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Section 3.17

Worker Health and Safety

Appendices

Appendix 3.17A
Firefighting Water Supply Analysis

Representative Firefighting Water Supply Analysis Using Sungrow Power Titan 2.0

May 2, 2025

[redacted]
Prairie Song Reliability Project LLC
140 Broadway, 46th Floor
New York, NY 10005-1155

Dear [redacted]

Fire & Risk Alliance, LLC (FRA), was contracted by Prairie Song Reliability Project LLC (Client) to perform a firefighting water supply analysis for the Prairie Song Reliability Project Battery Energy Storage System (BESS) proposed for installation in Los Angeles County, California. The proposed Prairie Song Reliability Project site is anticipated to initially include 2,035 SunGrow PowerTitan 2.0 containers. The Prairie Song Reliability Project is currently in the design phase. Currently, a public water supply from the local municipality is not available at the proposed installation location. Therefore, an analysis is required to determine the volume of water necessary to be stored on-site for firefighting operation. The analysis includes calculations on the anticipated fire flow necessary for fire department personnel responding to a fire at the Prairie Song Reliability Project and the associated water tank size necessary to meet that fire flow demand.

APPLICABLE CODES, STANDARDS, TEST METHODS AND REFERENCE MATERIALS

The following codes, standards, and reference materials were reviewed as part of the analysis:

- 2022 California Building Code (CBC)
- 2022 California Fire Code (CFC)
- 2023 Los Angeles County Fire Code (LACFC)
- NFPA 22, Standard for Water Tanks for Private Fire Protection, 2018 Edition (NFPA 22)
- NFPA 24, Standard for the Installation of Private Fire Service Mains and their Appurtenances, 2022 Edition (NFPA 24).
- NFPA 1142, Water Supplies for Suburban and Rural Fire Fighting, 2022 Edition (NFPA 1142).
- Factory Mutual Data Sheet 5-4, Transformers, Interim Revision October 2024 (FMDS 5-4).

ASSUMPTIONS

This analysis is based on the following assumptions:

- The transformers being installed at the Prairie Song Reliability Project have less than 1,000 gallons of mineral oil.
- The Control House Enclosure (CHE) has a height of no greater than 10 feet tall.

PRAIRIE SONG RELIABILITY PROJECT OVERVIEW

The Prairie Song Reliability Project is anticipated to include 2,035 SunGrow PowerTitan 2.0 containers and 517 medium-voltage transformers. The PowerTitan 2.0 containers are not occupiable. Access to the equipment installed inside the BESS is only provided through access doors on the front of the containers. Maintenance and service is performed by reaching into the container from the outside, through these access doors, similar to other electrical equipment cabinets, panels, or a transformer. Therefore, the BESS containers are not defined by the CBC as a building.

In addition to the 2,035 PowerTitan 2.0 containers, the Prairie Song Reliability Project site also includes a substation and a Control House Enclosure, as shown in Figure 1. The CHE is 95 ft long, 27 ft wide, and 10 ft tall. It has a footprint of 2,565 square feet (sf) and an interior volume of no more than 25,650 cubic feet (cf). It houses electrical equipment, electrical connection/junction points, and monitoring equipment for the Prairie Song Reliability Project and does not contain storage or other special hazards. During typical day-to-day operations, it is not normally occupied; however, it can be entered from time to time, as necessary. The CHE is installed within the secured substation area and is approximately 1,000 feet away from the nearest PowerTitan 2.0 container.

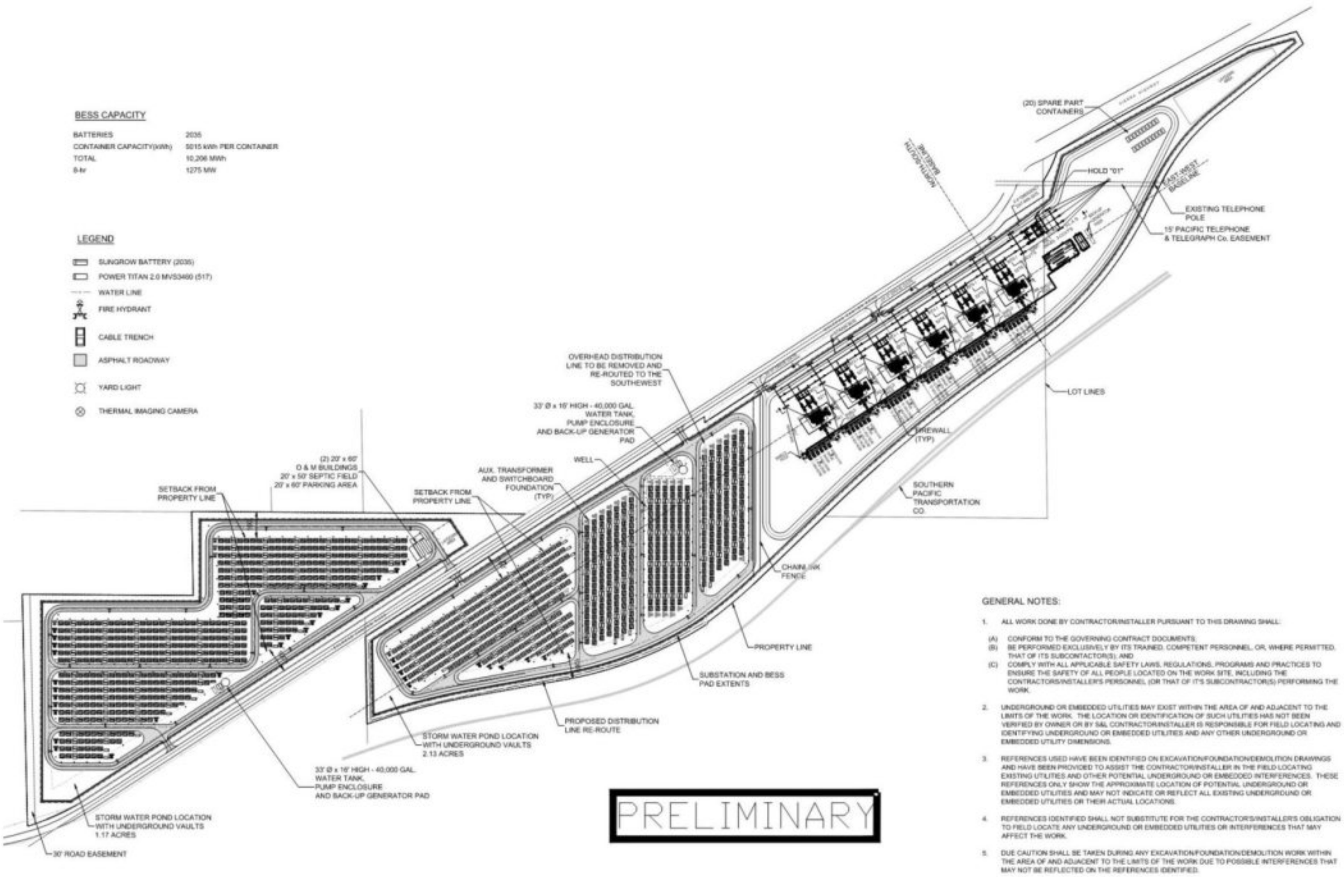

Figure 1 Prairie Song Reliability Project Site Layout

The Prairie Song Reliability Project is proposed to be provided with two 40,000-gallon fire water tanks. The fire water tanks will be NFPA 22 compliant and connected to fire hydrants throughout the site via a dry, underground, NFPA 24 compliant private fire service main. The size of the outlets on the fire hydrants shall be coordinated with the Los Angeles County Fire Department.

CODE REVIEW

When determining the required fire flow for a building, the LACFC does not provide prescriptive approaches. As such, the LACFC, Section 507 Fire Protection Water Supplies, is referenced as it outlines the requirements for fire protection water supplies and fire flow calculations. Fire flow is the flow rate of a water supply that is available for firefighting. This flow rate is typically described in gallons per minute (gpm) and is measured at 20 pounds per square inch (psi) residual pressure. LACFC, Section 507.3 states fire flow requirements for buildings or portions of buildings and facilities must be determined by an approved method or Appendix B.

LACFC, Appendix B Fire Flow Requirements for Buildings, provides a tool for determining fire flow requirements for buildings; however, the Prairie Song Reliability Project installation site does not have access to a municipal water supply. In instances where no municipal water supply is provided, the LACFC, Section B103.3, refers to NFPA 1142. NFPA 1142 specifies guidance for providing water supplies for firefighting purposes in rural and suburban areas in which adequate and reliable water supply systems do not exist. Therefore, NFPA 1142 can be utilized to determine the minimum water supply required to be on site for the CHE.

The BESS Yard contains the PowerTitan 2.0 containers, transformers, and other auxiliary electrical equipment. As the title of the LACFC Appendix B suggests, the procedure for determining the fire flow applies to buildings, not an electrical equipment (such as the PowerTitan 2.0 containers, transformers, or auxiliary equipment), as stated in LACFC, Section B101.1. The PowerTitan 2.0 container (and the other electrical equipment in the BESS Yard) are not occupiable structures and are not considered as a building. Similarly, NFPA 1142 only provides guidance on calculating fire flow for occupied buildings, not a piece of electrical equipment. Therefore, the prescriptive requirements outlined in the LACFC and NFPA 1142 to determine the fire flow and water supply requirements necessary for the electrical equipment installed within the BESS Yards of the Prairie Song Reliability Project, are not applicable. As such, FRA performed an alternative analysis to determine these values, as permitted by LACFC 507.3, where fire flow requirements can be determined by an “approved method”.

WATER SUPPLY ANALYSIS

As described above, the prescriptive method outlined in NFPA 1142 can be utilized to determine the water supply required for the CHE whereas an alternative analysis for the BESS Yard is required. This firefighting water supply analysis for both of these scenarios is outlined below.

CHE Fire

NFPA 1142, Section 4.1.5 classifies the CHE as a structure without exposure hazards given it is not within 50 ft of another structure and is not an Occupancy Hazard Classification Number of 3 or 4. Note, occupancy classifications are described in Chapter 5 of NFPA 1142. Occupancy Hazard Classification Number 3 or 4 are high or severe hazard occupancies such as plastic processing, flammable liquid spraying, warehouses, etc. The CHE is a light hazard occupancy that would be classified with an Occupancy Hazard Classification Number 7. Following the procedure for calculating the water supply required for structures without exposure hazards per NFPA 1142, Section 4.2.1, yields the following equation:

[4.2.1]

$$WS_{min} = \frac{VS_{tot}}{OHC}(CC)$$

where:

WS_{min} = minimum water supply in gal (For results in L, multiply by 3.785.)

VS_{tot} = total volume of structure in ft^3 (If volume is measured in m^3, multiply by 35.3.)

OHC = occupancy hazard classification number

CC = construction classification number

Assuming the construction classification number is 1.5 for a Type V building (a conservative classification for the CHE), the required water supply would be 5,497 gallons (25,650 x 1.5 / 7 = 5,497 gallons).

BESS Yard Fire

LACFC, Section 507.1 requires that a water supply must be capable of supplying the required fire flow for fire protection. Therefore, in order to determine the volume of firefighting water that is necessary for the BESS Yard, the fire flow required to respond to a fire event and the duration of the firefighting response, must be determined. To determine the fire flow and duration, FRA reviewed the UL 9540A unit level fire test results of the PowerTitan 2.0 container and typical firefighting tactics/procedures to analyze two scenarios: (1) a fire originating inside the PowerTitan 2.0 container and (2) a fire originating outside of the PowerTitan 2.0 container from nearby site exposures: including a transformer, a vehicle, and/or combustible vegetation.

SunGrow PowerTitan 2.0 Container Fire

The UL 9540A unit level fire test demonstrated that thermal runaway inside a PowerTitan 2.0 container does not propagate beyond the initiating module and is contained within the unit. Temperature measurements of modules adjacent to the initiating module showed that the temperature needed to induce thermal runaway was not reached. The thermal runaway did not propagate to neighboring BESS units and heat flux measurements in front of the initiating unit were below the maximum permitted levels per UL 9540A and did not pose heat exposure risks. These results were achieved without an integral suppression system (aerosol or water based for instance) installed within the PowerTitan 2.0 container nor was external fire suppression (water hose) required. Based on the results of the UL 9540A unit level fire test, a fixed fire suppression system (such as a sprinkler system or water spray system) or offensive fire department efforts are not required to stop a fire originating inside a PowerTitan 2.0 container from spreading to adjacent containers. In addition, the Prairie Song Reliability Project will have a site-specific Emergency Response Plan (ERP). The ERP will provide firefighting tactics for first responders. Those tactics are anticipated to include recommendations for first responders to approach a PowerTitan 2.0 container fire defensively. The fire crew should maintain a safe distance, outside of the site perimeter fence, and to allow the container to burn itself out. Fire crews could utilize a fog pattern from a single one-and-three-quarter inch handline, typically flowing at 125 gpm, to protect neighboring exposures, or control the path of smoke, if necessary. However, the ERP will not recommend that they actively fight a PowerTitan 2.0 container fire or continuously flow water onto neighboring containers.

As such, a single 1 3/4-inch handline intermittently flowing at 125 gpm is sufficient for a fire department response to a PowerTitan 2.0 fire. The handline can be utilized to cool nearby exposures, control the path of smoke, or extinguish any small vegetation fires at the Prairie Song Reliability Project.

Transformer Exposure Fire

Since the Prairie Song Reliability Project is secured by a perimeter fence and is an outdoor BESS installation, there are only a few potential exposures at the site that could present a risk to a PowerTitan 2.0 container. These exposures, if ignited, could impact the nearby PowerTitan 2.0 containers and present fire spread risk to those units. A review of the drawings and an analysis of other potential hazards associated with Prairie Song Reliability Project maintenance activities yielded two external exposure risks to the PowerTitan 2.0 containers: a transformer fire and a maintenance vehicle fire.

Based on a review of the drawings, the most significant external exposures within the BESS Yard are the transformers. They are typically installed within 4.5 ft of a PowerTitan 2.0 container. Other electrical equipment associated with the substation will be greater than 1,00 ft away from the PowerTitan 2.0 containers and do not pose a serious fire spread risk. As such, a transformer fire is the closest significant fire hazard to the PowerTitan 2.0 containers. A review of FMDS 5-4 provides guidance regarding the fire flow necessary to respond to and suppress a transformer fire. Specifically, Section 2.3.2.3 states:

Where transformers present an exposure to buildings or equipment, provide a hose stream allowance as follows:

A. Adequate for 1 hour hose stream demand of 250 gpm (950L/min) for transformers holding FM Approved liquids or up to 1,000 gal (3.8 m^3) of mineral oil.

B. Adequate for 2 hour hose stream demand of 500 gpm (1,900 L/min) hose stream for greater than 1,000 gal (3.8 m^3) of mineral oil in an individual transformer.

It is assumed all the transformers proposed for installation at the Prairie Song Reliability Project are units with less than 1,000 gallons of mineral oil. As such, per FMDS 5-4, a 250-gpm water delivery rate from a single hose stream for one hour is recommended to suppress a transformer fire. At a delivery rate of 250 gpm for 60 minutes, the necessary water supply to be stored on-site would be 15,000 gallons.

Vehicle Exposure Fire

In addition to a fixed electrical equipment hazard, such as a transformer, transient exposures, such as maintenance vehicles, could also pose an external exposure hazard to the PowerTitan 2.0 containers. The largest exposure risk to a PowerTitan 2.0 container likely involves a vehicle (maintenance vehicle for instance) that is parked within the BESS Yard in close proximity to a PowerTitan 2.0 container. Based on a review of the drawings, a minimum 26-foot-wide vehicle access road will be provided in the BESS Yard. As such, it is possible that a vehicle could be parked within 4 feet in front of or to the side of a PowerTitan 2.0 container. Based on typical firefighting tactics and procedures, first responders would require two 1 3/4-inch handlines flowing at 125 gpm (each) for one hour (at the maximum) to respond to a large commercial vehicle fire. If two handlines are flowing at 125 gpm (each) for 60 minutes, the necessary water supply to be stored on-site would be 15,000 gallons.

WATER SUPPLY CALCULATION

When analyzing the four fire flow scenarios listed above, the BESS Yard external exposures (vehicle exposure fire and the transformer exposure fire) present the largest required water supply of 15,000 gallons, as summarized in Table 1.

Table 1 Summary of Required Firefighting Water Supply

Exposure	Required Water Supply
Transformer	15,000 gallons
Vehicle Fire	15,000 gallons
CHE	5,497 gallons
PowerTitan 2.0 Container	0 gallons (see discussion below)

If the fire originates inside the PowerTitan 2.0 container, the ERP will not recommend offensive firefighting tactics utilizing handlines. Since offensive firefighting tactics will not be required per the ERP, the 40,000 gallons of water provided on site for the other exposure fires can provide up to five hours of continuous water application from a single 1 3/4-inch handline flowing at 125 gpm to cool nearby exposures, control the path of smoke, or extinguish any small vegetation fires. During this initial two-hour duration, a shuttle service can be set up by the fire service, if necessary, to provide additional water to the site. More likely though, a single 1 3/4-inch handline will be used intermittently by the fire service during a PowerTitan 2.0 container fire. Meaning, this volume of water can provide a significantly longer duration of water for cooling nearby exposures, controlling the path of smoke, or extinguishing any small vegetation fires while the shuttle service is set up.

CONCLUSIONS

Based on our review of the available materials, our background, experience and training, the assumptions listed above, and the analysis performed to date, the following conclusions are submitted within a reasonable degree of scientific and engineering certainty:

1. To ensure a supply of firefighting water is on-site, a 5,497-gallon water capacity would be required to respond to a transformer, vehicle, or Control House Enclosure fire. However, two 40,000-gallon water tanks are proposed.

2. The 40,000-gallon water supply in each tank would provide an initial water supply for up to five hours for cooling exposures, controlling smoke, or extinguishing small vegetation fires during a PowerTitan 2.0 fire event. During this initial five hours, a shuttle service can be set up by the fire service, to provide additional water to the site if it is required.

3. The water tank should be installed in an approved location.

4. In accordance with LACFC Section 507.2.2, the water tank utilized for private fire protection should be installed in accordance with NFPA 22.

5. The fire hydrants should be installed in accordance with LACFC Section 507.5.

Sincerely,

Christian Ng, P.E.
Senior Fire Protection Engineer

Appendix 3.17B

Hazard Mitigation Analysis Template

EXECUTIVE SUMMARY

<< *Insert Consultant*>>, was requested by <<*Insert Project Company*>> to develop a Hazard Mitigation Analysis (HMA) document for the << *Insert Battery Energy Storage System (BESS) Product*>>. <<*Insert BESS Product*>> proposed to be installed at BESS site located in Los Angeles, California. This HMA includes information about the BESS assembly, applicable codes, and fire code analysis.

The HMA was prepared in accordance with 2022 California Fire Code (CFC), Los Angeles County Fire Code (LACFC), and National Fire Protection Association (NFPA) requirements. UL (Underwriters Laboratories) 9540A testing was conducted in accordance with the UL 9540A Test Method for Evaluating Thermal Runaway Fire propagation in Battery Energy Storage Systems, 4th edition.

<<*Insert description of testing of cell level testing results*>> **example text** - Cell level testing consists of 5 tests. Cell tests 1, 2, 3, and 4 simulated a single battery cell undergoing thermal runaway. Cell test 5 was used to characterize the flammable gases that are vented during thermal runaway. The cells generated flammable gases, which resulted in the need for module level testing.

<<*Insert description of module testing results*>> **example text** - Module level testing consists of a single battery module undergoing thermal runaway. The test showed that thermal runaway of the event cell propagated into one adjacent cell and generated flammable off gassing through the module exterior, which resulted in the need for unit level testing.

<<*Insert description of unit testing results*>> **example text** - Unit level testing demonstrated that thermal runaway does not propagate beyond the initiating module and is contained within the module. Temperature measurement of modules adjacent to the initiating module showed that temperature needed to induce thermal runaway was not reached. No visible flames or flying debris were observed. The thermal runaway did not propagate to neighboring BESS units. Temperature and heat flux measurements in front of the initiating unit did not pose heat exposure risks.

<<*Insert description of additional protection engineering*>> **example text -** The UL 9540A unit level testing does not account for the protection provided by the BMS. The BMS provides multiple layers of protection and detection for the batteries by monitoring the cell voltage, temperature, discharging power, overvoltage protection, cell impedance, and fuse detection. In the event of an abnormal reading for any of the listed conditions, the BMS prevents the affected module from charging or discharging. In addition, the BESS container is equipped with a liquid battery coolant system that was not operational during testing.

<<*Insert description of additional UL test results*>> **example text -** The UL 9540A testing indicated that thermal runaway failure of battery cells will produce flammable gas. The BESS container explosion protection is providing using combustible concentration reduction method as described by NFPA 69. The system's performance is unknown; however, it will be validated for compliance prior to installation. Once the system specifics are provided, this document will be updated accordingly.

<<*Insert description of additional fault condition testing*>> **example text** A fault condition consequence analysis was conducted by the BESS manufacturer which illustrated that there are

numerous protections in place at the cell, module, and unit level to minimize the likelihood of a thermal runaway event within the cells. The condition consequence analysis, in conjunction with the UL testing, demonstrates that in the unlikely event that a thermal runway does occur, the risk is minimal.

<<Insert description of code criteria required for approval>> **example text -** Section §1207.1.4.2 of the LACFC list the criteria that must be met in order to gain approval of the HMA by the AHJ:

1. *Fires or explosions will be contained within unoccupied battery storage rooms for the minimum duration of the fire-resistance-rated specified [LACFC §1207.1.4.2(1)]:* The BESS containers are non-occupiable units installed outdoors and are not installed within rooms. Nonetheless, this has been demonstrated to be met through UL 9540A unit level testing showing thermal runaway is contained within a single module within a BESS unit.
2. *Fires and explosions in battery cabinets in occupied work centers will be detected in time to allow occupants within the room to evacuate safely [LACFC §1207.1.4.2(2)]:*
   The BESS containers are intended for outdoor installation. Nonetheless, this will be accomplished via smoke and gas detection with local notification. Further, the UL 9540A testing showed that the heat flux measurement in the means of egress path in front of the thermal runaway BESS is below the permitted testing value and does not pose a heat exposure risk.
3. *Toxic and highly toxic gases released during fires and other fault conditions shall not reach concentrations in excess of Immediately Dangerous to Life or Health (IDLH) levels in the building or adjacent means of egress routes during the time deemed necessary to evacuate from that area [LACFC §1207.1.4.2(3)]:* There are no toxic gases released during normal operation. Gas released during a fire emergency could result in a localized IDLH (since the units are not occupiable). First responders should don proper personal protective equipment (PPE) when responding to a battery emergency.
4. *Flammable gases released from batteries during charging, discharging and normal operation shall not exceed 10 percent of their lower flammability limit (LFL) [LACFC §1207.1.4.2(4)]:* Flammable gases are not released from the batteries during normal operation, charging, or discharging.
5. *Flammable gases released from batteries during fire, overcharging, and other abnormal conditions will be controlled through the use of ventilation of gases, preventing accumulation, or deflagration venting [LACFC §1207.1.4.2(5)]:* The BESS container explosion protection system using combustible gas concentration reduction method as described by NFPA 69. Details on the explosion protection system are being finalized and the HMA will be updated once provided.

In summary, compliance with the Hazard Mitigation Analysis criteria laid out in LACFC 2023 will be determined once the combustible gas concentration reduction system's performance is verified.

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Emergency Response Plan Template

Emergency Response Action Plan

<<Insert Project Name and Address>>

This plan has been developed ***to assist the local emergency responders*** *with important safety and emergency response information concerning CSI energy storage system battery installations.*

This site-specific document and supporting material ***should be consulted prior to any fire service personnel performing firefighting operations or entering the <<Insert Project Name>> site.***

Approved By:

Confidential

Date:

{{Reserved for Notice that materials may be privileged, confidential, trade secret or otherwise protected}}

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Plume Analysis

Representative Plume Analysis for Outside Ground Mounted Battery Using Sungrow Power Titan 2.0

Prairie Song Reliability Project

Plume Analysis for Outside Ground Mounted Battery Energy Storage Systems: SunGrow PowerTitan2.0 Los Angeles County, California

Report | REV0 | March 20, 2025

Prepared for:

Prairie Song Reliability Project, LLC.

[redacted]

Prepared by:

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Date	Revision	Reason for Issue	Developed By	Checked By	Approved by
2/14/2025	REVA	DRAFT	MHR	MHR	CNN
3/20/2025	REV0	FINAL	MHR	MHR	CNN

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EXECUTIVE SUMMARY

Fire & Risk Alliance, LLC (FRA) was contracted by Prairie Song Reliability Project LLC to perform a Plume Analysis of the SunGrow PowerTitan2.0 Energy Storage System (ESS) (model ST5015UX) intended for installation at the Prairie Song Reliability Project facility located in Los Angeles County, California. The analysis objective is to evaluate the plume dynamics for the modeled release of battery vent gas due to a propagating thermal runaway event. This plume analysis was performed using the Process Hazard Analysis Software Tools (PHAST) consequence modeling tool to model the pre-combustion gas dispersion and their associated consequences based on the gas composition and release dynamics described in the UL 9540A cell/module/unit level tests.

This report considers all potential release scenarios and consequence extents for pre-combustion battery vent gas release scenarios. Scenarios for pre-combustion releases included the 5-cell UL 9540A module level test-based release, and hypothetical scenarios for a full-volume module release, a full-volume rack of 8 modules each, and a full-volume release of the entire 48 module enclosure.

Analysis of results for all pre-combustion battery vent gas release scenarios show that there are no significant hazards that extend measurably beyond the nearest property boundary for both the flammable and toxic portions of the cloud.

The following results were reported for pre-combustion battery venting scenarios. For the UL 9540A-based propagation duration release scenarios, the maximum extent of impact from the ½ LFL flammable vapor cloud (3.1%) was 7.64 m for Scenario 4.1, the entire. Flash fires were a modeled consequence for all pre-combustion scenarios. However, the flash 48 module enclosure release fire envelope did not extend beyond the proposed generic property boundaries for any scenarios. For non-flaming pre-combustion releases where all battery vent gas is released via thermal runaway conditions alone, the component with the largest IDLH footprint is CO. The largest modeled CO IDLH extent was 17.69 m for Scenario 4.1 (48 module enclosure release), which is below the nearest distance to the proposed property boundaries. It is recommended that a 1.5x safety factor be incorporated into the minimum approach distance (MAD) for non-flaming release conditions. The resulting MAD is 26.5m.

Disclaimer:

This report and its contents are provided for informational purposes only and are based on the specific conditions, data, and product specifications available at the time of its preparation. The recommendations, designs, and conclusions presented herein are applicable solely to the specific product, site, or application described in this report.

The results presented in this report do not constitute a guarantee or warranty of performance in the field. All designs, calculations, and recommendations should be verified through appropriate field testing and site-specific evaluations. The accuracy and applicability of this report's findings may be subject to changes in conditions, technology, and standards that are beyond the scope of this analysis.

It is the responsibility of the owner, contractor, or designated party to conduct comprehensive testing and obtain all necessary approvals to confirm the validity of the design in the field. The authors, engineers, and firms involved in the creation of this report assume no liability for performance, errors, omissions, or failures that may arise during construction or operation, and no warranty of fitness for a particular purpose is implied.

Limitations:

At the request of the Client, FRA performed a plume analysis for the Sungrow PowerTitan2.0 lithium-ion battery BESS. The Sungrow PowerTitan2.0 is a fully integrated BESS consisting of battery modules, power electronics, control systems, a battery management system, a thermal management system, and an explosion control system all pre-assembled within a single, non-occupiable cabinet. It is meant for outdoor installations, mounted to the ground, for commercial, industrial, and utility applications. This assessment evaluated the plume dynamics from the release of battery vent gas due to a propagating thermal runaway event from the Sungrow PowerTitan2.0 for the Prairie Song Reliability Project Site. The modeled battery vent gas release scenarios could be caused by a non-fire propagating thermal runaway event affecting specified numbers of cells and modules. This analysis is based on one Sungrow PowerTitan2.0 enclosure.

The scope of services performed during this analysis may not adequately address the needs of other users of this report, and any re-use of this report or its conclusions presented herein are at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the analysis from the UL 9540A test reports provided to FRA by the Client. Any engineering analysis that utilizes modeling and calculations, such as the one presented in this report, has inherent limitations. While the methodology and assumptions used are based on best practices and available data, there are inherent assumptions made in any analysis and there may be additional uncertainties and unknown factors that can affect the accuracy of the results. Additionally, the analysis is limited by the quality and quantity of the data available at the time of the study. Therefore, the results of this analysis should be interpreted with these limitations in mind and should not be considered as absolute or definitive. No guarantee or warranty as to future performance is expressed or implied.

1.0 INTRODUCTION

Fire & Risk Alliance, LLC (FRA) was contracted by Prairie Song Reliability Project LLC to perform a Plume Analysis of the SunGrow PowerTitan2.0 Energy Storage System (ESS) (model ST5015UX) intended for installation at the Prairie Song Reliability Project facility located in Los Angeles County, California. The analysis objective is to evaluate the plume dynamics for the modeled release of battery vent gas due to a propagating thermal runaway event. This plume analysis was performed using the PHAST consequence modeling tool to model pre-combustion battery gas venting releases, subsequent gas dispersion, and associated consequences. The Prairie Song Reliability Project facility layout is shown below in Figure 1.

The PowerTitan2.0 ESS is a lithium-ion Battery Energy Storage System (BESS) with a capacity of 5,015 kilowatt hours (kWh) for a 6-rack configuration. The PowerTitan2.0 ESS is equipped with six (6) racks of eight (8) modules, with each module comprised of 104-cells in series. It is a pre-assembled, non-walk-in (NWI) style, containerized BESS that is listed to the 2020 Edition of UL 9540, *Energy Storage Systems and Equipment*. It is not occupiable and is meant for outdoor installations only.

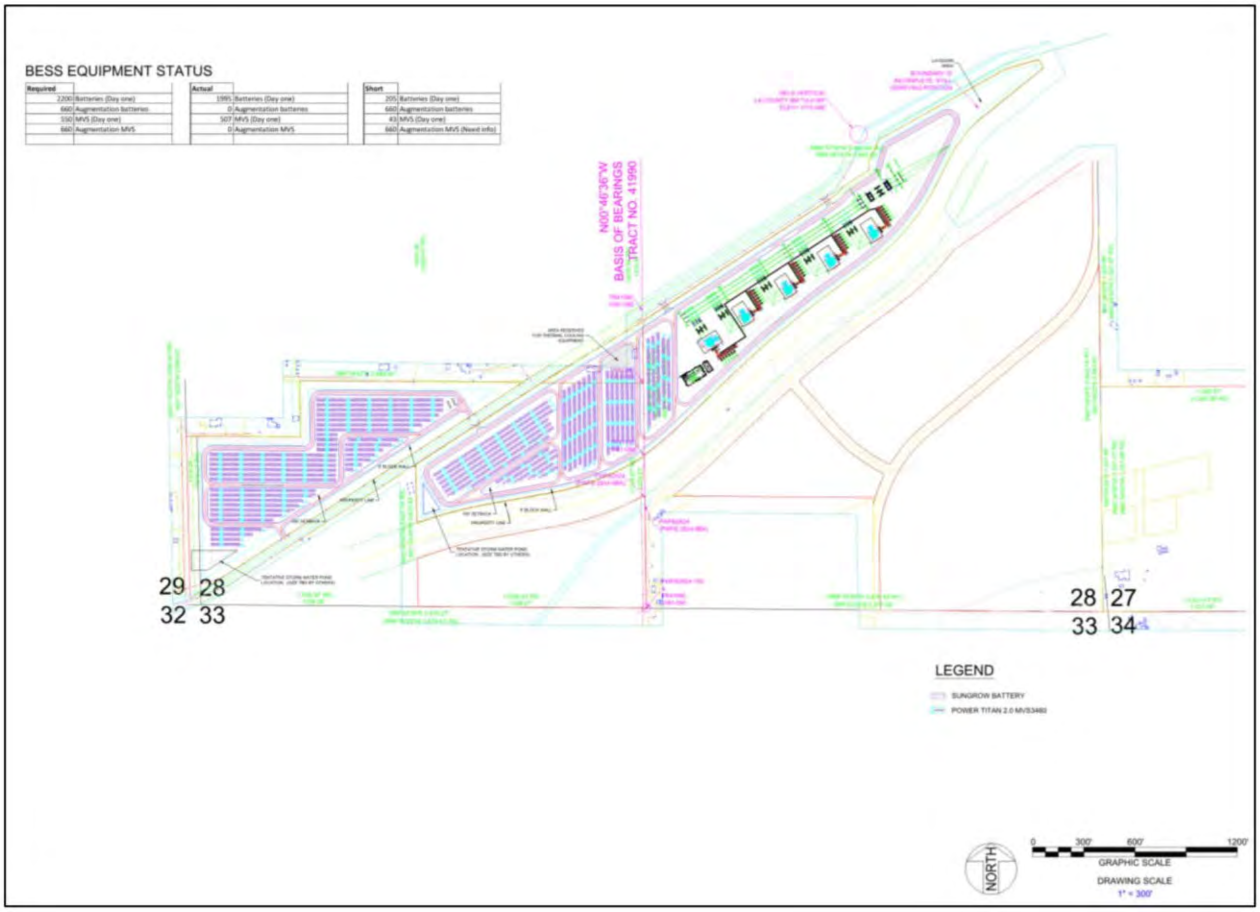


Figure 1. Prairie Song Reliability Project Site Layout

2.0 PowerTitan2.0 ESS Description

The PowerTitan2.0 ESS is a fully integrated BESS with battery modules, power electronics, control systems, battery management system (BMS), thermal management system (TMS), fire detection and notification system, and explosion control system (NFPA 68 & 69) all assembled within a single enclosure. It is meant for outdoor installations and is ground mounted.

2.1 Cell

The cell is the smallest anatomy of the battery assembly. The PowerTitan2.0 ESS utilizes a lithium iron phosphate (LFP) prismatic cell, as shown in Figure 2. The cells are CALB model L173F314 and are UL 1973 compliant. Each cell has a nominal capacity of 314 ampere hours (Ah), a nominal voltage of 3.2 volts (V), and a nominal energy of 1.004 kWh. CCIC-CSA International Certification Co., Ltd. Kunshan Branch (CSA) performed UL 9540A cell level testing and issued a report.[1]

Based on a review of the UL 9540A report, the gas volume released during the cell test measured 192 liters and the gas composition produced during the test is shown in Table 1. The cell vent gas flammability properties are shown in Table 2.

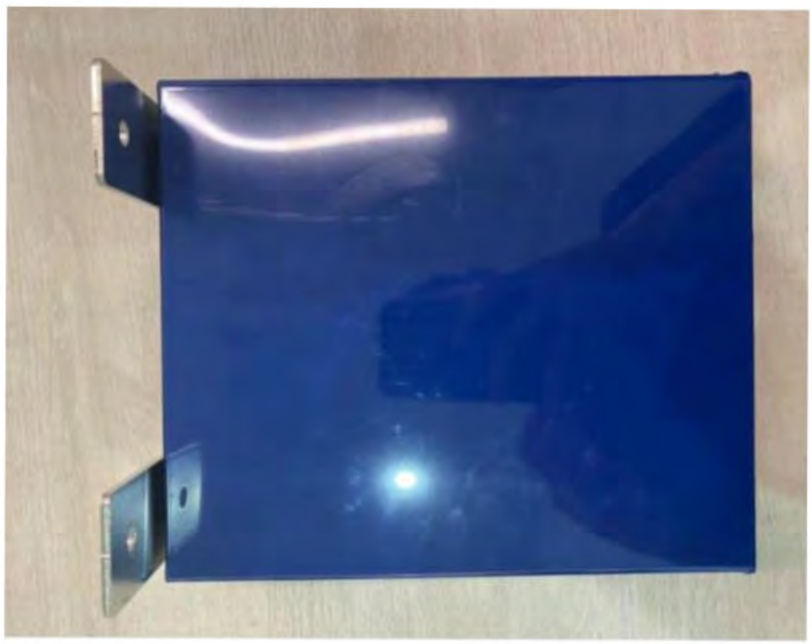


Figure 2. PowerTitan2.0 Cell

[1] Project # 80184345, CCIC-CSA International Certification Company Limited Kunshan Branch, Dated 2023.09.28

Table 1. UL 9540A Cell Vent Gas Composition

Gas Composition	Cell gas analysis	
	Liters	%
Carbon monoxide	23.35	13.92
Carbon dioxide	45.68	27.24
Hydrogen	75.34	44.93
Methane	10.77	6.42
Acetylene	0.57	0.34
Ethylene	6.42	3.83
Ethane	1.67	1.00
Propylene	2.06	1.23
Propane	0.54	0.32
C4 Hydrocarbons	1.11	0.66
C5 Hydrocarbons	0.20	0.12
Total	**192**	**100**

Table 2. UL 9540A Cell Vent Gas Flammability Properties

Vent gas information and flammability properties	
Average cell surface temperature at gas venting	140.5°C
Average cell surface temperature at thermal runaway	210.6°C
LFL, % volume in air at the ambient temperature	6.2%
LFL, % volume in air at the venting temperature	5.6%

2.2 Module

The battery module is the second smallest level of the battery assembly. The PowerTitan2.0 ESS module is comprised of one hundred-four (104) CALB LFP cells wired in series and has a rated capacity of 314 Ah, a nominal voltage of 332.8 V, and a nominal energy rating of 104.5 kWh. The module configuration is shown below in Figure 3. Insulation pads and aerogel layers are installed between the cells to reduce the likelihood of thermal runaway propagation. TUV Rheinland performed UL 9540A module level testing and issued a report.[2]

[2] Project # CN23P68X, TUV Rheinland (Shanghai) Co., Ltd., Dated 2023.12.16

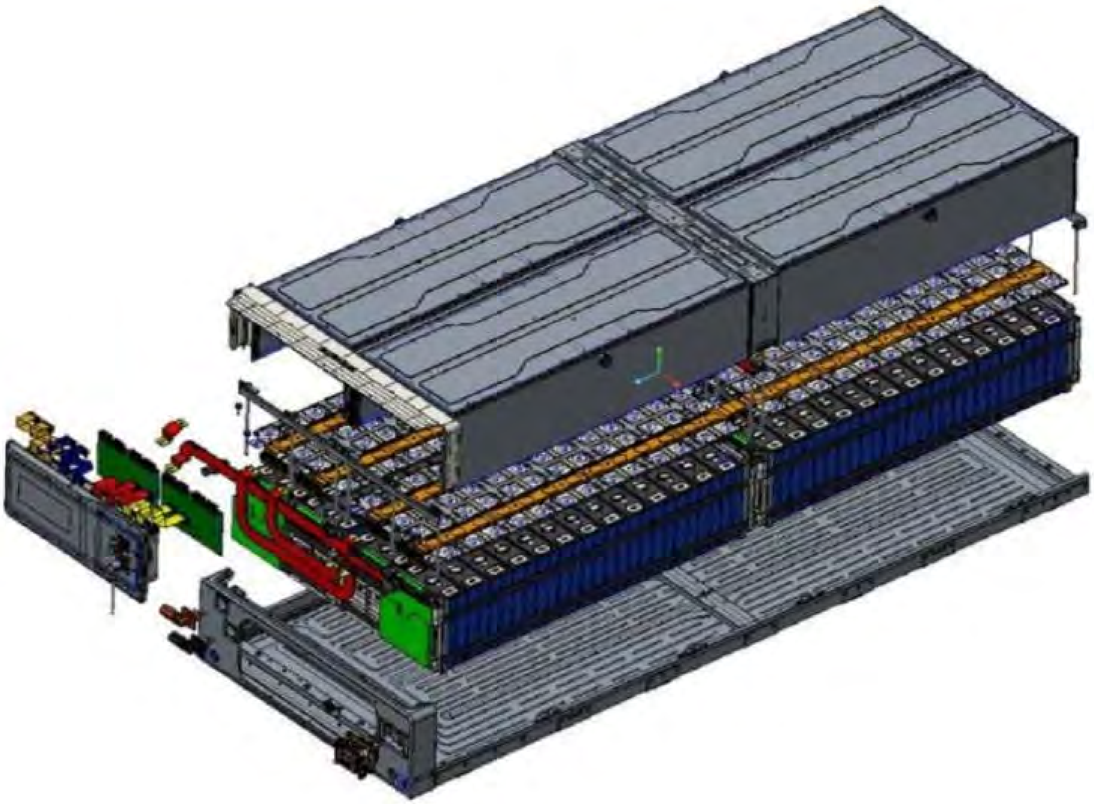


Figure 3. PowerTitan2.0 Module

2.3 PowerTitan2.0 Rack

The rack is the third level of the battery assembly. The racks utilized in the PowerTitan2.0 ESS are model R0417BL-AH with rack dimensions of 790mm x 2214mm x 1000mm (WxDxH), as shown below in Figure 4. The rack has a rated capacity of 314 Ah, a nominal voltage of 1,331 V, and a nominal energy rating of 417.996 kWh. Each PowerTitan2.0 rack holds eight (8) modules, and a BMS. TUV Rheinland performed UL 9540A module level testing and issued a report.[3]

[3] Project # CN23JPBV 001, TUV Rheinland (Shanghai) Co., Ltd., Dated 2023.12.16

Figure 4. PowerTitan2.0 Rack

2.4 PowerTitan2.0 Enclosure

The PowerTitan2.0 enclosure is the final level of the battery assembly. The PowerTitan2.0 ESS is a pre-assembled, non-walk-in (NWI) style, containerized BESS that is listed to the 2020 Edition of UL 9540, *Energy Storage Systems and Equipment*. It is not occupiable and is meant for outdoor installations only. The PowerTitan2.0 enclosure protects the batteries from mechanical damage and weather conditions and provides a rigid metal frame to house the six (6) racks of eight (8) modules, BMS, and components, as shown in Figure 5.

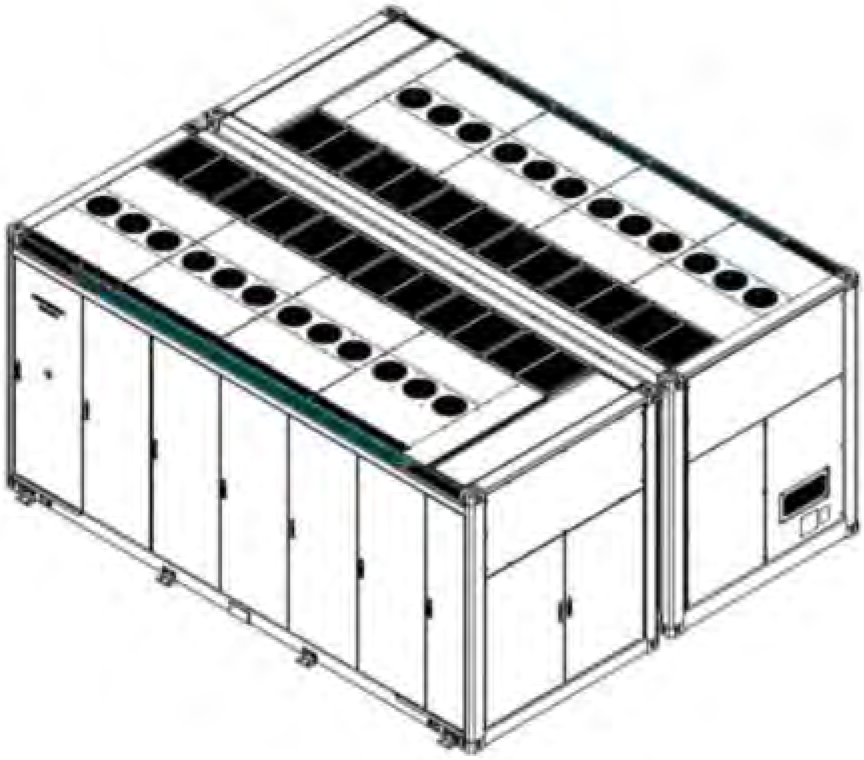


Figure 5. PowerTitan2.0 ESS (rear to rear configuration)

3.0 PHAST CONSEQUENCE MODELING

The Process Hazard Analysis Software Tools (PHAST) Unified Dispersion Model (UDM) was used to calculate the downwind dispersion distances, concentration profiles, and widths of flammable and toxic (CO Immediately Dangerous to Life and Health) releases for pre-combustion battery vent gas. Dispersion models require the use of an averaging time to calculate the maximum concentration and plume width for the duration of the release and subsequent time until the cloud concentration falls below threshold values for flammable and toxic levels. PHAST uses a time dependent calculation approach that iterates through timesteps based on release dynamics. In order to calculate consequences from releases, time steps are averaged independently for fire, explosion, and toxic dispersion based on established and validated ranges. The PHAST default averaging time for flammable dispersion models is 18.75 seconds and 30 minutes for Immediately Dangerous to Life and Health (IDLH) concentrations.

All pre-combustion battery venting scenarios use a calculated release duration based on the cell-to-cell thermal runaway propagation rate observed in the UL9540A test data. The UL 9540A test data show that 5-cells underwent venting and thermal runaway within a ~30-minute duration. This 5-cell propagation rate was then applied to all 104-cells at the module level, resulting in a module level release duration of 124.8 minutes for venting and thermal runaway. The 124.8-minute module level release duration was used as the modeled duration for all subsequent module/rack/enclosure level releases. In an effort to model upper-level conservative boundaries, the model assumed a common fault/failure leading to thermal runaway in all affected modules simultaneously.

For the modeled release scenarios, the gas generation source term was modeled as a mixture according to gas properties with the component concentrations taken from those listed in the UL 9540A reports for pre-combustion. In addition to Lower Flammability Limit (LFL) and associated consequences, the CO component of the gas mixture was tracked to determine the maximum extent of the component IDLH concentration (1,200 ppm CO) within the cloud.

3.1 Battery Vent Gas Release Scenarios

To define the extent of flammable and toxic components, battery vent gas release scenarios were modeled in PHAST to determine the maximum extent of the flammable cloud (3.1% ½ LFL; 6.2% LFL), and of the CO IDLH of 1200 parts per million (ppm) of the cloud. CO was selected as the toxic component to be tracked as all other toxic components within the battery gas composition fell below IDLH toxic thresholds. All release timing and mass flow rates for battery vent gas releases were based directly on values obtained from UL 9540A cell/module test data, with a cell-based mass flow rate for total vent gas (TVG) of 0.00055 kg/s.

Battery vent gas release scenarios were selected to cover the entire range of potential non-flaming releases from the minimum number of cells determined to have undergone thermal runaway in UL 9540A module level testing (5-cells), assumed propagation at the module level (104-cells), assumed propagation to the BMS/rack level (8-modules), and assumed propagation to the enclosure level (6-0racks; 48-modules).

As such, the following four (4) battery vent gas release scenarios were modeled in PHAST:

- Scenario 1: UL 9540A Based Scenario (5-cells venting under thermal runaway)

  - 1.1: Propagation rate of 5-cells per 30-minutes from UL 9540A module test report (32 l/min)
  - 1.2: Instantaneous release
- Scenario 2: 1-Module Release (104-cells)
  - Propagation rate of 5-cells per 30-minutes from UL 9540A module test report (160 l/min for 124.8 min)
- Scenario 3: 1-Rack Release (8-modules (832-cells))
  - Propagation rate of 5-cells per 30-minutes from UL 9540A module test report (1280 l/min for 124.8 min)
- Scenario 4: Enclosure Release (48-modules (4992-cells))
  - Propagation rate of 5-cells per 30-minutes from UL 9540A module test report (7680 l/min for 124.8 min)

For the above scenarios, the flammable cloud was modeled as a mixture according to the component concentrations listed in the UL 9540A reports and gas properties, and CO was tracked as a component of the release to determine the maximum extent of IDLH concentrations (1200 ppm of CO).

3.2 PHAST Model Parameters

Atmospheric stability and wind speed impact the consequence analysis results by increasing or reducing turbidity of the air flow, in turn maximizing or minimizing the dispersion of the vapor cloud. Pasquill stability classes are given in Table 3. Stability Class F was used as it represents stable atmospheric conditions with the least amount of turbulent mixing and dilution. Using Class F maximizes the predicted extent and concentration of the vapor cloud LFL and CO IDLH and represents the most conservative atmospheric model input.

Table 3. Pasquill Stability Classes

Stability Class	Definition	Stability Class	Definition
A	Very Unstable	**D**	Neutral
B	Unstable	**E**	Slightly Stable
C	Slightly Unstable	**F**	Stable

Wind speed data, as shown in Table 4, was obtained for the site based on long-term weather data.

Table 4. Weather Stations Utilized

Wind Speed (mph)	Pasquill Stability
2 (avg min)	F
5.2 (avg)	F
10.2 (avg max)	F

The site based average daily maximum, daily average, and daily minimum wind speeds (2 mph, 5.2 mph, 10.2 mph) that were used in a sensitivity analysis to determine what produced the furthest extent of the cloud (flammable and CO IDLH). As shown below in Figure 6 and Figure 7, the 2 mph wind speed produced the farthest extents for a flammable cloud and CO IDLH, and was used as the baseline for all PHAST modeling scenarios.

