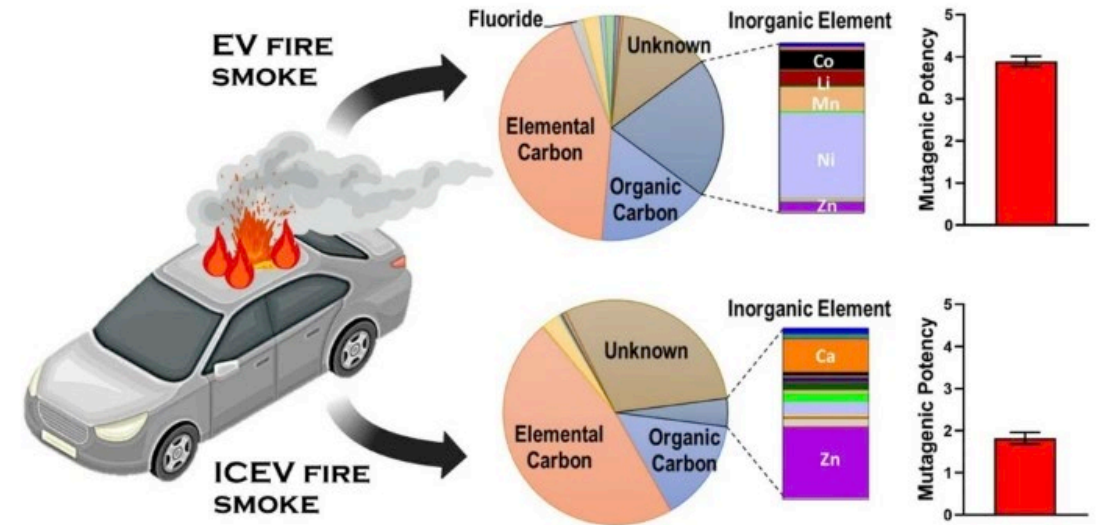
Toxic Emissions

Chemical Composition of EV/ICE Fires and Mutagenic Effects

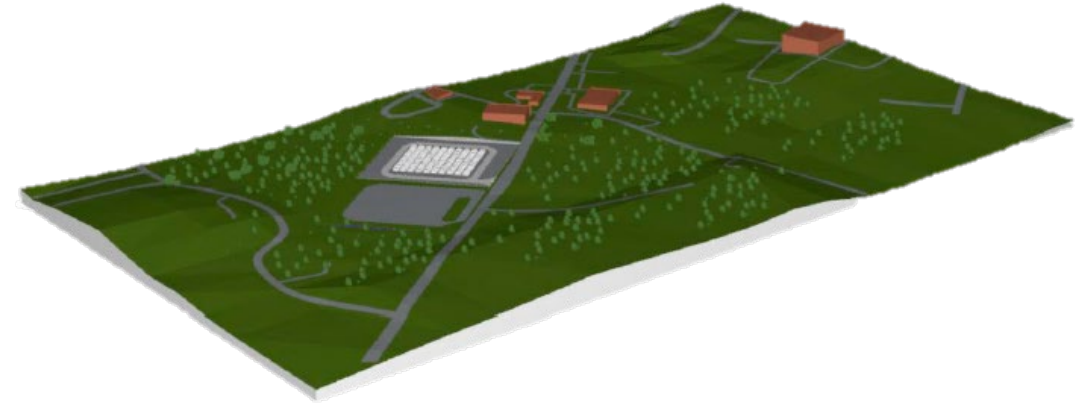
UL Fire Safety Research Institute

- EV fires emitted 2–7 times more inorganic elements than gas vehicle fires and a significant amount of fluoride (up to 2% of total particulate mass).
- Smoke particulate from EV fires was primarily nickel, manganese, cobalt, and lithium, while gas vehicle fire smoke was mostly zinc.
- Organic compounds in EV fire smoke were more likely to cause bacterial mutations than those from gas vehicle fires.
- Both EV and gas vehicle smoke had a higher potential to cause bacterial mutation than smoke from municipal waste, residential wood, or crude oil fires.

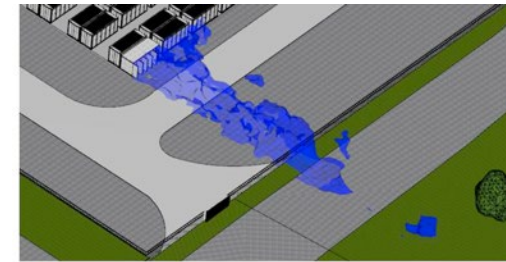
- Kim, Y.H., Nored, A., Horn, G.P. et al. Chemical components of electric vehicle and internal combustion engine vehicle fire smoke and their mutagenic effects. Environ Sci Pollut Res 32, 26629–26639 (2025). <https://doi.org/10.1007/s11356-025-37210-9>



