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<b>Filer:</b>	Doug Urry
<b>Organization:</b>	Tetra Tech
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# Project Description Update

## #2, Part 2

### Corby Battery Energy Storage System Project

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Prepared for



700 Universe Boulevard  
Juno Beach, FL 33408

Prepared by



17885 Von Karman Avenue  
Suite 500  
Irvine, CA 92614

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## Acronyms and Abbreviations

Applicant	Corby Energy Storage, LLC
Application	Opt-in Application
BESS	battery energy storage system
BLM	Bureau of Land Management
CalEEMod	California Emission Estimator Model
CATL	Contemporary Amperex Technology Company
CFC	California Fire Code
CLR	current limiting reactor
CO <sub>2</sub>	carbon dioxide
DOT	U.S. Department of Transportation
ESS	Energy Storage System
GHG	greenhouse gas
HMA	hazard mitigation analysis
HV	high voltage
KOP	key observation point
LGES	LG Energy Solution
LORS	laws, ordinances, regulations, and standards
MW	megawatt
MWh	megawatt-hours
NFPA	National Fire Protection Association
PM <sub>2.5</sub>	particulate matter less than 2.5 microns
PM <sub>10</sub>	particulate matter less than 10 microns diameter
Project	Corby Battery Energy Storage System Project
UL	Underwriters Laboratories
YSAQMD	Yolo Solano Air Quality Management District

## 1.0 INTRODUCTION AND PURPOSE

Since filing the Corby Battery Energy Storage System Project (Project) Opt-in Application (Application) in November 2024 (TN# 259872) and the Project Description Update in April 2025 (TN# 262554) with associated addendum in May 2025 (TN# 263283) (collectively “Project Description Update #1”), the proposed battery manufacturer has changed. The Application originally specified Contemporary Amperex Technology Company (CATL)’s EnerC+ batteries; the Project will now use LG Energy Solution’s (LGES) JF2 DC LINK batteries, requiring updates to the project description and environmental analysis. Corby Energy Storage, LLC (the Applicant) is proposing the technology change to an alternative domestic battery supplier to reduce risk to Project execution and support the planned construction and commercial operation schedule. As a result of the change in technology, updates are needed due to a revised battery energy storage system (BESS) site plan, minor changes to the Project substation equipment and fenceline, and associated minor changes to site grading to accommodate the Project changes. Accordingly, this document serves as the updated analysis to account for these Project description updates.

Section 2.0 describes these Project description updates in further detail; Section 3.0 analyzes the potential environmental impacts resulting from these updates relative to the analysis included in the Application and Project Description Update #1. As discussed herein, the Project, with these updates, will not result in any significant environmental impacts.

## 2.0 PROJECT DESCRIPTION UPDATES

The updates and additions to the Project design since submittal of the Application and subsequent Update #1 include the following elements:

- BESS Array Technology and Layout
- Project Substation
- Site Grading and Drainage

Refer to the Project Description Update #2, Part 1 filed on January 16, 2026 (TN# 268258) for detailed description of these Project updates.

## 3.0 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

An analysis of each of the remaining six environmental areas included in the Application and withheld from the Project Description Update #2, Part 1, is presented below, as related to the Project changes included in Section 2.0. Section 3.0 numbering in the following subsections has been retained from the Project Description Update #2, Part 1. Additionally, applicable laws, ordinances, regulations, and standards have been reviewed to determine the Project’s consistency with them.

### 3.1 Aesthetics

The Project description updates presented in Section 2.0 will not result in impacts greater than those analyzed in the Application and Project Description Update #1 and will not alter the previously identified findings related to aesthetics. All additional Project components and activities will occur within the Project site and generation tie corridor as previously defined. Specifically in terms of

modified and added visual elements, the revised BESS technology, the addition of include two (2) current limiting reactors (CLRs), the change in dimensions of the substation, changes to the size of both stormwater ponds, minor shift of the water tank closer to Byrnes Road, and the relocated substation access road to the north described herein will be constructed within the Project footprint. No additional visible Project elements will be constructed outside of the previously analyzed Project site. The CLRs will not be visible from Interstate 80 and will not be visible from the Vacaville-Dixon Greenbelt and therefore will not impact scenic vistas or scenic highways.