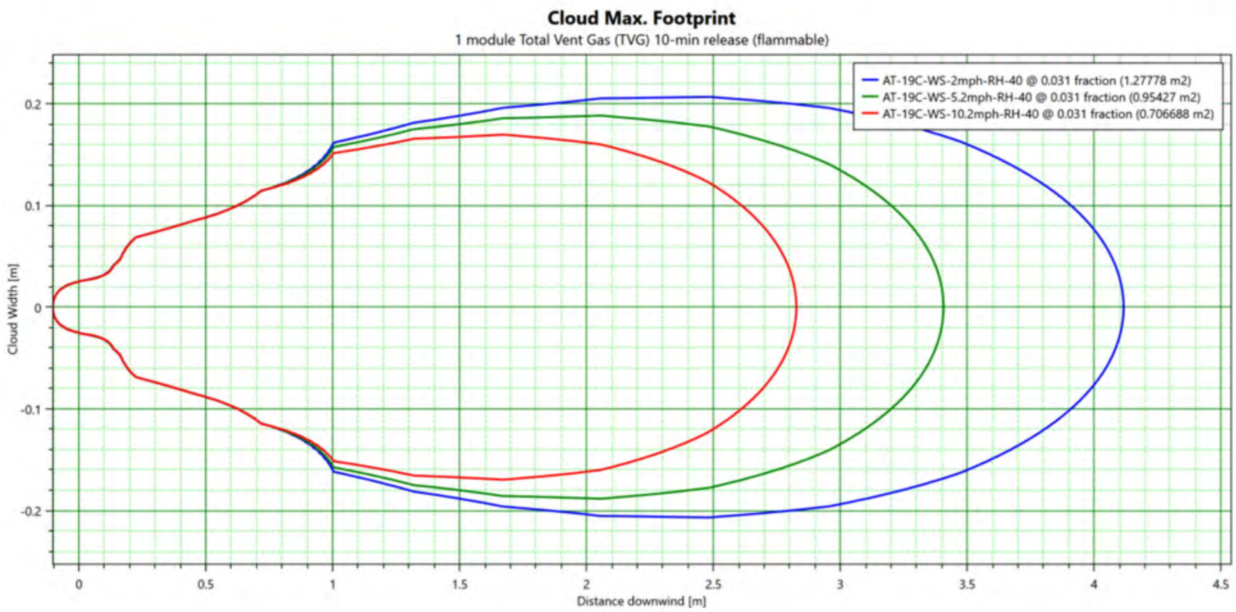


Figure 6. Wind Speed Comparison for TVG ½ LFL Extent (blue = 2 mph)

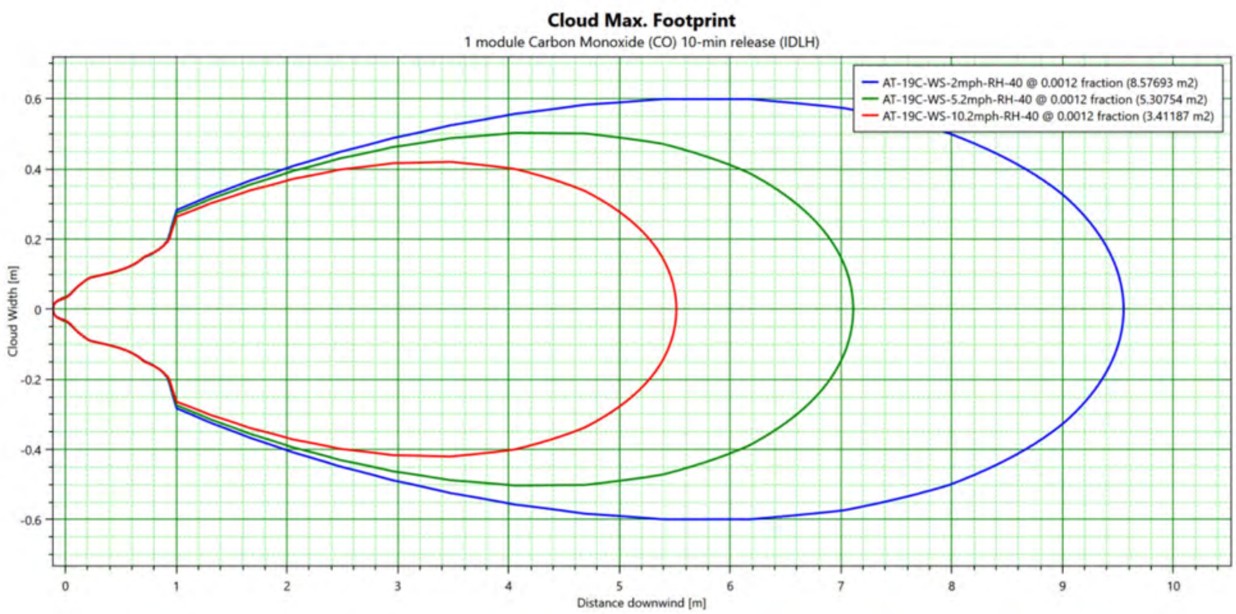
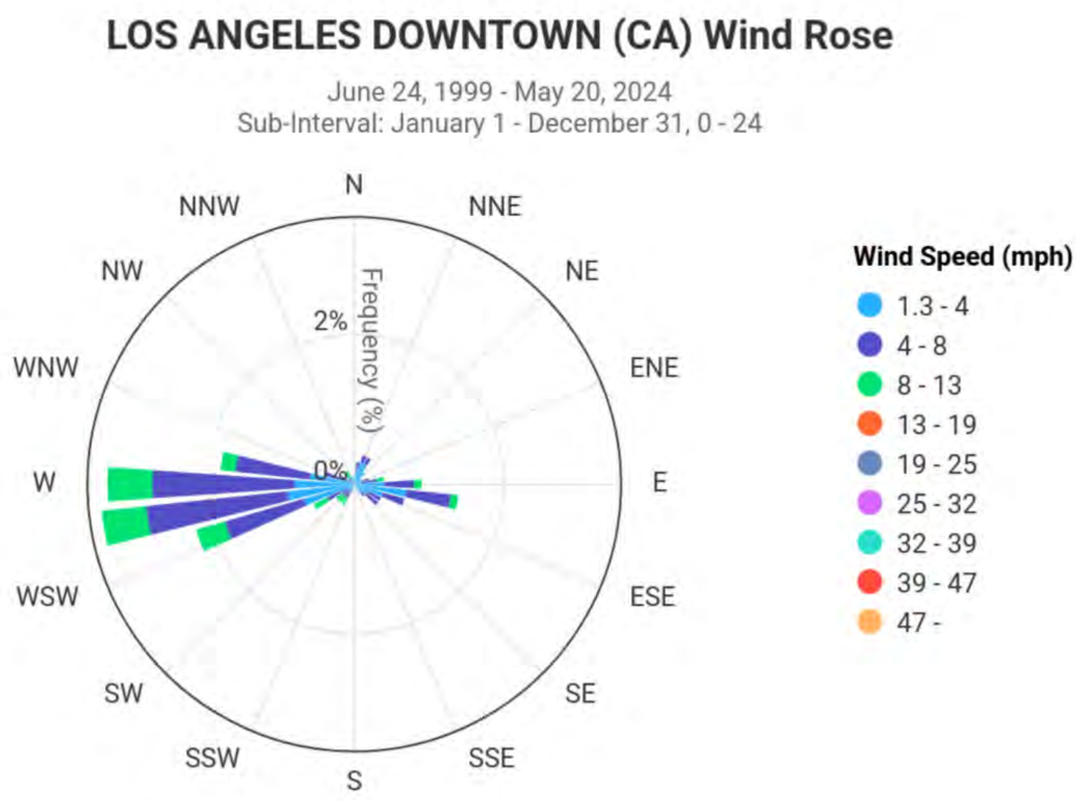


Figure 7. Wind Speed Comparison for CO IDLH Extent (blue = 2 mph)

Table 5. Representative Weather Conditions

Type	Prairie Song Reliability Project Facility
Average minimum wind speed (mph)	2
Pasquill stability class	F
Ambient temperature (°F)	66
Relative humidity (%)	40

All other PHAST modeling parameters for release conditions were taken directly from the UL 9540A reports and from the conservative calculations of the battery vent gas release rate, release duration, and propagation rate for individual cells.



4.0 PHAST RESULTS

Results of the PHAST consequence analysis for the four (4) main battery gas venting scenarios and associated sub-scenarios identified above in Section 3.0 are presented below.

Table 6. Results for Flammable and Toxic Extents for Release Scenarios (m)

Scenario	Duration	Flash-Fire Radius	100% LFL	50% LFL	CO IDLH
1 (UL 9540A 5-cell)	1.1 (30-min)	1.1	0.38	0.64	1.66
1 (UL 9540A 5-cell)	1.2 (Instantaneous*)	1.61	1.14	1.57	2.8
2 (1-module)	124.8-min	1.5	0.71	1.44	5.73
3 (1-Rack)	124.8-min	3.53	1.9	3.35	7.85
4 (Enclosure [6-rack])	124.8-min	8.03	4.34	7.64	17.69

**Instantaneous release was modeled for 5-cell volumes only. Module and enclosure level releases exceed the interior volume space of the BESS*

Table 7. Results for Fireball Thermal Radiation Extents (m)

Scenario	Duration	Fireball (m)		
		4.7 kW/m^2	12.5 kW/m^2	37.5 kW/m^2
1 (UL 9540A 5-cell)	1.2 (Instantaneous*)	8.24	5.08	NA

4.1 Scenario 1 (5-cell UL 950A based release) Modeling Results

4.1.1 5-cell UL 9540A 30-minute duration release

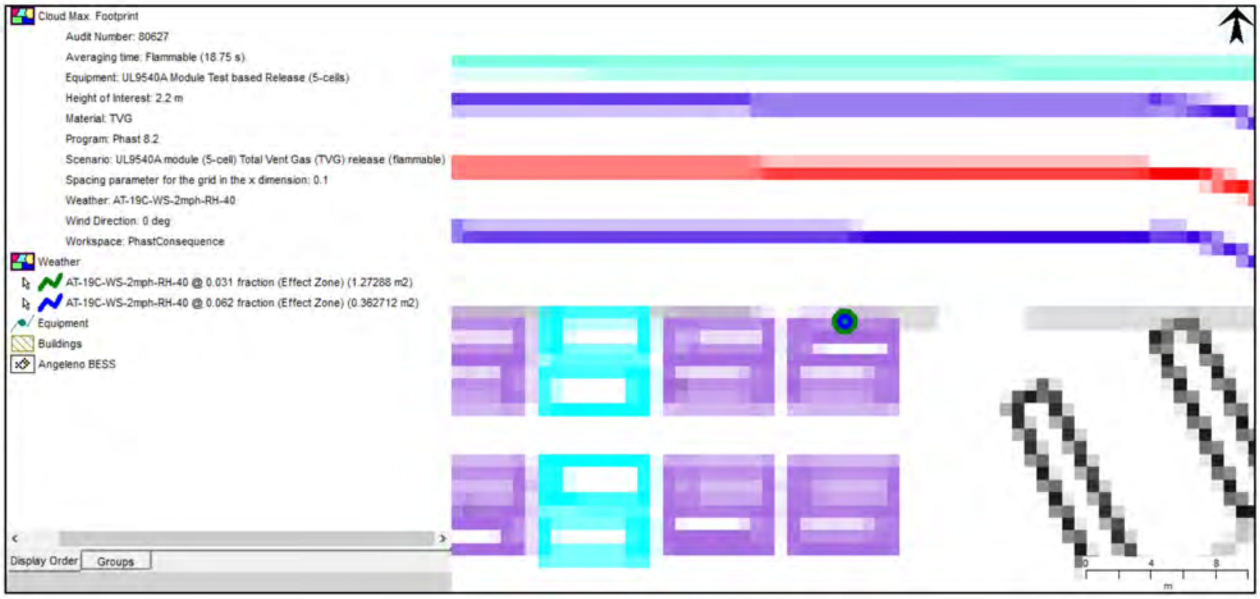


Figure 8. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

Figure 9. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

4.1.2 5-cell Instantaneous Release

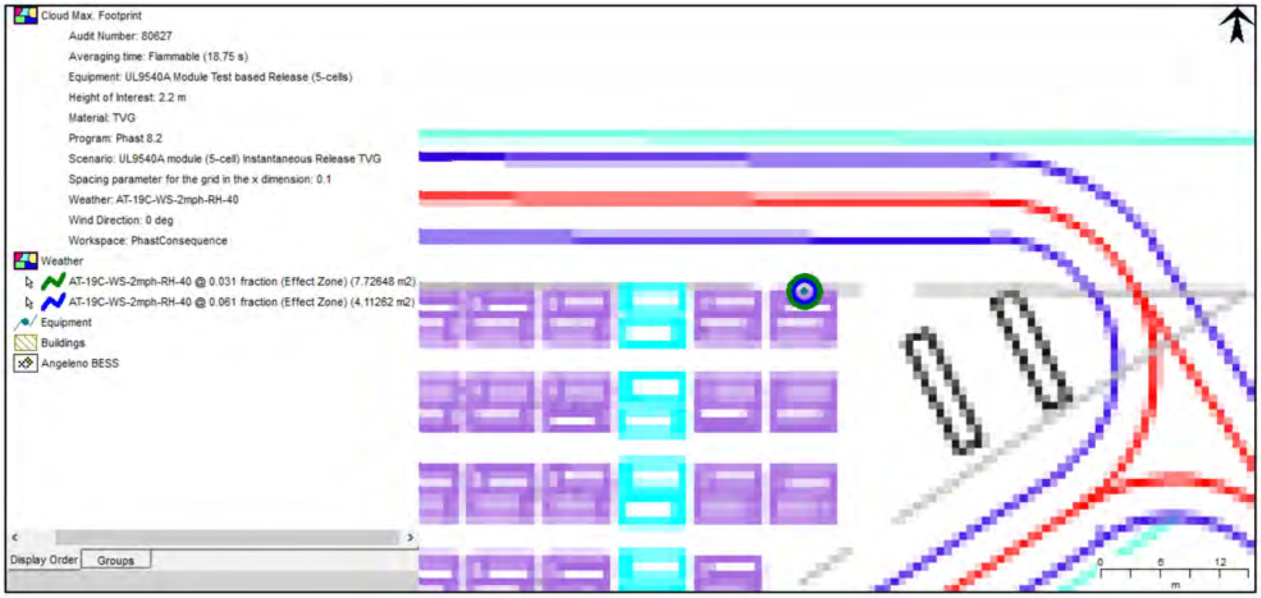


Figure 10. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

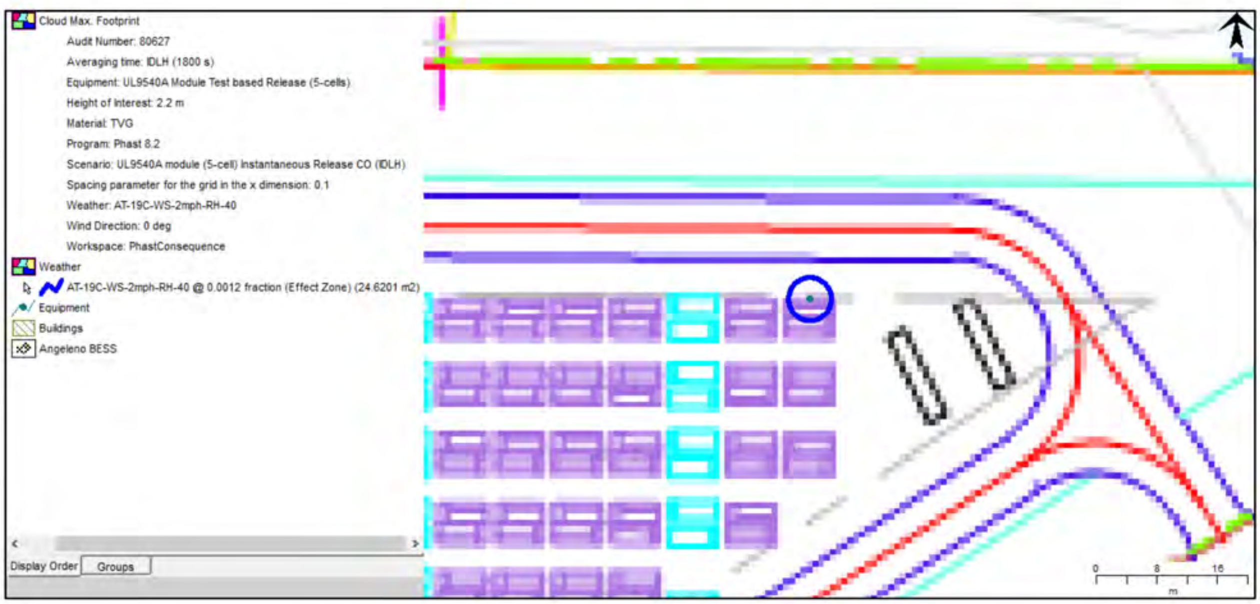


Figure 11. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

4.2 Scenario 2 (1-module release): PHAST Modeling Results

Figure 12. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

Figure 13. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

4.3 Scenarios 3 (1-rack [8-module] release): PHAST Modeling Results

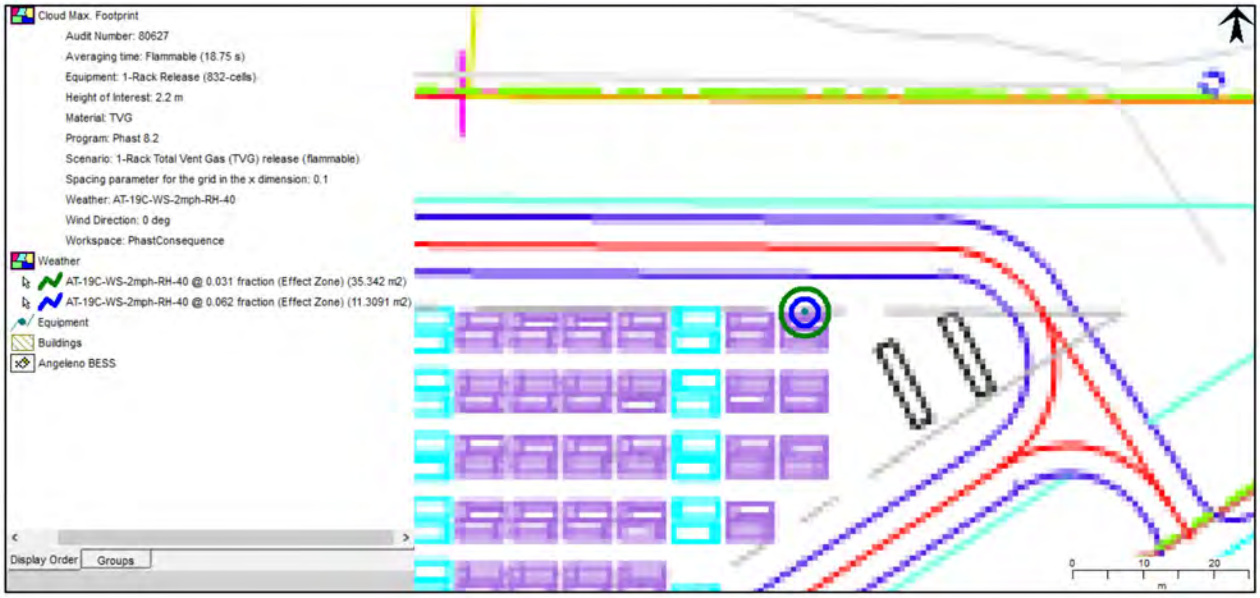


Figure 14. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

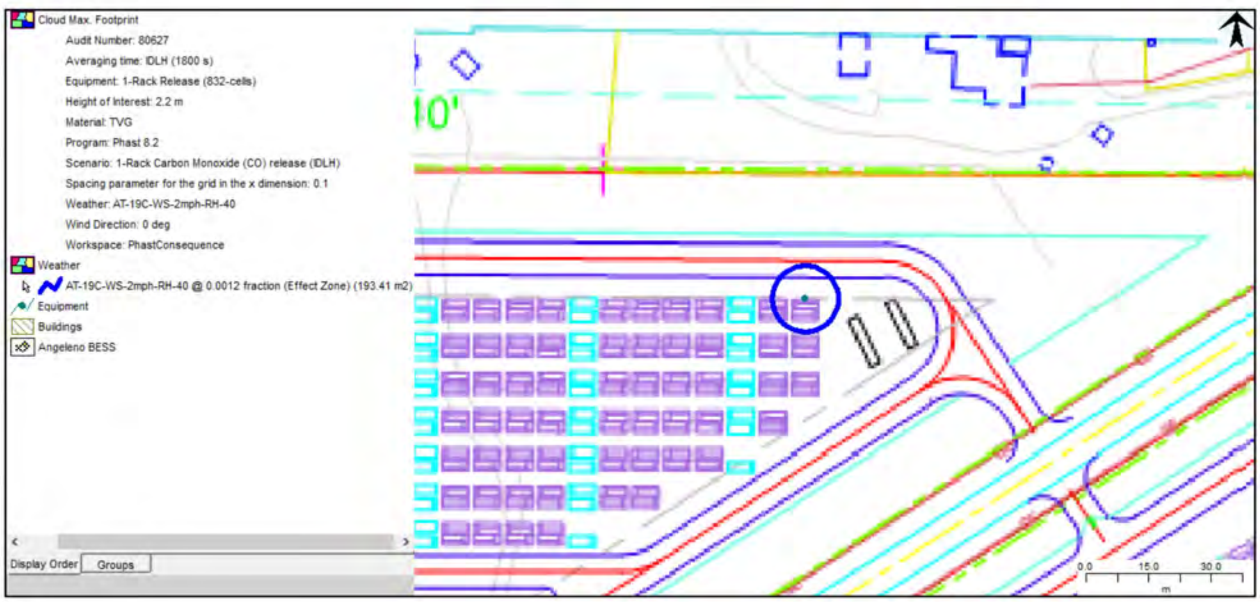


Figure 15. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

4.4 Scenarios 4 (Enclosure [6-rack] release): PHAST Modeling Results

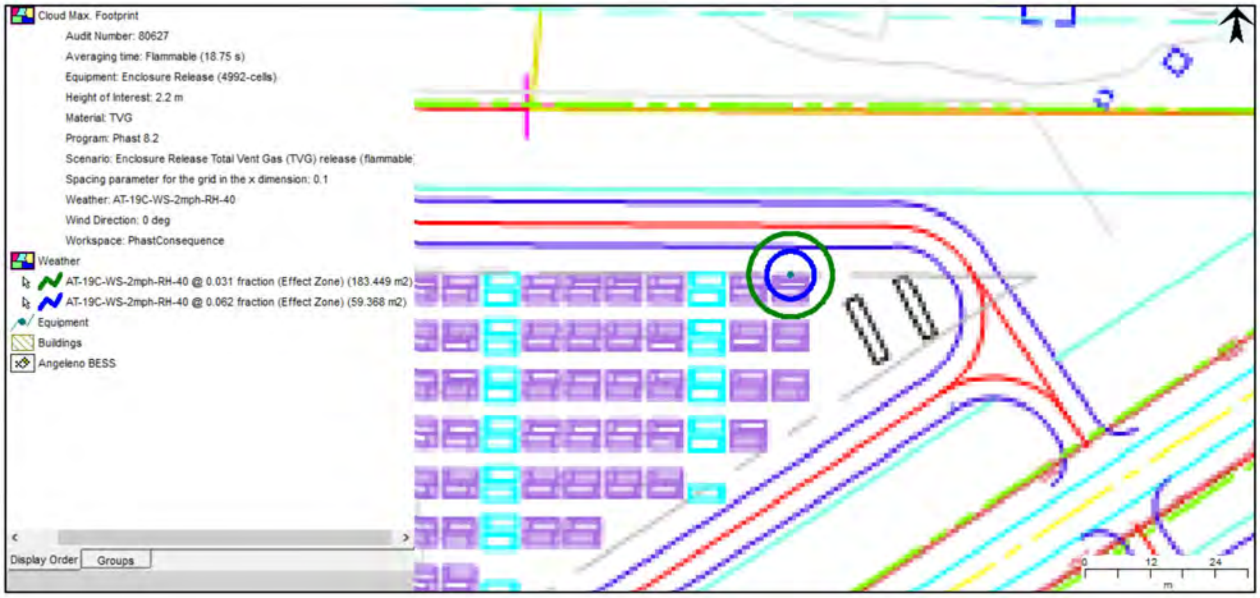


Figure 16. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

Figure 17. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

4.5 Flash-Fire Results for All Scenarios

A flash fire occurs when the battery vent gas released is diffused in air such that all flammable fuel shall be consumed nearly instantaneously once ignited. In a flash fire, the flame front accelerates rapidly from the ignition point to the limit of the flammable cloud, after which it immediately goes out. Thus, the duration of heat flux values equal to those sufficient to ignite flammable clothing or cause second-degree burns to exposed skin does not occur for more than 1-3 seconds (NFPA defines the upper limit of a flash fire to be 3 seconds) in any single location within the flash fire envelope.

4.5.1 Scenario 1 (5-cell UL 9540A based release)

Figure 18. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

4.5.2 Scenario 2 (Single module release)

Figure 19. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

4.5.3 Scenario 3 (1-rack [8-module] release)

Figure 20. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

4.5.4 Scenario 4 (Enclosure [6-rack] release)

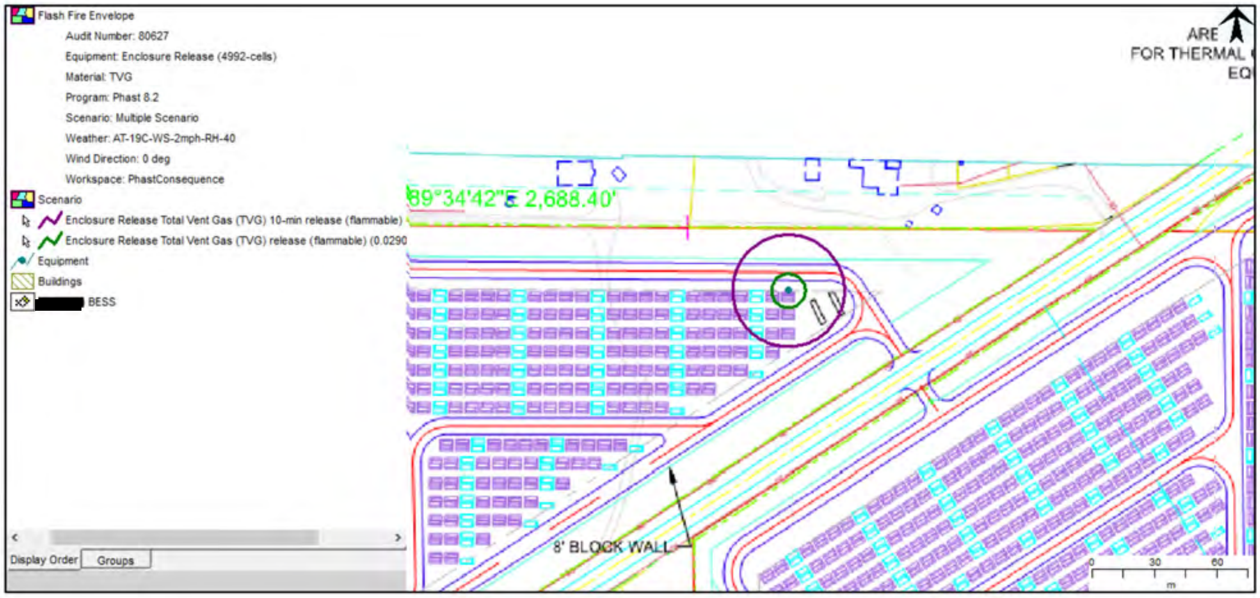


Figure 21. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

4.6 Explosion & Fireball Results

No UL 9540A based battery vent gas release scenario resulted in the formation of explosion overpressures. Only Scenario 1.3 (5-cell UL 9540A based instantaneous release) resulted in a potential fireball occurring as fireballs require late ignition and had an approximately 1 second duration as shown in Figure 22.

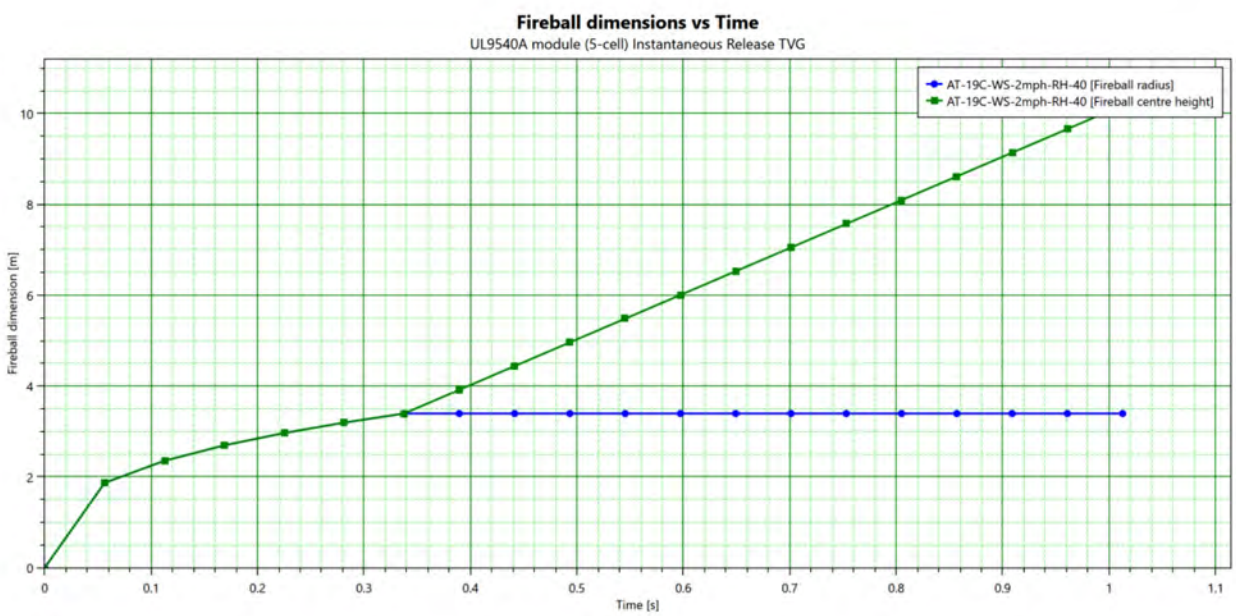


Figure 22. Fireball Duration and Extent for Scenario 1.3

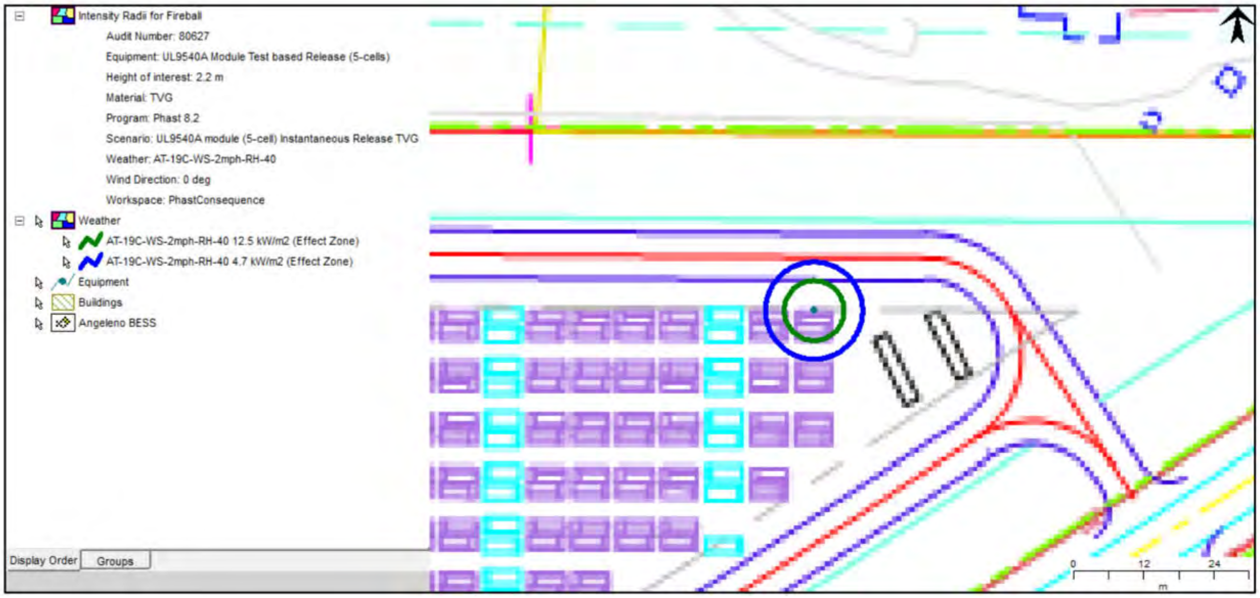


Figure 23. Fireball Heat Flux Extent (green = 12.5 kW/m^2; blue = 4.7 kW/m^2)

Additionally, based on the release rates and release volumes, none of the other battery vent gas release scenarios led to the consequence of a fireball. Therefore, there was no thermal radiation risk identified from a release of battery gas to atmosphere leading to a fireball or flash fires, and there is no significant off-site risk from overpressures due to a vapor cloud explosion.

5.0 CONCLUSIONS

It must be noted that though Scenario 4 (6-rack, 48-module full ESS release) was included in the analysis for understanding the theoretical worst-case scenarios of a pre-combustion release from all cells within an enclosure (4,992 cells), it is not a feasible scenario as the UL 9540A reports show no direct propagation between modules. Additionally, there are no single failures identified in the failure modes and effects analysis, documented in available BESS failure literature, or reported in anecdotal case reports that show or support a mechanism of failure that would cause thermal runaway to occur in 104 cells within a single module simultaneously, let alone for all 4,992 cells within the entire 6-rack 48-module ESS. As such, there is no existing test data or established failure mechanism in the UL 9540A reports that documented all 104 cells within a module or 4,992 cells within an ESS to undergo thermal runaway from a single failure. Rather, thermal runaway propagation from cell to cell would remain a direct component of battery gas release timing, release conditions, and associated consequences for all potential single failures initiating thermal runaway and battery gas venting in the PowerTitan2.0 ESS.

5.1 Total Vent Gas LFL Extent

In conclusion, modeling results for all UL 9540A-based scenarios and sub-scenarios showed no significant impact from flammable battery vent gas dispersion, with all releases staying within the site property boundaries.

The maximum extent of impact from the ½ LFL flammable vapor cloud (3.1%) was 7.64 m from the BESS for the UL 9540A- based propagation duration release of 124.8 minutes from the full enclosure (48 modules), as shown in the figure below in comparison to the other modeled release scenarios.

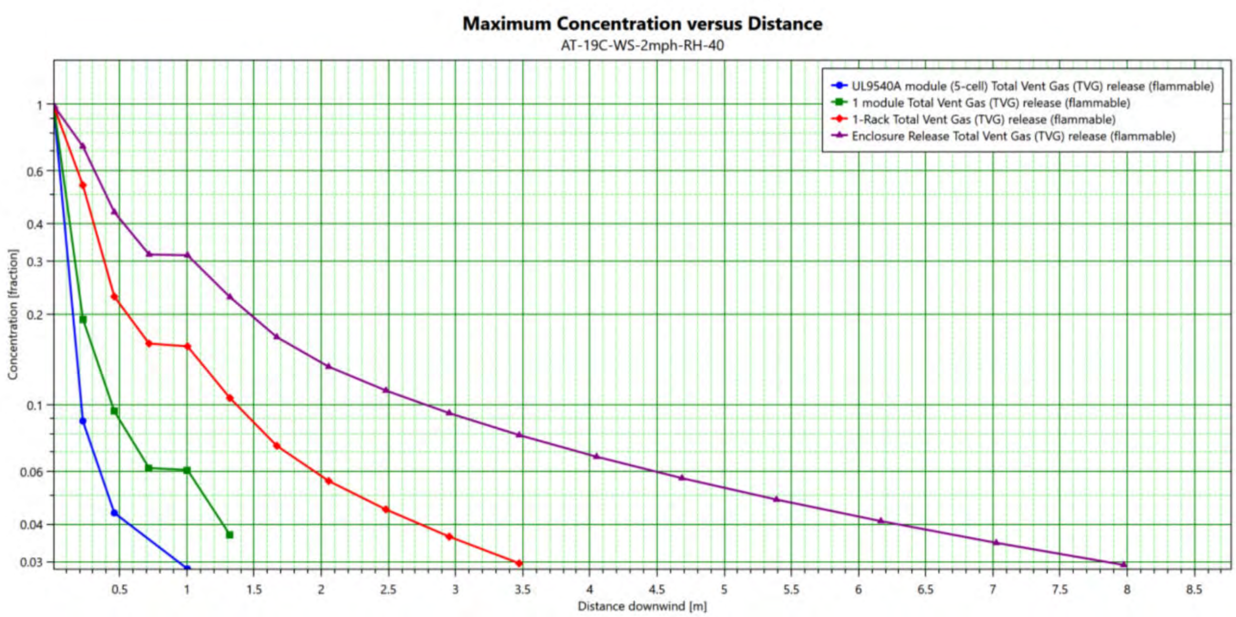


Figure 24. Concentration v. Distance for Sub-Scenarios 1.1, 2.1, 3.1, 4.1 (UL 9540A cell-to-cell release duration)

5.2 Flash Fires

Flash fires were a modeled consequence for all scenarios. The flash fire envelope did not extend beyond the proposed generic property boundaries for any of the UL 9540A-based venting scenarios. Even within the affected area on the general site plan, the duration of heat flux values equal to those sufficient to ignite flammable clothing or cause second-degree burns to exposed skin does not occur for more than one to three seconds (NFPA defines the upper limit of a flash fire to be three seconds) in any single location within the flash fire envelope.

As such, there would be no significant risk to persons or property offsite from the described venting scenarios.

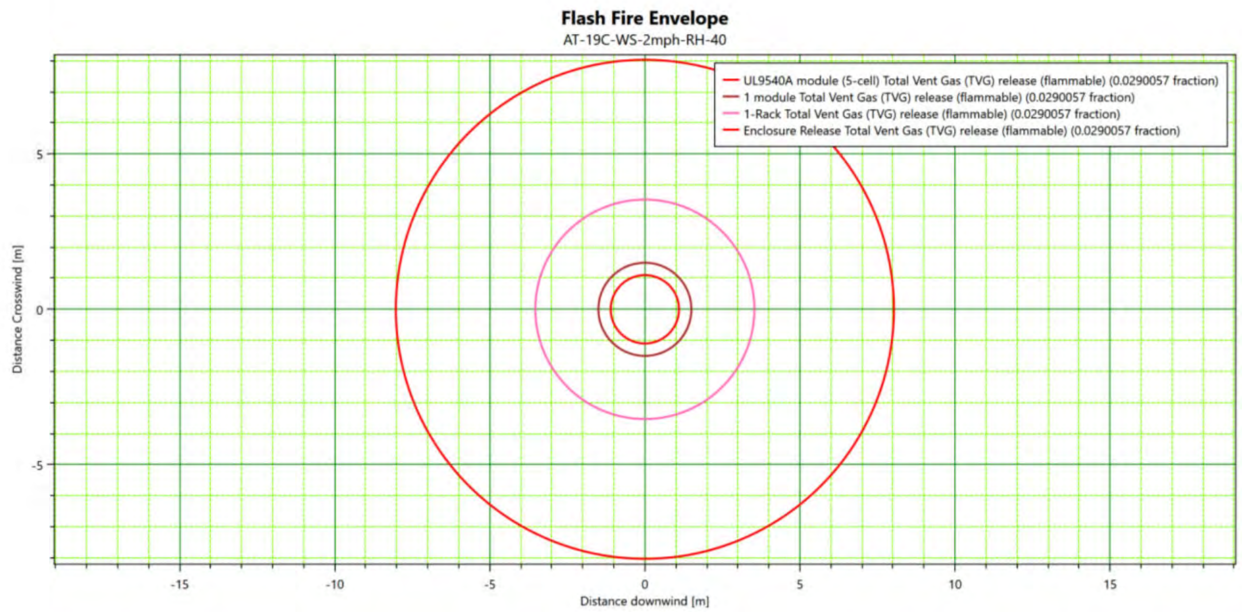


Figure 25. Flash Fire Envelope for Sub-Scenarios 1.1, 2.1, 3.1, 4.1 (UL 9540A cell-to-cell propagation release duration)

5.3 Carbon Monoxide IDLH Extent

Risk from CO exposure is comprised of both concentration and exposure time, with a minimum required exposure time of 30 minutes at the IDLH concentration of 1,200 ppm. A modeled release of carbon monoxide (CO) of battery vent gas, at the IDLH concentration of 1,200 ppm, from the entire 48-module enclosure with a 124.8-minute duration resulted in an IDLH extent of 17.69 meters.

All releases stay within the property boundaries, therefore there is no significant risk offsite from CO exposure for any modeled scenario.

See the quote below from the CDC CO IDLH publication as reference.

> *"It has been stated that a 1-hour exposure to 1,000 to 1,200 ppm would cause unpleasant but no dangerous symptoms, but that 1,500 to 2,000 ppm might be a dangerous concentration after 1 hour [Henderson et al. 1921a, 1921b].* ***In general, a carboxyhemoglobin (COHb) level of 10-20% will only cause slight headaches [NIOSH 1972]*** *and a COHb of 11-13% will have no effect on hand and foot reaction time, hand*

steadiness, or coordination [Stewart and Peterson 1970]. At a COHb of 35%, manual dexterity is impaired [Stewart 1975]. At 40% COHb, mental confusion, added to increasing incoordination, precludes driving an automobile [Stewart 1975]. ***A 30-minute exposure to 1,200 ppm will produce a COHb of 10-13% [NIOSH 1972].****"*

5.4 Recommended Minimum Approach Distance (Based on Toxic Exposure)

The Minimum Approach Distance (MAD) for emergency response personnel based solely on potential toxic exposure shall be governed by the component with the largest IDLH footprint.

For non-flaming pre-combustion releases where all battery vent gas is released via venting during thermal runaway conditions alone, the component with the largest IDLH footprint and required potential exposure duration (30-minutes) is CO. The extent of the CO IDLH cloud was ~17.69 meters for the entire enclosure release scenario (Scenario 4) with a 124.8-minute duration release. As such, it is recommended that by incorporating a 1.5x safety factor, the MAD for non-flaming release conditions be a minimum of 26.5 meters.

Disclaimer:

This report and its contents are provided for informational purposes only and are based on the specific conditions, data, and product specifications available at the time of its preparation. The recommendations, designs, and conclusions presented herein are applicable solely to the specific product, site, or application described in this report.

The results presented in this report do not constitute a guarantee or warranty of performance in the field. All designs, calculations, and recommendations should be verified through appropriate field testing and site-specific evaluations. The accuracy and applicability of this report's findings may be subject to changes in conditions, technology, and standards that are beyond the scope of this analysis.

It is the responsibility of the owner, contractor, or designated party to conduct comprehensive testing and obtain all necessary approvals to confirm the validity of the design in the field. The authors, engineers, and firms involved in the creation of this report assume no liability for performance, errors, omissions, or failures that may arise during construction or operation, and no warranty of fitness for a particular purpose is implied.

Limitations:

At the request of the Client, FRA performed a plume analysis for the Sungrow PowerTitan2.0 lithium-ion battery BESS. The Sungrow PowerTitan2.0 is a fully integrated BESS consisting of battery modules, power electronics, control systems, a battery management system, a thermal management system, and an explosion control system all pre-assembled within a single, non-occupiable cabinet. It is meant for outdoor installations, mounted to the ground, for commercial, industrial, and utility applications. This assessment evaluated the plume dynamics from the release of battery vent gas due to a propagating thermal runaway event from the Sungrow PowerTitan2.0 for the Prairie Song Reliability Project Site. The modeled battery vent gas release scenarios could be caused by a non-fire propagating thermal runaway event affecting specified numbers of cells and modules. This analysis is based on one Sungrow PowerTitan2.0 enclosure.

The scope of services performed during this analysis may not adequately address the needs of other users of this report, and any re-use of this report or its conclusions presented herein are at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the analysis from the UL 9540A test reports provided to FRA by the Client. Any engineering analysis that utilizes modeling and calculations, such as the one presented in this report, has inherent limitations. While the methodology and assumptions used are based on best practices and available data, there are inherent assumptions made in any analysis and there may be additional uncertainties and unknown factors that can affect the accuracy of the results. Additionally, the analysis is limited by the quality and quantity of the data available at the time of the study. Therefore, the results of this analysis should be interpreted with these limitations in mind and should not be considered as absolute or definitive. No guarantee or warranty as to future performance is expressed or implied.