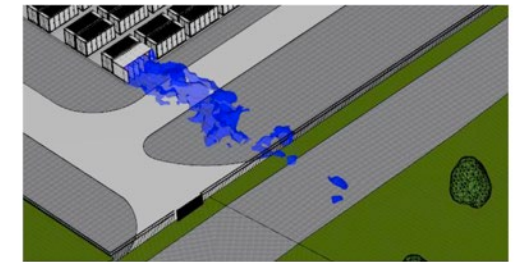
Plume Modeling



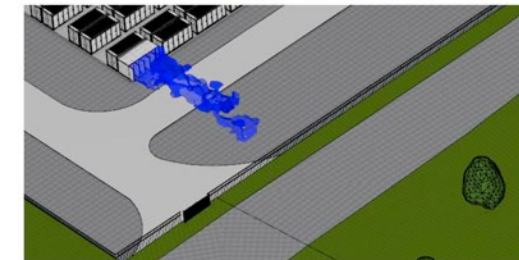
- Analysis performed by Fire Risk Alliance utilized both flaming and non-flaming dispersion modeled in Fire Dynamic Simulator (FDS).
- Process Hazard Analysis Software Tool (PHAST) used for parametric models of hazardous materials to inform FDS.
- Model based on aggregated data set from UL9540A and LSFT data. Not a site-specific plume model.
- Toxicity based on 3 thresholds systems:
 - Immediately Dangerous to Life & Health (IDLH)
 - Emergency Response Planning Guidelines (ERPG)
 - Acute Exposure Guideline Levels (AEGL) – most conservative.



5 mph



12 mph



20 mph



Plume Modeling

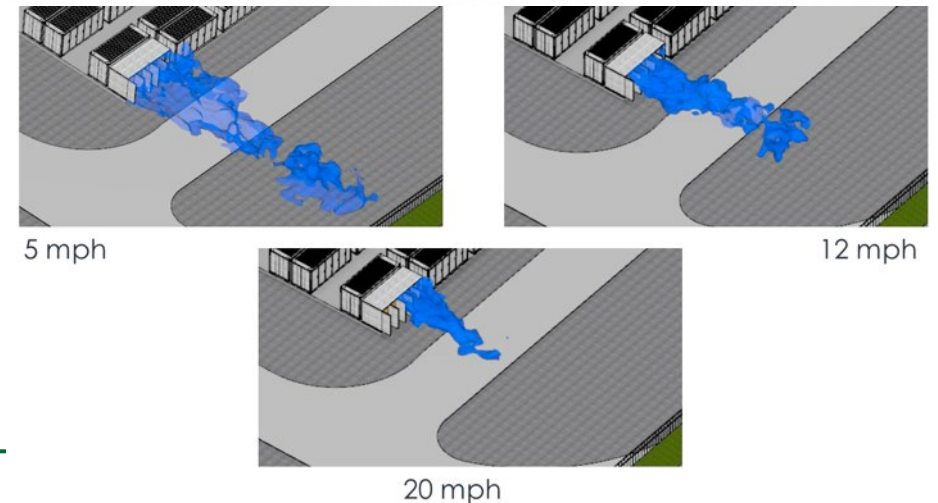


- HF is extremely reactive and very difficult to measure
- CO:HF ratio of 7:1 used as HF is not measured in UL9540A.
- Pre-combustion values used (lower plume height)
- Extents are at breathing height and instantaneous measurements. Not representative of sustained concentrations.
- Using this model, toxic values measured at fence (100')
 - Very conservative values based on CO:HF ratio and 30 min continuous exposure duration.

Table 17. CO toxic gas extents at breathing height

Endpoint Criteria	Wind Speed (mph)	Maximum Radial Horizontal Extent from Initiating containerized BESS (m)	Maximum Radial Horizontal Extent from Property Line* (m)
AEGL-2 (83 ppm)	5	73.7	43.6
	12	47.5	17.4
	20	24.5	Does not reach property line
ERPG-1 (200 ppm)	5	32.8	2.7
	12	24.2	Does not reach property line
	20	17.6	Does not reach property line
AEGL-3 (330 ppm)	5	24.5	Does not reach property line
	12	17.3	Does not reach property line
	20	12.9	Does not reach property line
ERPG-3 (500 ppm)	5	18.2	Does not reach property line
	12	13.4	Does not reach property line
	20	12.4	Does not reach property line
IDLH (1200 ppm)	5	9.2	Does not reach property line
	12	5.9	Does not reach property line
	20	6.2	Does not reach property line

*30 m downwind of the initiating BESS unit



Poll:

Plume modeling should be part of a complete permit package?