A complete set of revised simulations has been provided for review and provided as Figures 3.1-1 through 3.1-12. The addition of the CLRs and the adjustments to the substation layout will be visible from key observation point (KOP) 2a, KOP 3, KOP 7a, and KOP 7b, as shown in Figures 3.1-3, 3.1-4, 3.1-9, and 3.1-11 as well as the updated KOP 2a, KOP 3, KOP 7a, and KOP 7b Bureau of Land Management (BLM) Visual Contrast Rating Worksheets (Form 8400-4) provided as Appendix 3.1-A. The BESS layout will be visible from KOP 2a, KOP 2b, and KOP 3, as shown in Figures 3.1-2, 3.1-3, and 3.1-7, as well as the updated KOP 2a, KOP 2b, and KOP 3 BLM Visual Contrast Rating Worksheets (Form 8400-4) in Appendix 3.1-A. The addition of the CLRs will blend in with the remainder of the substation equipment; the updated simulations and forms reflect the minor changes that are visible from these KOPs. The addition of the CLRs and adjustments to the substation layout will appear substantially similar to the layout previously analyzed in the Application and the Project Description Update #1 and will not result in a change to visual contrast. The BESS units will be slightly larger in length and width as shown in Table 3.1-1<sup>1</sup>. The small increase in BESS unit size creates slightly more visual prominence than the previously proposed model. The water tank will be located closer to Byrnes Road and slightly more visibly prominent. However, the BESS and the water tank will both continue to be gray, similar to other Project elements (Project substation, fencing, and sound barrier) and to the existing structures (roadway, agricultural structure, and transmission towers and lines). The contrast determined for the BESS and the water tank will be the same as that previously discussed in Project Description Update #1. They will contrast with the undeveloped agricultural land but will be consistent with the horizontal and vertical lines and colors of other human-made structures throughout the landscape. While they will introduce a contrast, they will blend in with the other Project elements and therefore not increase the contrast created by the Project. Views for local motorists would be of short duration due to partial or full blockage of views by vegetation and structures prior to approaching the Project site, which will limit view accessibility of the Project including these components by continuing to soften the contrast between the agricultural land and the Project. As the landscaping matures in height and fills out, the landscaping will largely obscure the Project, reducing the contrast with agricultural land.

The Project will continue to not include lighting, and surface coatings and materials will continue to have overall low reflectivity. Construction of the modified Project features will not impact scenic vistas, scenic highways, visual character, or light and glare, beyond those previously assessed in the Application; and the Project, with the changes described, will continue to comply with applicable laws, ordinances, regulations, and standards (LORS) as related to aesthetics. Therefore, the Project description changes do not result in a change to the Less Than Significant determination for aesthetics.

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<sup>1</sup> Table 3.1-1 was previously provided in Project Description Update #1 (TN# 262554).