APPENDIX A: SUPPORTING GRAPHICAL OUTPUT

APPENDIX A: GRAPHICAL RESULTS (PHAST ANALYSIS)

1.0 Scenario 1: 5-cell UL9540A Thermal Runaway (from UL9540A test data)

1.1.1 TVG Flammable Vapor Cloud Extent (30 min Release)

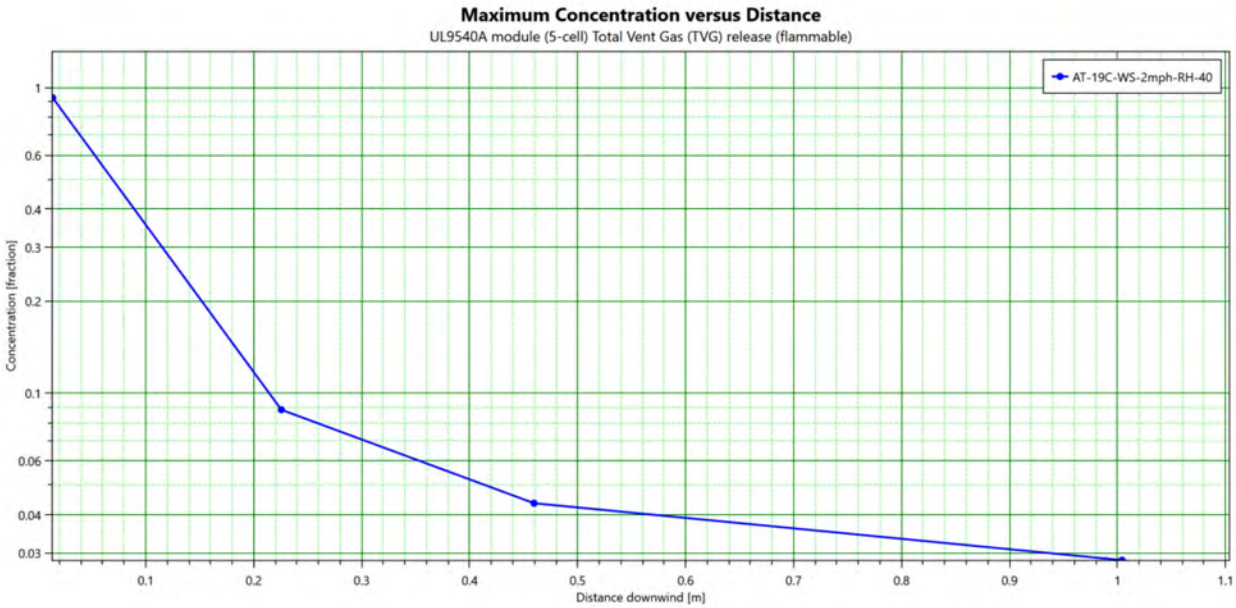


Figure 1. Maximum concentration vs distance for flammable vapor cloud

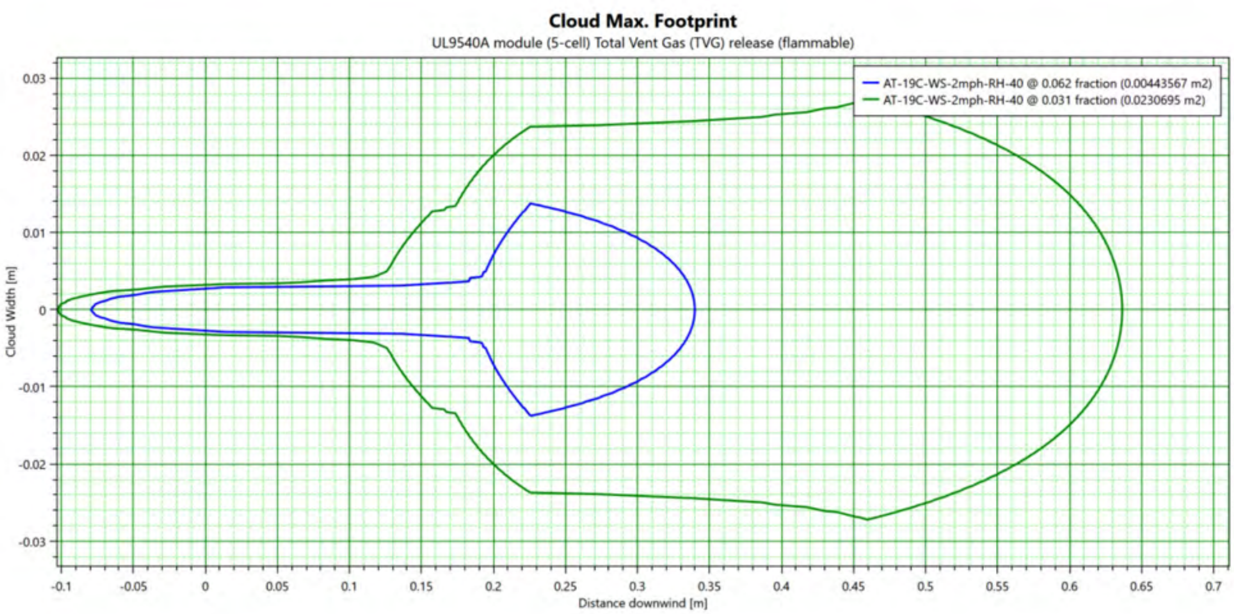


Figure 2. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

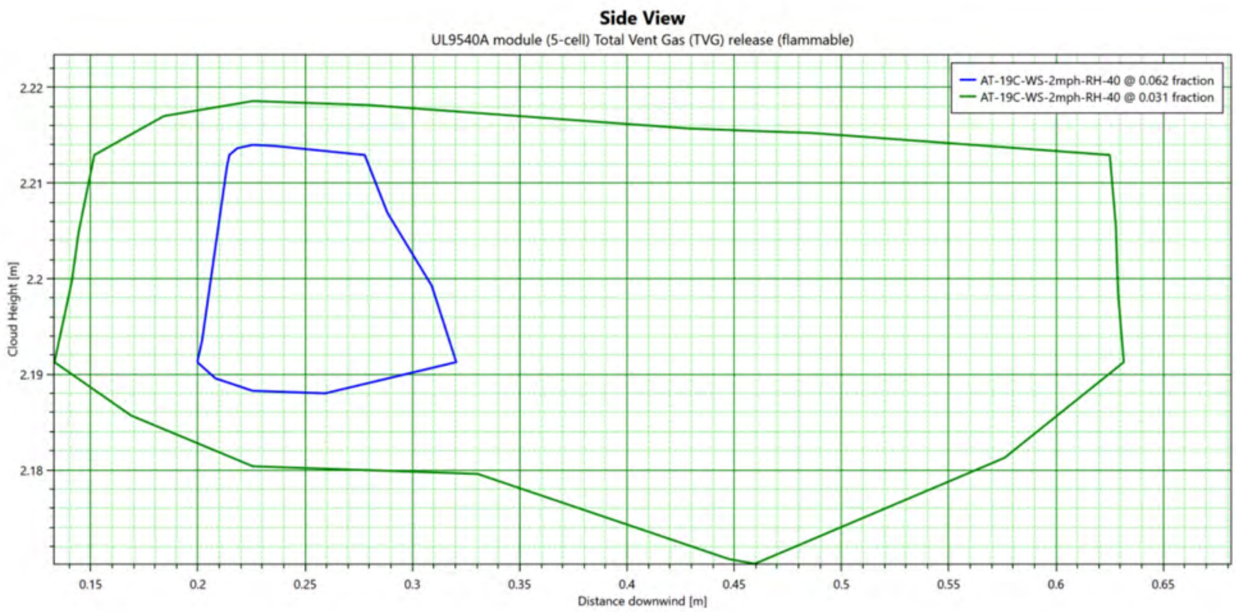


Figure 3. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

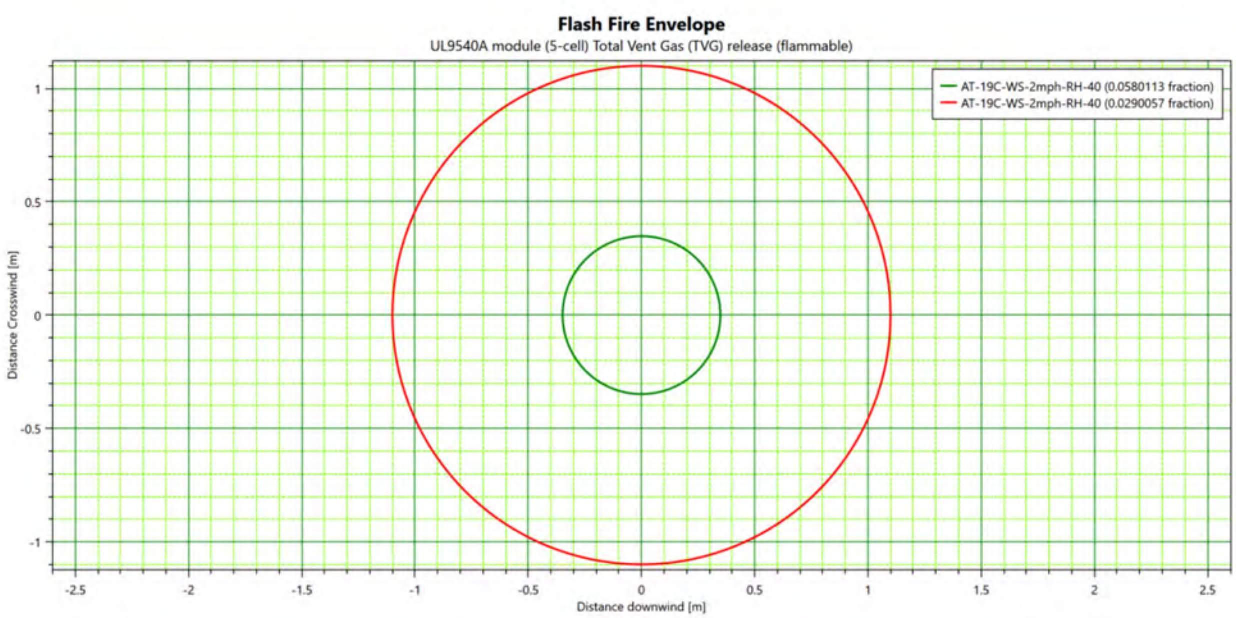


Figure 4. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.1.2 CO IDLH (1200 ppm) Component Extent (30 min Release)

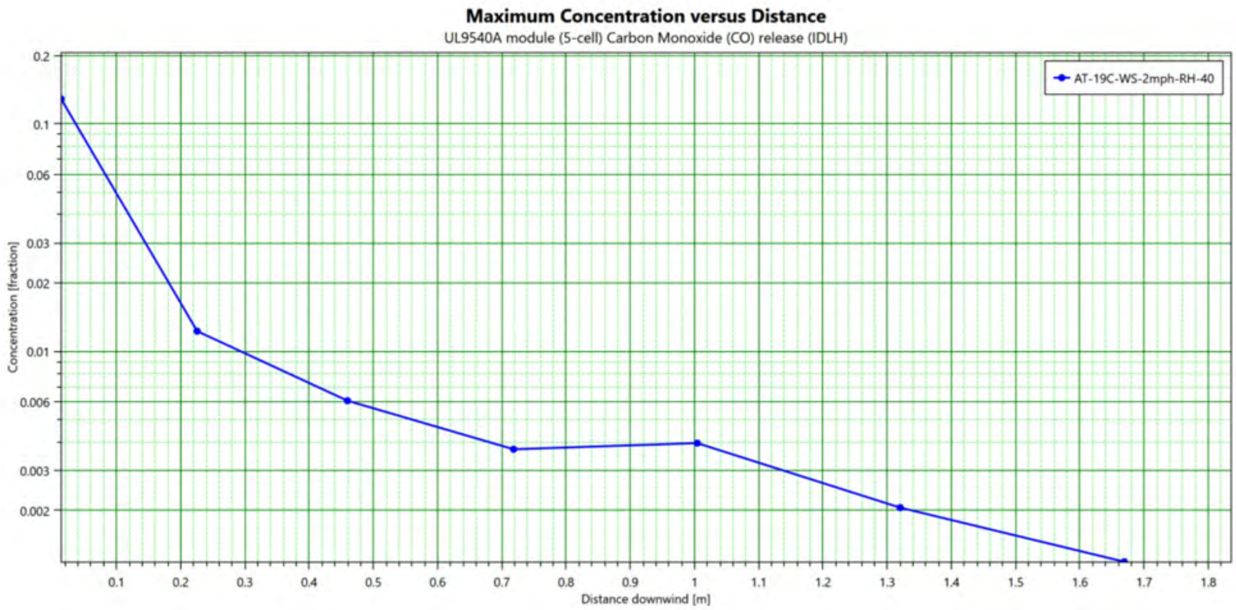


Figure 5. Maximum Concentration vs distance for CO gas component

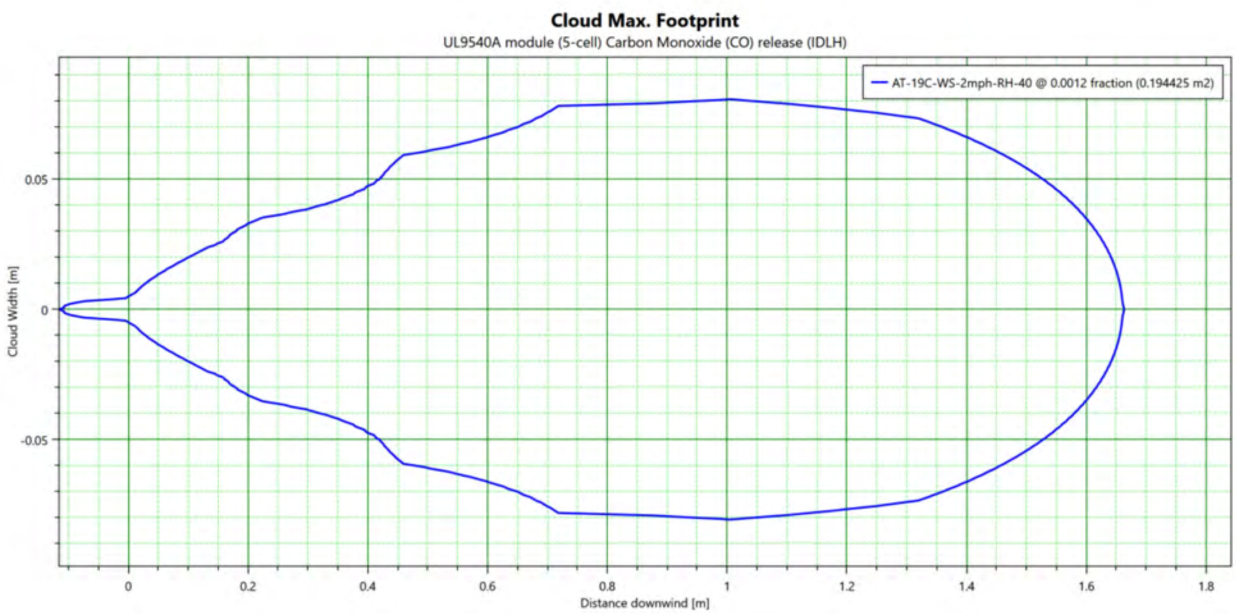


Figure 6. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

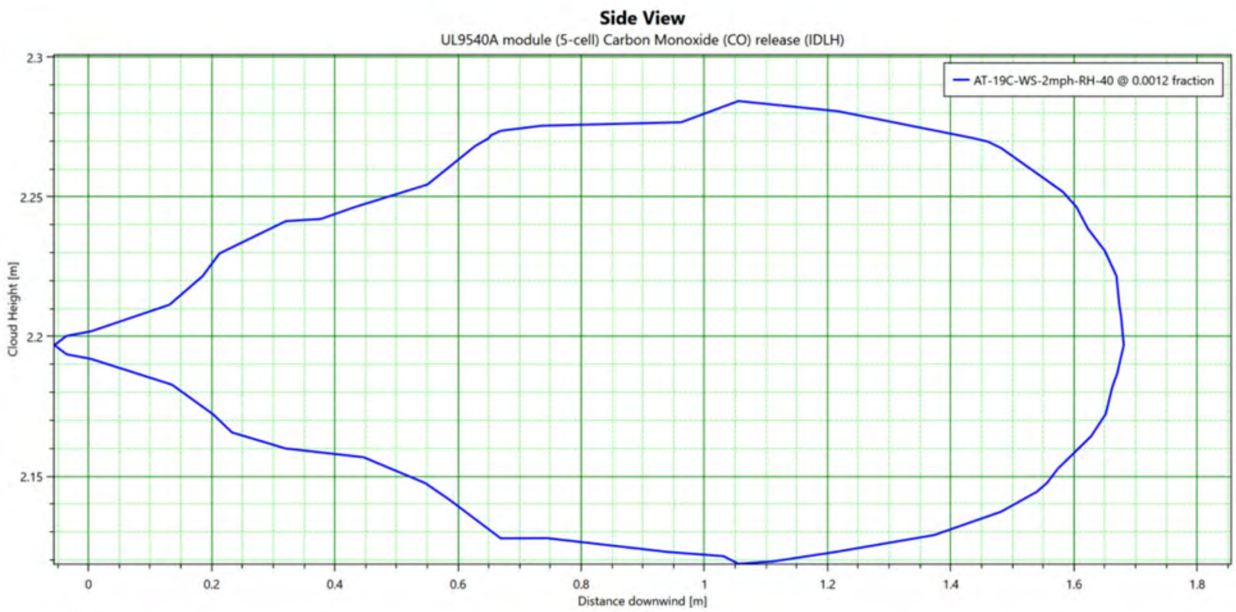


Figure 7. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

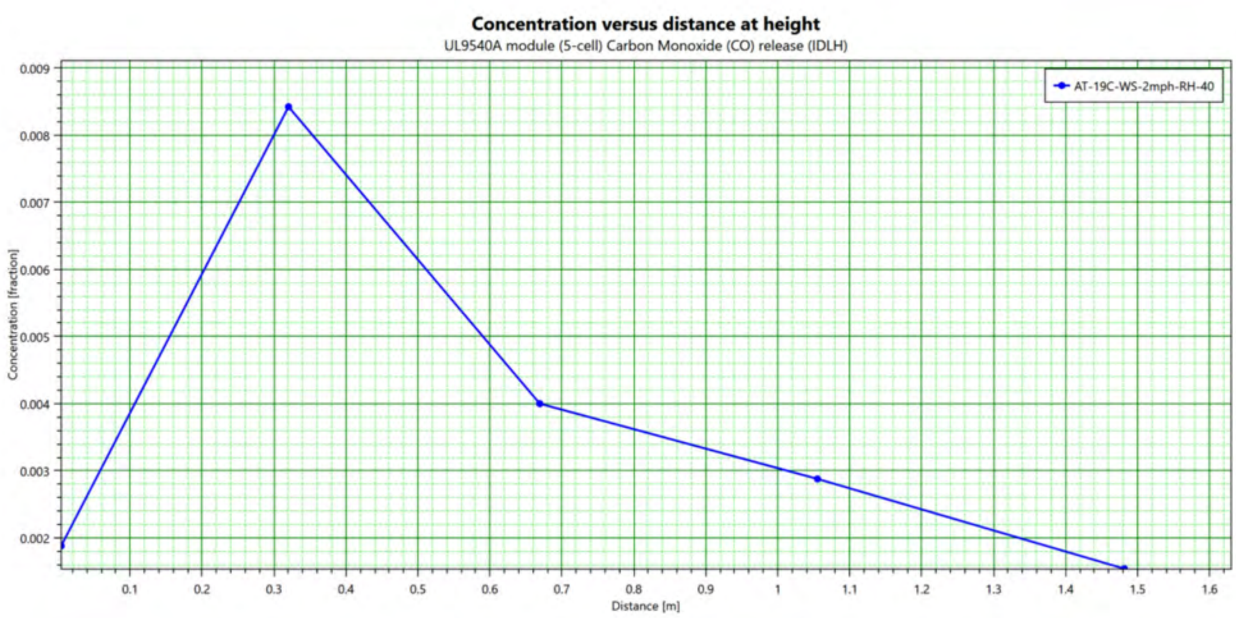


Figure 8. Concentration vs distance for CO IDLH (1200 ppm)

1.1.3 TVG Flammable Vapor Cloud Extent (10 min Release)

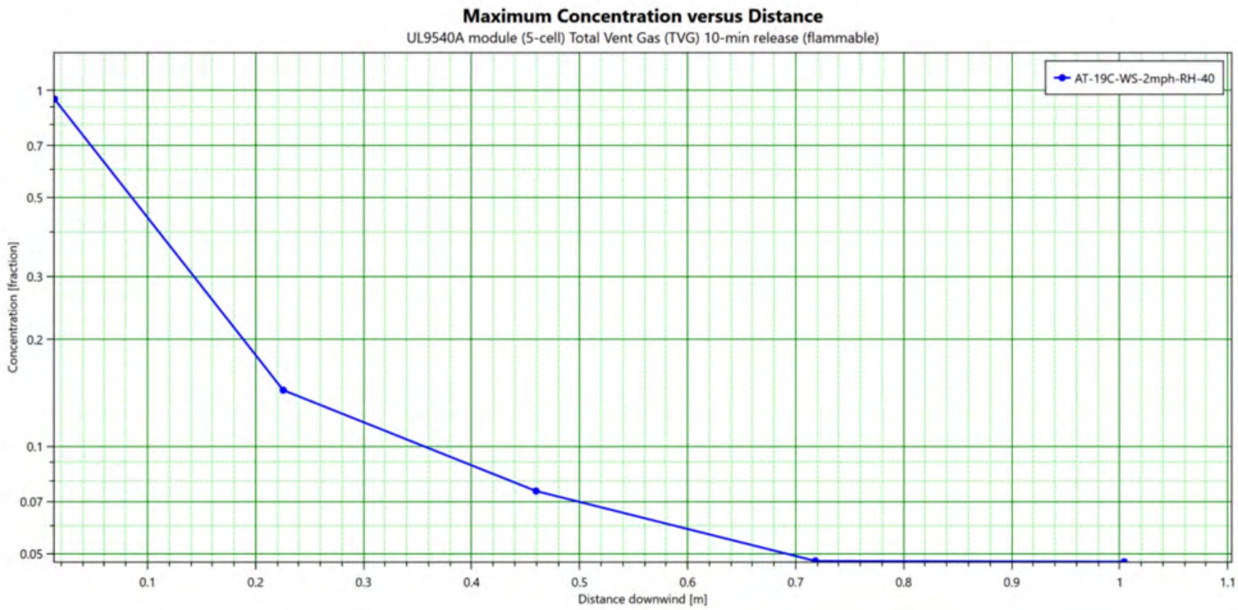


Figure 9. Maximum concentration vs distance for flammable vapor cloud

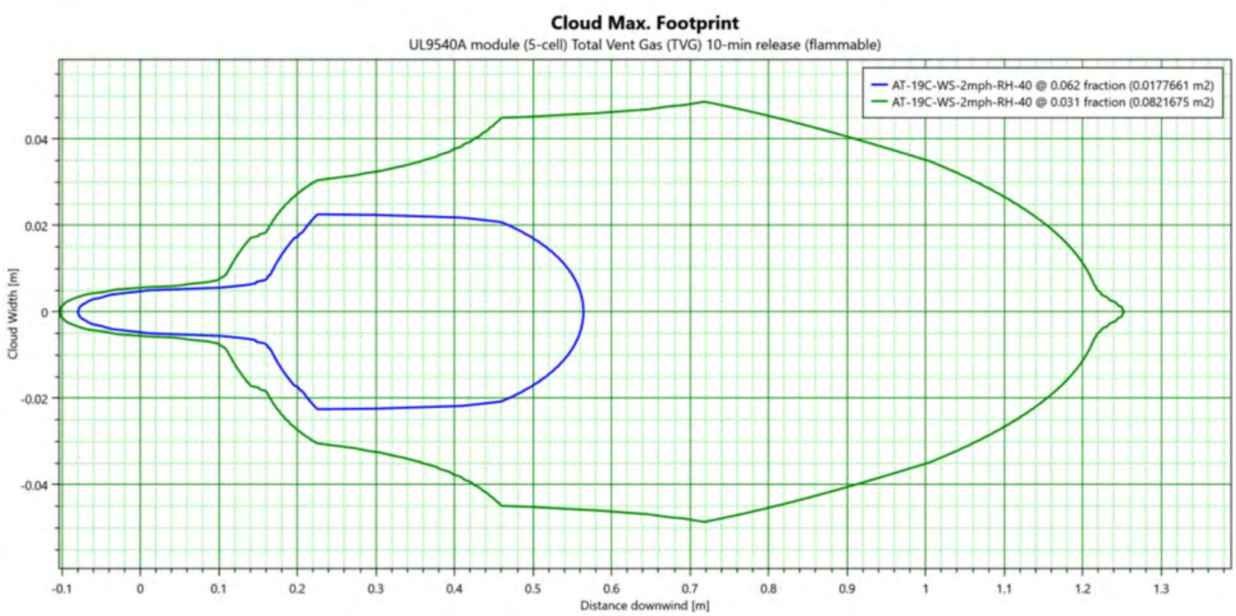


Figure 10. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

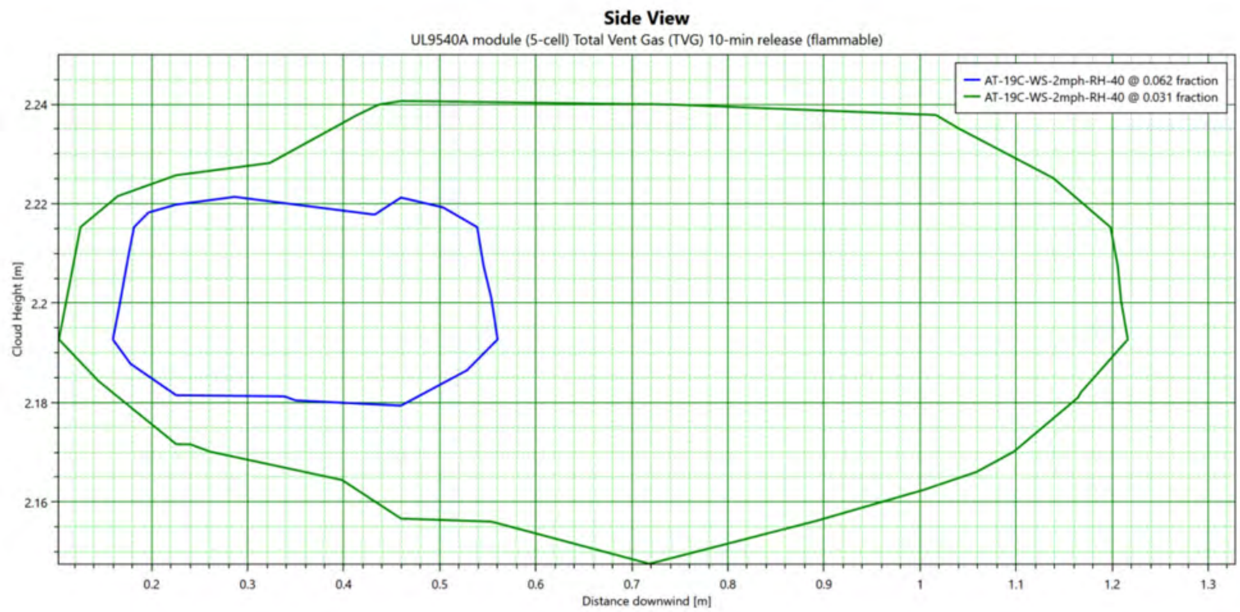


Figure 11. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

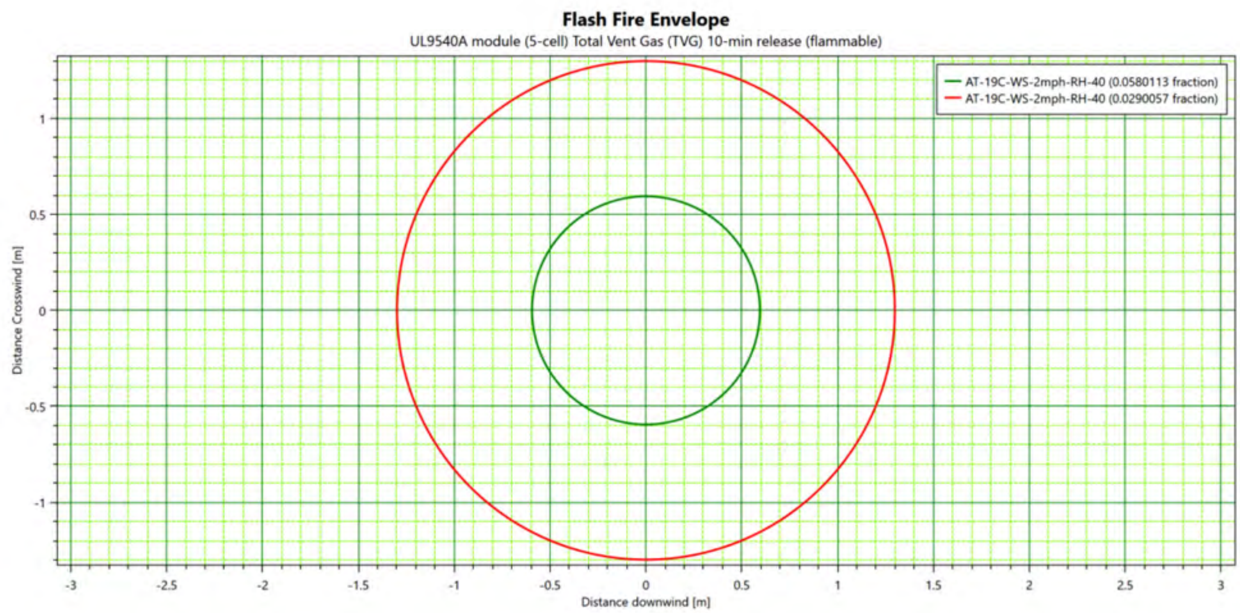


Figure 12. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.1.4 CO IDLH (1200 ppm) Component Extent (10 min Release)

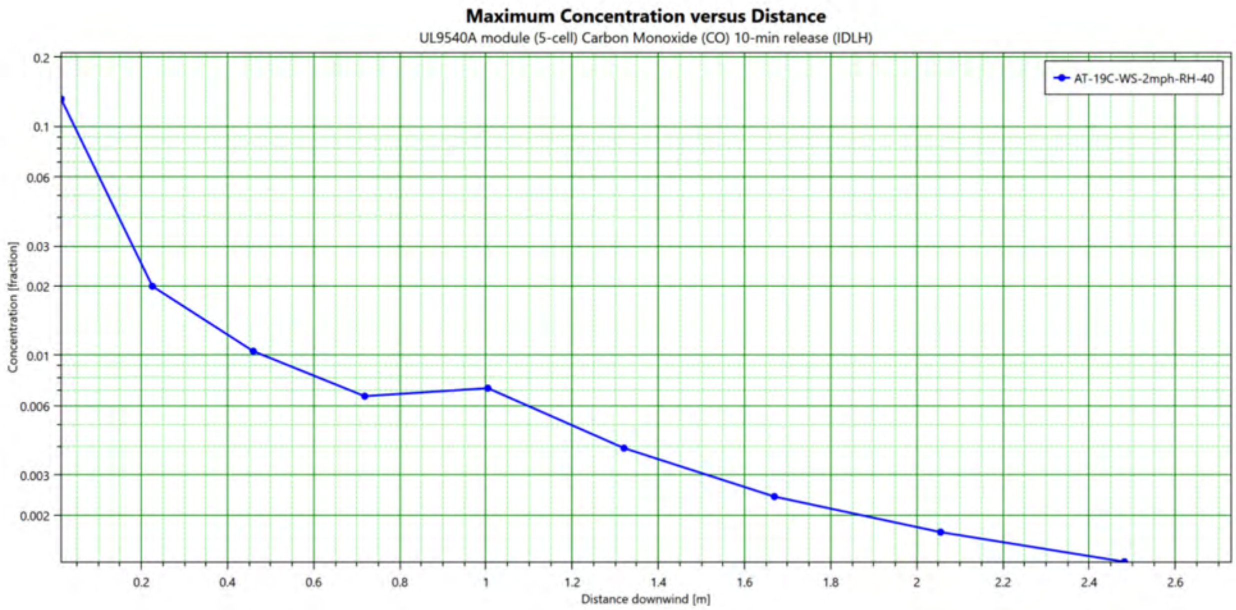


Figure 13. Maximum Concentration vs distance for CO gas component

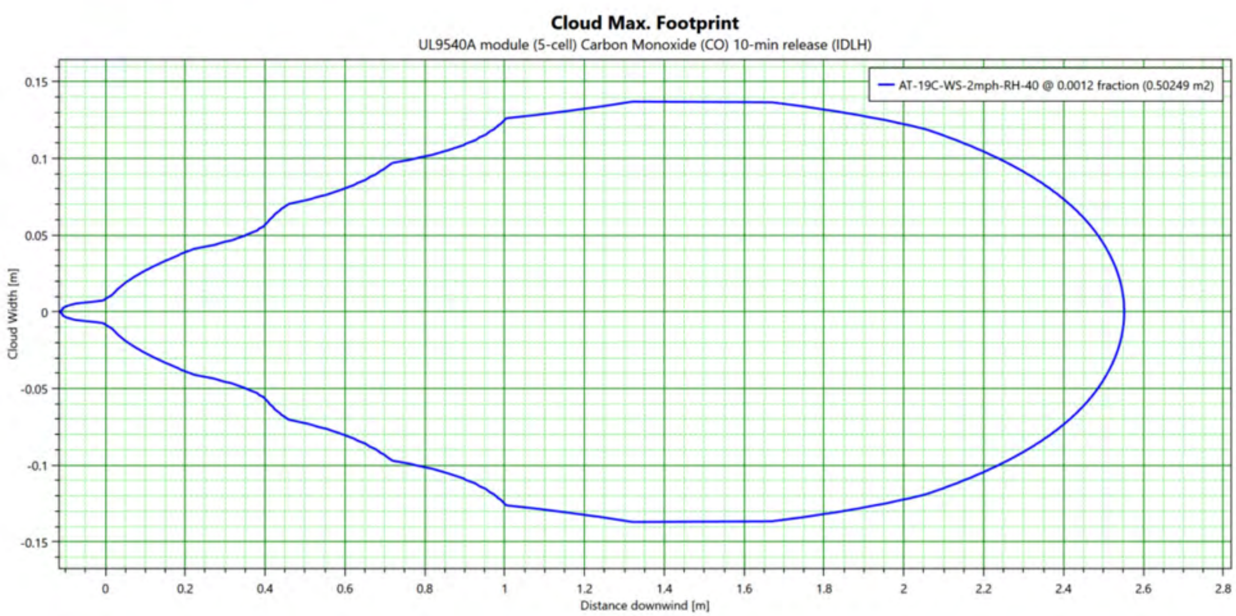


Figure 14. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

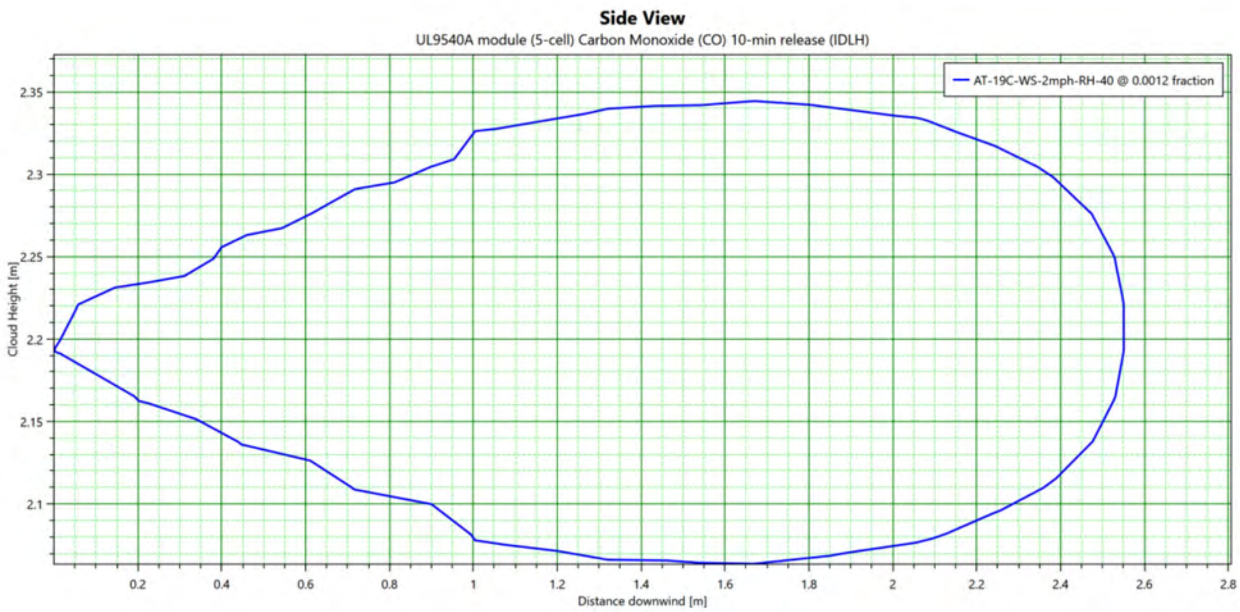


Figure 15. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

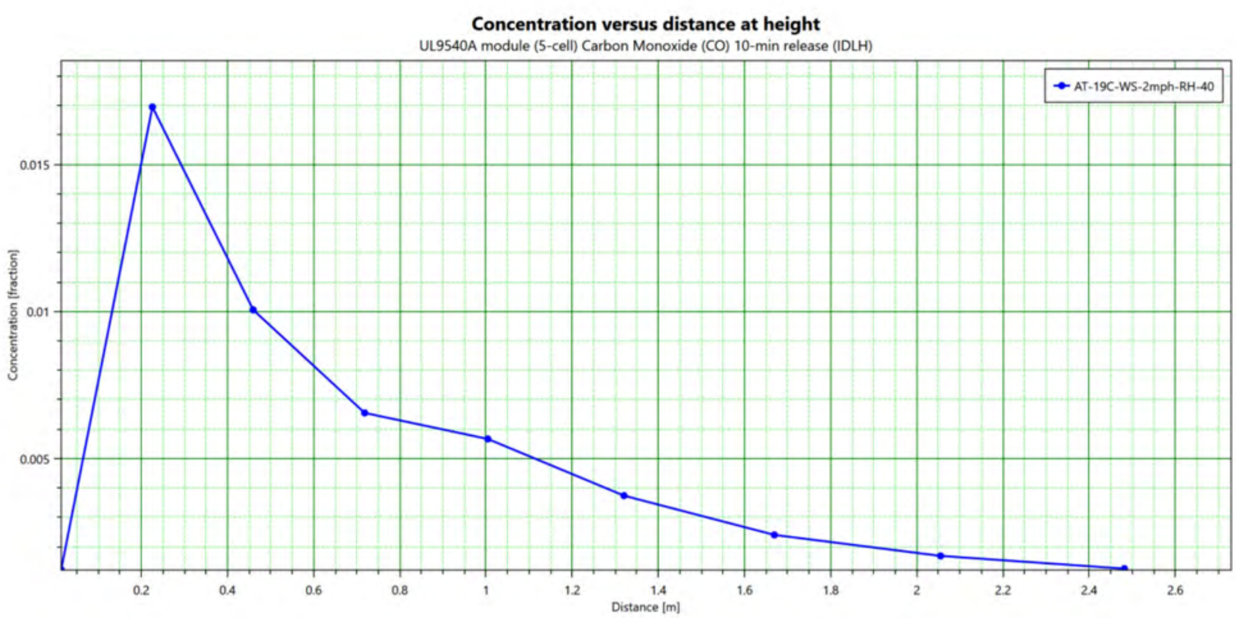


Figure 16. Concentration vs distance for CO IDLH (1200 ppm)

1.1.5 TVG Flammable Vapor Cloud Extent (Instantaneous Release)

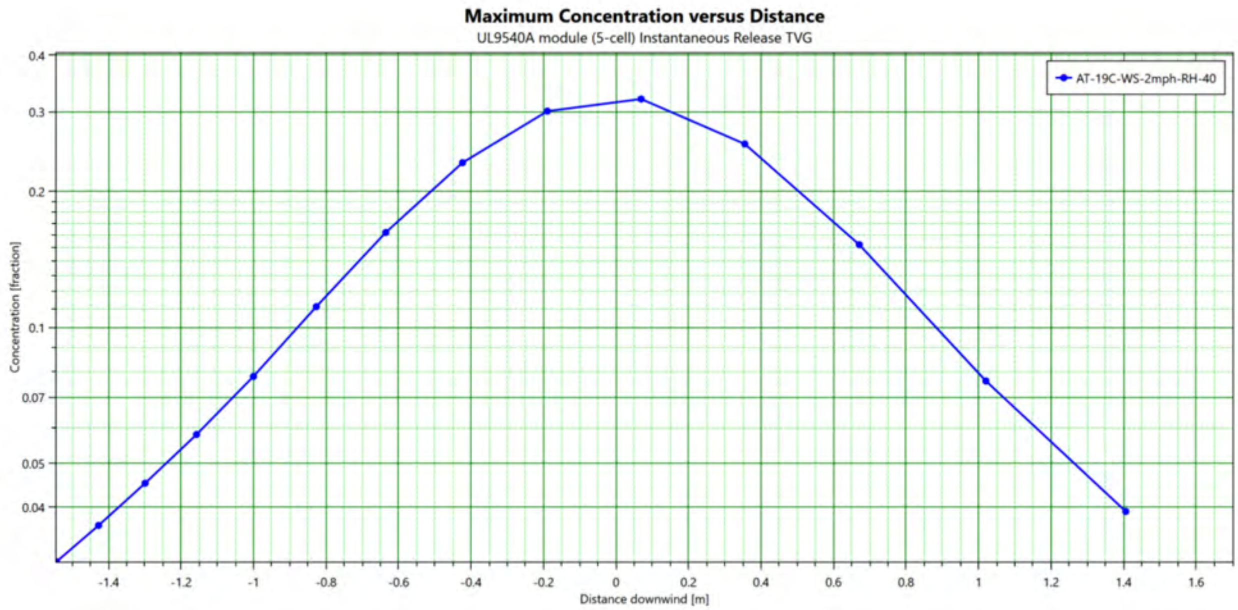


Figure 17. Maximum concentration vs distance for flammable vapor cloud

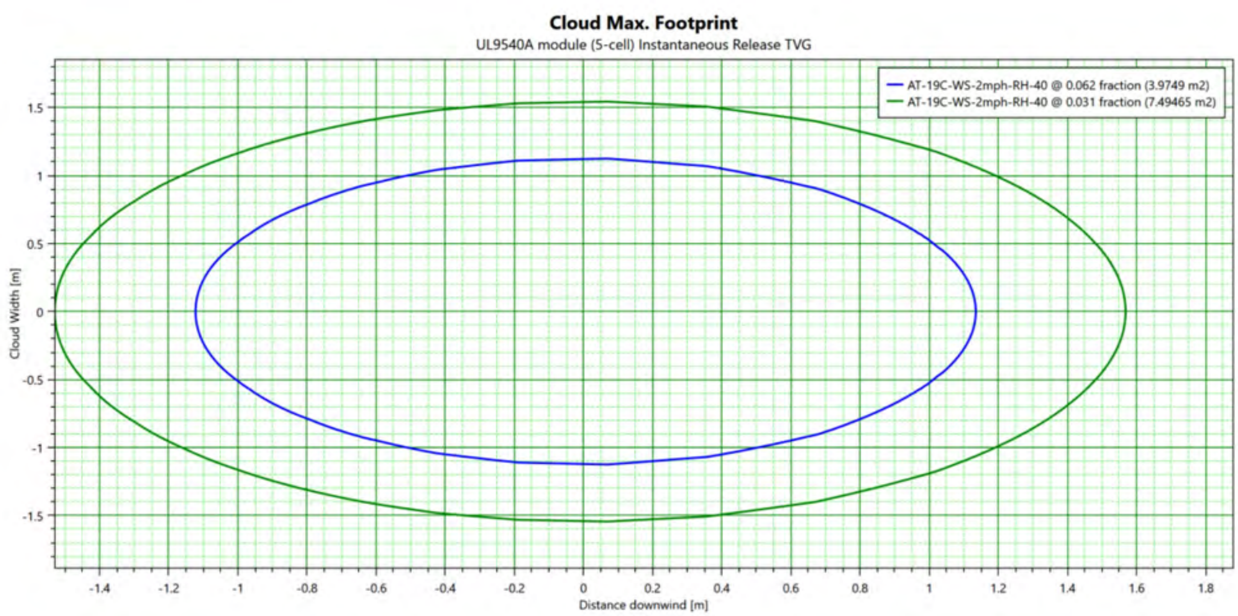


Figure 18. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

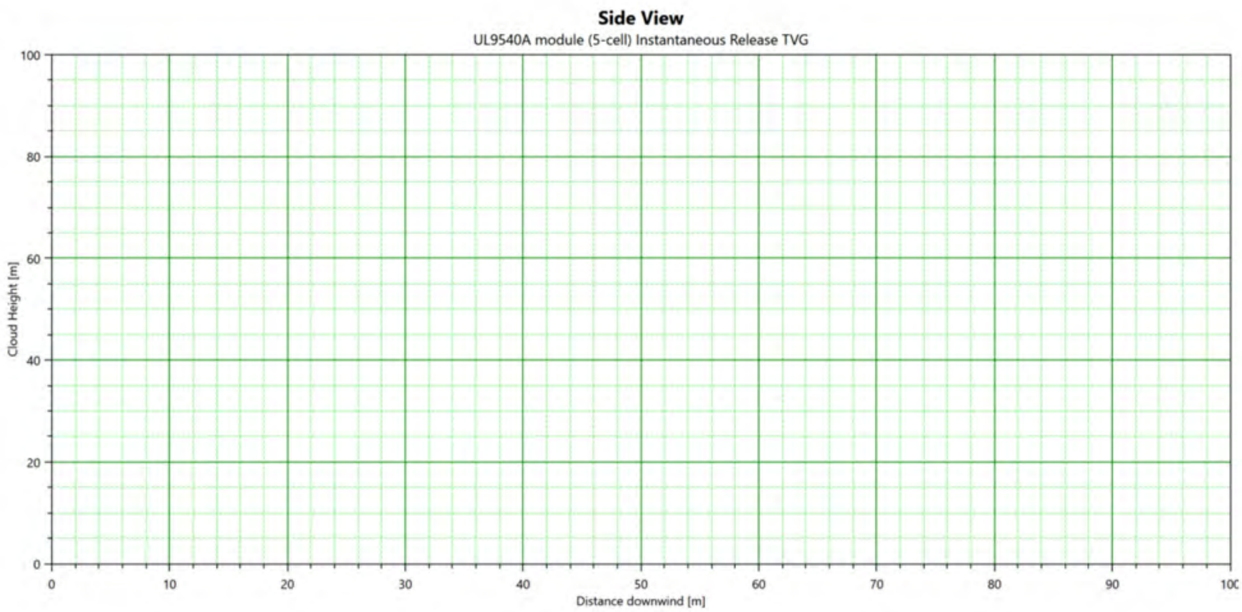


Figure 19. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

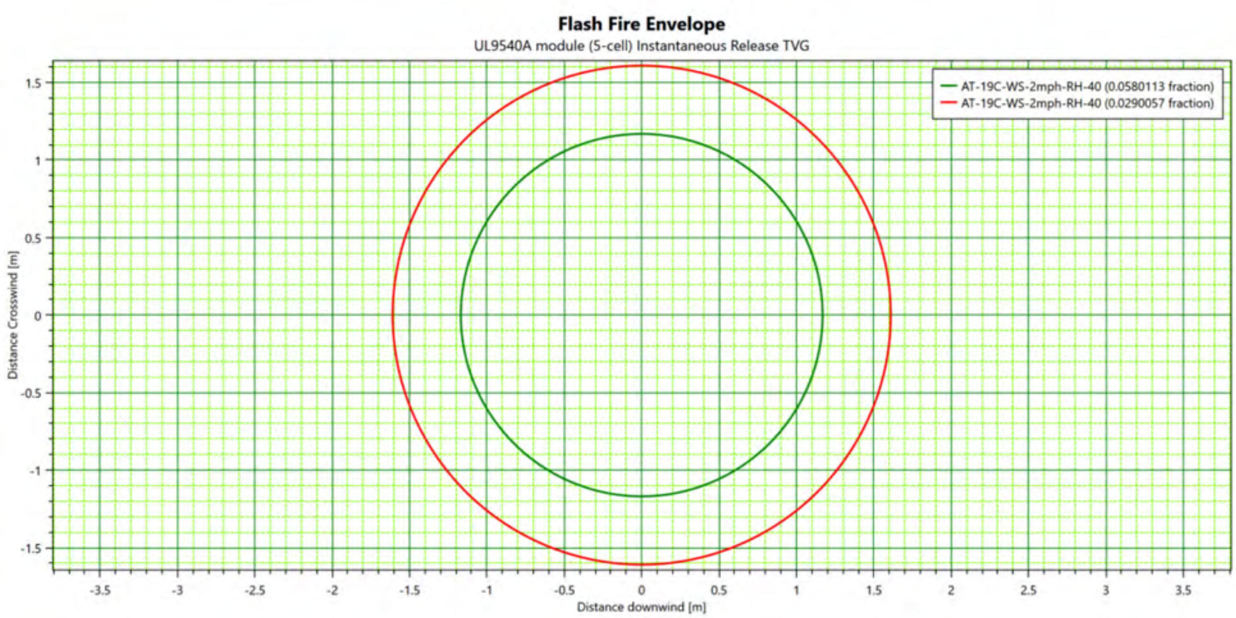


Figure 20. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.1.6 CO IDLH (1200 ppm) Component Extent (Instantaneous Release)