Yes
No



Decommissioning

- Planned vs Unplanned
 - Planned is across the board from liability, to + recycling value, neutral, or expense. Shipping location is huge unknown 10yrs down the line. Site restoration is another huge factor. Blind spot for industry.
 - Unplanned expense can exceed CAPEX
- EPA developing best practices
 - “Maui Method”
 - LA County Fires
 - Gateway BESS
 - Moss Landing



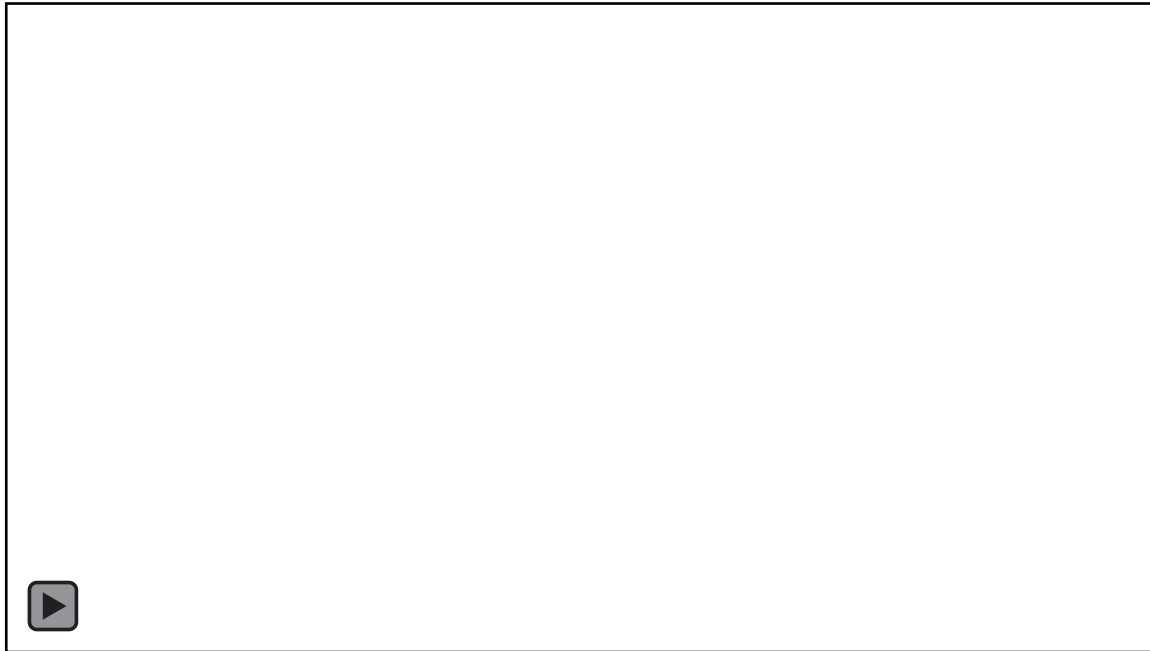
Credit: Bloomberg





LA Wildfires and Battery Shredding

When you need to turn batteries into “not batteries”



Credit: US EPA



Before



After



Case Study: Gateway BESS

May 15, 2024	Initial Fire
May 31, 2024	Fire Contained
December 2024	Building Disassembled
January 2025	Battery Removal Start
September 2025	Applied for DOT Permit
October 2025	Special Permit Obtained
January 2026	Last Batteries Shipped to Recycler





Case Study: Gateway BESS



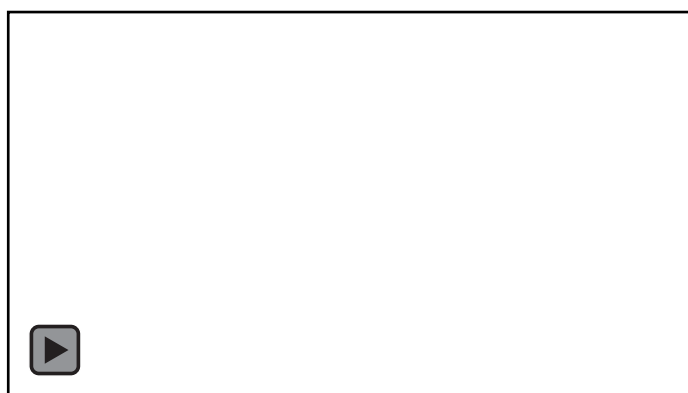
Credit: US EPA





Case Study: Moss Landing BESS

Jan 16, 2025	Initial Fire
Jan 18, 2025	Fire out
Feb 18, 2025	Reignition
Feb 22, 2025	Delinking of undamaged modules begins
Mar 13, 2025	Delinking complete
July 2025	Fire debris removal begins
Aug 2025	Building stabilization Begins
Sept 2025	Batteries removal begins (Phase 1)
Feb 2026	Batteries removed from undamaged sections of the building
Ongoing	Access to damaged building for battery removal (Phase 2)



Poll:

Should O&M be mandatory for C&I BESS installations?

Yes

No



Looking Forward...

- What will be the drivers of safer systems?
 - New technologies and system designs
 - Predictive analytics
 - Insitu sensing and notification
 - Improved workmanship and experience
 - Codes & Standards
 - AI Impacts

ES Manufacturers



Analytics/Sensing



Codes/Standards



JUNE 2, 2026

THANK YOU

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References

[UL Fire Safety Research Institute](#)

[US EPA Considerations for Safe Installation](#)

[US EPA Moss Landing Fire Response](#)

[US EPA Battery Collection Best Practices Toolkit](#)

[Fire Risk Alliance – Storage Development Kit](#)