**Table 3.1-1. Approximate Dimensions, Color, Materials, and Finishes of the Major Project Features<sup>1/</sup>**

Feature	Length (feet)	Width (feet)	Height (feet)	Color	Materials	Finish
<b>BESS Array Components</b>						
Batteries and battery enclosures	<del>2023.5</del>	<del>8</del> <b>8.4</b>	9.5	Traffic Gray RAL 7042	Prefabricated Metal Building	Semi-gloss
Inverters	22	7	7	Gray/Dark gray	Electrical Equipment	NA
Auxiliary transformers	7	6.5	8	Munsell Green 7GY 3.29/1.5	Electrical Equipment	NA
Auxiliary switchboard	10	3	7.5	ANSI 61 Gray	Electrical Equipment	Textured powder coat
<b>Project Substation Components</b>						
Generator step-up transformers	22	28	26	Painted steel – ANSI 61 Gray	Electrical Equipment	NA
Switchgear	8	12	28	No paint - Steel/Galvanized steel	Electrical Equipment	NA
Busbar structures	274	275	28	No paint - Galvanized steel	Electrical Equipment	NA
Riser structures	-	-	65	No paint – Galvanized steel	Steel	NA
Substation control house	60	14	11.6	Ash Gray	Concrete, Steel, Metal alloys, Electrical Equipment	NA
Shield Poles	NA	NA	70	No paint - Galvanized steel	Steel	NA
<b>CLRs</b>	<b>NA</b>	<b>10</b>	<b>25</b>	<b>No paint - Galvanized steel</b>	<b>Steel</b>	<b>NA</b>
<b>Other Project Components</b>						
Generation tie line (above ground portion) (up to 10 structures)	NA	37.1 inches in diameter	90 - 130 (Monopole, H- Frame, and 3-Pole Tubular Steel Pole [TSP])	No paint/gray	Steel	NA
Perimeter Fence (Substation)	<del>4,230</del> <b>1140</b>	-	6	No paint/gray	Steel	NA
Perimeter Fence (BESS array)	<del>2,977</del> <b>3113</b>	-	6	No paint/gray	Steel	NA
Sound Barrier	785	-	15	Gray	Blend of wood shavings and cement	NA
Signage	NA	8	4	various	Steel/plastic	NA
Fiber Optic Poles (approximately 10 structures)	NA	13.8 inches in diameter	30-80	Brown	Wood	NA
Water Tank	15	15	19.25	No paint/gray	Steel	NA

<sup>1/</sup> Replaces Table 4.1-2 in Application. Updated information is provided in **bold text**.

### 3.3 Air Quality

The Project description updates presented in Section 2.0 will not result in impacts greater than those analyzed in the Application and Project Description Update #1 and will not alter the previously identified findings related to air quality. As noted in Section 2.0, the construction schedule, workforce, and equipment requirements provided in Project Description Update #1 will not change as a result of the current Project description updates. Therefore, construction-related impacts from off-road equipment and vehicle trips will remain unchanged.

Dust impacts from earthmoving activities provided as part of the Project Description Update #1 were evaluated using a California Emissions Estimator Model (CalEEMod) default grading area of 32.5 acres to be conservative. Therefore, although the proposed grading area for the Project has increased from 18.6 acres to 19.6 acres, the construction impact estimates in the Project Description Update #1 remain conservative.

Mitigated emissions for reactive organic gases and nitrogen oxides are expected to remain below the Yolo Solano Air Quality Management District (YSAQMD) annual threshold of 10 tons. The maximum daily particulate matter less than 10 microns diameter (PM<sub>10</sub>) construction emissions will continue to be less than the YSAQMD's significance threshold of 80 pounds per day. Additionally, the AERMOD predicted impacts for nitrogen dioxide, PM<sub>10</sub>, particulate matter less than 2.5 microns (PM<sub>2.5</sub>), carbon monoxide, and sulfur dioxide during construction, previously evaluated in response to Data Request Response Set #2, DR AQ-1 (TN# 263281), confirms that the Project will continue to comply with all state and federal Ambient Air Quality Standards. Therefore, the Project will continue to not violate any air quality standard or contribute substantially to an existing or projected air quality violation, and impacts will continue to be Less Than Significant.

The cancer and chronic health risks associated with the additional Project components are also expected to continue to remain below the YSAQMD cancer risk threshold of 10 in one million and the chronic hazard index of 1, for all the residential, worker and sensitive receptors previously identified. Therefore, the Project will continue to not expose sensitive receptors to substantial pollutant concentrations, and the Project description changes do not result in a change to the Less Than Significant determination for health risk-related impacts.

Finally, the Project description updates will not make a cumulatively considerable contribution during construction. The YSAQMD (2020) *Handbook for Assessing and Mitigating Air Quality Impacts* states that any proposed project that would individually have a significant air quality impact (determined based on YSAQMD's Thresholds of Significance described above) would also be considered to have a significant cumulative impact. Since Project impacts continue to remain less than significant after the updates, the cumulative impacts will also remain less than significant.