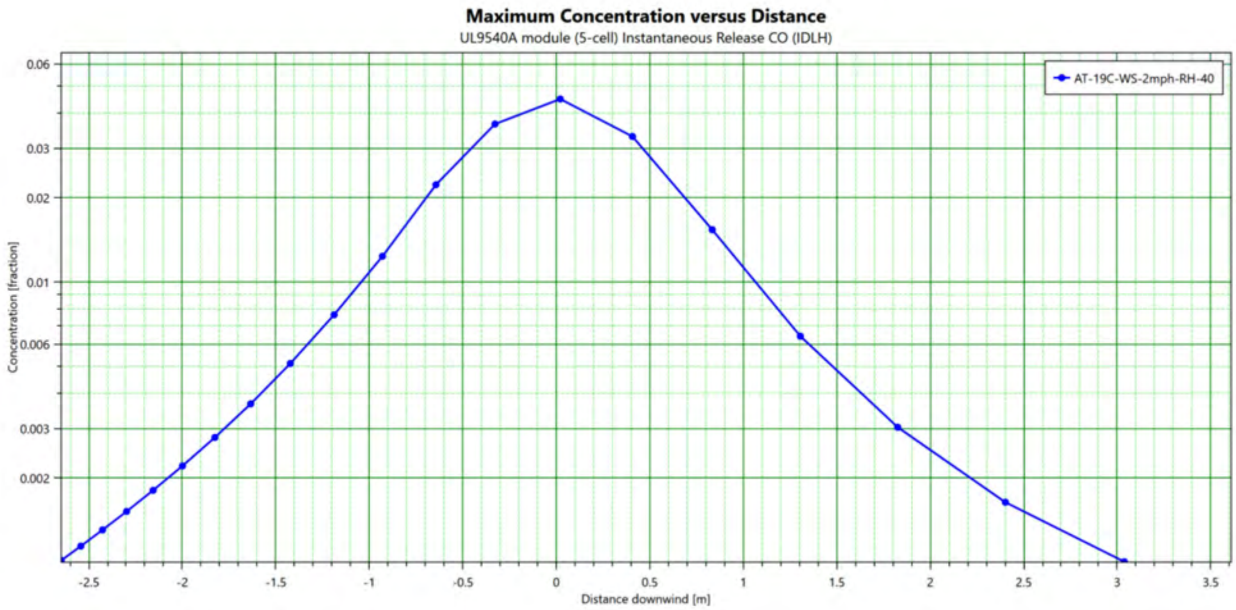


Figure 21. Maximum Concentration vs distance for CO gas component

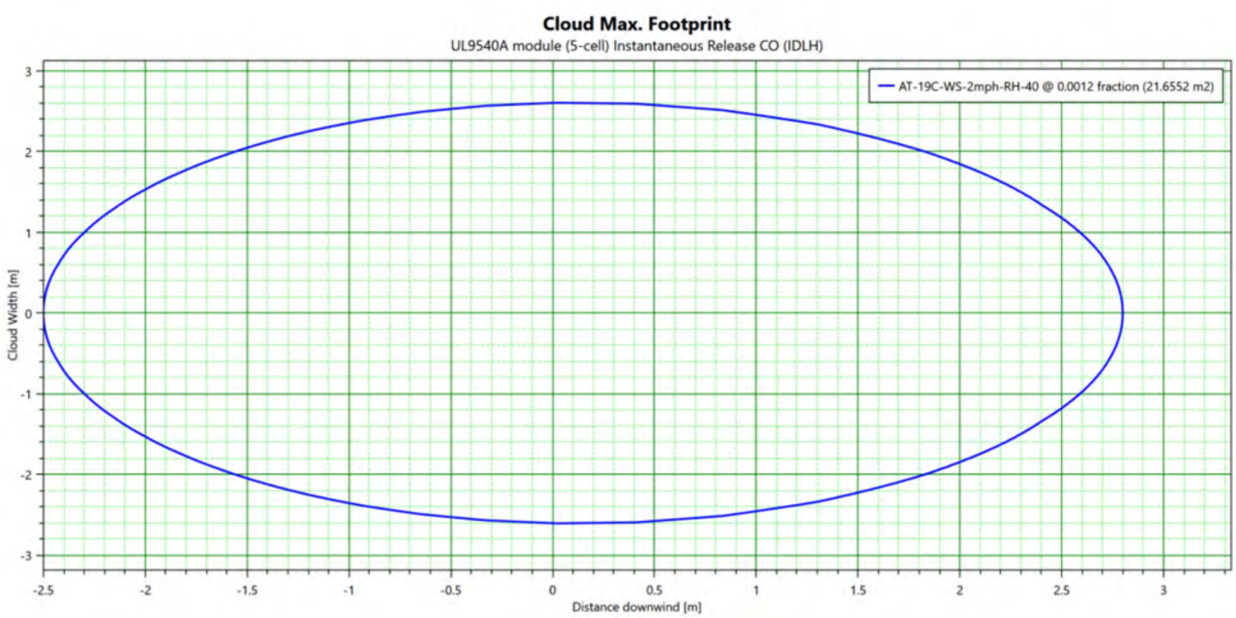


Figure 22. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

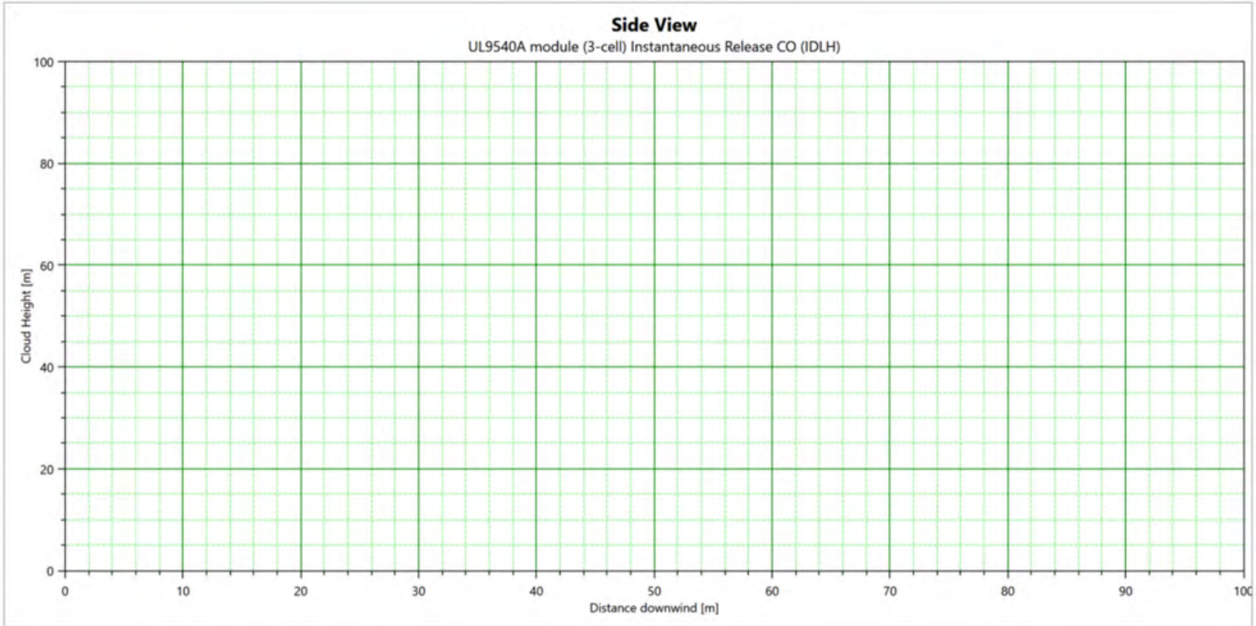


Figure 23. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

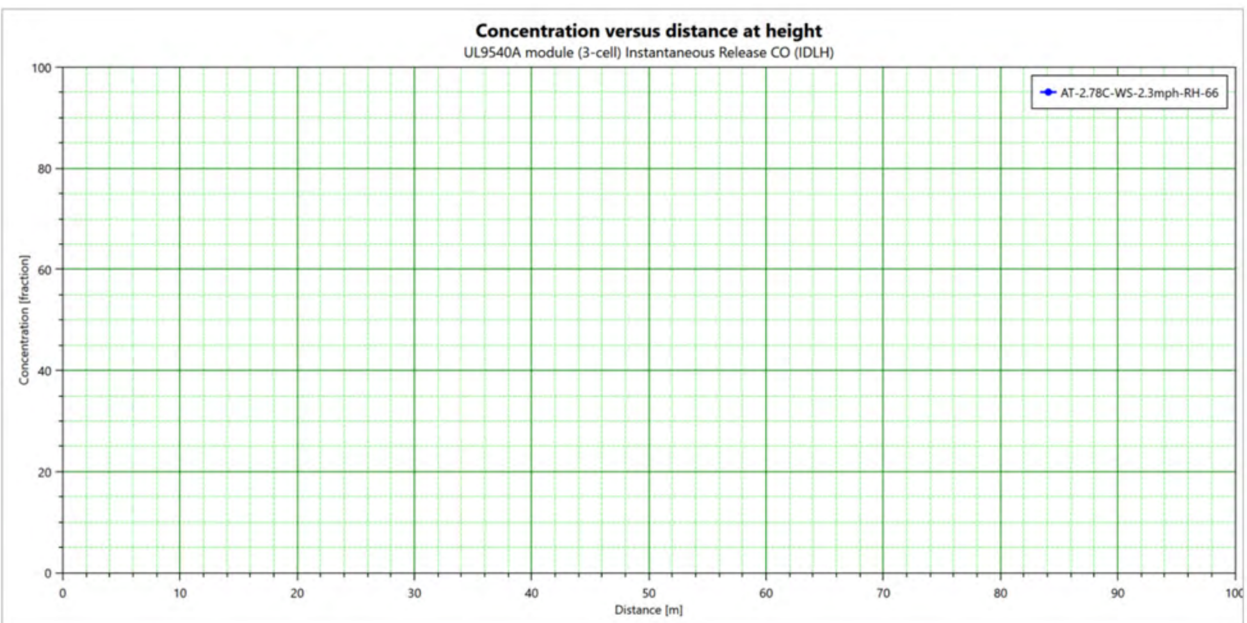


Figure 24. Concentration vs distance for CO IDLH (1200 ppm)

1.2 Scenario 2: Single-Module Release

1.2.1 TVG Flammable Vapor Cloud Extent (124.8 min Release)

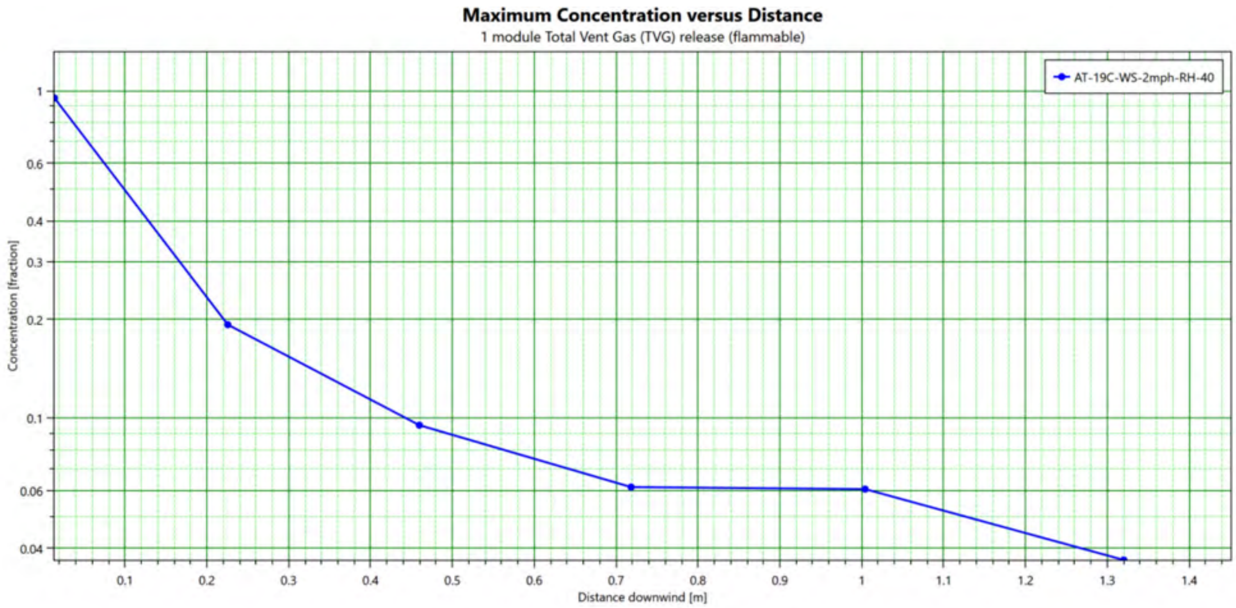


Figure 25. Maximum concentration vs distance for flammable vapor cloud

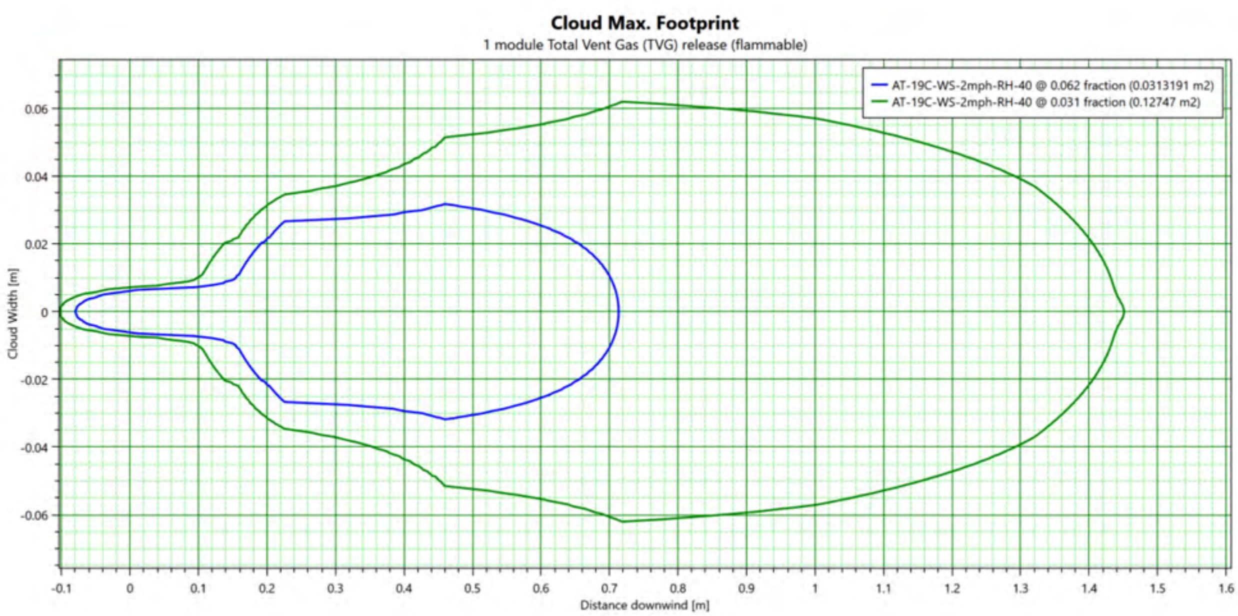


Figure 26. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

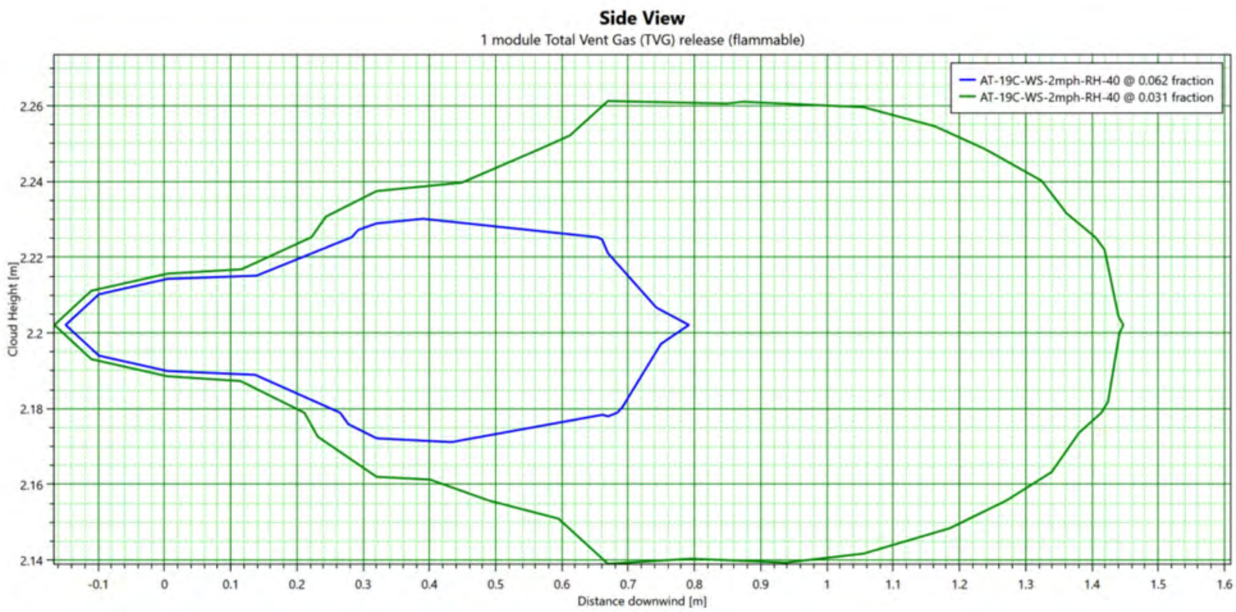


Figure 27. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

Figure 28. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.2.2 CO IDLH (1200 ppm) Component Extent (124.8 min Release)

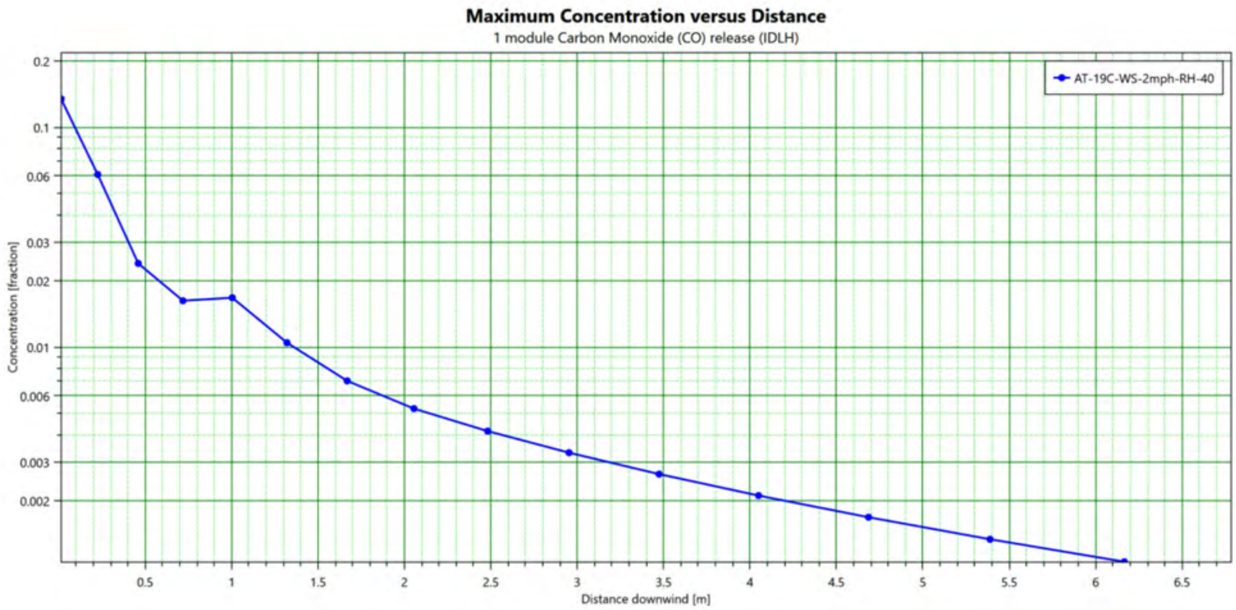


Figure 29. Maximum Concentration vs distance for CO gas component

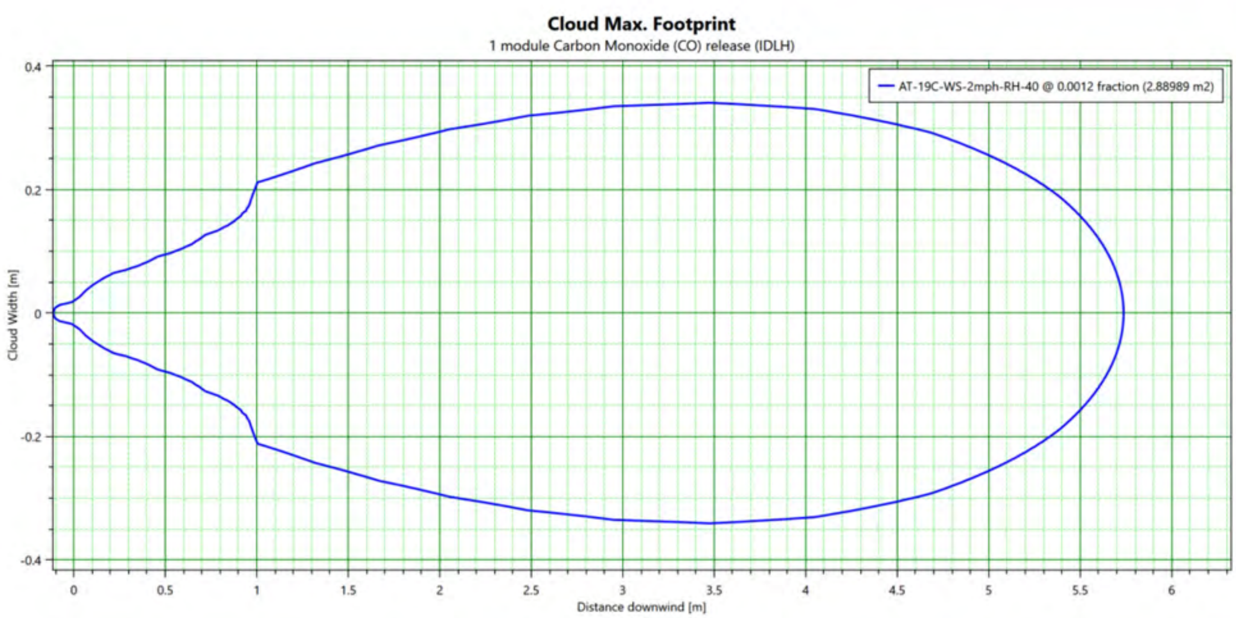


Figure 30. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

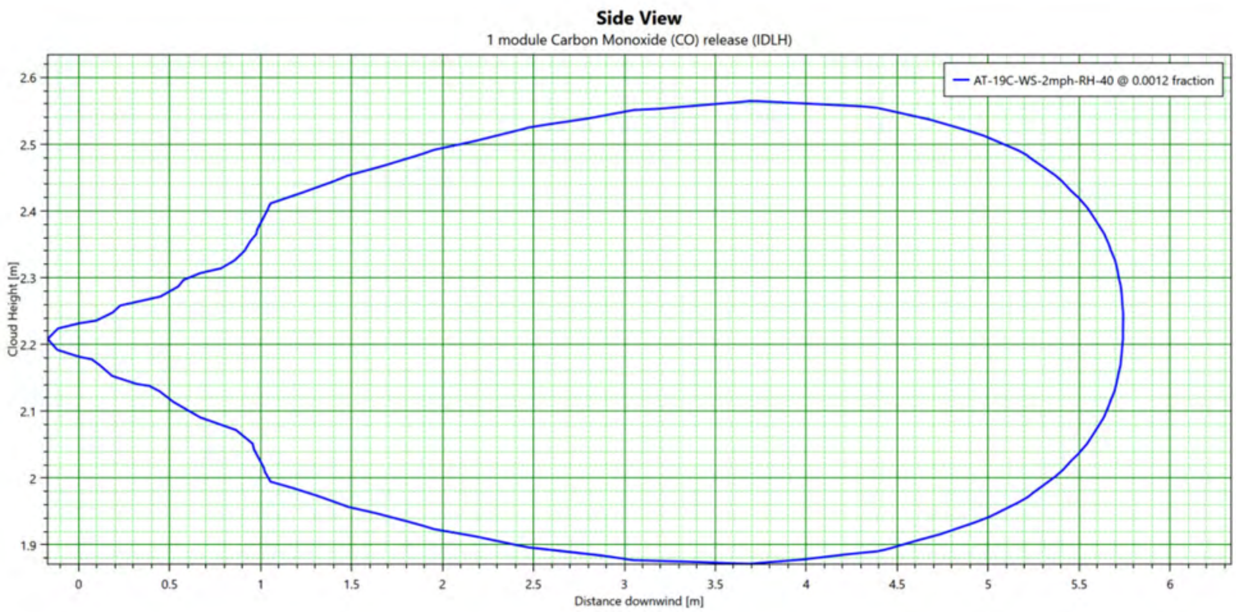


Figure 31. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

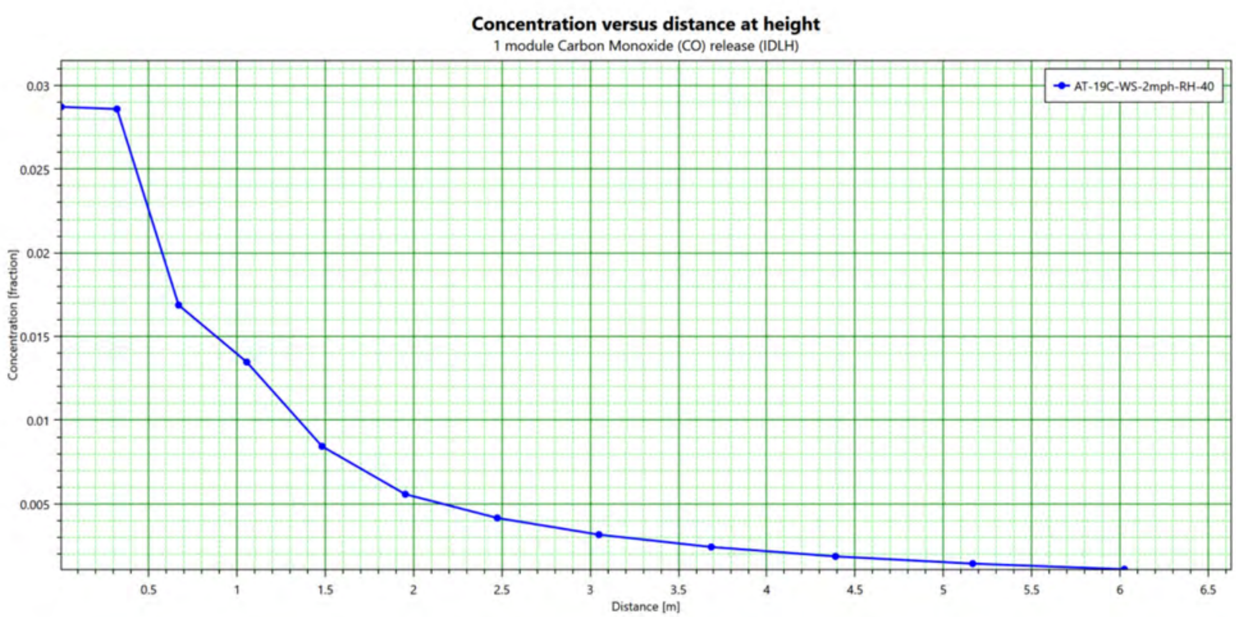


Figure 32. Concentration vs distance for CO IDLH (1200 ppm)

1.2.3 TVG Flammable Vapor Cloud Extent (10 min Release)

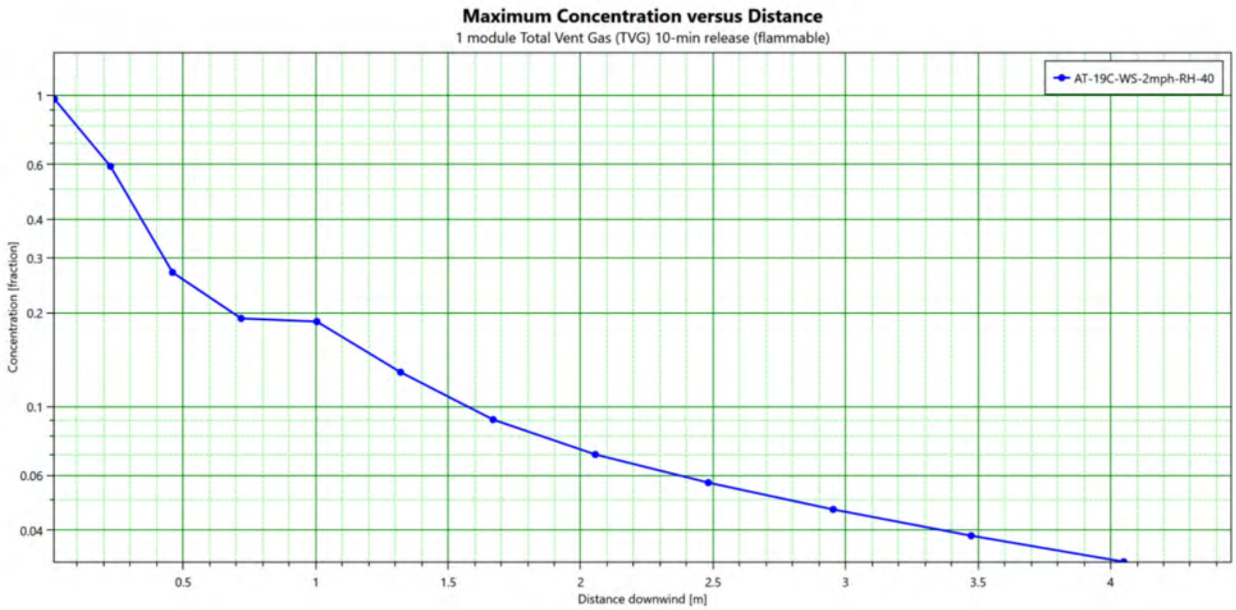


Figure 33. Maximum concentration vs distance for flammable vapor cloud

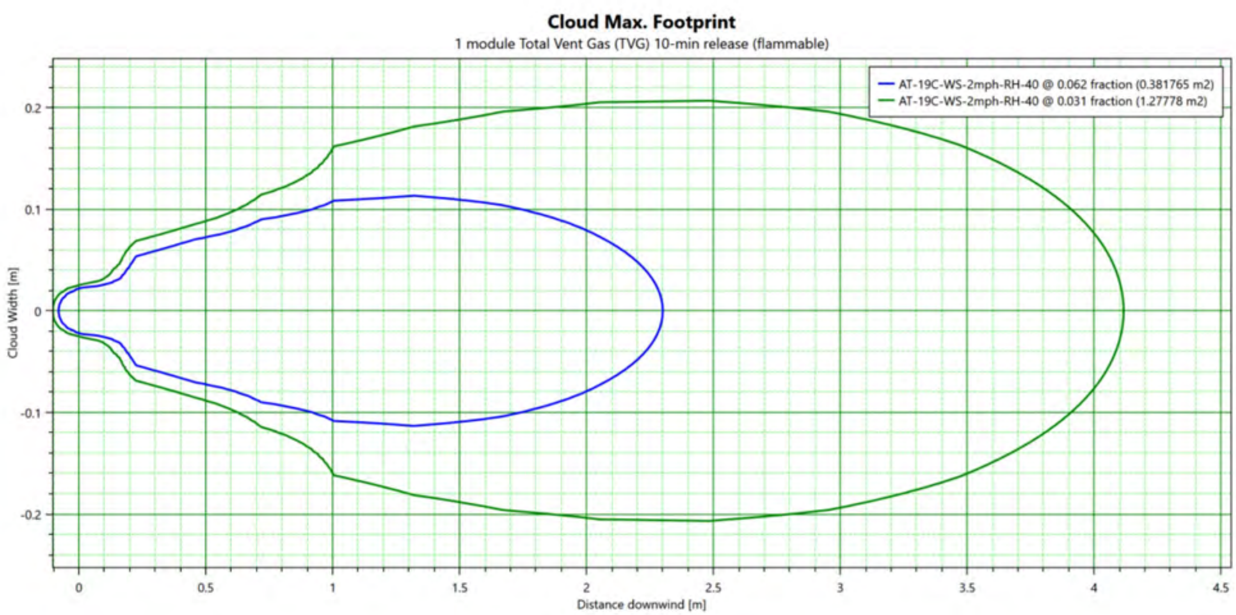


Figure 34. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

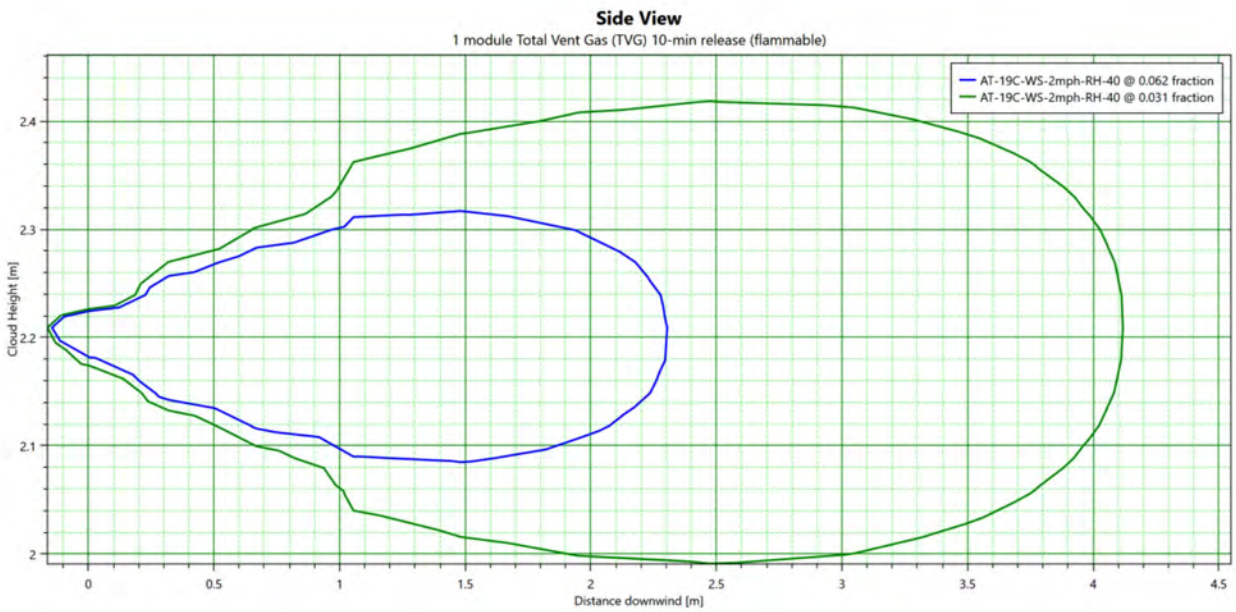


Figure 35. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

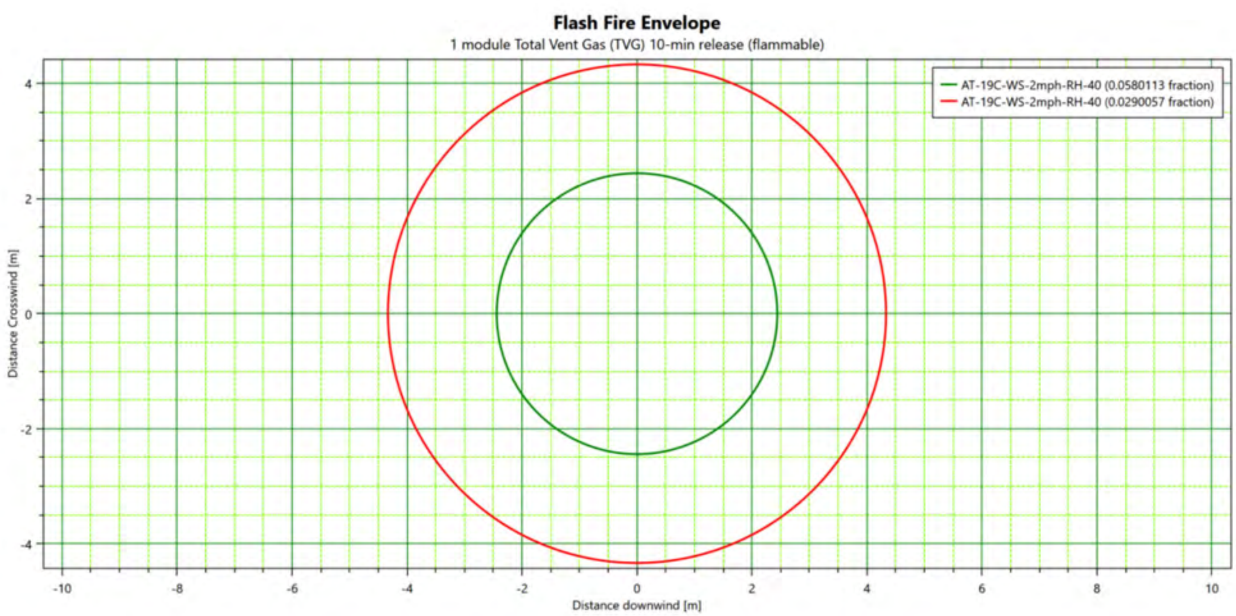


Figure 36. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.2.4 CO IDLH (1200 ppm) Component Extent (10 min Release)

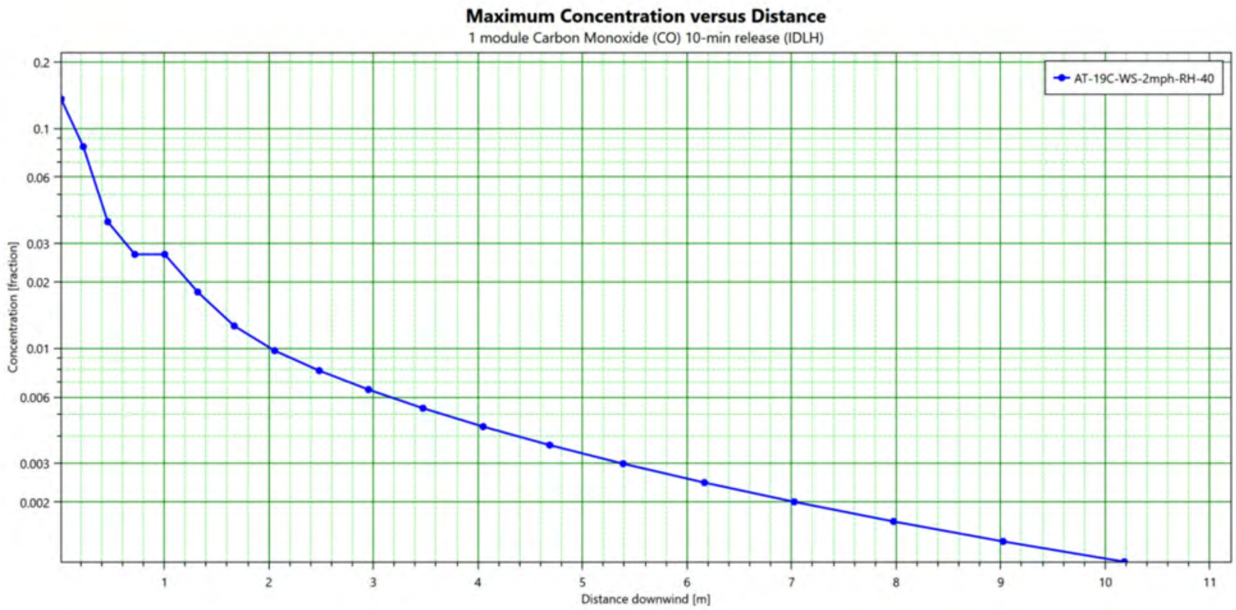


Figure 37. Maximum Concentration vs distance for CO gas component

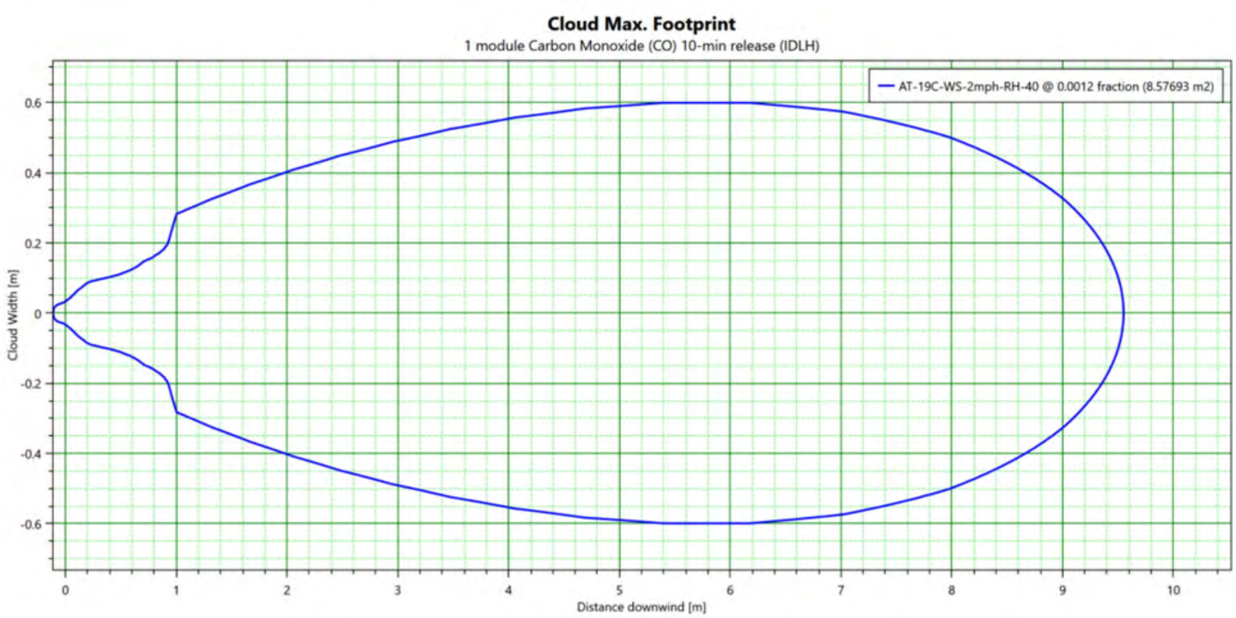


Figure 38. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

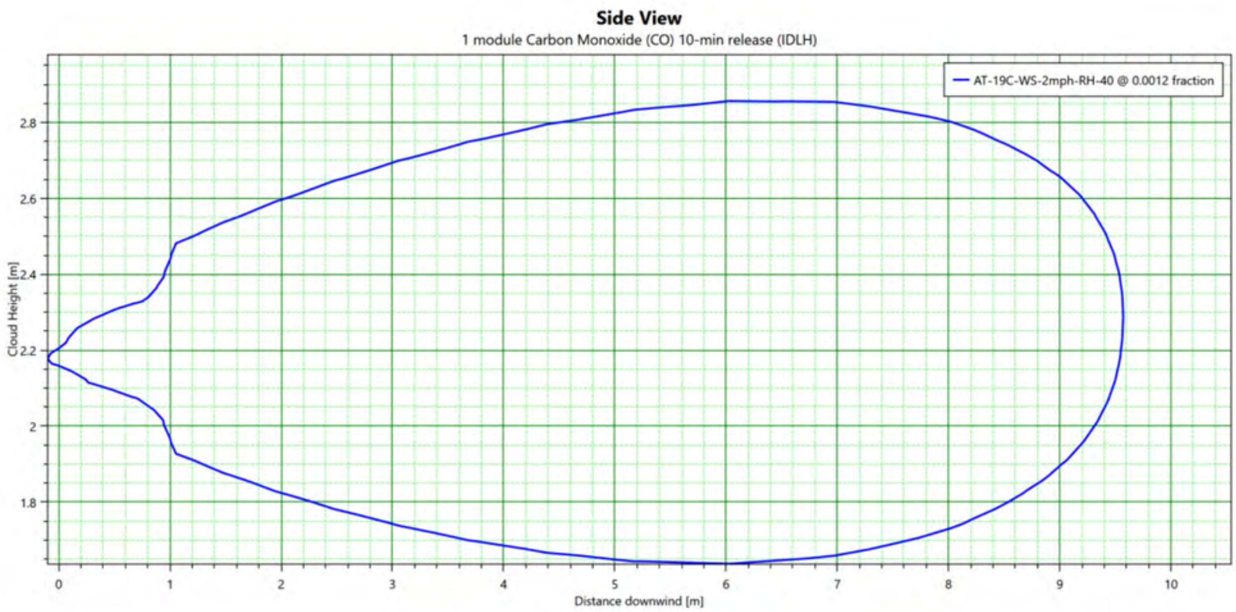


Figure 39. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

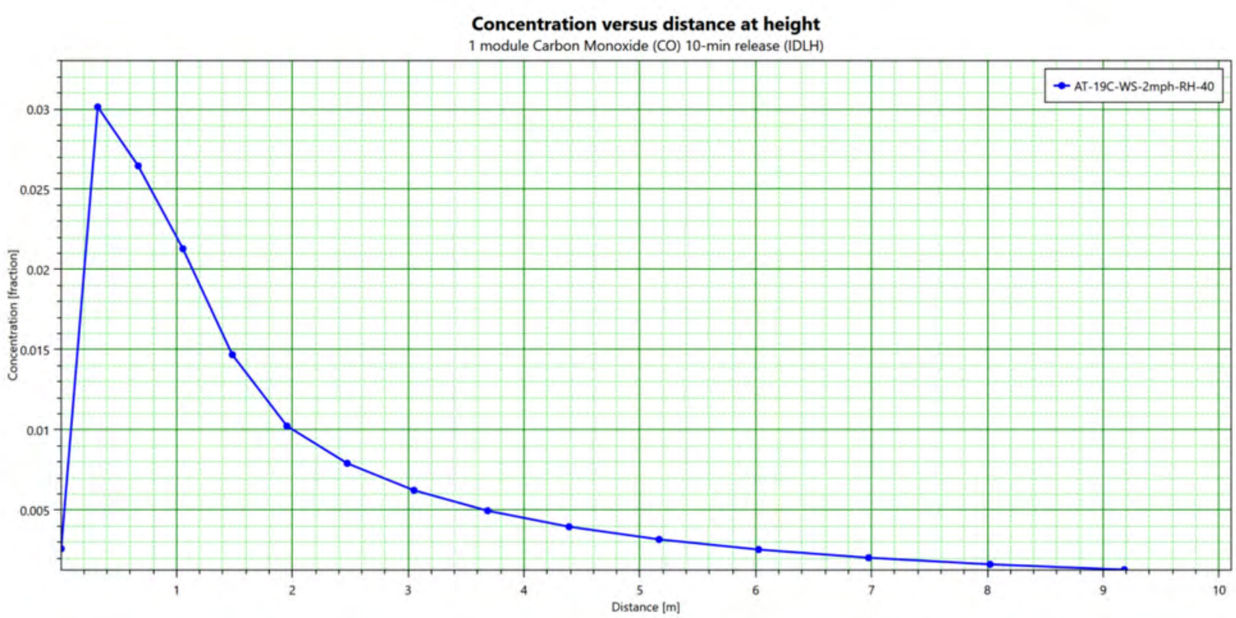


Figure 40. Concentration vs distance for CO IDLH (1200 ppm)

1.3 Scenario 3: 1-Rack of 8-Modules Release

1.3.1 TVG Flammable Vapor Cloud Extent (124.8 min Release)

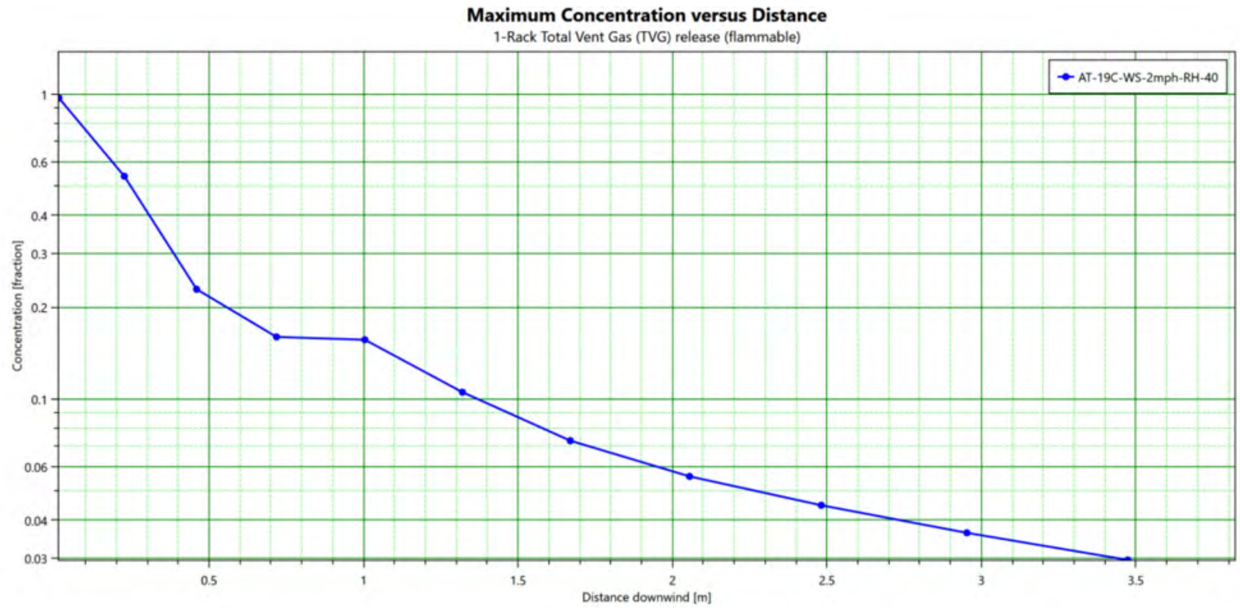


Figure 41. Maximum concentration vs distance for flammable vapor cloud

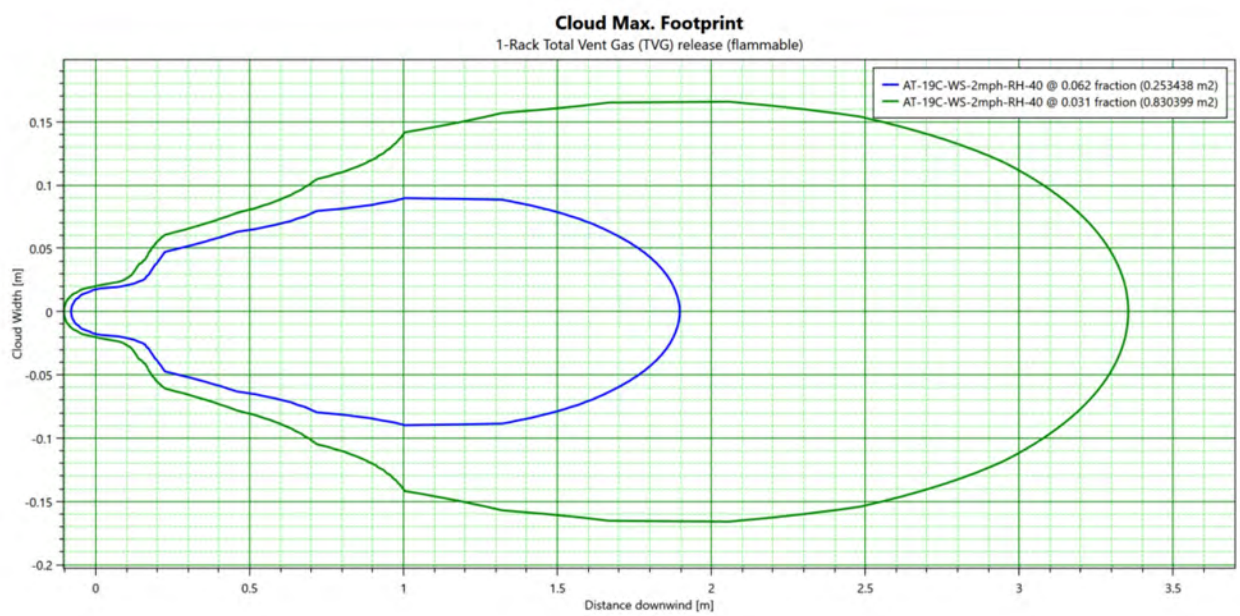


Figure 42. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

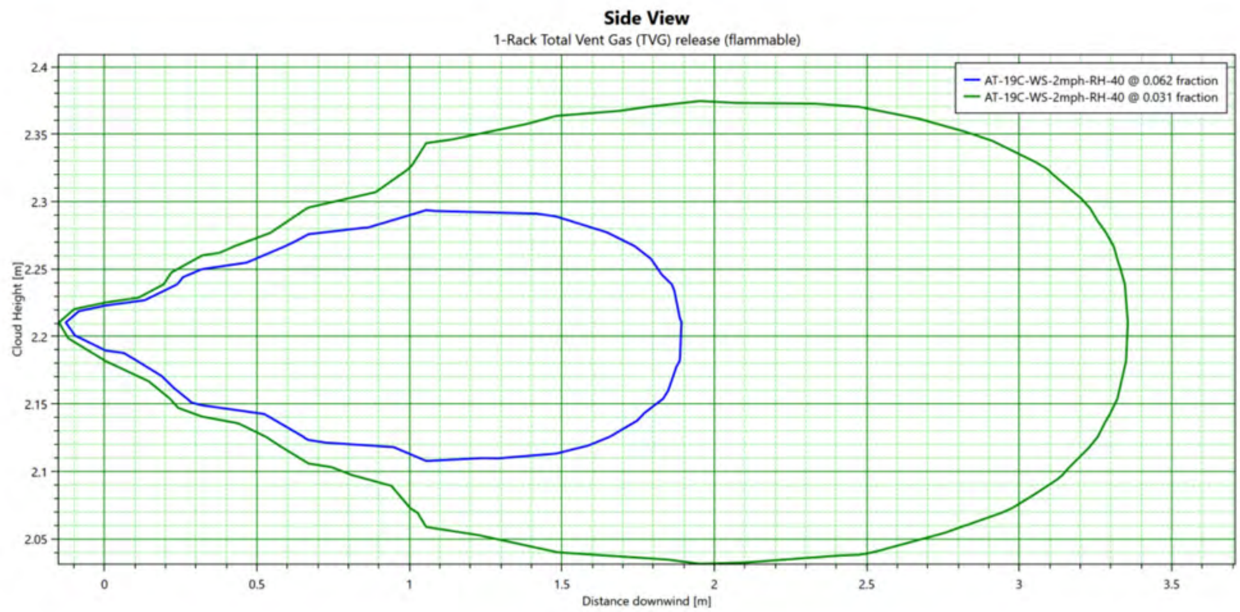


Figure 43. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

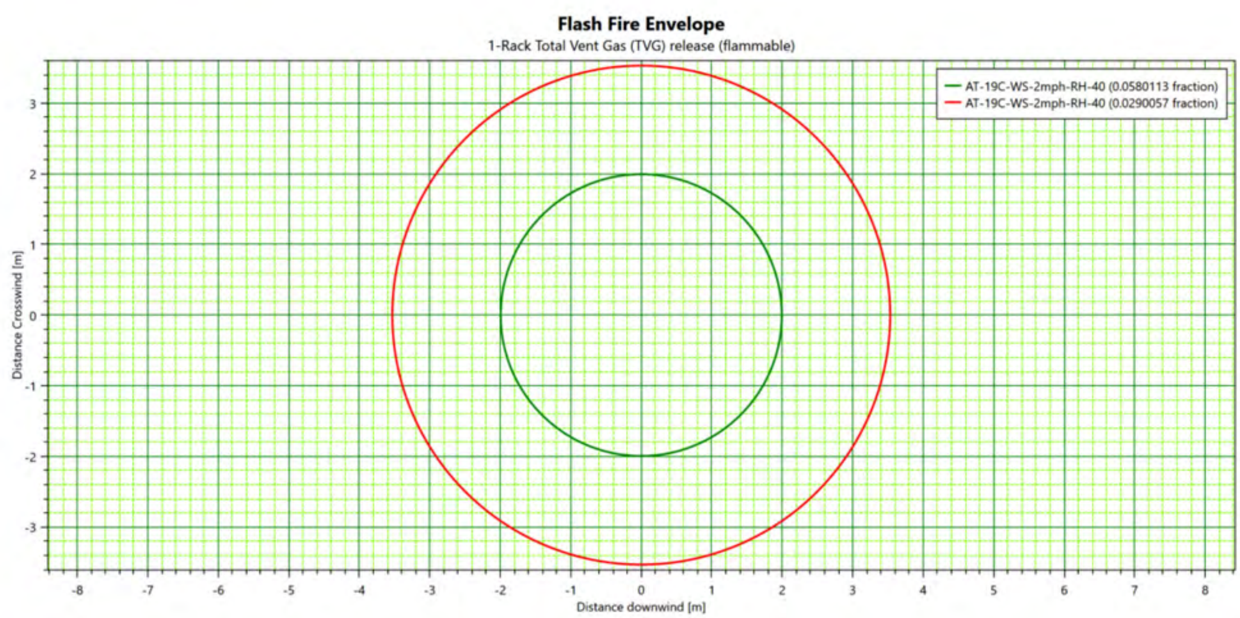


Figure 44. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.3.2 CO IDLH (1200 ppm) Component Extent (124.8 min Release)

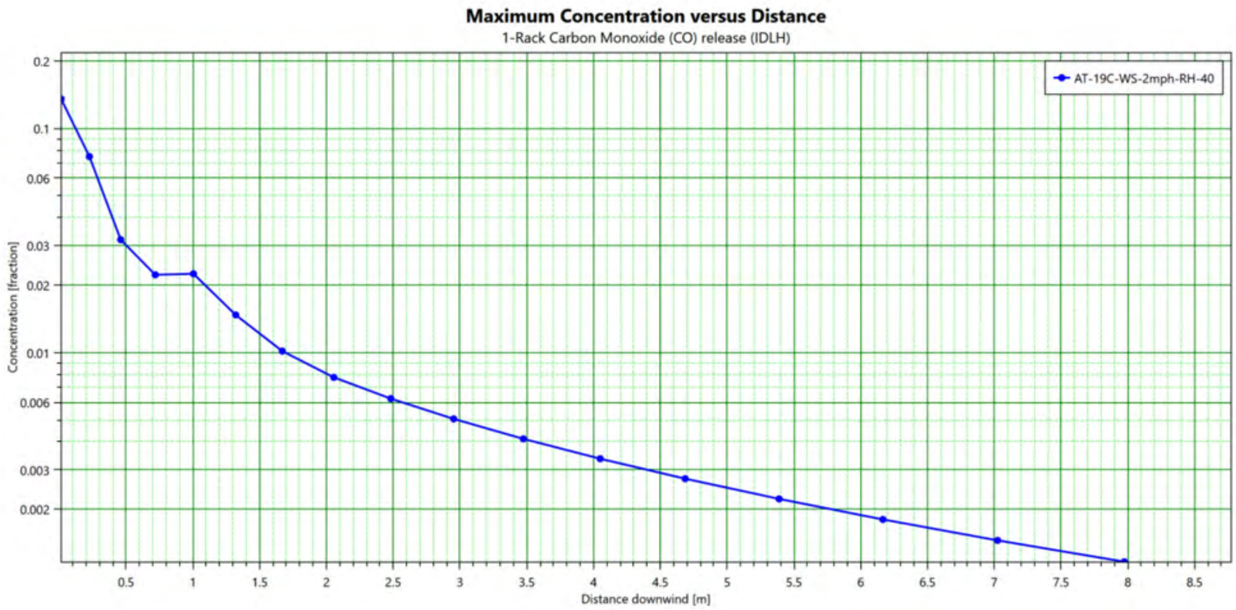


Figure 45. Maximum Concentration vs distance for CO gas component

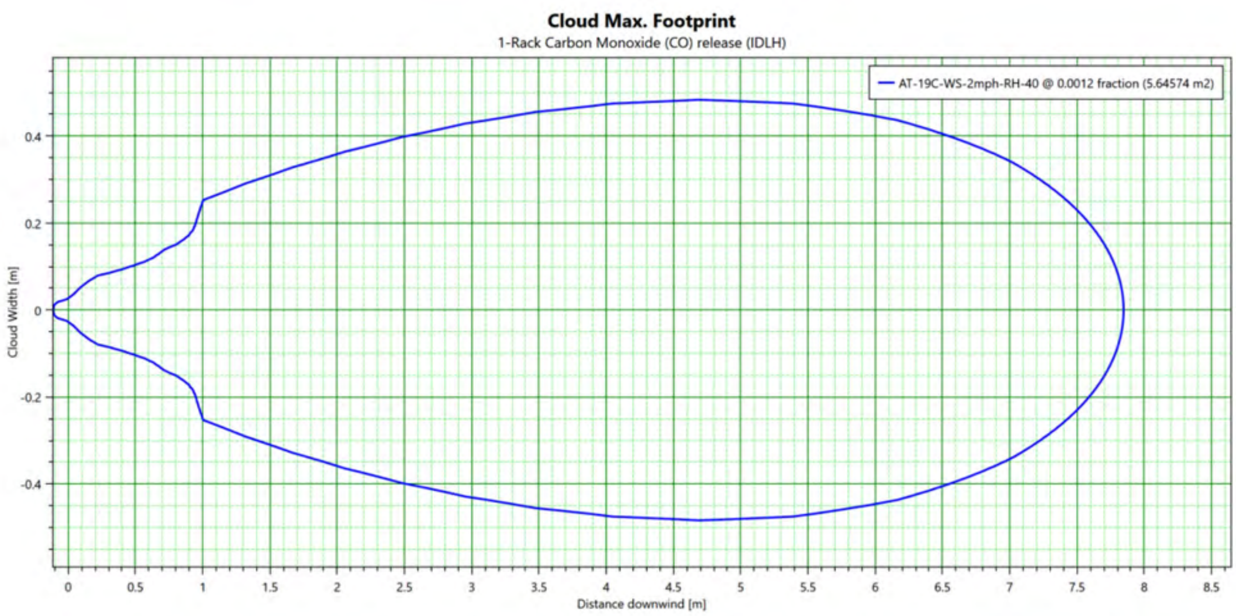


Figure 46. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

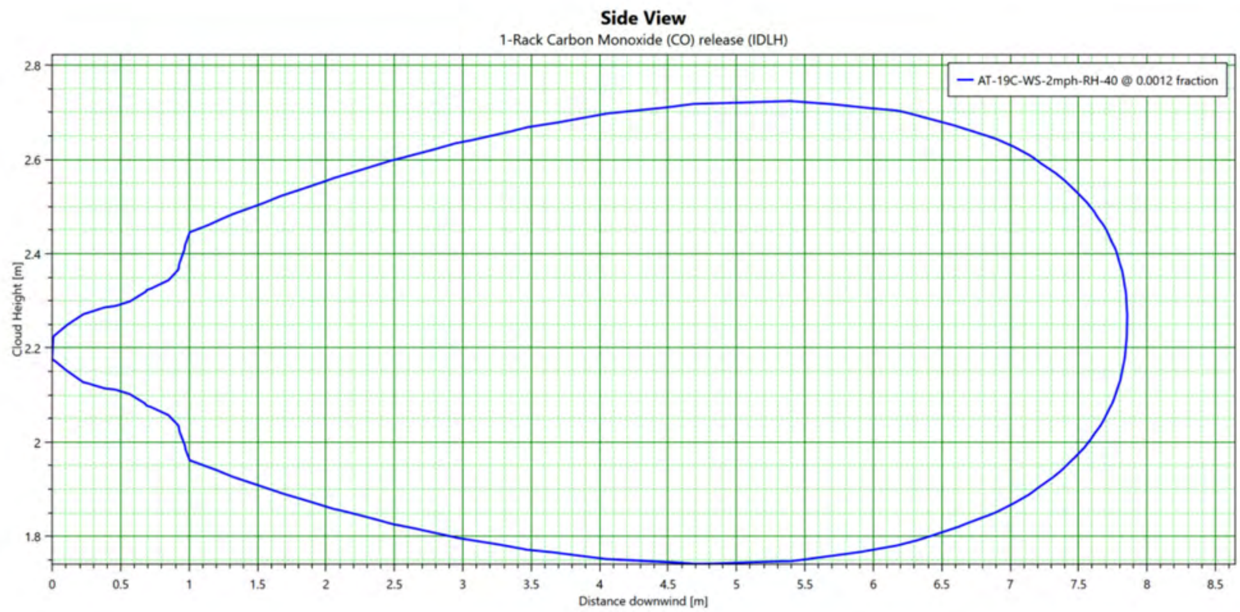


Figure 47. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

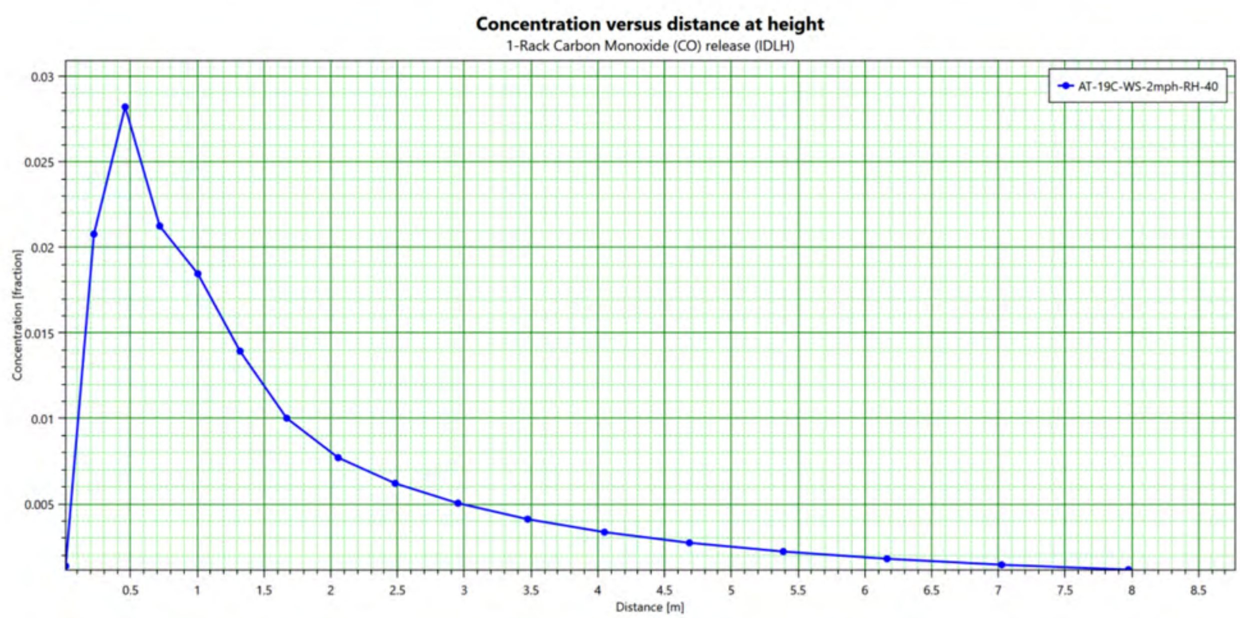


Figure 48. Concentration vs distance for CO IDLH (1200 ppm)

1.3.3 TVG Flammable Vapor Cloud Extent (10 min Release)

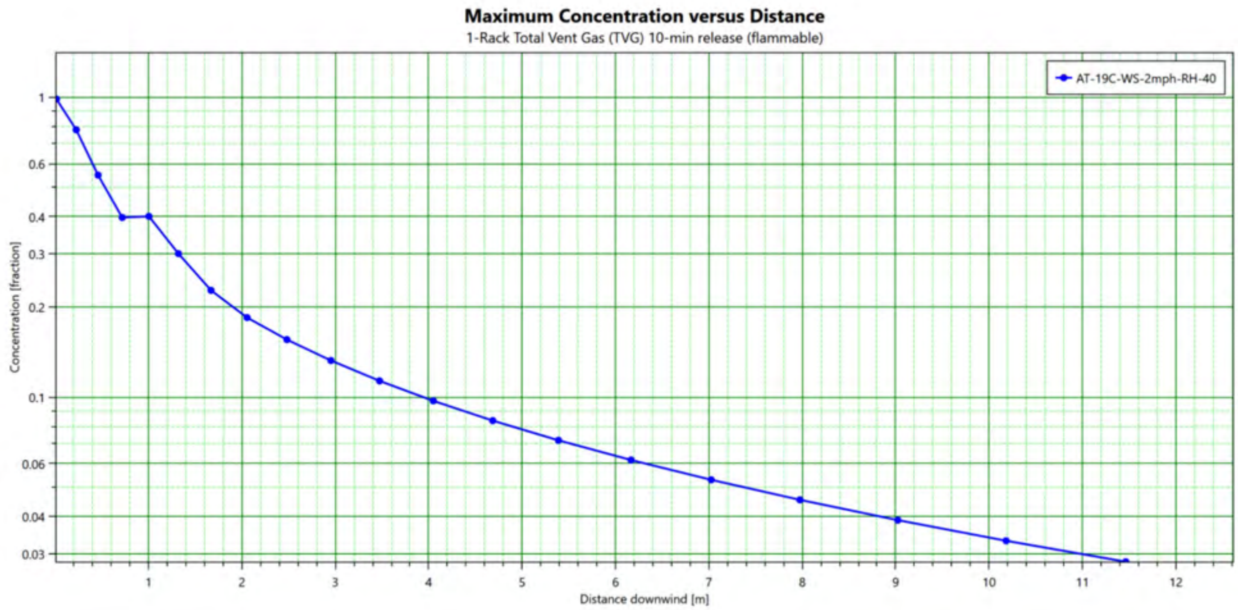


Figure 49. Maximum concentration vs distance for flammable vapor cloud

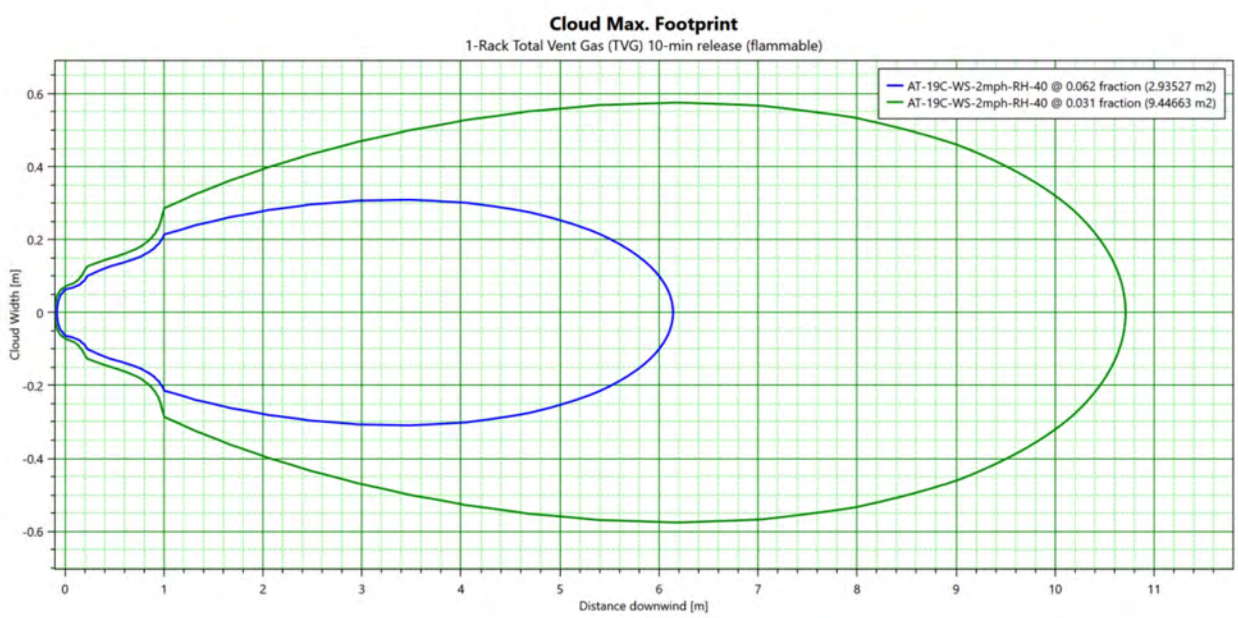


Figure 50. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

Representative Plume Analysis for Outside Ground Mounted Battery Using Sungrow Power Titan 2.0

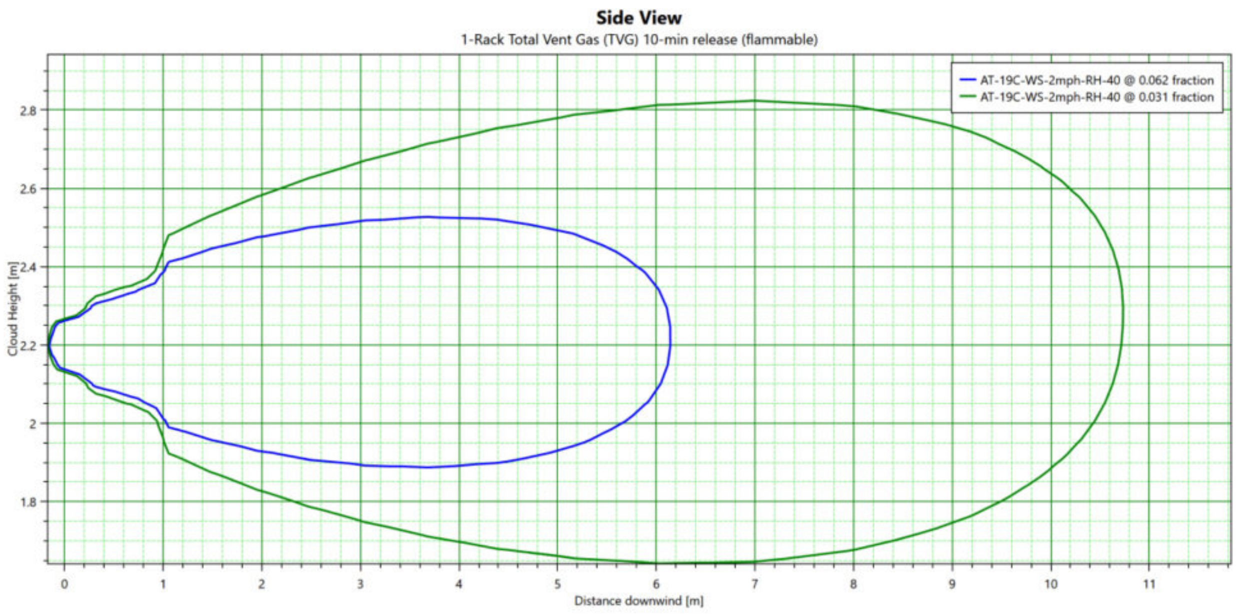


Figure 51. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

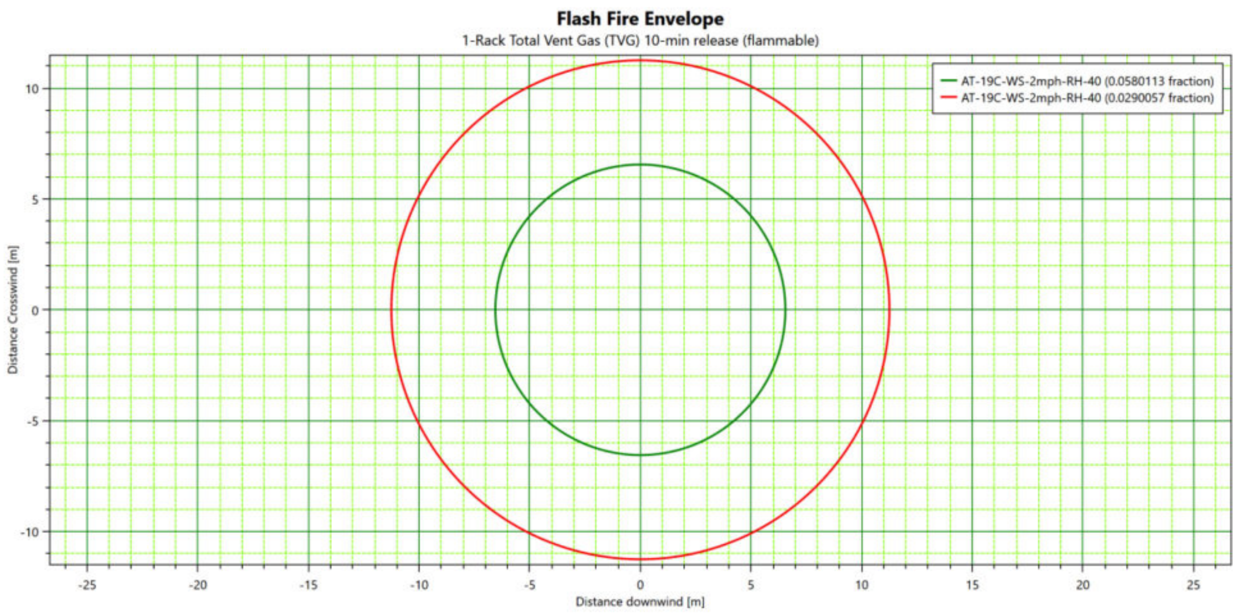


Figure 52. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.3.4 CO IDLH (1200 ppm) Component Extent (10 min Release)

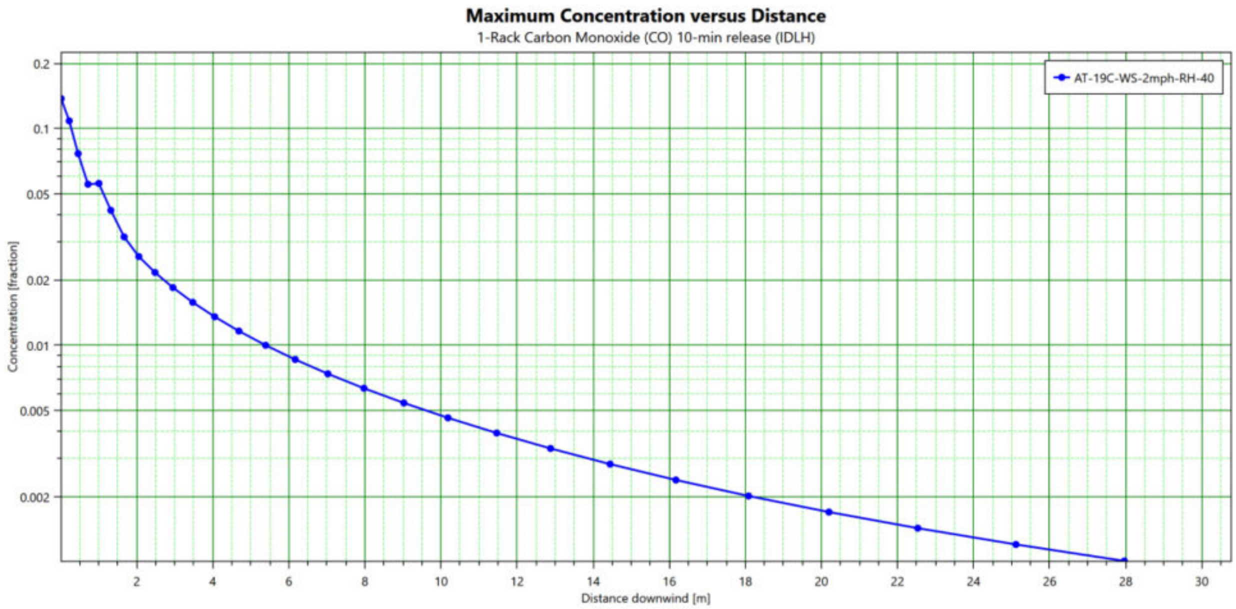


Figure 53. Maximum Concentration vs distance for CO gas component

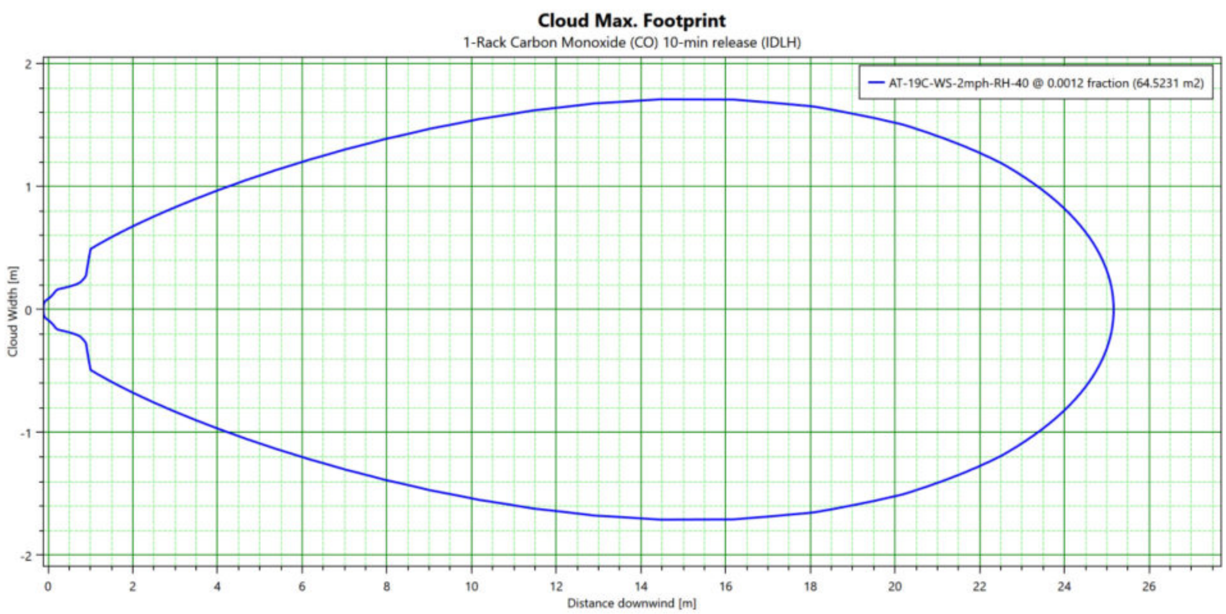


Figure 54. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

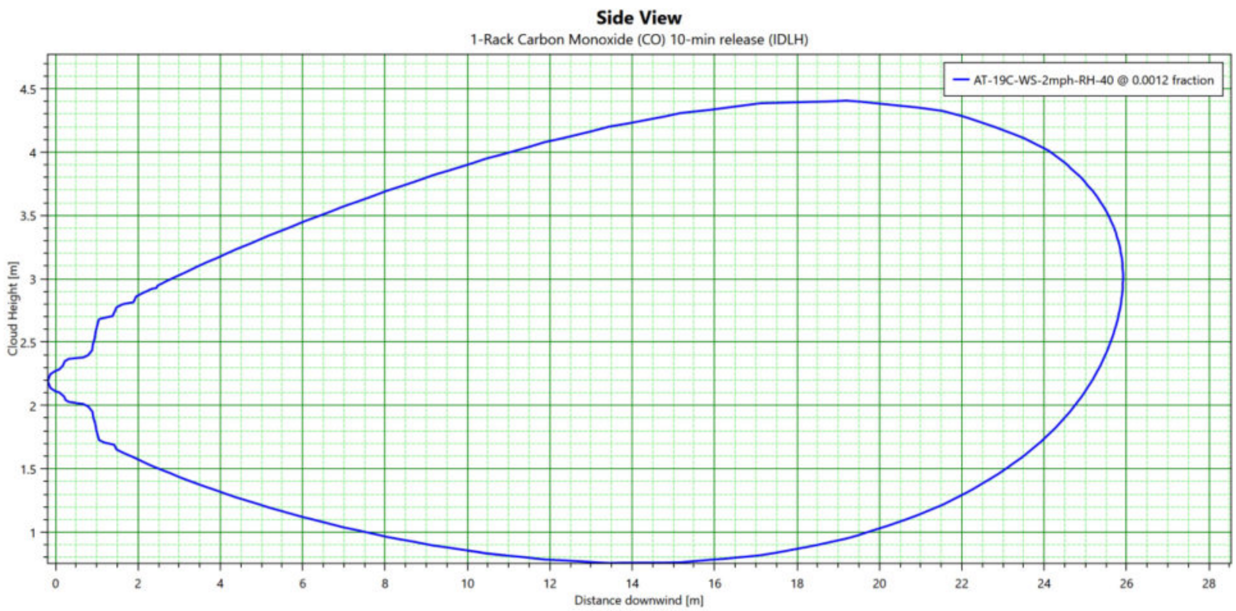


Figure 55. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

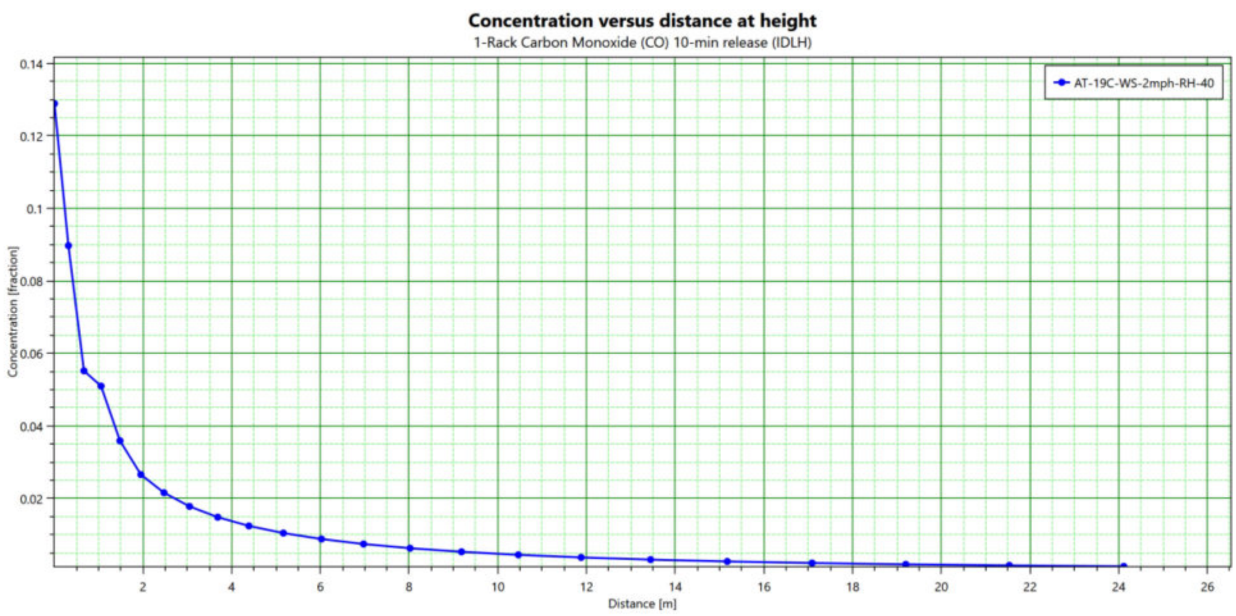


Figure 56. Concentration vs distance for CO IDLH (1200 ppm)

1.4 Scenario 4: Enclosure of 8-Modules Release

1.4.1 TVG Flammable Vapor Cloud Extent (124.8 min Release)

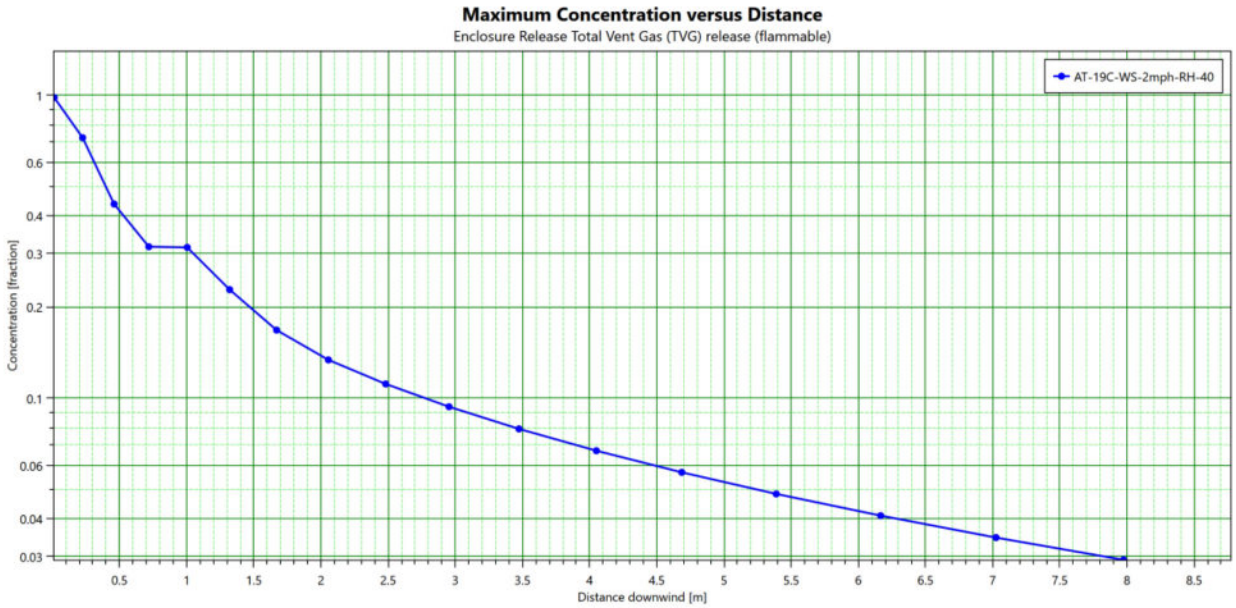


Figure 57. Maximum concentration vs distance for flammable vapor cloud

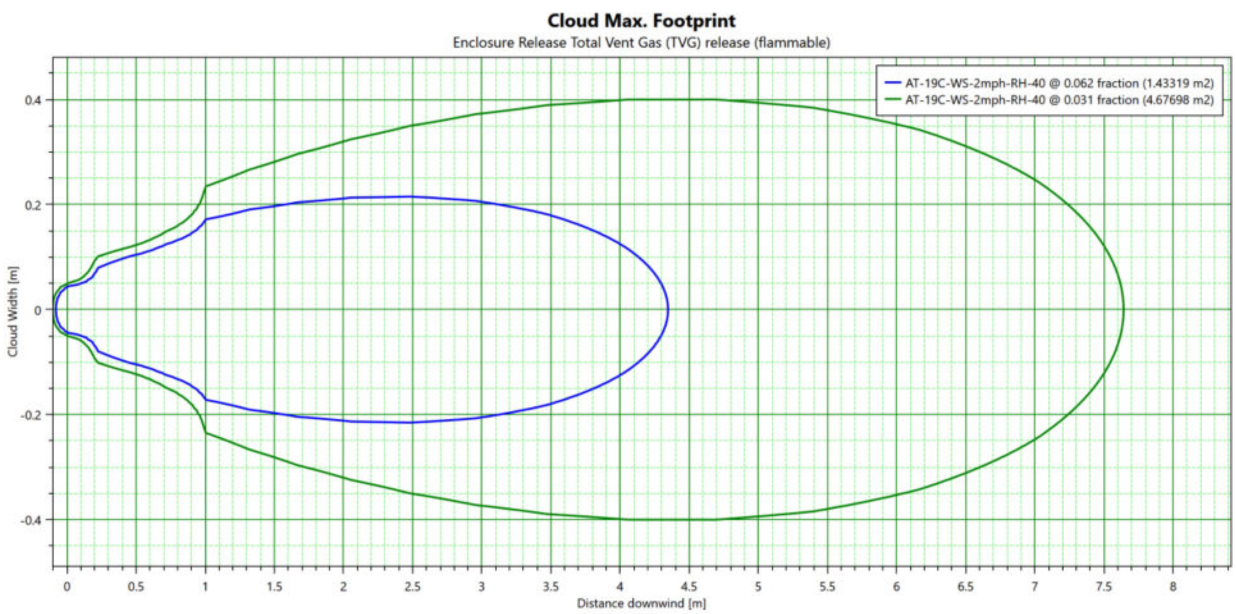


Figure 58. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

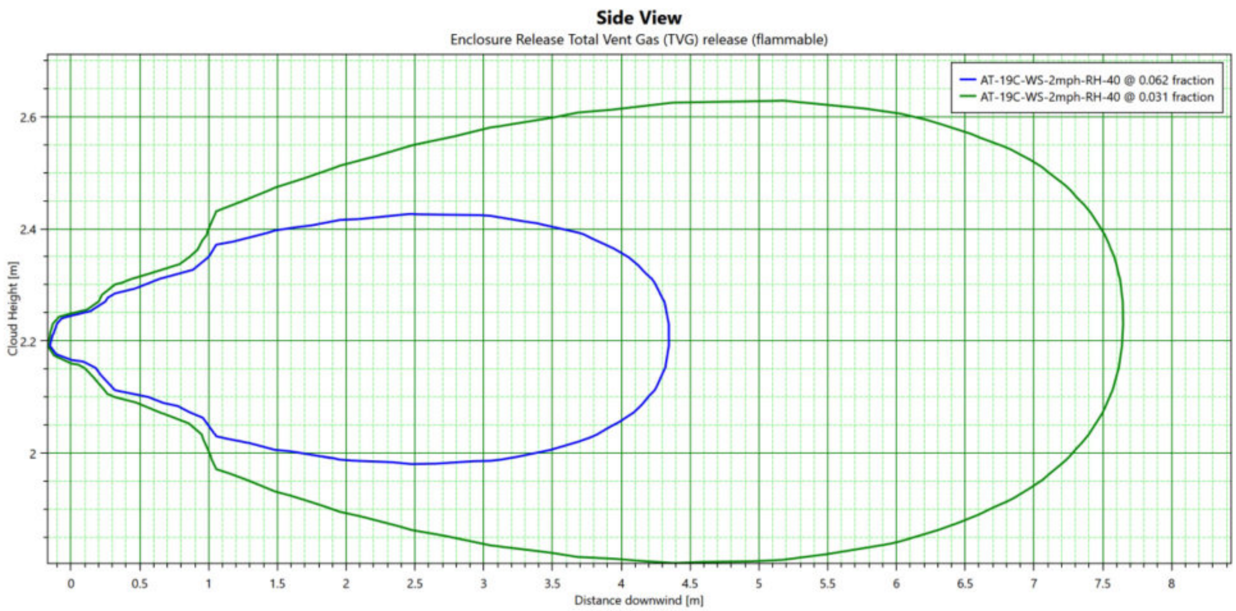


Figure 59. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

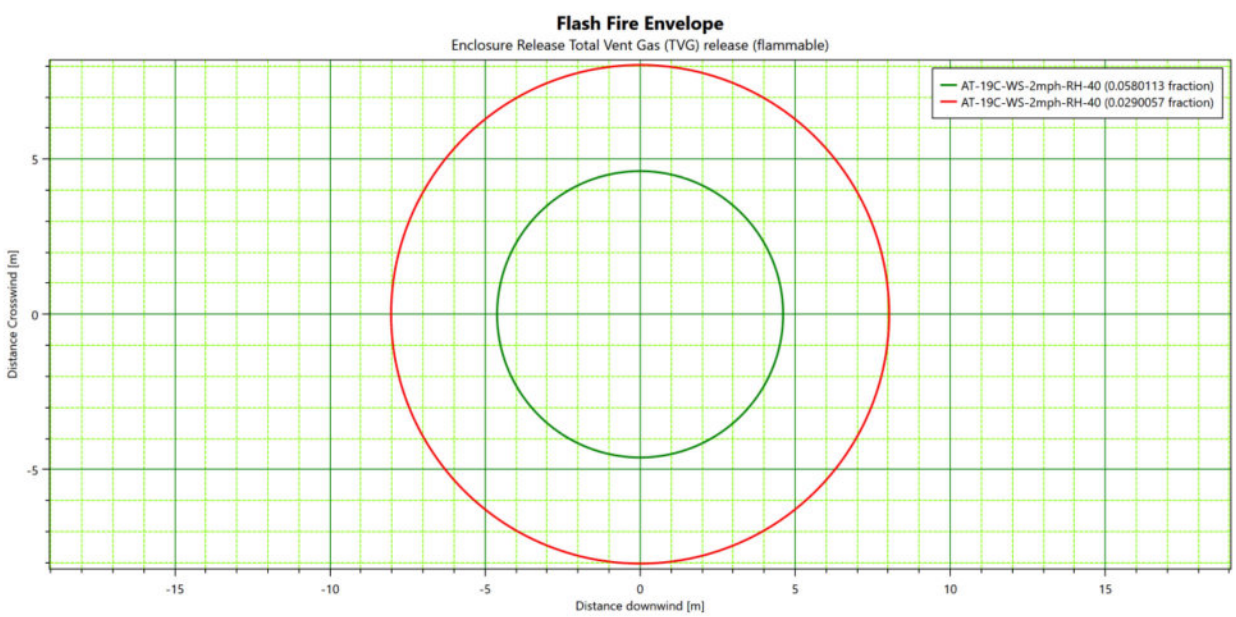


Figure 60. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.4.2 CO IDLH (1200 ppm) Component Extent (124.8 min Release)

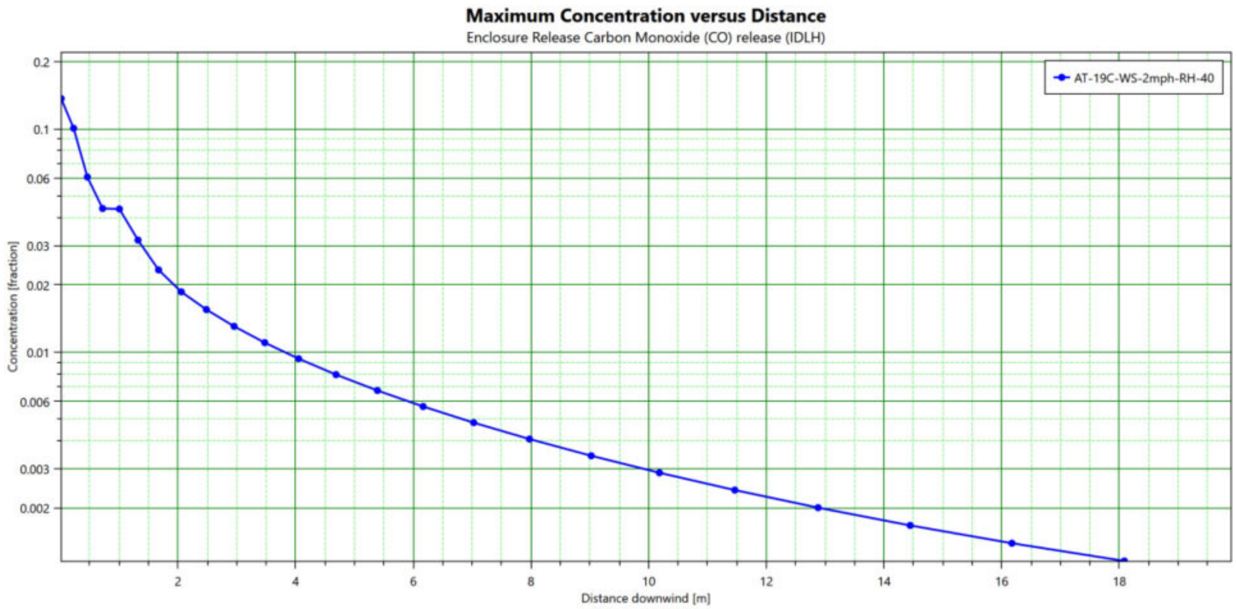


Figure 61. Maximum Concentration vs distance for CO gas component

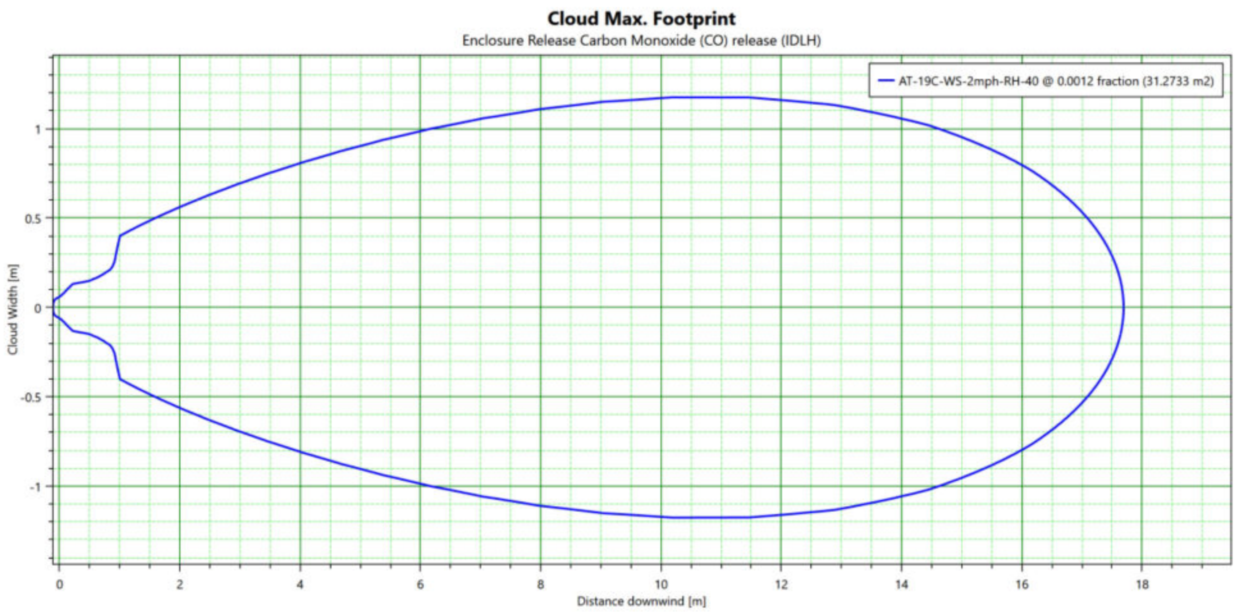


Figure 62. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

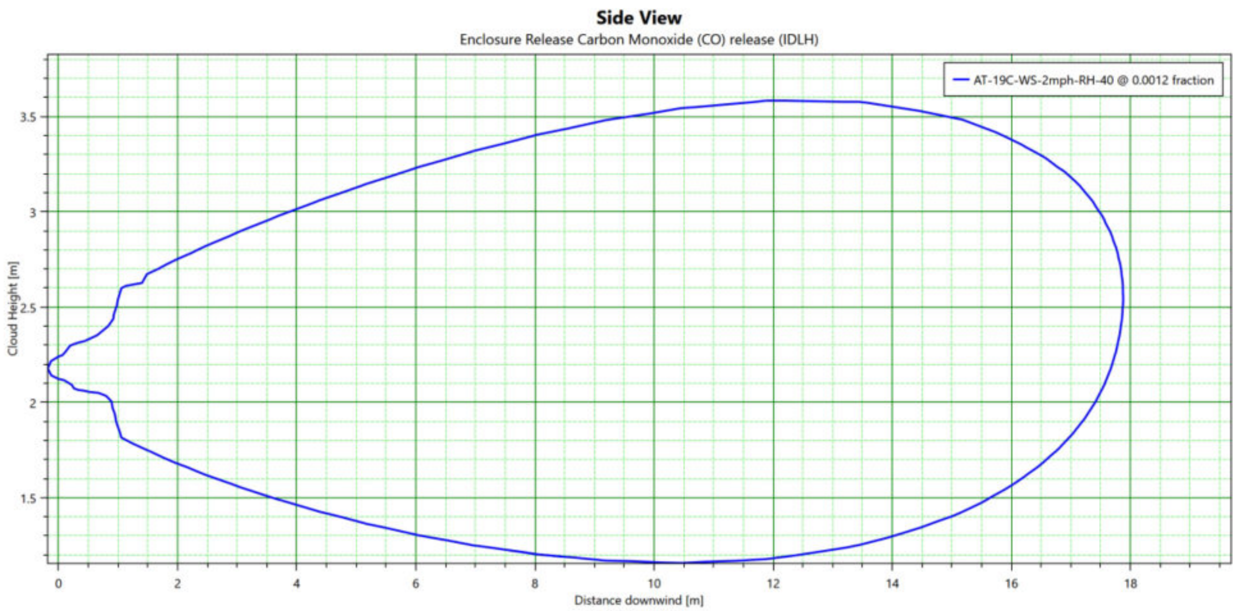


Figure 63. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

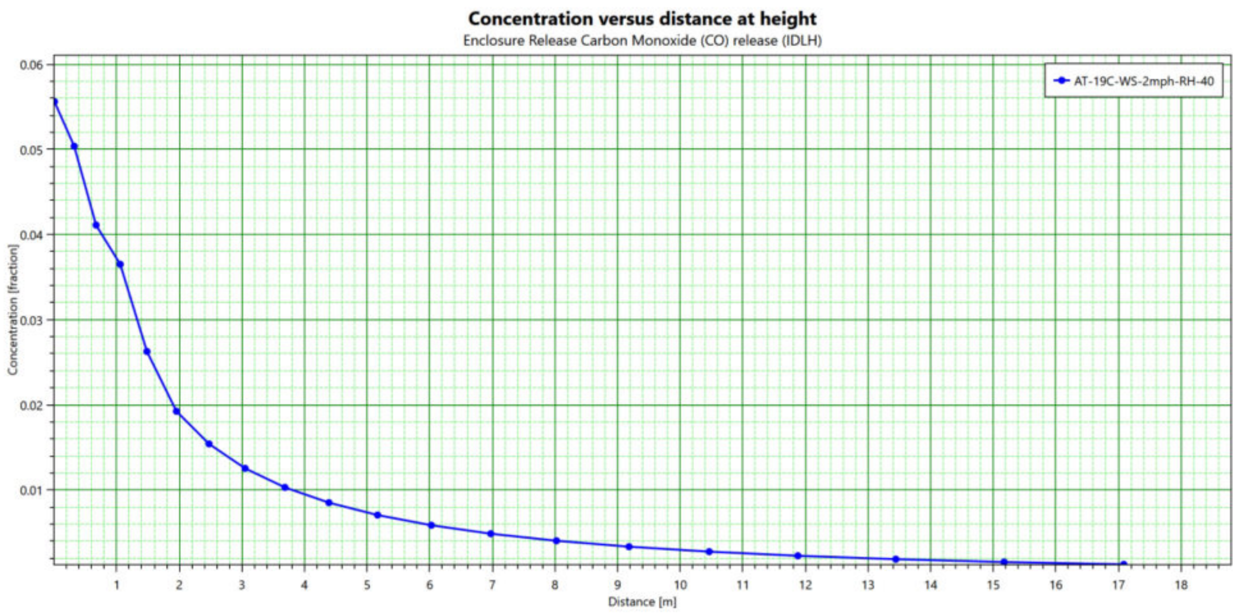


Figure 64. Concentration vs distance for CO IDLH (1200 ppm)