### 3.6 Energy

The Project description updates presented in Section 2.0 will not result in impacts greater than those analyzed in the Application and Project Description Update #1 and will not alter the previously identified findings related to energy. As noted in Section 2.0, the construction schedule, workforce, and equipment requirements provided in Project Description Update #1 will not change as a result of

the current Project description updates. Further, as noted in Section 3.3, Air Quality, construction related impacts from off-road equipment and vehicle trips will remain unchanged; and as noted in Section 3.8, Greenhouse Gas Emissions, construction greenhouse gas (GHG) emissions are expected to remain the same as those evaluated in the Project Description Update #1. Given that energy consumption is calculated based on the GHG emissions of on-road vehicle trips and distances and off-road equipment use, the energy consumption estimates are expected to remain the same as those evaluated in Project Description Update #1. Therefore, the Project description changes do not result in a change to the Less Than Significant determination for energy.

### 3.8 Greenhouse Gases

The Project description updates presented in Section 2.0 will not result in impacts greater than those analyzed in the Application and Project Description Update #1 and will not alter the previously identified impact analysis and findings related to GHG emissions. As noted in Section 2.0, the construction schedule, workforce and equipment requirements provided in Project Description Update #1 will not change as a result of the current Project description updates. Therefore, the direct Project GHG emissions are expected to remain the same as those evaluated in Project Description Update #1 and as result, will continue to be below the California Air Pollution Control Officers Association threshold of significance of 900 metric tons per year.

The proposed change to JF2 DC LINK batteries will result in a reduction of estimated indirect GHG emissions relative to the previously proposed technology due to lower auxiliary loads. Table 3.8-1 below presents updated estimated indirect operational GHG emissions, using the same methodology described in Section 3.4.1.2 of the May 2025 Air Quality and Greenhouse Gas Technical Report (TN# 263284).

**Table 3.8-1. Estimated Indirect Operational Greenhouse Gas Emissions<sup>1/</sup>**

CalEEMod Electric Utility GHG Emission Factors	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
	Emissions (lb/MWh)		
Pacific Gas and Electric Company	203.983	0.033	0.004
Annual Indirect GHG Emissions	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
	Emissions (Metric tons)		
Indirect GHG Emissions from Round-Trip Efficiency Losses	6,886	1.11	0.14
Indirect GHG Emissions from Auxiliary Loads	<b>2,406 1940</b>	<b>0.39 0.31</b>	<b>0.05 0.04</b>
Total Indirect GHG Emissions from BESS Operation	<b>9,292 8,826</b>	<b>1.50 1.43</b>	<b>0.18 0.17</b>
Global Warming Equivalence Factor	1	25	298
Equivalent CO <sub>2e</sub> Emissions <sup>2/</sup>	<b>9,292 8,826</b>	<b>37.58 35.70</b>	<b>54.30 51.57</b>
<b>Total Indirect Operational GHG Emissions (CO<sub>2e</sub>)</b>	<b>9,384 8,913</b>		

1/ Estimated emissions are based on year 15 energy usage projections. Updated information is provided in **bold text**.

2/ Equivalent CO<sub>2e</sub> Emissions = Indirect GHG Emissions x Global Warming Equivalent Factor.

CO<sub>2</sub> = carbon dioxide; CO<sub>2e</sub> = carbon dioxide equivalent; CH<sub>4</sub> = methane; GHG = greenhouse gas; N<sub>2</sub>O = nitrous oxide

As noted below in Section 3.9, the proposed JF2 DC LINK thermal management system will include HFC-32 chiller refrigerant, which was not included with the previous battery technology. HFC-32 has a global warming potential of 675, which is less than 750 and therefore compliant with the “Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Stationary Air-conditioning and Other End-Uses” (California Code of Regulations, Title 17, Division 3, Chapter 1, Subchapter 10, Article 4, Subarticle 5).