1.4.3 TVG Flammable Vapor Cloud Extent (10 min Release)

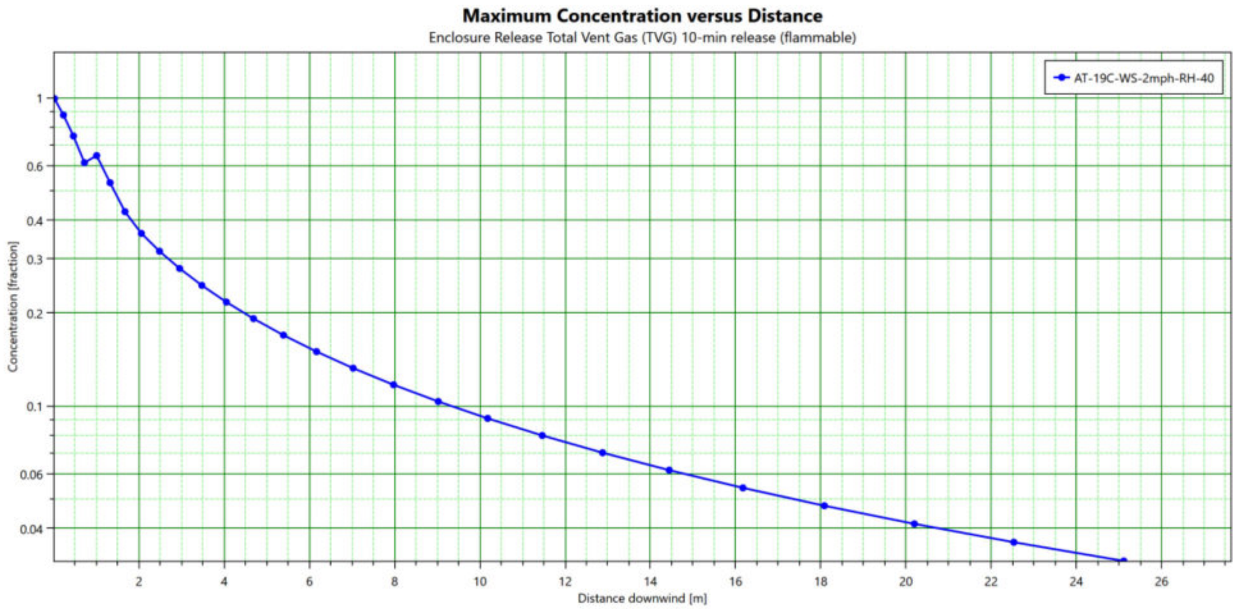


Figure 65. Maximum concentration vs distance for flammable vapor cloud

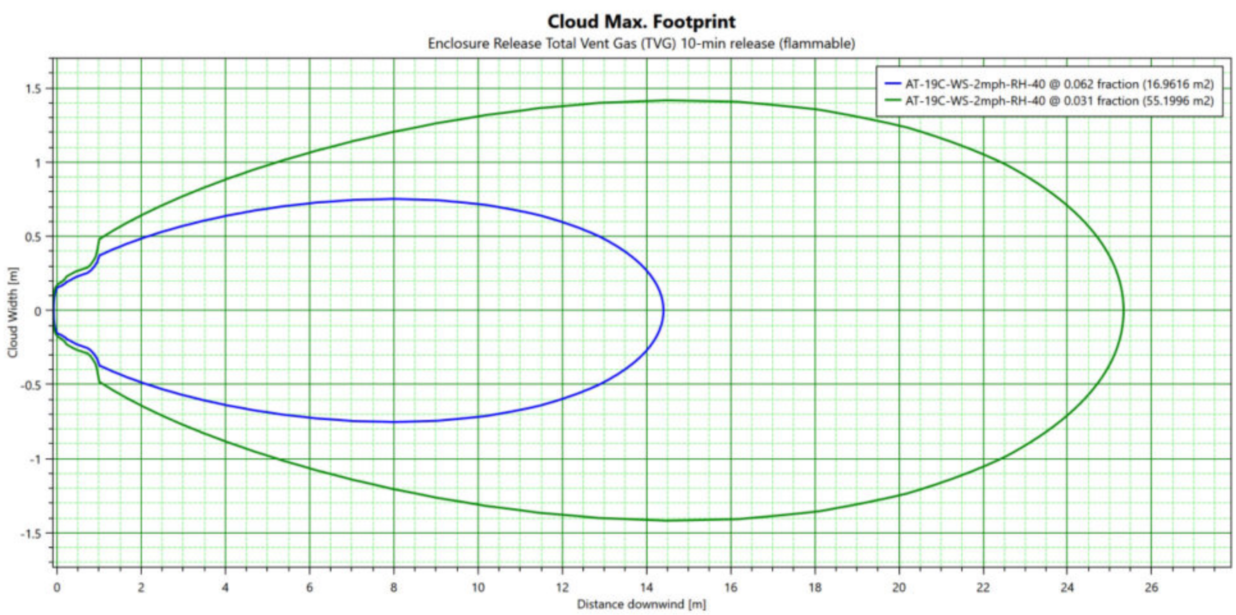


Figure 66. Maximum horizontal extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

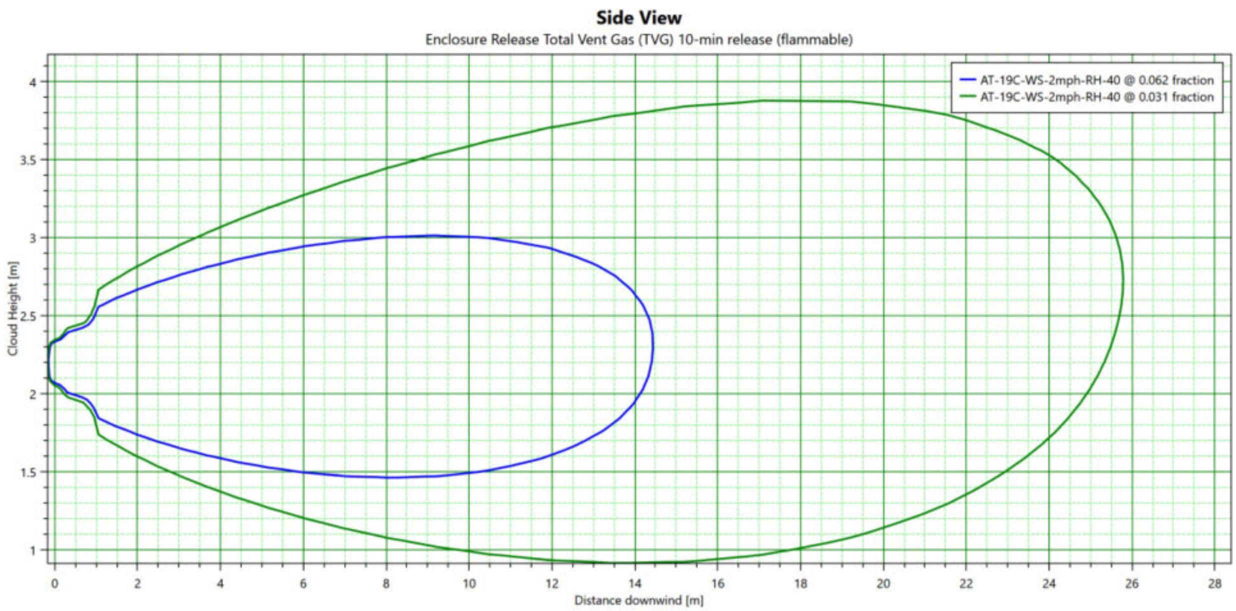


Figure 67. Maximum vertical extent of vapor cloud for LFL (6.2%) and ½ LFL (3.1%)

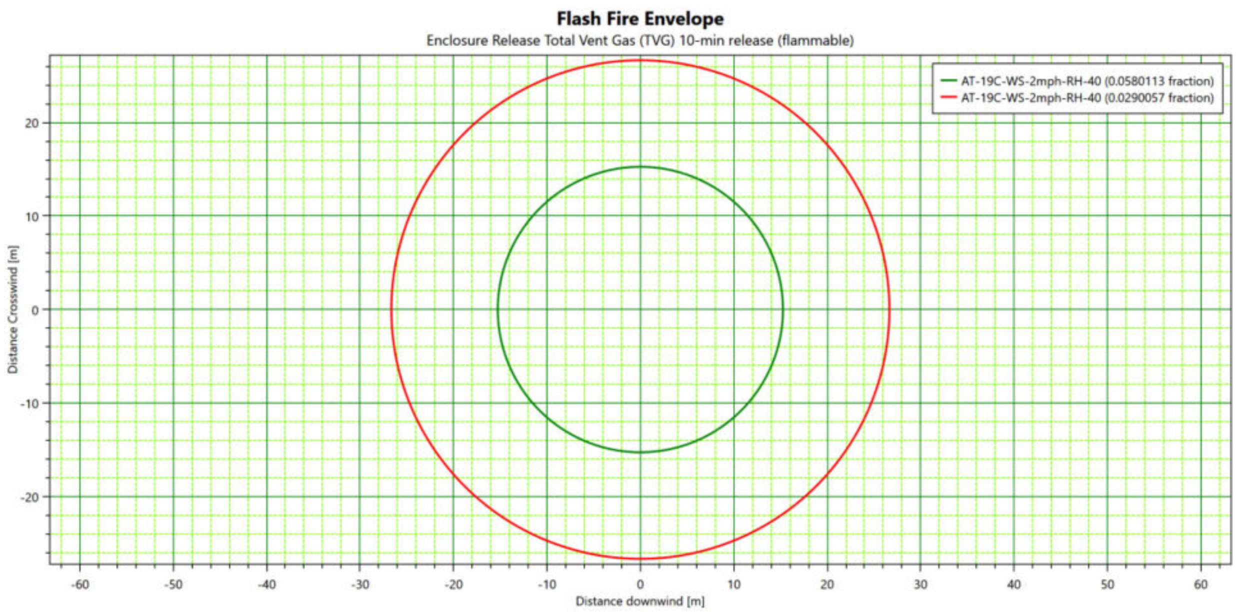


Figure 68. Flash Fire Envelope for LFL (6.2%) and ½ LFL (3.1%)

1.4.4 CO IDLH (1200 ppm) Component Extent (10 min Release)

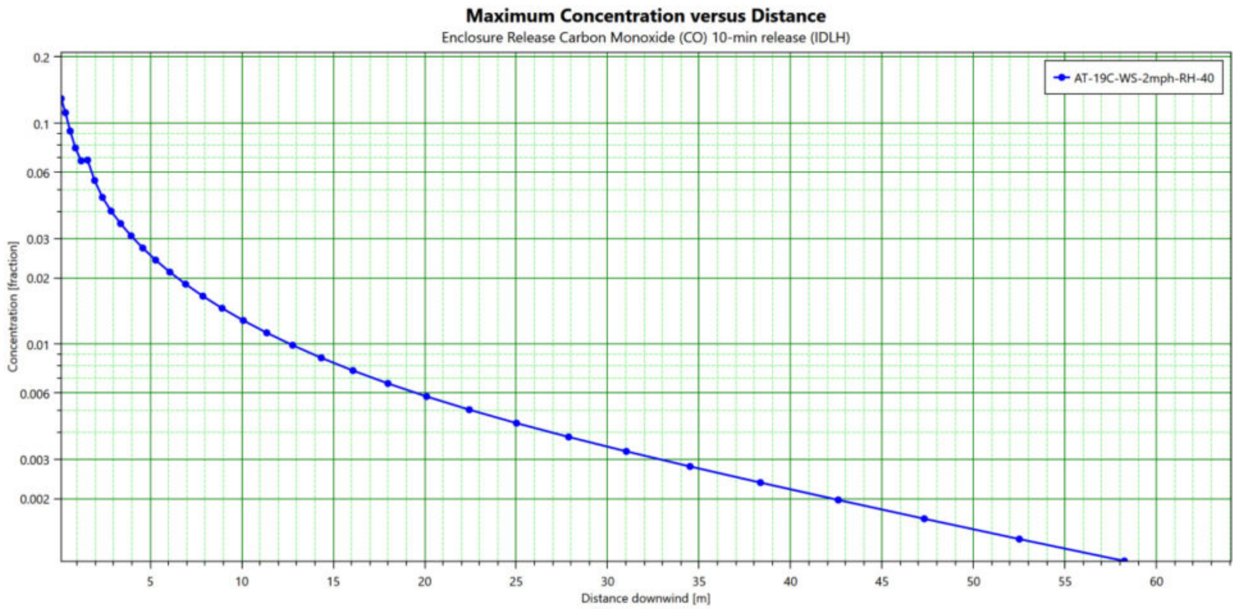


Figure 69. Maximum Concentration vs distance for CO gas component

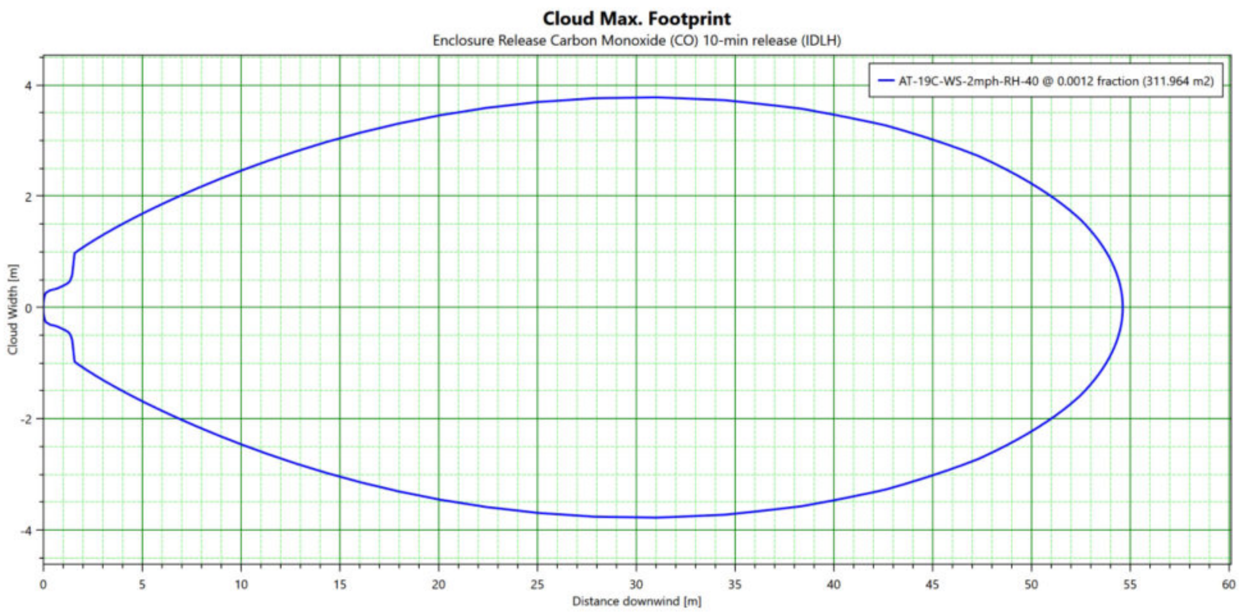


Figure 70. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm)

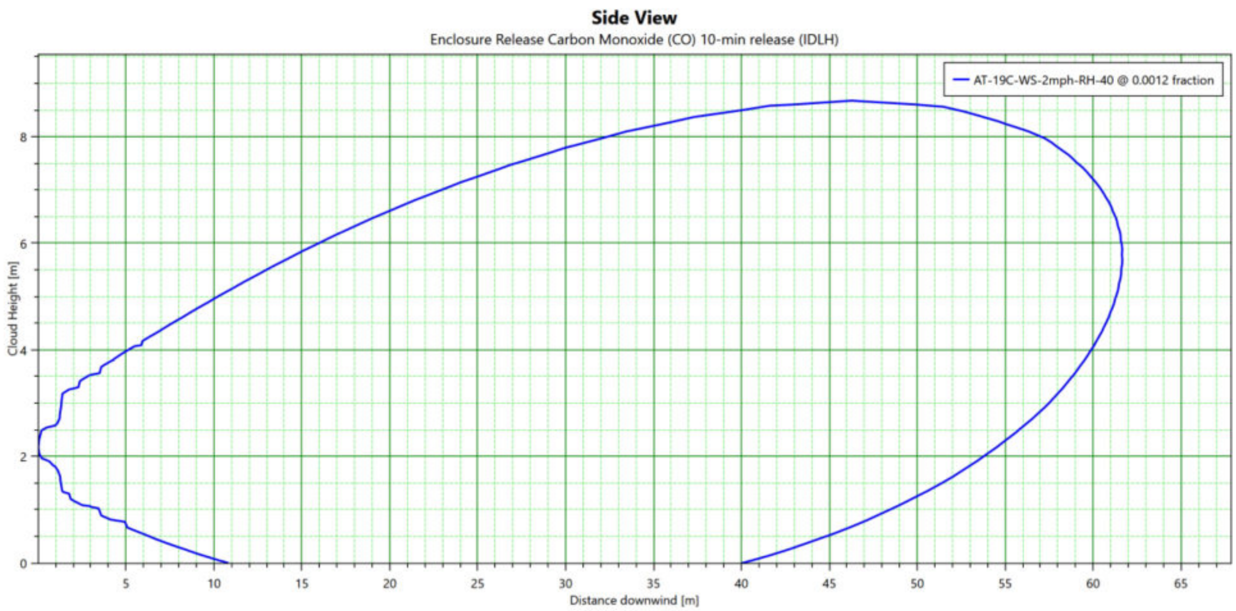


Figure 71. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm)

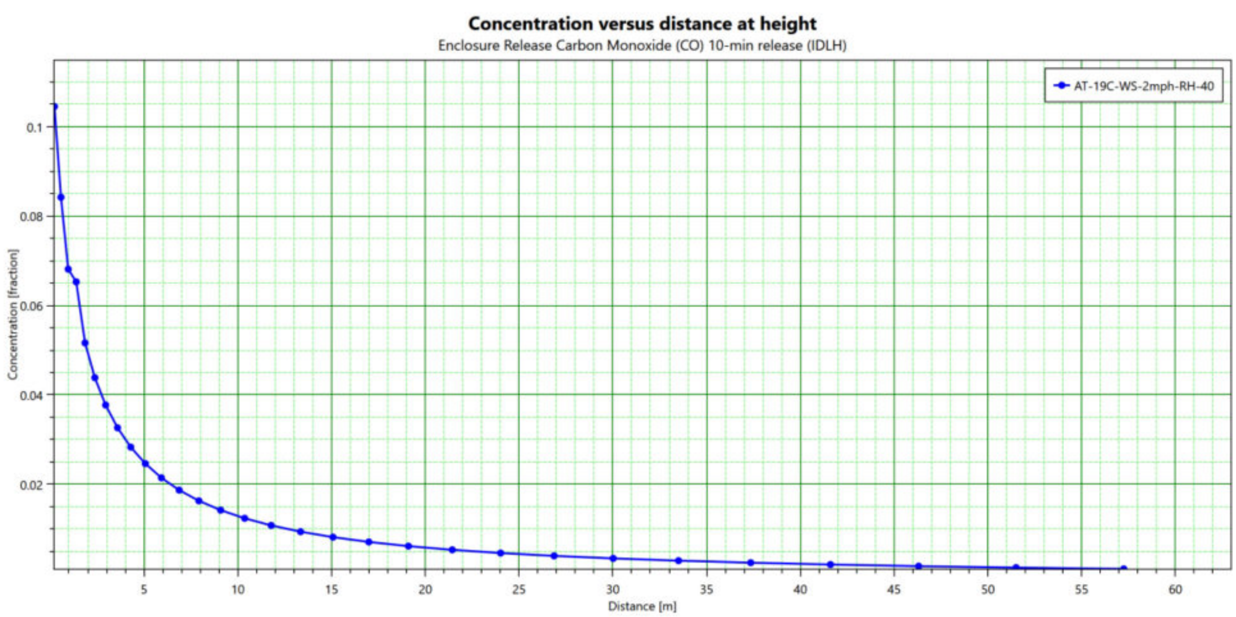


Figure 72. Concentration vs distance for CO IDLH (1200 ppm)

1.5 Summary Results for Vent Gas LFL Extent

1.5.1 Scenarios 1-4

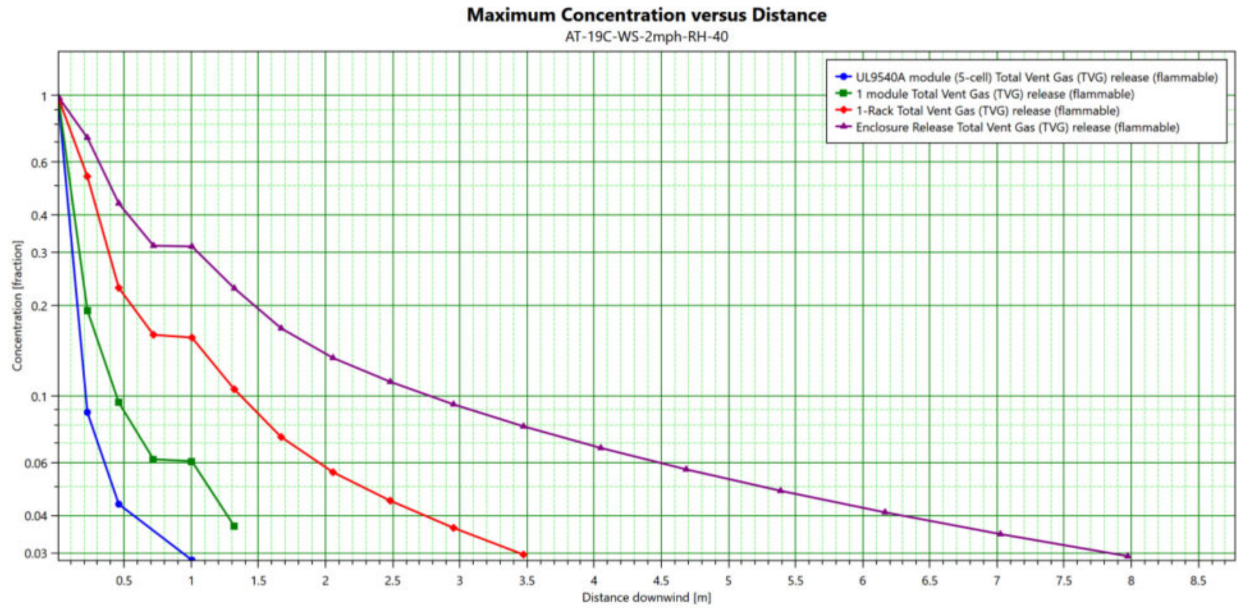


Figure 73. Maximum concentration vs distance for flammable vapor cloud for all sub-scenarios

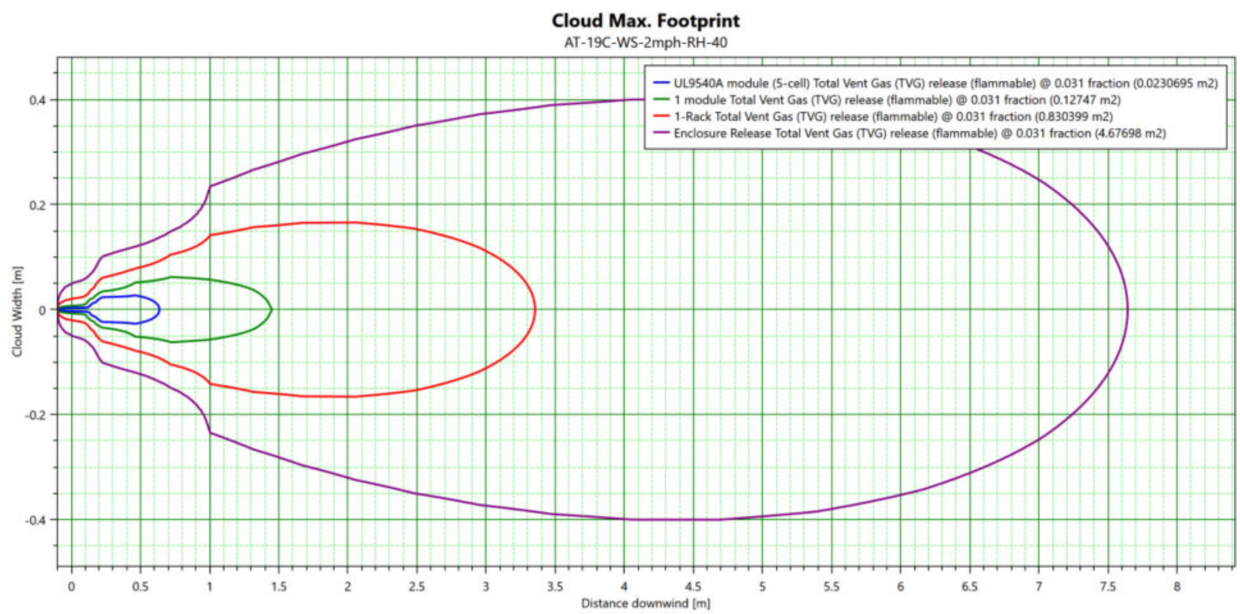


Figure 74. Maximum horizontal extent of vapor cloud for ½ LFL (3.1%) for all sub-scenarios

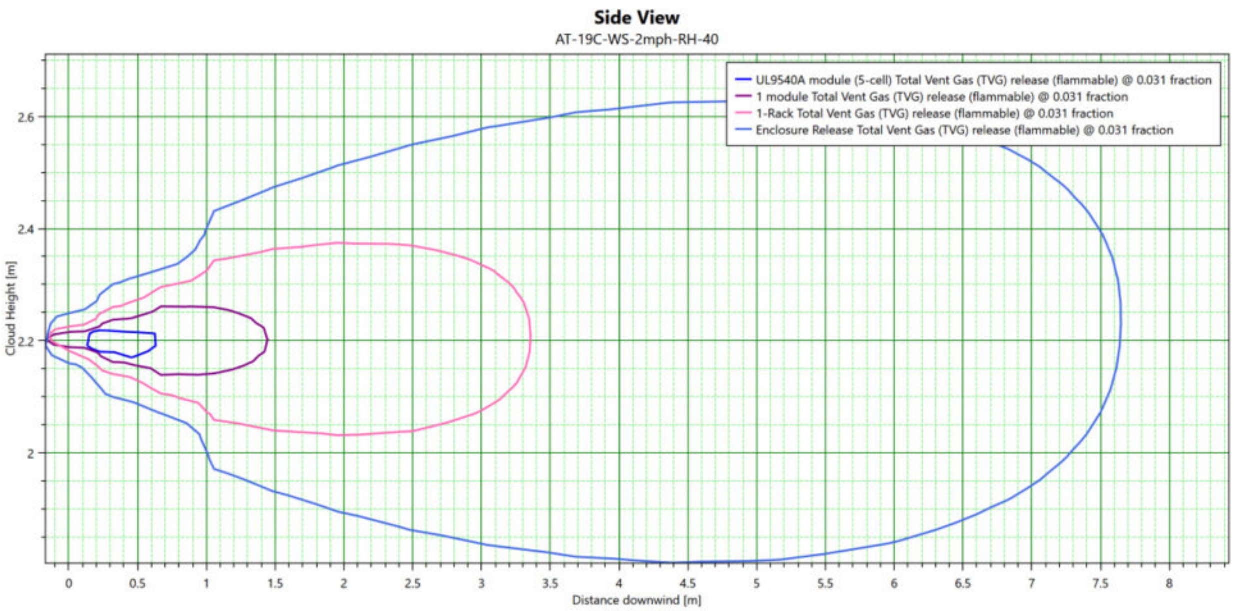


Figure 75. Maximum vertical extent of vapor cloud for ½ LFL (3.1%) for all sub-scenarios

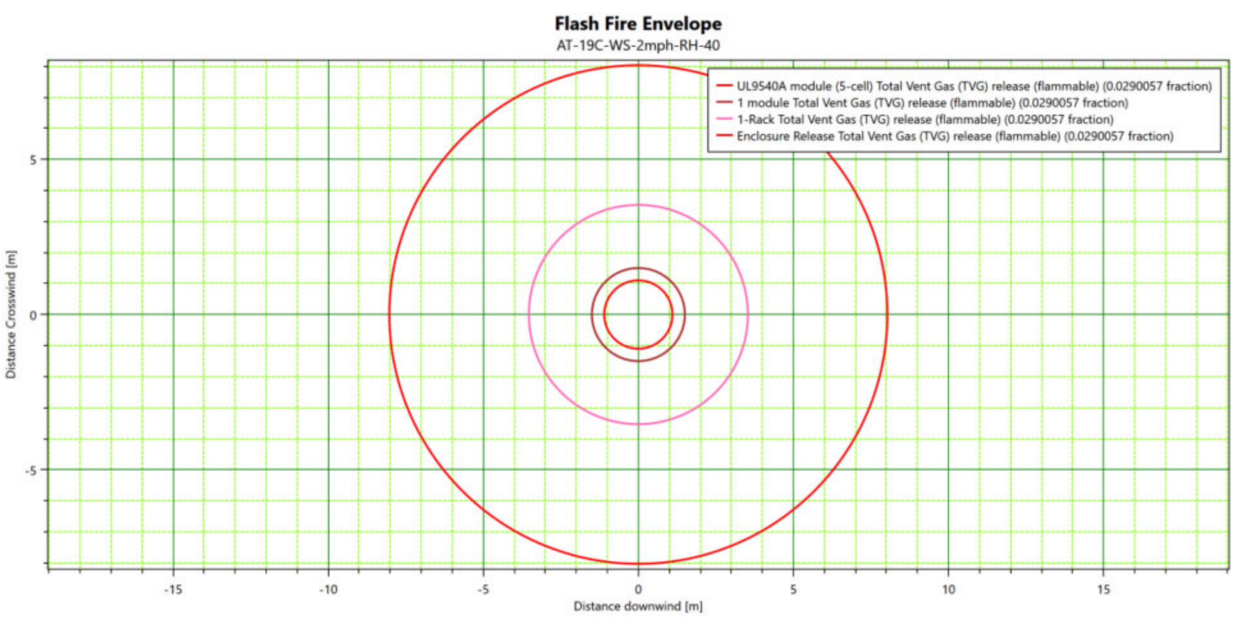


Figure 76. Flash Fire Envelope for ½ LFL (3.1%) for all sub-scenarios

1.6 Summary Results for Vent Gas CO IDLH (1200ppm) Extent

1.6.1 Scenarios 1-4

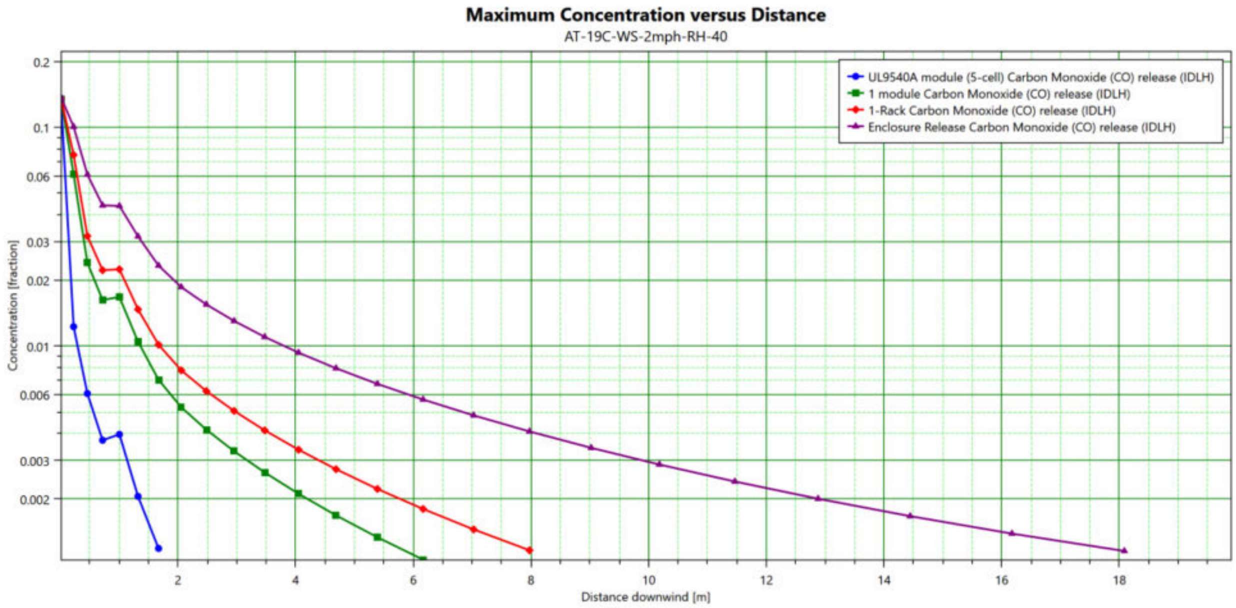


Figure 77. Maximum concentration vs distance at height (2.5m) for CO IDLH (1200ppm) for all sub-scenarios

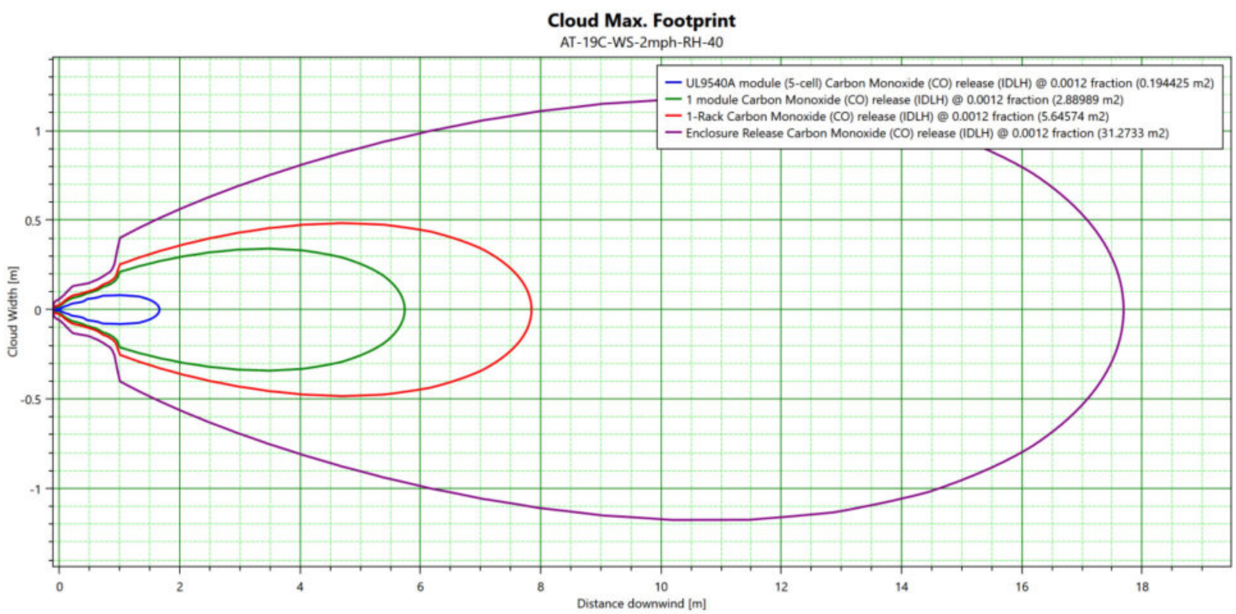


Figure 78. Maximum horizontal extent of vapor cloud for CO IDLH (1200 ppm) for all sub-scenarios

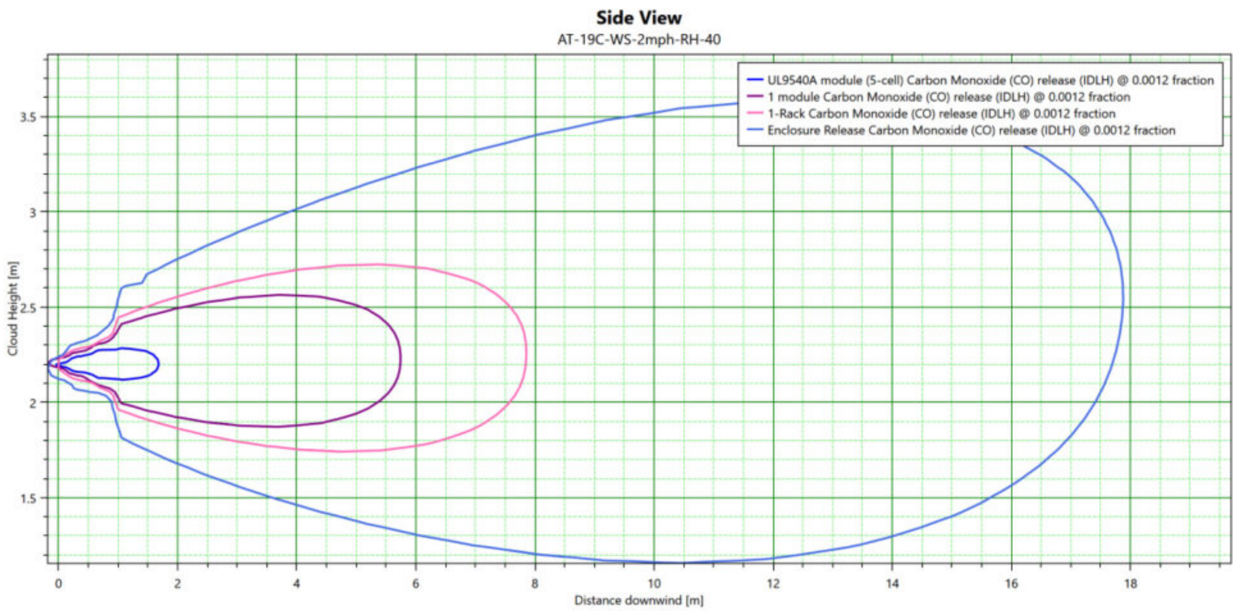


Figure 79. Maximum vertical extent of vapor cloud for CO IDLH (1200 ppm) for all sub-scenarios

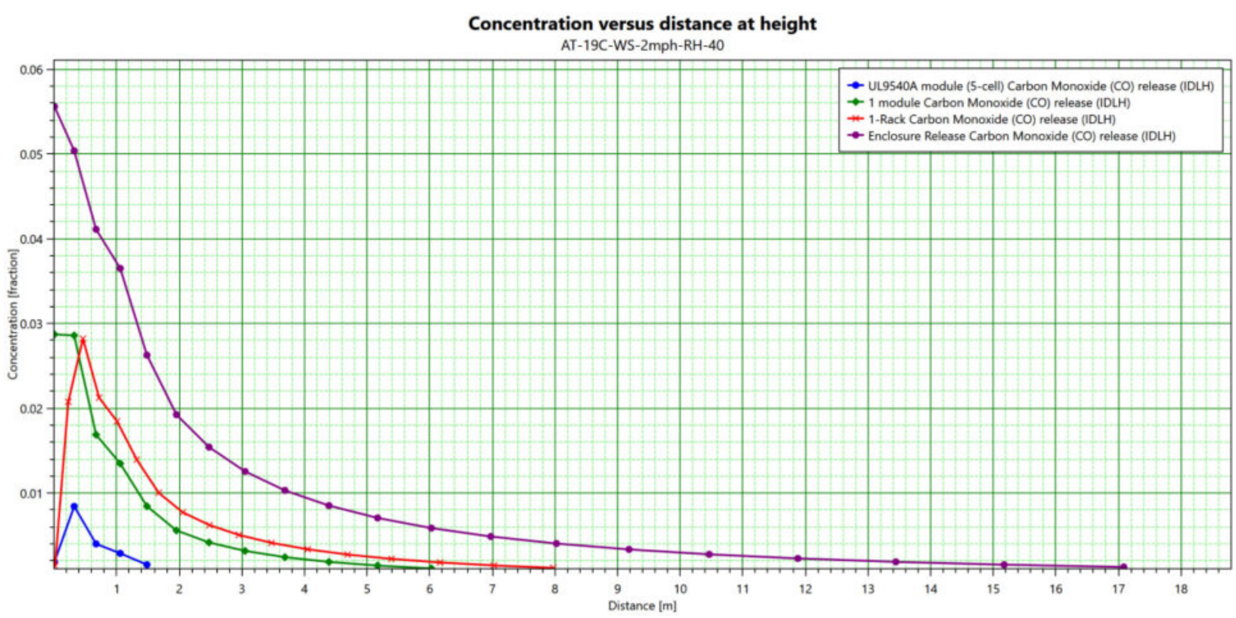


Figure 80. Concentration vs. distance for CO IDLH (1200 ppm) for all sub-scenarios

APPENDIX B: THEORETICAL UPPER BOUNDING RELEASES (TURC)

APPENDIX B: THEORETICAL UPPER BOUNDING RELEASES (TURC)

The following analysis was conducted as a sensitivity analysis to understand the potential impacts offsite from the theoretical upper-bounding battery vent gas release cases (hereby referenced as TURC. These TURC scenarios are representative of a case where all of the cells within each release scenario are assumed to have a common source of failure and to undergo venting and thermal runaway simultaneously (i.e. no cell-to-cell propagation), such that the entire vent gas volume of all involved cells is released within a 10-minute duration. This 10-minute release duration represents the average total duration for venting and thermal runaway taken from the literature, UL 9540A reports, and based on extensive FRA experience.

These TURC scenarios are only included in this analysis for use as a means of understanding the hypothetical peak potential impacts and are not representative, in any way, of the consequences to be expected from a propagating non-flaming thermal runaway event, nor utilized for evaluating facility siting.

As done for the UL 9540A based propagating release scenarios, the gas generation source term was modeled as a mixture according to gas properties with the component concentrations taken from those listed in the UL 9540A reports for pre-combustion. In addition to Lower Flammability Limit (LFL) and associated consequences, the CO component of the gas mixture was tracked to determine the maximum extent of the component IDLH concentration (1,200 ppm CO) within the cloud.

TURC Scenarios

As for the UL 9540A based release scenarios, the TURC release scenarios were modeled in PHAST to determine the maximum extent of the flammable cloud (3.1% ½ LFL; 6.2% LFL), and of the CO IDLH of 1200 parts per million (ppm) of the cloud. All release timing and mass flow rates for PHAST modeling were based on the conservative values obtained from UL 9540A cell/module test data, with a single cell-based mass flow rate for total vent gas (TVG) of 0.00055 kg/s.

The following four (4) scenarios and associated sub-scenarios were modeled in PHAST:

- Scenario 1: UL 9540A Based Scenario (5-cells venting under thermal runaway)
  - 10-minute release duration (TURC)
- Scenario 2: 1-Module Release (104-cells)
  - 10-minute release duration (TURC)
- Scenario 3: 1-Rack Release (8-modules (832-cells))
  - 10-minute release duration (TURC)
- Scenario 4: Enclosure Release (48-modules (4992-cells))
  - 10-minute release duration (TURC)

For all of the above TURC scenarios, the flammable cloud was modeled as a mixture according to the component concentrations listed in the UL 9540A reports and gas properties, and CO was tracked as a component of the release to determine the maximum extent of IDLH concentrations (1200 ppm of CO).

PHAST Model Parameters

See Section 3.2 of the main report for model parameter details.

PHAST RESULTS

Results of the PHAST consequence analysis for the four (4) main battery gas venting TURC scenarios identified above are presented below.