Based on the updates to the GHG analysis described above, GHG impacts will be slightly lower than what was presented in the Application and Project Description #1 and do not result in a change to the Less Than Significant determination for GHG emissions.

### **3.9 Hazards and Hazardous Materials**

The Project description updates presented in Section 2.0 will not result in impacts greater than those analyzed in the Application and Project Description Update #1 and will not alter the previously identified findings related to hazards and hazardous materials. All modified Project components and activities will occur within the Project footprint as previously defined in the Application.

#### **3.9.1 Hazardous Materials Use and Disposal**

Hazardous materials used during construction activities will continue to be limited to fuels, lubricants, other oils, and greases, which will continue to be used to fuel and service construction equipment consistent with those described in the Application, Project Description Update #1, and Data Request Set #2 (TN# 263281). Refueling construction-related equipment will continue to be performed within secondary containment. No changes to the construction hazardous materials use or storage is anticipated based on the Project description updates presented in Section 2.0.

Hazardous materials that will be stored onsite during Project operation will continue to be contained within the Project components, including the battery cells, transformers, high-voltage (HV) breakers, CLRs and BESS enclosures. At each stage of battery augmentation, only the hazardous materials associated with the battery cells and BESS enclosures will increase, as these are the only components with hazardous materials that will be added during augmentation. No additional transformers or HV breakers will be added to the Project site during augmentation. As such, the quantities of hazardous materials for these components (including mineral oil and sulfur hexafluoride) will remain constant throughout the life of the Project.

For all other hazardous materials associated with the battery cells and BESS enclosures, the quantities of these chemicals were factored based on the conservative full buildout quantities, initial buildout, and the increase in BESS enclosures at each stage of planned augmentation for the first 15 years of the Project’s lifespan.

The Applicant currently has commercial commitments to provide 300 megawatts (MW) and 1,200 megawatt-hours (MWh) of energy storage for the initial 15 years of the Project’s operating life. Commercial commitments for years 16 through 30 are currently undefined. The initial buildout of 303 enclosures will provide sufficient overbuild to provide the nameplate energy storage capacity for 6 years. It is expected that a first augmentation of 13 enclosures (66.46 MWh) will occur in year 6, a

second augmentation of 13 enclosures (66.46 MWh) will occur in year 9, and a third augmentation of 12 enclosures (61.34 MWh) will occur in year 12 to achieve commercial commitments through year 15. Future augmentation activities beyond year 15 will depend on future commercial commitments.

Table 3.9-1 contains a list of all materials used or stored on the Project site during operations that are hazardous or acutely hazardous, as defined in Title 22 California Code of Regulations Section (§) 66261.20 et seq., at initial buildout (303 BESS enclosures), full buildout (341 BESS enclosures), and after each of three planned augmentation events (years 6, 9, and 12). Aside from those stored within the sealed battery cells, the other hazardous materials listed in these tables will be stored within the other Project components, including insulating oil within the transformers, sulfur hexafluoride within the HV breakers, and R513a, HFC-32, and ethylene glycol within the BESS enclosures. The remaining hazardous materials listed in these tables will be stored within sealed battery cells. These hazardous materials are part of the Project components, rather than materials that are stored onsite for use by operations and maintenance staff.

Hazardous materials used during operation will be stored offsite at a regional operations and maintenance facility and transported to the Project site as needed during regular site inspections and minor repairs.

Table 3.9-2 list the toxicity, reactivity, and flammability levels of the hazardous materials identified in Tables 3.9-1.

Batteries will continue to be delivered to the Project site in U.S. Department of Transportation (DOT)-certified vehicles and will be in compliance with all applicable requirements of the DOT, California Highway Patrol, and California Department of Motor Vehicles. During Project operation, the facility will require battery augmentation to maintain Project capacity; batteries will be added but not replaced during this planned activity. In addition, lithium-ion battery cells may occasionally be replaced due to defects or loss of efficiencies. Disposal of lithium-ion batteries is discussed in Section 4.19, *Utilities and Service Systems* of the Application. As discussed therein, hazardous materials disposed of during operation, including any battery cells that require replacement, will continue to be recycled or disposed of in accordance with the applicable hazardous waste requirements and impacts will be less than significant.