Table 1. Results Summary of Flammable and Toxic Extents for Release Scenarios (m)

Scenario	Duration	Flash-Fire Radius	100% LFL	50% LFL	CO IDLH
1 (UL 9540A 5-cell)	*10-min TURC)*	*1.3*	*0.57*	*1.22*	*2.54*
2 (1-module)	*10-min TURC*	*4.33*	*2.3*	*4.12*	*9.55*
3 (1-Rack)	*10-min TURC*	*11.25*	*6.24*	*10.71*	*25.16*
4 (Enclosure [6-rack])	*10-min TURC*	*26.65*	*14.405*	*25.33*	*54.63*

**Instantaneous release was modeled for 5-cell volumes only. Module and enclosure level releases exceed the interior volume space of the BESS*

Table 2. Results Summary of Explosion Overpressures

Scenario	Duration	Deflagration (m)		
		0.02068 bar	0.1379 bar	0.2068 bar
4 (Enclosure [6-rack])	*10-min TURC*	48.12	27.28	25.63

Scenario 1 (5-cell release): PHAST Modeling Results

Figure 1. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

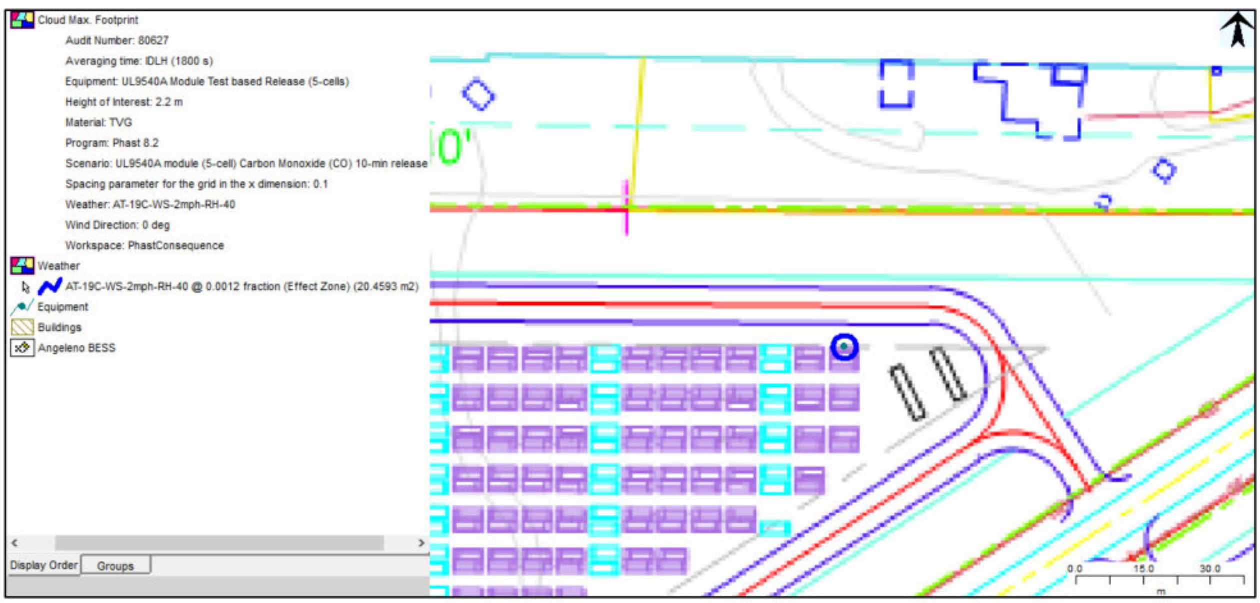


Figure 2. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

Scenario 2 (1-module release): PHAST Modeling Results

Figure 3. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

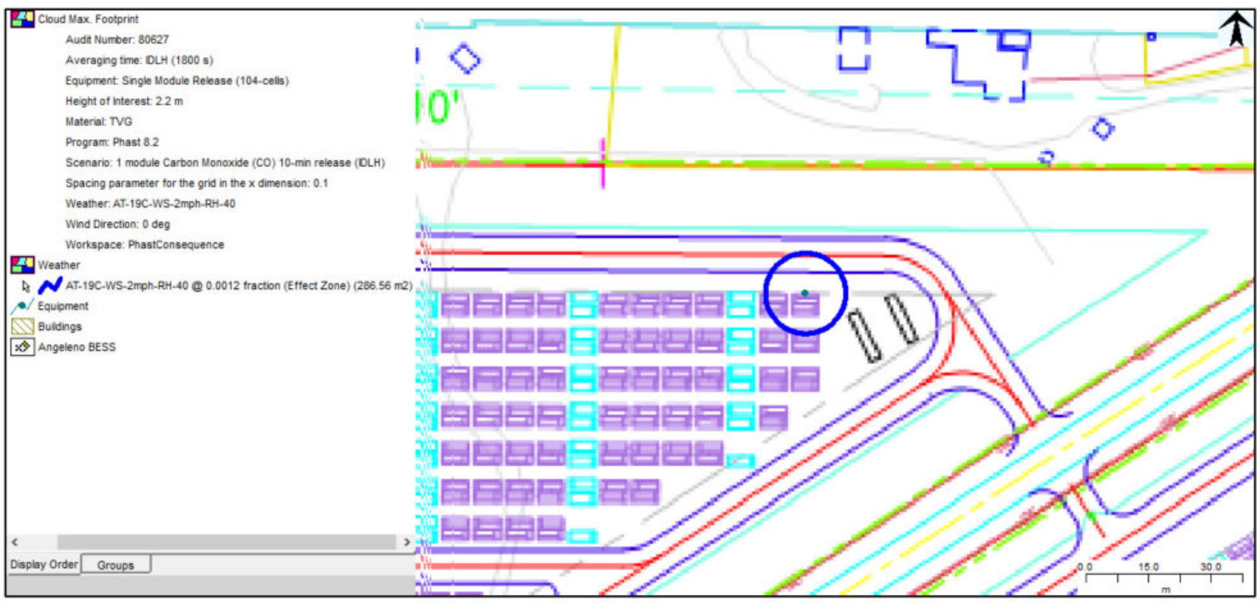


Figure 4. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

Scenarios 3 (1-rack release): PHAST Modeling Results

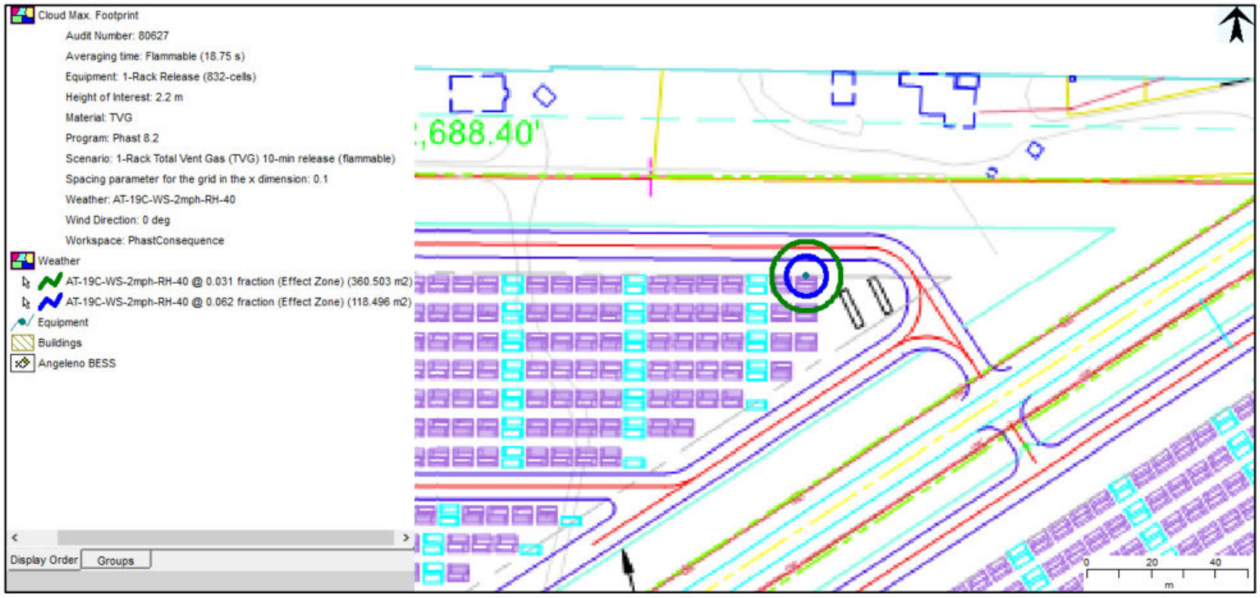


Figure 5. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

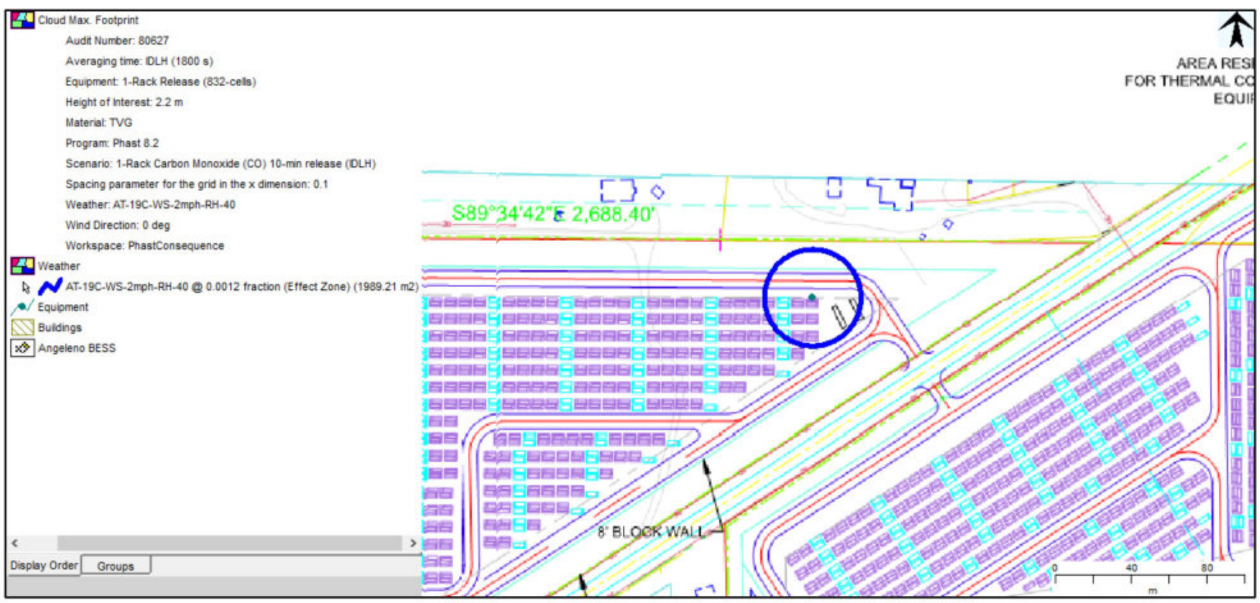


Figure 6. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

Scenarios 4 (Enclosure [6-rack] release): PHAST Modeling Results

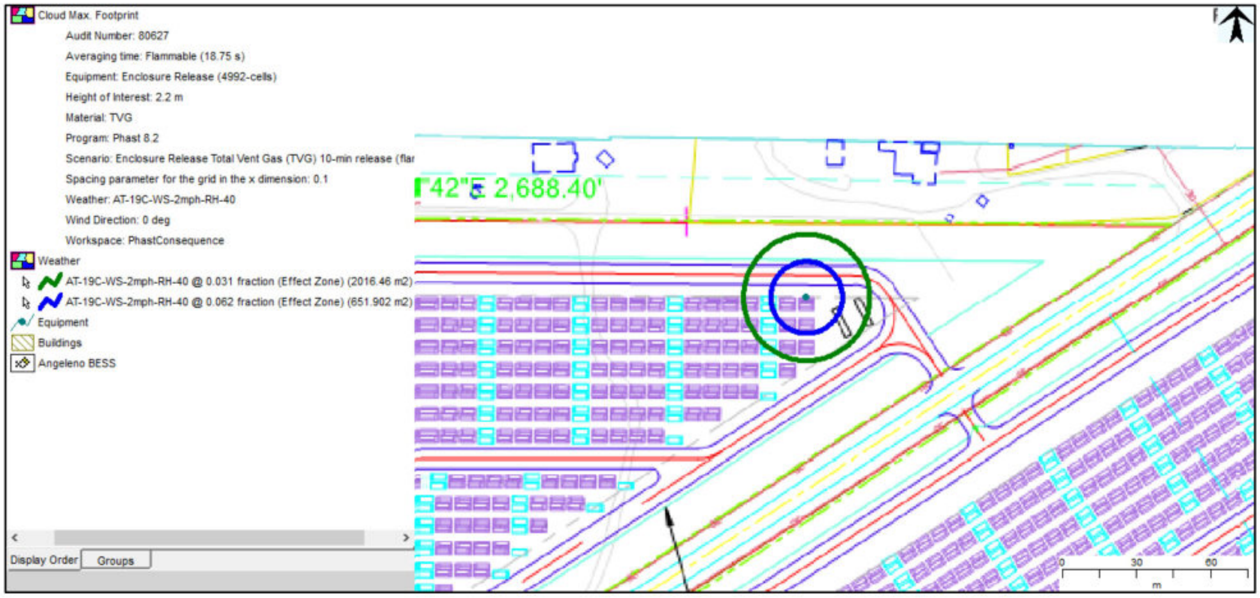


Figure 7. Map of horizontal extent of vapor cloud for LFL (6.2% in blue) and ½LFL (3.1% in green)

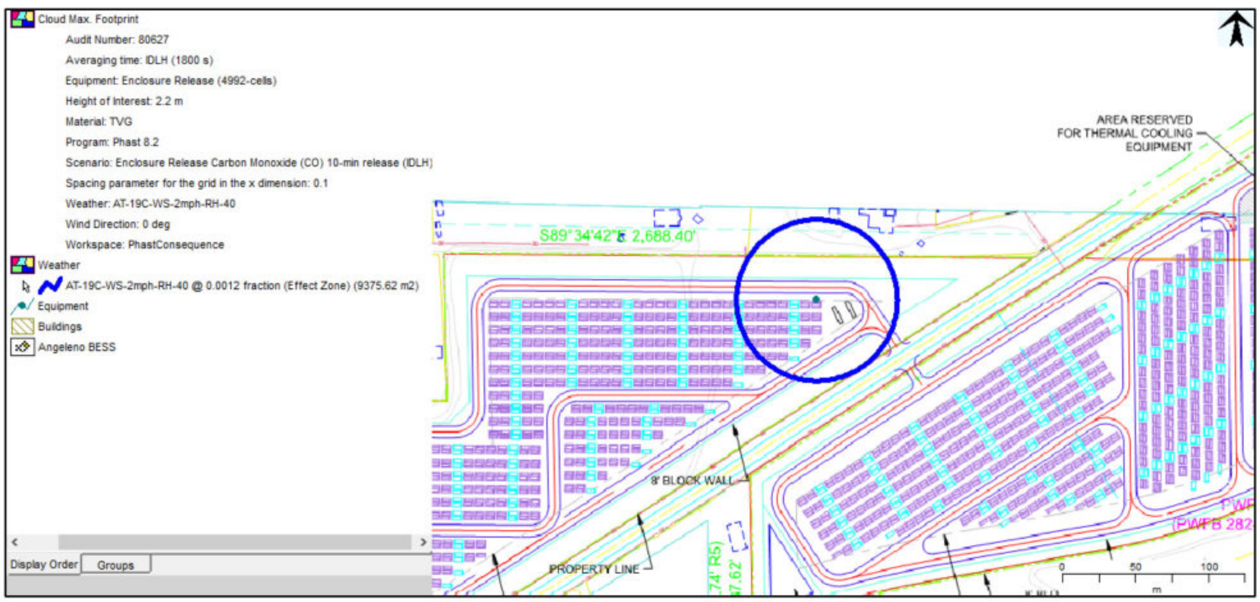


Figure 8. Map of horizontal extent of vapor cloud for CO IDLH (1200 ppm)

Scenarios 1-4: Flash-Fire Results

A flash fire occurs when the battery vent gas released is diffused in air such that all flammable fuel shall be consumed nearly instantaneously once ignited. In a flash fire, the flame front accelerates rapidly from the ignition point to the limit of the flammable cloud, after which it immediately goes out. Thus, the duration of heat flux values equal to those sufficient to ignite flammable clothing or cause second-degree burns to exposed skin does not occur for more than 1-3 seconds (NFPA defines the upper limit of a flash fire to be 3 seconds) in any single location within the flash fire envelope.

Scenario 1 (5-cell release)

Figure 9. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

Scenario 2 (Single module release)

Figure 10. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

Scenario 3 (1-rack [8-module] release)

Figure 11. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

Scenario 4 (Enclosure [6-rack] release)

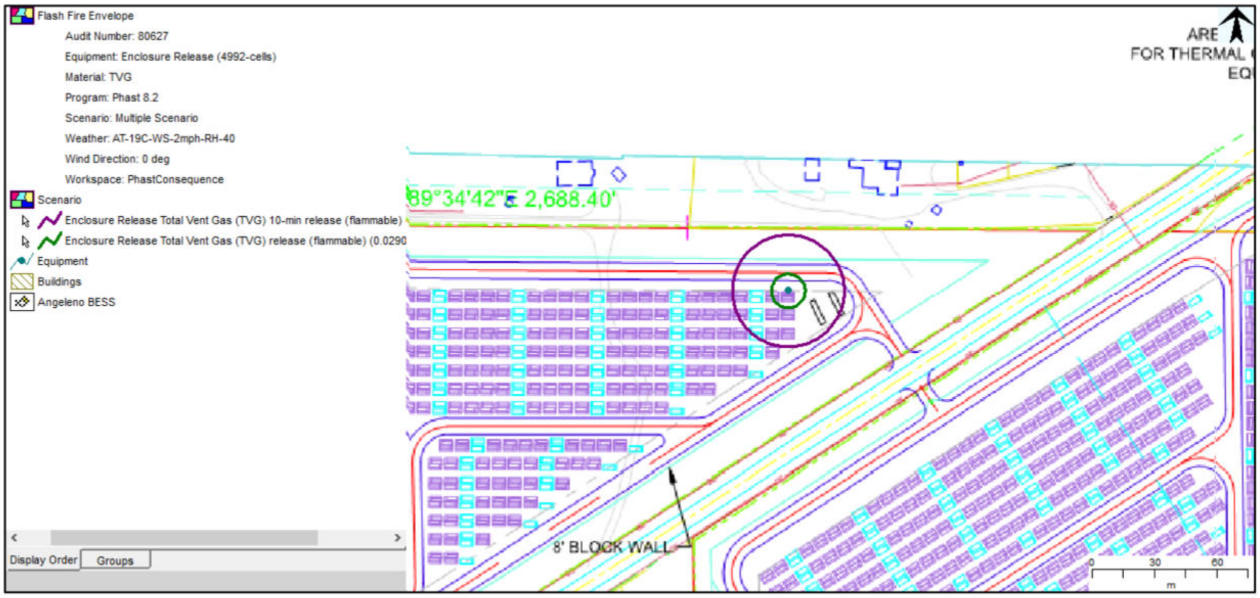


Figure 12. Maximum Extent of Flash Fire Envelope (Duration < 3 sec)

Explosion & Fireball Results

Only the enclosure (TURC) release scenario resulted in the formation of explosion overpressures. It must be noted that this scenario, i.e., that of a full volume release of all battery vent gas from all 4,992 cells in the enclosure within the 10-minutes, has no mechanism of occurrence documented in the BESS literature, in documented failure modes, in BESS failure modes and effect analyses (FMEAs), or anecdotally. This scenario is only included in this analysis as a comparison of the upper bounding release scenario for understanding the hypothetical peak potential impacts from a condensed release (assumes instantaneous TR in all 4,992 cells) and is not representative of the consequences to be expected from a propagating non-flaming thermal runaway event nor utilized for evaluating facility siting.

As this scenario is not representative of a potential real-world release, the associated impacts are taken only to establish the potential peak consequences. However, there was no impact across the property boundary as no significant overpressures (>.02068 bar) extended beyond 48.12 m, within the offset distance.

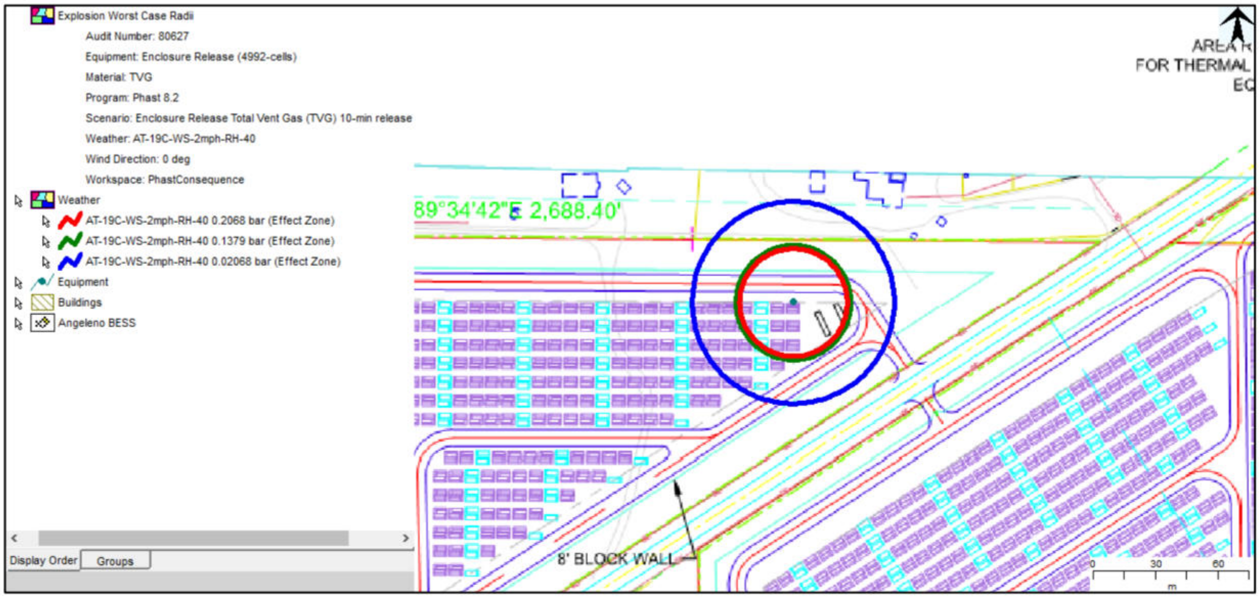


Figure 13. Explosion worst-case radii for 48 module 10-minute duration (TURC) release scenario

None of the other pre-combustion battery vent gas TURC release scenarios led to the consequence of an explosion or fireball occurring.

CONCLUSIONS

All TURC releases (theoretical upper-bounding 10-minute duration release scenarios) are included in the analysis only as a comparison tool to frame the UL 9540A test data-based analysis results against the theoretical upper-bounding condition, achieved by assuming thermal runaway and venting are initiated simultaneously for the entire released vent gas volume over a 10-minute duration for all module/string/container-level scenarios. These upper-bounding theoretical cases are only included to provide an understanding of the theoretical peak impact associated with a condensed 10-minute duration release and are not representative of the consequences to be expected from any propagating non-flaming thermal runaway event.

Total Vent Gas LFL Extent

In conclusion, modeling results for all UL 9540A-based scenarios and sub-scenarios showed no significant impact from flammable battery vent gas dispersion, with all releases staying within the site property boundaries.

The maximum extent of impact from the ½ LFL flammable vapor cloud (3.1%) was 25.33 m from the BESS for an upper-bounding release from all 48 modules within the ESS where all of the battery vent gas is released to the atmosphere within 10 minutes (Scenario 4.2), as shown in the figure below in comparison to the other release scenarios

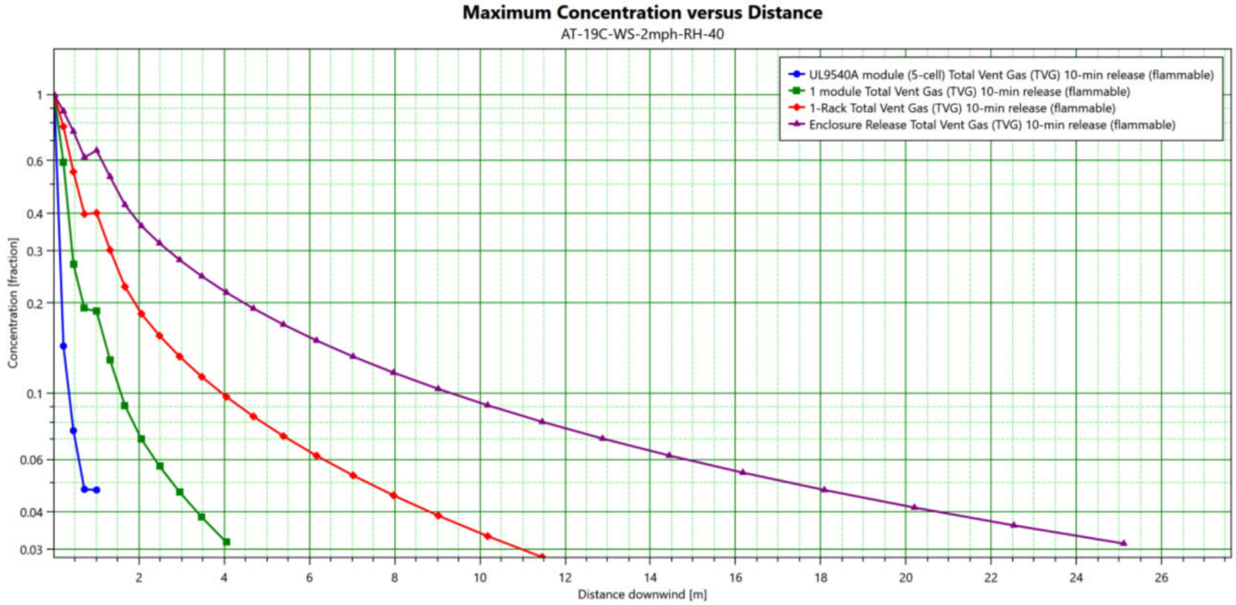


Figure 14. Concentration v. Distance for Sub-Scenarios 1.2, 2.2, 3.2, 4.2 (10-minute release duration)

Flash Fires

Flash fires were a modeled consequence for all TURC scenarios. The flash fire envelope did not extend beyond the proposed generic property boundaries for any of the UL 9540A-based venting scenarios. Even within the affected area on the general site plan, the duration of heat flux values equal to those sufficient to ignite flammable clothing or cause second-degree burns to exposed skin does not occur for more than one to three seconds (NFPA defines the upper limit of a flash fire to be three seconds) in any single location within the flash fire envelope.

As such, there would be no significant risk to persons or property offsite from the described venting scenarios.

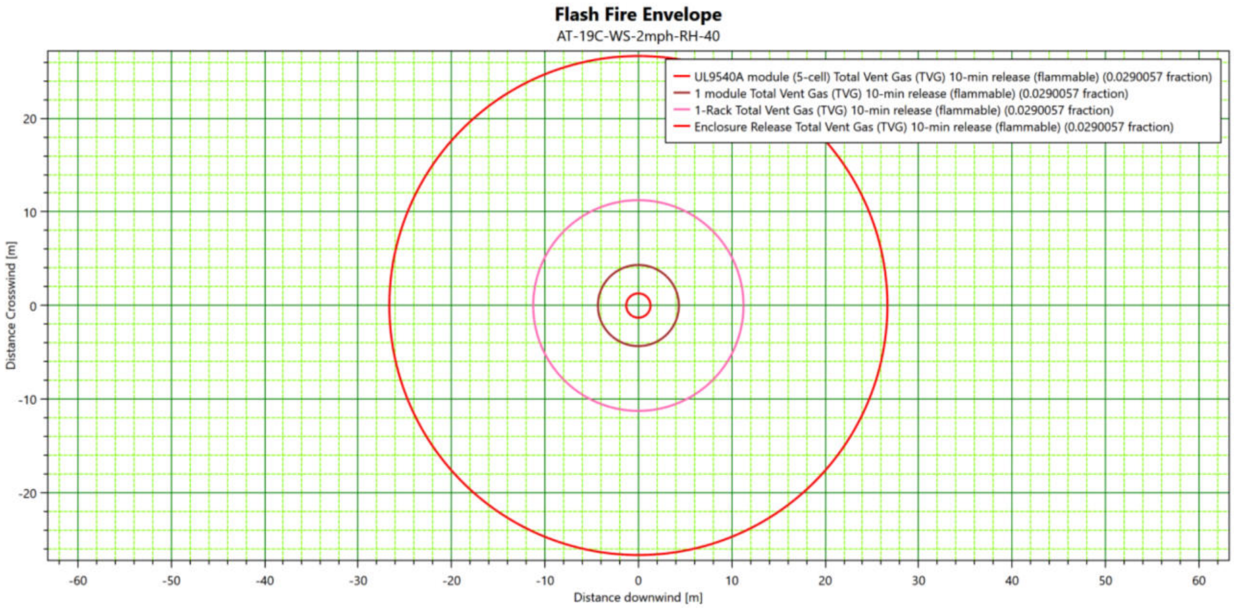


Figure 15. Flash Fire Envelope for Sub-Scenarios 1.2, 2.2, 3.2, 4.2 (10-minute release duration)

Carbon Monoxide IDLH Extent

Modeling results for the carbon monoxide (CO) component of battery vent gas for IDLH concentrations (1,200 ppm) showed that the maximum extent of 54.63 meters for the CO IDLH contour was from the theoretical upper-bounding Scenario 4.2 (TURC 48-module enclosure release for 10-minute duration).

However, risk from CO exposure is a factor of both concentration and exposure time, with a minimum required exposure time of 30 minutes at the IDLH concentration of 1,200 ppm. Therefore, this hypothetical upper bounding release scenario posed no significant health risk.

See the quote below from the CDC CO IDLH publication as reference.

> *"It has been stated that a 1-hour exposure to 1,000 to 1,200 ppm would cause unpleasant but no dangerous symptoms, but that 1,500 to 2,000 ppm might be a dangerous concentration after 1 hour [Henderson et al. 1921a, 1921b].* ***In general, a carboxyhemoglobin (COHb) level of 10-20% will only cause slight headaches [NIOSH 1972]*** *and a COHb of 11-13% will have no effect on hand and foot reaction time, hand steadiness, or coordination [Stewart and Peterson 1970]. At a COHb of 35%, manual dexterity is impaired [Stewart 1975]. At 40% COHb, mental confusion, added to increasing incoordination, precludes driving an automobile [Stewart 1975].* ***A 30-minute exposure to 1,200 ppm will produce a COHb of 10-13% [NIOSH 1972].****"*

Appendix 3.17E

UL 9540 & UL 1973 Certificates

Representative UL 9540 and UL1973 Certificates for Sungrow Power Titan 2.0

TÜVRheinland®

Date: 2025-01-23

Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd.,New & High
Technology Industrial
Development Zone,
Hefei
230088 Anhui
P.R. China

Ref: CU US + Canada Certificate

Type of Equipment	:	AC Energy Storage System
Certificate No.	:	CU 72404072 0008
Report No.	:	CN24A36R 008
Engineer/Contact	:	Stone Wang
Standards	:	ANSI/CAN/UL 9540:2023

Dear Madame or Sir,

Enclosed you will find the additional page of certificate
No. CU 72404072 0008.

Please keep this page with your original certificate.

Call the TUV hotline at 1-TUV-Rheinland (1-888-743-4652) to get answers for all your compliance needs. If we can be of any further assistance to you, please do not hesitate to contact us.

With kind regards,

Certification Body

Bowen Dong

Enclosure

Certificate

Certificate no. CU 72404072 0008

License Holder:
Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd.,New & High
Technology Industrial
Development Zone,
Hefei
230088 Anhui
P.R. China

Manufacturing Plant:
SUNGROW ENERGY STORAGE TECHNOLOGY
CO.,LTD.
No.788, Mingchuan Road,
Boyan Technology Park, Hi-tech Zone
Hefei City,
230088 Anhui
P.R. China

Report Number: CN24A36R 008

Client Reference: Min Yue

Certification acc. to: ANSI/CAN/UL 9540:2023

Product Information

Certified Product: AC Energy Storage System

Model Designation: ST5015UX-2H-US , ST4595UX-2H-US , ST4175UX-2H-US , ST3760UX-2H-US , ST3340UX-2H-US , ST5015UX-4H-US , ST4175UX-4H-US , ST3340UX-4H-US

Technical Data: as pages 0001-0007

Other data : See appendix

Remarks: Add CALB cell(L173F314B) as alternative, the battery system of CALBcell(L173F314B) had been evaluated and certified.

Appendix: 1, 1-86

Date of issue: 2025-01-23 (yr/mo/day)

C TÜVRheinland US

TUV Rheinland of North America, Inc.
400 Beaver Brook Rd, Boxborough, MA 01719
Tel +1 (978) 266 9500, Fax +1 (978) 266-9992

TÜVRheinland®

Date: 2024-12-09

Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd.,New & High
Technology Industrial
Development Zone,
Hefei
230088 Anhui
P.R. China

Ref: CU US + Canada Certificate

Type of Equipment	:	(Rechargeable Li-ion Battery System)
Certificate No.	:	CU 72303382 0003
Report No.	:	CN232YU5 003
Engineer/Contact	:	Zhen Chen
Standards	:	ANSI/CAN/UL 1973:2022

Dear Madame or Sir,

Enclosed you will find the additional page of certificate
No. CU 72303382 0003.

Please keep this page with your original certificate.

Call the TUV hotline at 1-TUV-Rheinland (1-888-743-4652) to get answers for all your compliance needs. If we can be of any further assistance to you, please do not hesitate to contact us.

With kind regards,

Certification Body

Weichun Li

Enclosure

Certificate

Certificate no. CU 72303382 0003

License Holder:
Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd.,New & High
Technology Industrial
Development Zone,
Hefei
230088 Anhui
P.R. China

Manufacturing Plant:
SUNGROW ENERGY STORAGE TECHNOLOGY
CO.,LTD.
No.788, Mingchuan Road,
Boyan Technology Park, Hi-tech Zone
Hefei City,
230088 Anhui
P.R. China

Report Number: CN232YU5 003

Client Reference: Li Guangqiang

Certification acc. to: ANSI/CAN/UL 1973:2022

Product Information

Certified Product: (Rechargeable Li-ion Battery System)

Model Designation: Addition:

Type Designation: R0835BL-AHFA

Technical Data: as page 0001-0002
Other Data: Refer to report CN232YU5 003 for details

Remarks:

Appendix: 1, 1-130

C US

Date of issue: 2024-12-09
(yr/mo/day)

TUV Rheinland of North America, Inc.
400 Beaver Brook Rd, Boxborough, MA 01719
Tel +1 (978) 266 9500, Fax +1 (978) 266-9992

Appendix 3.17F

Los Angeles County Fire Department Correspondence

From:	Garrett Lehman <glehman@covalinfra.com>
Sent:	Monday, June 2, 2025 11:30 AM
To:	Erin Phillips; Keith Carwana
Subject:	Fw: LACoFD Commercial-BESS Guidelines and Current AMMR-Process Guidance Therefor
Attachments:	Commercial Li-Ion BESS Facilities - LACoFD Guideline DRAFT, 2024-04-17, EXTRACT (SECURED).pdf; [Blank Form] ESS Applicant Declaration Detail of Compliance, 2023-09-07 (final, restricted).docx; Request for Modification or Alternate Materials and Methods Request REVISED 10 8 20.pdf; ERP for BESS - TEMPLATE - LACoFD, 2025-02-11 - Extract of Capabilities Disclosure.docx

Garrett Lehman
Director of Development
E: glehman@covalinfra.com

Coval Infrastructure | covalinfra.com

From: Joshua Costello <Joshua.Costello@fire.lacounty.gov>
Sent: Friday, May 23, 2025 7:18 AM
To: Nadia Pabst <npabst@covalinfra.com>; Garrett Lehman <glehman@covalinfra.com>
Cc: Juan Padilla <Juan.Padilla@fire.lacounty.gov>; Joshua Costello <Joshua.Costello@fire.lacounty.gov>
Subject: Fw: LACoFD Commercial-BESS Guidelines and Current AMMR-Process Guidance Therefor

As requested, please see the attached as well as the email body, below, for the latest guidance.

Respectfully,
Joshua Costello
Fire Fighter Specialist
Codes and Ordinances Unit, Fire Prevention Division
County of Los Angeles Fire Department
Joshua.Costello@fire.lacounty.gov
213-503-5468

From: Joshua Costello <Joshua.Costello@fire.lacounty.gov>
Sent: Wednesday, February 19, 2025 9:12:44 AM
Subject: FW: LACoFD Commercial-BESS Guidelines and Current AMMR-Process Guidance Therefor

Applicant,

The attached documents are being provided to you because it ***appears*** you are proposing to use/install **large commercial/industrial or utility-scale BESS units in which the BESS unit(s), or the site design for their installation, will not *clearly* meet the default prescriptive requirements of the Fire Code.**

These documents will help you to determine if the BESS unit/installation design you are considering would trigger the need for an Alternate Materials and Methods Review (AMMR, also known as a variance request), and then, should you decide to pursue said design, help you to prepare the necessary AMMR submittal package. These documents advise of what may be involved and that the proposed BESS unit/installation design is not guaranteed approval.

Should your proposed design of large commercial/industrial or utility-scale BESS units/installations trigger any AMMR, then the following large-scale modeling/testing presented in the 1st document should be expected to be deemed necessary (until determined otherwise) as described below:

For explosion modeling/testing: The unit/installation design has the potential to, upon failure of *all* active means of mitigation during a thermal-runaway event, produce gases such that they accumulate (e.g., inside a BESS-unit container or inside a room) and present an explosion hazard.

For fire modeling/testing: The unit/installation design does not maintain default code prescriptions regarding:

- 50-kWh grouping maximums; or the
- Separations and/or Setbacks prescribed for those 50-kWh groupings.

For non-ignited plume modeling/testing: The unit/installation design triggers either of the above large-scale modeling/testing (explosion or fire).

There may be other triggers for necessitating this modeling/testing, but these are the most common.

General description of the attachments:

The 1st attached document (an extract from a larger draft guide that LACoFD is developing, for all parties) is being provided to applicants proposing to use large commercial/industrial or utility-scale lithium-ion-based BESS, specifically those models/installations that do not clearly meet the prescriptive requirements of the Fire Code and standards. It *attempts* to provide a **comprehensive set of submittal documents and data** for any such necessary variance requests.

- **Explanation of the AMMR Process** begins on **Page 1**.
- **Applicant Submittal Package Content** begins on **Page 3, bottom**.
  - **AMMR Form directions** begin on **Page 3, bottom**.
  - **Attached-Documents List** begins on **Page 4, bottom**.
  - **Details regarding Third-Party Test and Modeling Data** that will likely be necessary for these large BESS units begins on **Page 11, center**. This includes **large-scale explosion, fire, and non-ignited plume modeling/testing**. Each of the scenarios provide the following sections:
    - **Purposes.**
    - **Scenario assumptions.**
    - **Presentation of results.**

The 2nd attached document is provided as a means to ensure applicants are designing to the code, including local LA County amendments (links provided therein); that they declare their design approach in terms of the applicable code; and that where their design is not in clear compliance with the code, they specifically apply for a variance (AMMR).

Further, we offer the following preliminary list of what will likely be necessary for the proposed BESS facility design, given the experiences with these facilities thus far:

For *All* Commercial/Industrial or Utility-Scale BESS facilities:

- Windsocks at all major corners, at at least 20-ft height.
- Hardscaped fire-apparatus access may be necessary rather than merely compacted aggregate, especially in key locations where fire apparatus would be expected to park.
- Razor-wire means of security (these are hazardous sites and both failures and tampering/theft can be of great consequence, for all parties, including the intruder, those having to mitigate the ensuing incident, and those depending on the electricity the facility stores/provides).
- Video surveillance of all parts of the facility at all times, for both security and incident management.
- Property-line setback distances necessary to contain on the facility property the injurious extent of overpressures (and potentially projectiles) resulting from a worst-case explosion scenario. Depending on the explosion hazard presented by the BESS design in question and the

proposed setback distance, this may necessitate perimeter walls of sufficient heights and that are engineered to withstand certain pressures (based on those determined by the explosion modeling required by LACoFD), and/or passive overpressure-relief panels (preferably located on the tops of BESS units/enclosures) in order to mitigate the explosive potential of the facility and/or BESS-unit designs.

Pole-mounted sets of beacons (red or orange), industrial horns, and signs (stating move back and call 9-1-1 when in alarm), should there be a case where the BESS unit is not isolated by sufficient distance from the public or public way. Alternatively, it was recently suggested that instead of a horn and relying on the sign, there should be a loudspeaker and voice commands.

Detrimental and/or ineffective effects of fire-suppression systems shall be evaluated prior to the decision to allow them. They should not be allowed to give a false sense of security, nor to exacerbate the failure, nor to complicate site mitigation or cleanup.

Means for remote monitoring, possibly including the abilities to obtain the information listed in Item "o)" of the LACoFD Guideline, beginning at the very bottom of Page 7 of 26. In some cases the responses of "no capability" or "not applicable" will be acceptable to certain items in that list in Item "o)" of the LACoFD Guideline. The list serves to disclose the proposed capabilities, or lack thereof, so that LACoFD can make the necessary considerations.

Location of a fire-command room (of sorts) on site but located beyond the effects of any maximum-potential failure scenario. Where deemed necessary due to expected wind patterns, an alternate location may also be necessary.

An approved naming schedule/convention for the BESS units/racks and for the alarm devices.

Diesel generators as the backup "auxiliary" supplies for critical systems, as other backup power sources are incapable of lasting the duration of these failures.

A review of NWS lightning data for the proposed site, by which to consider the need for true lightning protection.

The use of the LACoFD Emergency Response Plan (ERP) template for the ERP required by 2022 CFC ***§403.10.6 Lithium-ion and lithium metal batteries*** through ***§403.10.6.1 Mitigation planning*** (https://codes.iccsafe.org/content/CAFC2022P2/chapter-4-emergency-planning-and-preparedness#CAFC2022P2_Pt02_Ch04_Sec403.10.6).

The disclosure of an incident-mitigation company on retainer to serve the requirement of 2022 CFC §1207.6–1207.1.6.2 (https://codes.iccsafe.org/content/CAFC2022P1/chapter-12-energy-systems#CAFC2022P1_Pt03_Ch12_Sec1207.1.6).

For *Outdoor* facilities utilizing *Container-Based* BESS:

The grouping of no more than 4 [large] BESS units without a significant "fire break" to the next grouping. Fire-break separation distances will be determined based on large-scale fire modeling/testing results.

Fire-alarm system means (with monitoring by a listed supervising station) of detection (i.e., smoke and gas at a minimum, and possibly heat) of the interior atmosphere of each compartment housing batteries/modules in every case, without exception. Active, non-fail-safe NFPA-69 or "engineered" explosion-control designs shall not be relied upon. This is already required by the code, but unfortunately this may need to be restated for the benefit of certain manufacturers.

The requirement (for maintaining the validity of the explosion-modeling results) that the level of population of the internal volume/space of the BESS-unit container/enclosure shall be maintained (in its end-use application, throughout the life of the installation) at the level of internal-space population for which the worst-case explosion scenario was modeled. This means that if/when battery modules, or other internal components of appreciable volume, are removed from or not present within the BESS unit (by comparison to the modeled version), then each shall be replaced with a noncombustible, nonporous object of equal air-tight volume to that which is removed or otherwise not present in the end-use installation in order to maintain the void space within the BESS unit at the value for which it was modeled.

The requirement for seals by which to prevent the unintentional migration of explosive gases during failures from the compartment of origin to another compartment or piece of equipment connected thereto by conduit.

For *Indoor* facilities housing BESS in operation*:

*Assuming this is still a feasible design approach after recent incidents.

*Note that LACoFD amends the CA Fire Code (CFC) to remove the "dedicated-use building" carveouts in the CFC because the CFC and IFC allow that "dedicated-use" building to also provide occupancy, such as office space, provided that "The areas do not occupy more than 10 percent of the building area of the story in which they are located." In other words, in the unamended version, 10 percent of a huge, actively charging and discharging BESS warehouse can be used for office space, and if it's a multistory building, 100% of every other floor of this so-called "dedicated-use building" can be used for office space so long as they are deemed "Administrative and support personnel".

The 2022 CFC version of this section (Section 1207.7) begins at: https://codes.iccsafe.org/content/CAFC2022P1/chapter-12-energy-systems#CAFC2022P1_Pt03_Ch12_Sec1207.7

The 2023 LAC *amendments* to the 2022 CFC for this section begin at: https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.7ININ

- Freestanding, separate buildings dedicated to this use and no other use whatsoever (i.e., no mixed occupancies, such as the presence of office space, etc. in the buildings).
- A limit to the size of each building or fire-resistive enclosure/room within, each served with its own fire-protection and explosion-control systems.
- Mechanical *and/or* manual means by which to ventilate each enclosure/room. Manual means shall be provided in all cases and shall be included with a chain or other fail-safe means by which to open the hatch from a safe distance. Heat-activated links are ineffective since research and incidents have shown that many batteries of current chemistries may be venting without the generation of much heat.
- *Passive* NFPA-68 explosion control (i.e., deflagration relief panels), for each room housing batteries, designed for the maximum feasible explosion scenario.
- Roof- and ceiling-support structures designed to survive the full duration of a worst-case extended-duration BESS-failure scenario.

Finally, The following link lists, in the order of California-Fire-Code section number, the sections to which a Los-Angeles-County amendment to the *2022 edition of the California Fire Code* (2022 CFC) publication exists. They are codified as Los Angeles County Code (LACC) Title 32. **Together with the unamended adopted portions of the 2022 CFC, these Los-Angeles-County amendments comprise the *2023 Los Angeles County Fire Code* (2023 LACFC):**

https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO

Fire Code section numbers that are not provided at the link above, revert to the unamended content of the adopted portions of the 2022 CFC publication. **The unamended 2022 CFC publication can be viewed at no cost at:**

https://codes.iccsafe.org/content/CAFC2022P2/chapter-1-scope-and-administration#CAFC2022P2_Pt01_Ch01_SubChI

Please also be advised that **for the required *disclosures** in the 1st attachment [see Item "o.)" thereof, which begins on the bottom of Page 7]**, the latest list has been improved upon and placed into a template in MSWord format, which has been attached as the 4th attachment. In other words, **please substitute the 4th attachment for the content of what is Item "o)", beginning on Page 7, of the 1st attachment.** Throughout this 4th-attachment Template, GREEN HIGHLIGHTS are verbiage or response-field placeholders for the applicant to replace with the appropriate verbiage or responses for the facility design being proposed. Eventually the completed version of this list gets rolled into the facility-specific emergency response plan (ERP) for the site in question. Every BESS site/facility, and every make and model of BESS, is configured differently, and can have different failure-scenario potentials; and it is critical for responding personnel to have readily available the list of capabilities they have (or do not have) to remotely monitor conditions of the involved and/or threatened BESS units or racks. This is all the more important because these failure incidents within a BESS may not otherwise be readily apparent and can take extended periods of time to run their course. Remote monitoring, along with a facility-specific ERP, can allow responders to better anticipate failure-event trajectories and to inform the need to make interventions.

*To be clear, these are ***disclosures of*** capabilities, not a requirement therefor. It is necessary for LACoFD to understand the full context of the suite of capabilities (and their limitations) when evaluating a product, and the site, and all the more when reviewing the proposed emergency response plan (ERP) for a specific site.

Thank you much.

Respectfully,
Codes and Ordinances Unit, Fire Prevention Division
County of Los Angeles Fire Department
323-890-4137

Attachment 1

Disclaimer.

The following draft guide extract is being provided preliminarily due to a pressing need for consistent, detailed, and technical direction throughout the jurisdiction regarding proposals to install or use large commercial/industrial and utility-scale lithium-ion battery energy storage systems (BESS) that are not allowed by the *prescriptive* requirements of the codes, standards, and other laws which the Los Angeles County Fire Department (LACoFD) Fire Prevention Division has a duty to enforce.

All such proposals require filing a request for variance from the aforementioned prescriptive requirements. These requests are processed via the LACoFD Alternate Materials and Methods Review (AMMR) process.

Since all AMMR's are site-specific, case-by-case, and required to be conducted based on the latest information available, including the latest response capabilities and practices, etc., the following shall *not* be construed as sufficient in all cases *nor* shall it imply specific performance criteria for obtaining *approval* of the proposed product or project. Rather, the intent of this extract is to provide a set of *necessary* submittal data and documents that is as detailed and comprehensive as necessary, and as up-to-date as possible.

City- and community-specific tolerances for potential impacts, site-specific exposures (e.g., presence of nearby schools, residential occupancies, etc.), and other factors may also affect determinations regarding tolerable performance during these types of failure events at the site/application in question.

IV. PROCEDURES

A. **Requirement for AMMR or Modification.** Applicants proposing the installation or use of lithium-ion-based BESS that exceed the prescriptive allowances of the laws that the Fire Department has the responsibility and authority to enforce (e.g., the Fire Code), shall require an Alternate Materials and Methods Review (AMMR) or Modification request, and approval of the subject proposal, by the Los Angeles County Fire Department (LACoFD) Fire Marshal.

1. **Purpose of AMMR.** The provisions of the Fire Code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by the code, provided that any such alternative has been approved by the Fire Marshal (2023 LACFC §104.10).

2. **Fees.** The applicant shall be invoiced for the fee associated with this review, and said fee shall be confirmed as paid prior to the issuance by Department personnel of the final determination by the Fire Marshal of the AMMR.

3. **Final Determination.**

    a. **Authority for Final Determination.** Final determinations regarding a request for an AMMR or Modification can only be made by the Fire Marshal.

    b. **Criteria for Final Determination.** An alternative material, design or method of construction shall be approved where the Fire Marshal finds that the proposed design is satisfactory and complies with the intent of the provisions of the code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in the code in quality, strength, effectiveness, fire resistance, durability, and safety (2023 LACFC §104.10).

    c. **Case-by-Case Basis.**

        1) Approval of a request for use of an alternative material, assembly of materials, equipment, method of construction, method of installation of equipment or means of protection made pursuant to these provisions shall be limited to the particular case covered by the request and shall not be construed as establishing any precedent for any future request (2023 LACFC §104.10).

        2) Reasons why these determinations are required to be case-by-case and not set precedent include, but are not limited to, the following:

            a) The requests (i.e., requests for exceeding the allowances established by code/law) that trigger the requirement for the AMMR process are usually due to a lack of established practice and/or data in the area of the specific alternative design, material, assembly of materials, equipment, method of construction, method of installation of equipment or means of protection being proposed. In the case of lithium-ion-based BESS, the lack of established practice and/or data is usually regarding the proposed battery chemistry, unit/equipment design, or associated technology.

b) As better information, awareness, understanding, and competencies come about regarding the following, the Department has a duty to take these into consideration when making determinations about that which is not allowed by the default allowances of the Fire Code or other laws for which the Fire Marshal has a responsibility and the authority to enforce. Examples of aspects for which better information may come about after an earlier determination was made include, but are not limited to:

i) Hazards presented by the subject proposal, or more specifically by the equipment, design, technology, chemistry, or site-plan being proposed.

ii) Needs and abilities to monitor, detect, and mitigate said hazards.

iii) First-responder capabilities when intervention thereby is necessary.

iv) Site-mitigation means for after the initial stages of the incident, and the impacts thereof (e.g., maintenance of evacuations for extended periods of time).

v) *Long*-term impacts (to persons, commerce, and the environment) of incidents.

B. Applicant Submittal Packages.

1. **Form.** Applicants shall submit an LACoFD ***Request for Modifications or Alternate Materials and Methods Review*** form, commonly referred to as an “AMMR Request Form”.

a. **“Applicable Code References:” Field.**

1) This field of the form is where the applicant is to list all applicable Fire-Code and/or referenced-standard sections containing requirements for which the applicant is proposing an alternative in place of the *default** prescriptive requirement.

   *Where an applicant is proposing to make use of an "exception" within the code or standard (for either exceptions that require determination by the fire code official, or *any* exceptions where the BESS unit in question does not meet all other prescriptive requirements of the code or standard), the section *and* exception number shall be included within the entry to this field.

2) For a list of Fire-Code and/or referenced-standard allowances that commercial, industrial, and/or utility-scale lithium-ion-based BESS are *most likely* to be proposing to exceed, see **Item I.,B.,5. Requests for AMMR** of this document.

b. **"Justification" Field.**

1) Note that this field requires that the applicant "Demonstrate conformity and equivalence with that prescribed in the Code." In general summary, it allows for a performance-based option to the prescriptive requirements of the code/laws.

2) Requests for approval to use an alternate material, assembly of materials, equipment, method of construction, method of installation of equipment or means of protection shall be made in writing to the Fire Marshal by the owner or the owner's authorized representative and shall be accompanied by a justification that is supported by evidence to substantiate any claim being made regarding the requested alternative and its compliance with the intent of the code. The Fire Marshal may require independent tests be performed by an approved testing organization in order to substantiate the proposed alternative. (2023 LACFC §104.10)

3) **Attached Documents.** Attached construction documents and justification shall include, at minimum, the following:

a) Site Plans, including but not limited to, clearly specified proposed:

i) Fire apparatus access means, widths, vertical clearance, and other specifications, noting any overhead wires in the immediate vicinity thereof.

ii) Fire department water sources and details thereof, including:

(a) Access-route distances to those water sources, as measured from the:

(i) Closest facility entrance thereto.

(ii) Furthest BESS unit therefrom, using a route through (i), above.

(b) Fire flows thereof.

iii) Make(s) and Model(s) of proposed BESS unit(s).

iv) Total number of BESS units.

v) *Minimum* BESS separation and setback distances (on each side *within* any proposed BESS groupings; *between* adjacent groupings of BESS units, in each direction; to the other types of nearest exposures).

vi) Fire-Control Facilities (e.g., FACP's, facilities housing said FACP's, etc.).

vii) Security means for the facility or BESS installation.

viii) Impact-protection means for the facility or BESS installation.

ix) Transformer types and locations.

x) Secondary-containment means (and sizing justification) for flammable/combustible oils (e.g., transformer oils).

xi) Other structures/buildings, new or existing, on the site: presence, location(s), occupancy classification(s), and use(s).

b) Manufacturer's Installation and Use Manuals, and Specifications Sheets, for the BESS, specifically those versions of these documents for which the Nationally Recognized Testing Laboratory (NRTL) granting the UL-9540 listing has granted approval.

c) *Complete* UL-9540A Test Reports [cell-level, module-level, unit-level, and (where conducted) installation-level].

d) *Complete* UL-1973 Test Reports.

e) Specifications of proposed BESS-unit-integrated (and/or facility):

i) Explosion-control systems (e.g., exhaust systems, deflagration-relief venting systems, barricades, etc.).

ii) Fire-suppression systems.

iii) BESS-unit-level fire-alarm systems (including smoke and/or fire detection, notification, and supervision).

iv) Thermal management.

v) Ventilation means.

vi) Secondary power supplies, what they serve, for how long, by what means, certifications therefor, etc.

vii) Humidity and moisture detection within the battery compartment(s).

f) Facility-level fire alarm system plans, including specifications of how the *unit*-level sequence of operation transmits information to, and triggers actions within, the *facility*-level sequence of operations.

g) Hazard Mitigation Analysis (HMA), as required by applicable fire codes and standards.

h) Approval from the jurisdictional building department of any required seismic restraint.

i) Commissioning Plan, as required by applicable fire codes and standards.

j) Decommissioning Plan, as required by applicable fire codes and standards, including a Stranded-Energy Management Plan.

k) Inspection, Testing, and Maintenance (ITM) Schedules for the BESS and related safety systems (and secondary power supplies therefor), both those schedules provided by the manufacturer(s), and, where different, those schedules proposed by the facility/site. Where differences between the two exist, they shall be clearly expressed.

l) Official documents from Nationally Recognized Testing Laboratories (NRTL's) granting certifications and/or listings to the subject product, equipment, assembly, and/or key components/systems thereof.

m) Any other documents required by the latest fire codes or standards for these systems and/or facilities.

n) Any other form required by LACoFD to be necessary for the applicant to convey the design approach taken by the equipment manufacturer and/or site/end-use designer.

o) Clearly stated **capabilities and means** by which **first responders** will be able to ***remotely*** **monitor conditions of the BESS unit**, including the following, presented as follows:

i) **% LEL** of **Container-*Interior* Atmosphere**, including:

(a) The *actual* value? *or*

Only that certain specific threshold(s) have been surpassed? If so, which set thresholds?

(b) In real time? *or*

At what time lag?

(c) Expected fouling, inability to accurately report, and/or failure of sensors and monitoring and power equipment thereof during an event [due to heat (specify temperature) or concentration (specify concentration)]?

(d) Part of listed 3rd-party-supervised NFPA-72 fire-alarm system? *or*

Reading obtained/monitored by what means?

ii) **Door(s).**

(a) Context:

(i) Number of BESS-Container Access Doors present?

(ii) Number of Passive Explosion-Relief Panels present?

(b) Capabilities to Remotely Obtain Status:

(i) Open/Closed status of Access Doors? *and/or* of

Deflagration-Vent Panels/Doors?

(ii) The degree open? *or*

Only if ajar?

(iii) Part of listed 3rd-party-supervised NFPA-72 fire-alarm system? *or*

Reading obtained/monitored by what means?

iii) **Exhaust-Fan(s)**, including:

(a) Active or Inactive?

(b) CFM flow? *and/or*

RPM?

(c) Louvers:

(i) Open or Closed?

(ii) To what Degree Open?

(d) Expected fouling and/or failure of fan and louver equipment (and power-supply/control circuitry) during an event [due to heat (specify temperature) or concentration (specify concentration)]?

(e) Expected fouling and/or failure of sensors and monitoring and power equipment thereof during an event [due to heat (specify temperature) or concentration (specify concentration)]?

(f) Part of listed 3rd-party-supervised NFPA-72 fire-alarm system? *or*

Reading obtained/monitored by what means?

(g) NFPA-69-compliant system?

(h) Qualified NFPA-69 Safety Instrumented System (SIS), with justification and Safety Integrity Level (SIL) rating?

iv) **<u>Cell and/or Interior Temperatures</u> of Involved and Exposed BESS Container(s)**, including:

(a) <u>The *actual* values of ambient air/cells/modules/other</u>? *or*

<u>Only that certain specific threshold(s) have been surpassed</u>? <u>If so, which set thresholds</u>?

(b) <u>In real time</u>? *or*

<u>At what time lag</u>?

(c) Expected fouling and/or failure of <u>sensors and monitoring and power equipment thereof</u> during an event [due to heat (specify temperature) or concentration (specify concentration)]?

(d) <u>Part of listed 3rd-party-supervised NFPA-72 fire-alarm system</u>? *or*

<u>Reading obtained/monitored by what means</u>?

v) **Voltages of individual cells/modules:**

(a) <u>In real time</u>? *or*

<u>At what time lag</u>?

(b) <u>Part of listed 3rd-party-supervised NFPA-72 fire-alarm system</u>? *or*

<u>Reading obtained/monitored by what means</u>?

vi) **Humidity and/or moisture within the battery compartment(s):**

(a) <u>In real time</u>? *or*

<u>At what time lag</u>?

(b) Part of listed 3rd-party-supervised NFPA-72 fire-alarm system? *or*

Reading obtained/monitored by what means?

p) Proposed emergency response plan (ERP). **This may be submitted at a later date but shall have received preliminary LACoFD approval prior to any BESS being brought on site.** LACoFD may provide a template for portions of this document.

q) See **Item 2 (*Other Third-Party Test Data and/or Modeling*)**, immediately below, in this document, about further necessary attachments.

2. **Other Third-Party Test Data and/or Modeling.** The Fire Marshal may require independent tests be performed by an approved testing organization in order to substantiate the proposed alternative (2023 LACFC §104.10).

For outdoor* utility-scale lithium-ion-based BESS container-/enclosure-based systems, the following data are the third-party-conducted modeling/testing results and reporting that LACoFD generally needs in order to determine if the site design and unit-enclosure design, considered together, is sufficient for the site/application in question.

*It is *not* anticipated at the time of this writing that LACoFD will be permitting utility-scale lithium-ion-based BESS container-/enclosure-based systems (i.e., BESS that far exceed the allowable kWh thresholds per grouping, etc.) to be installed inside another structure. Proposals for such installations would require additional considerations beyond those specifically prescribed herein.

a. **Worst-case scenario BESS *fire* modeling, or preferably testing*.**

*Where testing is required by the most current codes or standards, testing shall be required.

1) **Purposes:** This testing/modeling shall be provided in order to:

a) Justify the proposed:

i) **Separation distances*** between:

*Base these distances on no higher than the <u>*lowest*</u> temperature at which cell failure (i.e., thermal runaway or venting) was initiated during UL-9540A testing (*rather* than on the *average* temperature at which thermal runaway occurred).

(a) Adjacent BESS units/enclosures within the same grouping.

(b) Adjacent *groupings* of BESS units/enclosures.

ii) **Setback distances** between BESS units/enclosures and adjacent values, such as but not limited to:

(a) Buildings.

(b) Public ways.

(c) Combustible and/or hazardous materials (which may include a site transformer).

(d) Vegetation in an area deemed susceptible to wildland-type fires.

b) **Inform first-responders of:**

i) Determinations regarding the need to intervene in such an event.

ii) Goal(s) of intervention.

iii) Estimated time (after ignition) at which intervention might be necessary.

iv) Options by which to intervene, and which might be the most prudent means by which to intervene given a set of circumstances and the goal(s) of the intervention.

v) Hazards of intervention methods (e.g., electrical and water intrusion into uninvolved BESS units/enclosures, and/or possible extinguishment of fire, thereby *creating* an explosion potential).

vi) Expected duration and extent of event:

(a) With no intervention.

(b) With intervention.

2) <u>**Scenario assumptions**</u>**:**

a) **The BESS unit/enclosure shall:**

i) **Be fully charged in accordance with the UL-9540A charging and stabilization specifications for testing.**

ii) **Be fully populated with battery cells, modules, and other end-use components and configurations.** To be considered fully populated, the number of cells and modules shall be at least that of the greatest-populated configuration for which the testing/modeling claims to be representative.

iii) **Have container-access doors fully opened.**

b) **Only passive, fail-safe protection systems and features** shall be allowed to be factored into the unit performance during the scenario test/modeling.

i) If the applicant elects (assuming it is not otherwise required by codes or standards in place), another version of testing/modeling that includes active and/or non-fail-safe systems (e.g., integrated active suppression systems) may *also* be submitted.

c) **Regarding the number of cells to be producing vent gases prior to introducing external means of ignition**, <u>the greater of i) or ii) of the BESS unit, as specified below, whichever is the greatest number of cells</u>, shall be forced* into thermal runaway using the UL-9540A methodology therefor:

*Where the latest codes or standards do not require such a large-scale fire test, this can be either tested, or modeled (which may require use of UL-9540A-derived cell-vent gas compositions), or a combination of both.

i) The greater of either:

(a) 1 module; or

(b) 50% of the amount of cells/modules controlled by a single battery management system (BMS).

(or)

ii) A roughly contiguous set of cells amounting to 60 kWh of *nominal* capacity.

d) **Regarding the location of cells/module(s) chosen to be forced into thermal runaway**, they shall be those that are located in accordance with all of the following:

i) Near the lower elevations within the unit/container/enclosure.

ii) Beneath the largest amount of other cells/module(s) as is found within the BESS configuration.

iii) Nearest or most accessible to free air space (factoring in that the doors to the unit are to be open during the test/modeling).

e) **Ignition of the cell-vent gases (from the cells in thermal runaway) shall be obtained as follows:**

i) Ignite the gases at a point in close proximity to the cells producing them.

ii) If this does not achieve ignition, due to a location being above the UFL/UEL, then slowly/incrementally move the ignition source away from the venting cells in a horizontal plane until ignition of the vent gases is achieved.

iii) If combustion of cell-vent gases is not sustained, immediately repeat i) and ii) until such combustion is sustained.

iv) If no sustained combustion is achieved after 10 ignitions, then no further testing/modeling is necessary for this fire scenario.

3) **Presentation of results:** In addition to any reporting of input data, analyses, and discussion/explanation, express the results in terms of the effects on the temperatures of the most closely located exposure for each exposure type, the potential outcomes, and the intervention options/considerations, as described in the Purposes section, above.

b. **Worst-case scenario BESS *explosion* modeling.**

1) **Purposes:** This modeling shall be provided in order to:

a) **Justify the proposed setback distances between** BESS units/enclosures and adjacent values, including but not limited to:

i) Buildings, possibly considering uses/zoning thereof.

ii) Public ways, and possibly any non-secured areas without sufficient and reliable means of notification therefor.

iii) Combustible and/or hazardous materials.

b) **Inform first-responders of:**

i) Evacuation distances.

ii) Maximum-potential damages and injuries at various distances.

iii) Determinations regarding the need to intervene and/or evacuate when there is a threat of explosion.

iv) Estimated number of cells in thermal runaway necessary in order to produce enough cell-vent gases (assuming no active ventilation of the BESS interior atmosphere is occurring) to present:

(a) *Any* full-volume explosion hazard.

(b) A *maximum-potential* explosion potential.

v) Objective(s) of intervention.

vi) Options by which to intervene, and which might be the most prudent means by which to intervene given a set of circumstances and the objective(s) of the intervention.

2) **<u>Scenario assumptions</u>:**

a) **All doors and operable openings shall be in the closed position (and locked, if they are to be locked when in normal-operation configuration).**

b) Means shall be provided by which to prevent flammable gases from migrating from the BESS unit of origin into other enclosures or compartments (e.g., through conduit routes), whether those enclosures or compartments are directly connected to the unit assembly or located elsewhere on the site (e.g., conduit- or trench-connected enclosures housing transformers). Specifications of means to prevent this shall be provided.

c) **Thermal-runaway cell-vent gases** established during the UL-9540A cell-level testing shall be mixed evenly throughout the full void-space volume of the single largest compartment of the BESS unit that houses battery cell(s) (largest in terms of air/void space thereof) such that that volume of the **air-and-vent-gas mixture achieves a stoichiometric mixture throughout that void space**.

i) **Regarding the meaning of the "single largest compartment of the BESS unit that**

houses battery cell(s)", this means that where a battery compartment within a BESS unit is open to another battery compartment in that unit (such that the air in one can flow into the other), then those compartments are to be treated as one large compartment. This also intends to identify the battery compartment with the largest *air/void space* when populated with batteries, which may not necessarily be the largest of all battery compartments in the assembly.

ii) **Regarding the meaning of "the full void-space volume of [that] single largest compartment"**, this is referring to the void space that exists *after* the BESS-unit container/enclosure is populated with its battery cells/modules and other equipment.

(a) **The level of population of the internal volume/space of the BESS-unit container/enclosure shall be maintained (in its end-use application, *throughout the life of the installation*) at the level of internal-space population for which the worst-case explosion scenario was modeled.** This means that if/when battery modules, or other internal components of appreciable volume, are removed from or not present within the BESS unit (by comparison to the modeled version), then each shall be replaced with a noncombustible, nonporous object of equal air-tight volume to that which is removed or otherwise not present in the end-use installation in order to maintain the void space within the BESS unit at the value for which it was modeled.

(b) **Clearly state this largest *void-space* volume.**

d) **Passive, fail-safe explosion mitigation** (e.g., deflagration-relief panels integrated into the BESS unit, and perimeter walls providing security for the BESS installation, etc.) **shall be the *<u>only</u>* mitigation means allowed to be factored into the modeling.**

i) In other words, active systems such as an NFPA-69 mechanical-ventilation explosion-prevention system shall not be credited/allowed into the inputs for this modeling.

ii) Where such passive mitigation is site-specific and not mandated for every application/installation for which the modeling proposes to be valid, then results factoring in such mitigation means shall be provided in *addition* to those not factoring in these mitigation means.

3) <u>**Presentation of results**</u>**:** In addition to any reporting of input data, analyses, and discussion/explanation, provide the following:

a) **Site Map** with <u>*maximum-potential* failure-scenario</u> concentric-circle* impact overlays surrounding the container of origin**, in which the value that is represented by each concentric circle is identified in accordance with the following:

*Where modelers elect to factor in site-specific barriers, etc., those optional *additional* overlays may not be circular in shape.

**Choose a container of origin (or multiple individual containers of origin on large sites) that is located in closest proximity to the edge of the facility and, where impacted, to adjacent life values.

i) **Pressure Waves:**

(a) Represent by concentric-circle graduations at 0.5-psi graduations moving out from the container of origin to 0.5 psi, then at 0.3 psi, and 0.15 psi.

(b) Identify the distance of each wave from the container of origin.

ii) **Maximum Distances of Projectiles/Shrapnel Impact** from the container of origin.

b) **Tabular format of the above**.

c) **Estimated number of cells in thermal runaway necessary in order to produce** enough cell-vent gases (assuming no active ventilation of the BESS interior atmosphere is occurring) to present:

i) *Any* full-volume explosion hazard (i.e. to reach 100% LEL).

ii) A *maximum*-potential explosion potential (i.e. to reach the stoichiometric mixture within the void space, as described in the "Scenario assumptions" section, above).

d) **Identification of likely projectiles of significance** (in terms of creating damages/injuries) and justification of means being provided by which to tether/fasten doors or other equipment claimed not to be such projectiles of significance.

e) **Specifications** of means by which to prevent flammable gases from migrating from the BESS unit of origin into other enclosures or compartments (e.g., through conduit routes), whether those enclosures or compartments are directly connected to the unit assembly or modeled compartment(s), or located elsewhere on the site (e.g., conduit- or trench-connected enclosures housing transformers).

c. **BESS toxic-gas and flammable-gas _plume_ modeling.**

1) **_Purposes_:** This modeling shall be provided in order to:

a) **Justify the proposed setback distances between** BESS units/enclosures and adjacent values, including but not limited to:

i) Buildings, possibly considering uses/zoning thereof.

ii) Public ways, and possibly any non-secured areas without sufficient and reliable means of notification therefor.

iii) Combustible and/or hazardous materials.

iv) Ignition sources.

b) **Inform first-responders of:**

i) Evacuation distances.

ii) Maximum-potential extent of:

(a) Toxic-exposure hazards at various distances for various exposure periods.

(b) Ignitable flammable-gas clouds.

iii) Determinations regarding the need to intervene, evacuate, and/or conduct air/water sampling.

iv) Estimated number of cells in thermal runaway necessary in order to produce enough cell-vent gases to present a toxicity or free-space-ignition hazard at various distances outside the container of origin.

v) Objective(s) of intervention.

vi) Options by which to intervene, and which might be the most prudent means by which to intervene given a set of circumstances and the objective(s) of the intervention.

vii) Hazards (e.g., environmental) of intervention methods.

viii) Expected duration and extent of event:

(a) With no intervention.

(b) With intervention.

2) **Scenario assumptions**:

a) Use the cell-vent gas data that have been determined by, at minimum, the UL-9540A tests. This shall include the highest values of these gases detected between the cell-level gas-composition test(s) *and* the module- and unit-level tests. While UL-9540A module- and unit-level tests are less able than the cell-level gas-composition test to capture all gases generated, they factor in more end-use combustibles *and* are required to utilize added detection instrumentation, such as a Fourier Transform Infrared (FTIR) Spectrometer, which may be capable of identifying additional gases of concern (e.g., HF and HCN).

b) Assume no ignition occurs of the BESS cell-vent gases being generated.

*NOTE: This scenario is also representative of the event that may arise after ignition had caused an explosion or after a fire or explosion event may have been extinguished by intervention or by a heavy rainstorm.

b) Where an NFPA-69 or similar mechanical-exhaust system is designed into the end-use installation, factor its effects into this non-ignited plume-exposure modeling, because it will have the effect of actively and quickly pumping out the gases being generated into the surrounding area through specific exhaust port(s). Clearly state whether or not the system is designed to scrub/catalyze the exhaust gases, and to what degree, before being exhausted into the surrounding area.

c) Regarding windspeeds, model for both:

i) Minimal-wind circumstances; and

ii) Normal daily maximum prevailing windspeed for the site. Present the impact of this windspeed as concentric circles by which to represent the potential impact of said windspeeds for winds in all directions.

d) Model for the following levels of failure (i.e., where the following numbers of cells are in thermal runaway and produce the cell-vent gases):

i) One full module.

ii) The largest entire string of battery cells that are managed by one battery management system (BMS) within one BESS unit.

iii) All cells/modules in one BESS unit.

e) Scenarios may be modeled in a bell-curve over time, since not all cells would fail at exactly the same moment.

f) Regarding toxins: Where a manufacturer or operator has additional toxicity data than is available via the UL-9540A testing (being that UL-9540A is not designed to test for toxics and consequently only identifies some toxins that may exist*), this data shall also be factored into the modeling, provided it does not detract from the severity of the data obtained via the UL-9540A testing.

*NOTE: UL 9540A is currently *not* designed to detect nor characterize the toxicity profile of gases being produced during failure. While certain instrumentation thereof provides a glimpse at the toxicity profile, it shall not be considered comprehensive thereof.

3) **Presentation of results:** In addition to any reporting of input data, analyses, and discussion/explanation, provide the following:

a) **For Toxins:**

i) **Site Map** with *maximum-potential* failure-scenario concentric-circle* impact overlays surrounding the container of origin**, for each scenario being modeled, in which the value of CO (and/or any other toxin of significance) that is represented by each concentric circle is identified by its:

*Provide these concentric circles both for the minimal-wind scenario and for the normal maximum daily prevailing windspeed for the site (applied in all directions such that it represents the maximum impact of normal daily winds from any direction).

**Choose a container of origin (or multiple containers on large sites) that is located in closest proximity to the edge of the facility and, where impacted, to adjacent life values.

(a) **Concentration Value** (e.g., ppm or other measurement units used by field meters for said toxin).

(b) **Distance** from the container of origin.

ii) **Tabular format of the above**.

iii) **Table of OSHA and EPA thresholds of exposure** (e.g., concentration values and the associated allowable exposure-durations).

b) **<u>For Flammable Gases</u>:**

i) **Site Map** with <u>*maximum-potential* failure-scenario</u> concentric-circle* impact overlays surrounding the container of origin**, for each of the most-hazardous gases being modeled, in which the value of the gas that is represented by each concentric circle is identified by its:

*Provide these concentric circles both for the minimal-wind scenario and for the normal maximum daily prevailing windspeed for the site (applied in all directions such that it represents the maximum impact of normal daily winds from any direction).

**Choose a container of origin (or multiple containers on large sites) that is located in closest proximity to the edge of the facility and, where impacted, to adjacent life values.

(a) **Concentration Value** (e.g., %LEL or other measurement units used by field meters for said flammable gas).

(b) **Distance** from the container of origin.

ii) **Tabular format of the above**.

c) Expected duration and extent of event:

i) With no intervention.

ii) With intervention.

d. ***Transformer*-fire modeling or testing*.**

*Where testing is required by the most current codes or standards, testing shall be required.

1) **Purposes:** This testing/modeling shall be provided in order to:

a) Justify the proposed:

i) **Separation distances*** between transformers and adjacent BESS units/enclosures.

*Base these distances on no higher than the *lowest* temperature at which cell failure (i.e., thermal runaway or venting) was initiated during UL-9540A testing (*rather* than on the *average* temperature at which thermal runaway occurred).

ii) **Setback distances** between transformers and adjacent values, such as but not limited to:

(a) Buildings.

(b) Public ways.

(c) Combustible and/or hazardous materials.

(d) Vegetation in an area deemed susceptible to wildland-type fires.

b) **Inform first-responders of:**

i) Determinations regarding the need to intervene in such an event, primarily in order to prevent involvement of nearby BESS units/enclosures.

ii) Estimated time (after ignition) at which intervention might be necessary.

iii) Options by which to intervene, and which might be the most prudent means by which to intervene given a set of circumstances and the goal(s) of the intervention.

iv) Hazards (e.g., electrical) of intervention methods.

2) **Scenario assumptions:** Where the transformer(s) on the site contain flammable/combustible oil, for each applicable transformer type (and for each type of flammable oil provided in any significant amount), model the effect of a fire involving the full volume of the oil from the largest compartment thereof, entirely spilled into its secondary containment area.

3) **Presentation of results:** In addition to any reporting of input data, analyses, and discussion/explanation, express the results in terms of:

a) The effects on the temperatures of the most closely located exposure for each exposure described in the Purposes section, above.

b) Regarding interventions:

i) The need to intervene.

ii) Method(s) by which to intervene.

iii) Safety of the proposed methods of intervention.

c) Expected duration and extent of event:

i) With no intervention.

ii) With intervention.

Attachment 2

Declaration form <u>for applicants proposing ESS installations at sites other than those dedicated to individual Group-R-3/R-4 occupancies/properties</u>.

Energy Storage System (ESS) Applicant:

In order to conduct the plan review of a proposed ESS installation, other than ESS dedicated to individual Group-R-3/R-4 occupancies/properties, per Los Angeles County Fire Code (**LACFC**, i.e., LACC Title 32) **Section 106.2.1**, and California Fire Code (**CFC**, i.e., CCR Title 24, Part 9) **Section 105.2**, the Los Angeles County Fire Department (LACoFD), as the fire code official having jurisdiction, requires the applicant provide as a part of the application submittal package **<u>this word-processor document wherein the applicant shall provide responses to the following</u>**, providing as much explanation and detail as necessary to substantiate that the proposal is in full compliance with the LACFC* and all relevant laws, ordinances, rules and regulations as determined by the fire code official. This document shall serve to facilitate as timely a review as possible, on the condition that applicant responses are complete and do not simply reference another document. References to other documents within the larger submittal package may be incorporated so long as accompanied by explanation provided directly within this document.

*The Los Angeles County (LAC) amendments to the 2022 California Fire Code (CFC), when incorporated with the text of the 2022 CFC, create the 2023 LACFC.

- The 2022 CFC can be accessed at https://codes.iccsafe.org/content/CAFC2022P2/chapter-12-energy-systems#CAFC2022P2_Pt03_Ch12_Sec1207.

- A navigable list of the 2022 CFC sections that are amended by LAC, and any sections added in entirety by LAC, can be accessed at https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO. These are listed by section numbers corresponding with the organization of the 2022 CFC.

****<u>Provide responses to each item in the line(s)/space(s) directly below the item.</u>****
Applicant responses should be in red text. Add as many lines as necessary.

PART I — Applicant Information

A. **<u>Address of the proposed project site</u> (or other site locator where no address exists):**
➔

B. **<u>Applicant name and contact information</u>:**
➔

C. **<u>Applicant signature and date</u>:** By signing below, the applicant hereby certifies that all responses provided in this document are correct to the best of the applicant's knowledge and belief, and that the applicant understands all responses made herein shall be substantiated by accompanying plans and/or construction documents.
➔

PART II — General

A. **Where associated with an occupancy at the site**, provide **occupancy classification, use, and/or business name:**
➔

B. **Provide the ESS *technology* (or technologies), per Table 1207.1.1**, that the applicant is proposing to be installed**:**
➔

C. **Provide the categorical *location* classification** that the applicant is proposing is appropriated for the ESS being proposed. Examples include "Indoor installation – Occupied work center" (§1207.7 & §1207.4.10), "Indoor installation – Open rack installations" (§1207.7 & §1207.4.11), "Indoor installation – Walk-in units" (§1207.7 & §1207.4.12), "Outdoor installation, remote" (§1207.8), "Outdoor installation, near exposures" (§1207.8), "Special installations – Rooftop installations" (§1207.9), "Special installations – Open parking garage installations" (§1207.9), "Mobile ESS" (§1207.10)**:**
➔

D. **Energy capacity* (kWh) *per unit*:**
*"Energy capacity is the total energy capable of being stored (nameplate rating), not the usable energy rating" (CFC/LACFC Table 1207.1.1, footnote "a").
➔

PART III — Attachments

A. **Attach complete ESS user and installation manual(s)**.
➔

B. **Where requesting an exception or variance from default requirements of the code**, note this in responses to item number 10, below, provide rationale in those responses, and **attach the *complete* test report(s)**, not simply summaries nor fire-protection-engineer reports thereof; although, those may be provided in addition to the actual test reports.
➔

PART IV — Code Compliance

For the technology and location classifications selected, ***provide responses to each of the following subsections of 2023 LACFC Section 1207***, and for each, ***provide clear explanation whereby the applicant substantiates compliance therewith***. Where a subsection is clearly not applicable because it is for a technology or location other than that selected for the proposed project, simply respond with "N/A".

Applicant responses shall be complete. Do not simply reference another document. References to other documents of the larger submittal package may be incorporated so long as accompanied by explanation provided directly within this document. Where another document is referenced, specify the applicable page(s) and/or portion(s) thereof when practical.

Declaration form <u>for applicants proposing ESS installations at sites other than those dedicated to individual Group-R-3/R-4 occupancies/properties</u>.

2023 LACFC* CHAPTER 12: ENERGY SYSTEMS

*For the following code sections, links are provided to LACFC sections that differ in content from that of the 2022 CFC.

. . .

<u>SECTION 1207 – ELECTRICAL ENERGY STORAGE SYSTEMS (ESS)</u>

. . .

1207.1.2 Permits. (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.2PE)

➔

1207.1.2.1 Communication utilities.

➔

1207.1.3 Construction documents. (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.3CODO)

➔

1207.1.4 Hazard mitigation analysis. (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.4HAMIAN)

➔

1207.1.4.1 Fault condition. (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.4.1FACO)

➔

1207.1.4.2 Analysis approval. (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.4.2ANAP)

➔

1207.1.4.3 Additional protection measures.

➔

1207.1.5 Large-scale fire test. (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.5LAALFITE)

➔

1207.1.6 Fire remediation.

➔

1207.1.6.1 Fire mitigation personnel.

➔

1207.1.6.2 Duties.

➔

<u>1207.1.7 Forensic analysis.</u> (https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.1.7FOAN)

➔

1207.2 Commissioning, decommissioning, operation and maintenance.

➔

1207.2.1 Commissioning.
➔

1207.2.1.1 Initial acceptance testing.
➔

1207.2.1.2 Commissioning report.
➔

1207.2.2 Operation and maintenance.
➔

1207.2.2.1 Ongoing inspection and testing.
➔

1207.2.3 Decommissioning.
➔

1207.3 Equipment.
➔

1207.3.1 Energy storage system listings.
➔

1207.3.2 Equipment listing.
➔

1207.3.3 Utility interactive systems.
➔

1207.3.4 Energy storage management system.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.3.4ENSTMASY)
➔

1207.3.4.1 Annunciator panel.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.3.4.1ANPA)
➔

1207.3.5 Enclosures.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.3.5EN)
➔

1207.3.6 Repairs.
➔

1207.3.7 Retrofits.
➔

1207.3.7.1 Retrofitting lead acid and nickel cadmium.
➔

1207.3.8 Replacements.
➔

1207.3.9 Reused and repurposed equipment.
➔

1207.4 General installations requirements.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4GEINRE)
➔

1207.4.1 Electrical disconnects and associated signage.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4.1ELDIASSI)
➔

1207.4.2 Working clearances.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4.2WOCL)
➔

1207.4.3 Fire-resistance-rated separations.
➔

1207.4.4 Seismic and structural design.
➔

1207.4.5 Vehicle impact protection.
➔

1207.4.6 Combustible storage.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4.6COST)
➔

1207.4.7 Toxic and highly toxic gases.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4.7TOHITOGA)
➔

1207.4.8 Signage.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4.8SI)
➔

1207.4.9 Security of installations.
➔

1207.4.10 Occupied work centers.
➔

1207.4.11 Open rack installations.
➔

1207.4.12 Walk-in units.
➔

1207.4.13 Emergency energy release.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.4.13EMENRE)
➔

1207.5 Electrochemical ESS protection.
➔

1207.5.1 Size and separation.
➔

1207.5.2 Maximum allowable quantities.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.5.2MAALQU)
➔

TABLE 1207.5

➔

1207.5.2.1 Mixed electrochemical energy systems.

➔

1207.5.3 Elevation.

➔

1207.5.4 Fire detection.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.5.4FIDE)

➔

1207.5.4.1 System status.

➔

1207.5.5 Fire suppression systems.

➔

1207.5.5.1 Water-reactive systems.

➔

1207.5.6 Maximum enclosure size.

➔

1207.5.7 Vegetation control.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.5.7VECO)

➔

1207.5.8 Means of egress separation.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.5.8MEEGSE)

➔

1207.6 Electrochemical ESS technology-specific protection.

➔

TABLE 1207.6 ELECTROCHEMICAL ESS TECHNOLOGY-SPECIFIC REQUIREMENTS
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6ELESTEECPR)

Feature	Section
Exhaust ventilation	1207.6.1
➔ Explosion control	1207.6.3
➔ Safety caps	1207.6.4
➔ Spill control and neutralization	1207.6.2
➔ Thermal runaway	1207.6.5

➔

1207.6.1 Exhaust ventilation.

➔

1207.6.1.1 Ventilation based on LFL.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.1.1VEBALF)
➔

1207.6.1.2 Ventilation based on exhaust rate.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.1.2VEBAEXRA)
➔

1207.6.1. ~~2.1~~3 Standby power.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.1.3STPO)
➔

1207.6.1.~~2.2~~4 Installation instructions and controls.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.1.4ININCO)
➔

1207.6.1.~~2.3~~5 Supervision.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.1.5SU)
➔

1207.6.1.~~2.4~~6 Gas detection system.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.1.6GADESY)
➔

1207.6.2 Spill control and neutralization.
➔

1207.6.2.1 Spill control.
➔

1207.6.2.2 Neutralization.
➔

1207.6.2.3 Communications utilities.
➔

1207.6.3 Explosion control.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.6.3EXCO)
➔

1207.6.4 Safety caps.
➔

1207.6.5 Thermal runaway.
➔

1207.7 Indoor installations.
➔

TABLE 1207.7 INDOOR ESS INSTALLATIONS
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.7ININ)

FEATURE SECTION

Prohibited ESS installation locations ➔	1207.7.3
Elevation ➔	1207.5.3
Fire suppression systems ➔	1207.5.5
Fire-resistance-rated separations ➔	1207.7.4
General installation requirements ➔	1207.4
Maximum allowable quantities ➔	1207.5.2
Size and separation ➔	1207.5.1
Smoke and automatic fire detection ➔	1207.5.4
Technology-specific protection ➔	1207.6

1207.7.1 ~~Dedicated-use buildings~~Reserved.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.7.1RE)
➔

1207.7.2 ~~Nondedicated-use buildings~~Reserved.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.7.2RE)
➔

1207.7.3 ~~Dwelling units and sleeping units~~<u>Prohibited ESS installation locations</u>.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.7.3PRESINLO)
➔

1207.7.4 Fire-resistance-rated separations.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.7.4FISITESE)
➔

1207.8 Outdoor installations.
➔

TABLE 1207.8

Feature	Section
All ESS installations ➔	1207.4
Clearance to exposures ➔	1207.8.3
Fire suppression systems	1207.5.5

Maximum allowable quantities	1207.5.2
Maximum enclosure size	1207.5.6
Means of egress separation	1207.5.8
Size and separation	1207.5.1
Smoke and automatic fire detection	1207.5.4
Technology-specific protection	1207.6
Vegetation control	1207.5.7

1207.8.1 Remote outdoor installations.

1207.8.2 Installations near exposures.

1207.8.3 Clearance to exposures.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.8.3CLEX)

1207.8.4 Exterior wall installations.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.8.4EXWAIN)

1207.9 Special installations.

TABLE 1207.9

Feature	Section
All ESS installations	1207.4
Clearance to exposures	1207.9.3
Fire suppression systems	1207.9.4
Maximum allowable quantities	1207.5.2
Maximum enclosure size	1207.5.6
Means of egress separation	1207.5.8
Open parking garage installations	1207.9.6

Declaration form <u>for applicants proposing ESS installations at sites other than those dedicated to individual Group-R-3/R-4 occupancies/properties</u>.

Rooftop installations ➔	1207.9.5
Size and separation ➔	1207.5.1
Smoke and automatic fire detection ➔	1207.5.4
Technology-specific protection ➔	1207.6

1207.9.1 Rooftop installations. ➔

1207.9.2 Open parking garage installations. ➔

1207.9.3 Clearance to exposures. ➔

1207.9.4 Fire suppression systems.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.9.4FISUSY) ➔

1207.9.5 Rooftop installations.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.9.5ROIN) ➔

1207.9.6 Open parking garages. ➔

1207.10 Mobile ESS equipment and operations. ➔

TABLE 1207.10 MOBILE ENERGY STORAGE SYSTEMS (ESS)
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.10MOESEQOP)

Feature	Section
All ESS installations ➔	1207.4
Fire suppression systems ➔	1207.5.5
Maximum allowable quantities ➔	1207.5.2
Maximum enclosure size ➔	1207.5.6
Means of egress separation ➔	1207.5.8
Size and separation ➔	1207.5.1
Smoke and automatic fire detection ➔	1207.5.4
Technology-specific protection	1207.6

➔

Vegetation control 1207.5.7

➔

1207.10.1 Charging and storage.

➔

1207.10.2 Deployment.

➔

1207.10.3 Permits.

➔

1207.10.4 Construction documents.

➔

1207.10.4.1 Deployment documents.

➔

1207.10.5 Approved locations.

➔

1207.10.6 Charging and storage.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.10.6CHST)

➔

1207.10.7 Deployed mobile ESS requirements.

➔

1207.10.7.1 Duration.

➔

1207.10.7.2 Restricted locations.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.10.7.2RELO)

➔

1207.10.7.3 Clearance to exposures.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.10.7.3CLEX)

➔

1207.10.7.4 Electrical connections.

➔

1207.10.7.5 Local staging.

➔

1207.10.7.6 Fencing and impact protection.
(https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT32FICO_1207.10.7.6FEIMPR)

➔

1207.10.7.7 Smoking.

➔

Attachment 3

COUNTY OF LOS ANGELES
FIRE DEPARTMENT
FIRE PREVENTION DIVISION

Date: ____________________

10/01/20

REQUEST FOR MODIFICATIONS OR ALTERNATE MATERIALS AND METHODS REVIEW

Building Code Sections 104.2.7-Modifications and 104.2.8-Alternate Materials, Design, and Methods of Construction
Fire Code Sections 104.8 – Modifications and 104.9 – Alternate Materials and Methods

SECTION 1 – APPLICANT

INSTRUCTION: Applicants are Project Owners or Owner's designee (with written authorization from Project Ownership accompanying this form). Please complete SECTION 1 and submit this form and all supporting documents (building plans, calculations, specifications, test reports, etc.) to the applicable Fire Prevention Engineer or Fire Inspector for review of this document. An Alternate Materials and Methods Review fee is required upon submittal and prior to the review.

Project Address: ____ APN: ________________

City: ____ Incorporated ☐ Unincorporated Area ☐

Owner: __________________________ Applicant's Name: ______________________________

Owner's Address: ____

Applicant's Contact Phone Number: ( )__________ Applicant's Email: ______________________

Plan-check Number: __________________________ Fire Prevention Office: __________________

Type of Construction:____________Occupancy:__________Stories:_____ Fire Sprinklered? ☐ YES ☐ NO

Is this referral for:

☐ Modifications ☐ Alternate Materials ☐ Alternate Methods of Construction or Protection

Project description:

____

____

____

Modification Request - Explain the practical difficulties involved in carrying out the provisions of the Code and proposed application. –OR– Alternate Request - Explain the materials, designs, or methods of construction not specifically prescribed in the Code and proposed application. (Attach additional documents as necessary):

____

____

____

____

Applicable Code References: (List all applicable Code Sections)

____

____

Justification – Demonstrate conformity and equivalence with that prescribed in the Code. (Attach additional documents as necessary):

____

____

____

____

SECTION 2 – FIRE PREVENTION UNIT SUPERVISOR

INSTRUCTION: Please verify Alternate Materials and Methods Review fee is paid. Ensure the submittal package is complete and all pertinent information is included. Complete SECTION 2 and forward this form and all supporting documents to Engineering Section Chief.

Reviewed By: ___________________________________ Date:________________________

(print name)

Comments: ____

____

SECTION 3 – SECTION CHIEF

Reviewed By: _________________________________ Date:_______________________

(print name)

Comments:____

____

SECTION 4 – FINAL DETERMINATION, FIRE MARSHAL: This request is:

☐ **APPROVED** (Provide Conditions of Approval, if any) **APPROVED BY**: _____________________________

(print name)

☐ **NOT APPROVED** (Provide comments, if any) **NOT APPROVED BY**: _____________________________

(print name)

Comments**:**____

____

____

____

IF APPROVED, ROUTE TO: City Building Official, in the City of: _______________________________

SECTION 5 – USE

INSTRUCTION: To Contractors: Conditions of approval must be incorporated into the plans by attachment to the plans or electronically scanned into future plan submissions. All Approvals must be presented to Department Inspectors at the time of the project inspection.

Attachment 4

7.1 *Capabilities Disclosure – Detection & Remote Monitoring*

The following list serves to disclose the capabilities, or lack thereof, so that LACoFD can make the necessary considerations during incident management.

Clearly stated **capabilities and means** by which **first responders** will be able to (either directly, or through facility personnel) ***remotely* monitor conditions of the BESS unit**:

*Where more than one response is offered for an item:
- Select the appropriate ones by responding to them.
- ~~Cross out~~ the others.

(1) **% LEL of BESS Enclosure/Room *Interior* Atmosphere:**

(a) **Type/ Category of Gas Detector(s)** serving the interior space(s) of the container/ compartment:
[Response(s)]

(b) Gases these detectors measure/ detect:
[Response(s)]

(c) Aspirating-type detectors: [YES/NO, for each]
[Response(s)]

(d) These detectors trigger the following actions (for each):
[Response(s)]

(e) # of each type of gas detector per battery compartment:
[Response(s)]

(f) The system reports (for each type):

(i) The *actual* value [If not, leave this response option, but cross it out].
[If some detectors do, and others don’t, list which do here]
or
Only that the following specific threshold(s) have been surpassed:
[Response(s)]

(ii) **In real time**.
[If some detectors do, and others don’t, list which do here]
or
At a time lag and/or interval of:
[Response(s)]

(g) **Expected fouling, inability to accurately report, and/or failure** of **sensors and monitoring and power equipment thereof** during an event [due to heat (specify temperature) or concentration (specify concentration)]:

Commented [JC1]: Throughout this Template, GREEN HIGHLIGHTS are things for the applicant to replace.
...
Replace:
- All **green-highlighted fields** ALONG WITH
- The **brackets that enclose** them.

Replace each with the appropriate site-specific content/details.

This Entire Questionnaire SHALL BE COMPLETED BY THE FACILITY PERSONNEL DURING THE ERP-DEVELOPMENT Phase.

This is a part of the ERP; it is *NOT* a part to be waited upon until an incident arrives.

[Response(s)]

(h) **Reading(s) Obtained/ Monitored via:**
Listed 3rd-party-supervised NFPA-72 fire-alarm system.
or
The following non-fire-alarm-system means:
[Response(s)]

(i) Maintenance/ Calibration frequency for these detectors per the detector manufacturer:
[Response(s)]

(2) Door / Panel Status:

(a) Context:

(i) # of BESS-**Enclosure Access Doors** per BESS Room/ Container:
[Response(s)]

(ii) # of Passive **Explosion-Relief Panels** per BESS Room/ Container:
[Response(s)]

(b) Capabilities to Remotely Obtain Status:

(i) **Open/Closed status** of:

- Access Doors?: [Response(s)]
- Deflagration-Vent Panels/Doors?: [Response(s)]

(ii) For Each: **Degree Open *or* Only if Ajar?**:
[Response(s)]

(c) **Reading(s) Obtained/ Monitored via:**
Listed 3rd-party-supervised NFPA-72 fire-alarm system.
or
The following non-fire-alarm-system means:
[Response(s)]

(3) Exhaust-Fan(s) (and replacement-air openings):

(a) ***#* per battery compartment*** of each**:**
*Identify each as either a **fan**, **passive louver**, **active louver**, **fan and active louver** assembly, or **fan and passive louver** assembly.

(i) **Inlets:**
[Response(s)]

(ii) **Exhaust outlets:**
[Response(s)]

(b) The system reports:

(i) If the fans are Active or Inactive?:
[Response(s)]

(ii) CFM flow?
[Response(s)]

(iii) RPM?
[Response(s)]

(c) **Louvers** —The system reports the following for each?:

(i) Open or Closed?:
[Response(s)]

(ii) To what Degree Open?:
[Response(s)]

(d) **Controls – Means to Activate/ De-activate** Fans and Louvers:
[Response(s)]

(e) **Expected fouling and/or failure** of ***fan and louver equipment*** **(and power-supply/control circuitry)** during an event [due to heat (specify temperature) or concentration (specify concentration)]:
[Response(s)]

(f) **Expected fouling and/or failure** of ***sensors and monitoring*** **and power equipment thereof** during an event [due to heat (specify temperature) or concentration (specify concentration)]:
[Response(s)]

(g) **Reading(s) Obtained/ Monitored via:**
Listed 3rd-party-supervised NFPA-72 fire-alarm system.
or
The following non-fire-alarm-system means:
[Response(s)]

(h) NFPA-69-compliant system?: [YES/NO]
[Response(s)]

(i) Qualified NFPA-69 Safety Instrumented System (SIS)? [YES/NO],
[Response(s)]

- If yes, the Safety Integrity Level (SIL) rating:
  [Response(s)]

(4) ***Cell*** **and/or** ***Interior*** **Temperatures of Involved and Exposed BESS:**

(a) **Locations** and **Specific Means**, and **Level of Specificity*** of detection**:**
*For Level of Specificity: cell-level temperature, or module-level temperature, or battery-compartment-level temperature, or other.

[Response(s)]

(b) The system reports:

(i) The *actual* value [If not, leave this response option, but cross it out].
[If some detectors do, and others don’t, list which do here]
or
Only that the following specific threshold(s) have been surpassed:
[Response(s)]

(ii) **In real time**.
[If some detectors do, and others don’t, list which do here]
or
At a time lag and/or interval of:
[Response(s)]

(c) Expected fouling and/or failure of **sensors and monitoring and power equipment thereof** during an event [due to heat (specify temperature) or concentration (specify concentration)]:
[Response(s)]

(d) **Reading(s) Obtained/ Monitored via:**
Listed 3rd-party-supervised NFPA-72 fire-alarm system.
or
The following non-fire-alarm-system means:
[Response(s)]

(e) Maintenance/ Calibration frequency for these detectors per the detector manufacturer:
[Response(s)]

(5) Voltages of individual Cells/ Modules:

(a) Detects the following **Level of Specificity** (e.g., individual cells, modules, and/or strings):
[Response(s)]

(b) The system reports:
In real time.
[If some detectors do, and others don’t, list which do here]
or
At a time lag and/or interval of:
[Response(s)]

(c) **Reading(s) Obtained/ Monitored via:**
Listed 3rd-party-supervised NFPA-72 fire-alarm system.
or
The following non-fire-alarm-system means:

[Response(s)]

(6) **Humidity and/or moisture within the battery compartment(s):**

(a) Locations and Means of detection:
[Response(s)]

(b) The system reports:

(i) **In real time.**
[If some detectors do, and others don't, list which do here]
or
At a time lag and/or interval of:
[Response(s)]

(c) **Reading(s) Obtained/ Monitored via:**
Listed 3rd-party-supervised NFPA-72 fire-alarm system.
or
The following non-fire-alarm-system means:
[Response(s)]

(7) **Video Surveillance:**

(d) **Locations** of Video Surveillance:
[Response(s)]

(e) **Moveable Cameras?**:
[Response(s)]

(f) **Color** Available?:
[Response(s)]

(g) **Night Vision** Available?:
[Response(s)]

(h) **Infrared** Available?:
[Response(s)]

(i) The cameras record/display:

(i) **In real time.**
[If some cameras do, and others don't, list which do here]
or
At a time lag and/or interval of:
[Response(s)]

(j) **Camera Footage Obtained/ Monitored via:**
[Response(s)]