**Table 3.9-1. Use and Storage of Hazardous Materials During Operation <sup>2</sup>**

Chemical	Use	Quantity (544 341 Encl. - Full Buildout)	Quantity (384 303 Encl. - Initial Buildout)	Quantity (396 316 Encl. - Year 6)	Quantity (408 329 Encl. - Year 9)	Quantity (424 341 Encl. - Year 12 / Full Buildout)	Storage Location	State	Type of Storage
Carbon	Battery	2,121,000 kg 424,000 kg	1,884,642 kg 87,529 kg	1,965,501 kg 90,265 kg	2,046,361 kg 93,228 kg	2,121,000 kg 96,419 kg	Within sealed battery cells [4 22% by wt]	Solid	Continuously onsite
Aluminum	Battery	883,000 kg 498,000 kg	784,601 kg 351,529 kg	818,264 kg 362,546 kg	851,927 kg 374,417 kg	883,000 kg 387,232 kg	Within sealed battery cells [4 9% by wt]	Solid	Continuously onsite
Copper	Battery	662,000 kg 1,369,000 kg	588,229 kg 966,353 kg	613,466 kg 996,554 kg	638,704 kg 1,029,270 kg	662,000 kg 1,064,500 kg	Within sealed battery cells [44 7% by wt]	Solid	Continuously onsite
Ethyl Methyl Carbonate	Battery electrolyte	1,737,000 kg 934,000 kg	1,543,434 kg 659,294 kg	1,609,654 kg 679,899 kg	1,675,874 kg 702,249 kg	1,737,000 kg 726,255 kg	Within sealed battery cells [8 18% by wt]	Liquid	Continuously onsite
Polyvinylidene Fluoride (1,1-Difluoroethene homopolymer)	Battery	125,000 kg 341,000 kg	111,070 kg 249,529 kg	115,836 kg 226,390 kg	120,601 kg 233,822 kg	125,000 kg 241,826 kg	Within sealed battery cells [3 1% by wt]	Solid	Continuously onsite
Lithium iron phosphate Co-Crystallized	Battery	4,069,000 kg 3,423,000 kg	3,615,563 kg 2,416,235 kg	3,770,686 kg 2,491,749 kg	3,925,809 kg 2,573,550 kg	4,069,000 kg 2,661,639 kg	Within sealed battery cells [28 42% by wt]	Solid	Continuously onsite
Aluminum	Module	1,230,000 kg	1,092,933 kg	1,139,824 kg	1,186,716 kg	1,230,000 kg	Within Module [10% by wt]	Solid	Continuously onsite
Iron	Module	738,000 kg	655,760 kg	683,894 kg	712,029 kg	738,000 kg	Within Module [6% by wt]	Solid	Continuously onsite
Carbonic dichloride polymer with 4,4'-(1-methylethylidene)bis[phenol], 4-(1,1-dimethylethyl) phenylester	Module	246,000 kg	218,587 kg	227,965 kg	237,343 kg	246,000 kg	Within Module [2% by wt]	Solid	Continuously onsite
1-Propene polymer with ethene	Module	246,000 kg	218,587 kg	227,965 kg	237,343 kg	246,000 kg	Within Module [2% by wt]	Solid	Continuously onsite

<sup>2</sup> Table previously provided as Table 6-3 in Data Response Set #2, DR HAZ-7, TN# 263281

Chemical	Use	Quantity (544 341 Encl. - Full Buildout)	Quantity (384 303 Encl. - Initial Buildout)	Quantity (396 316 Encl. - Year 6)	Quantity (408 329 Encl. - Year 9)	Quantity (424 341 Encl. - Year 12 / Full Buildout)	Storage Location	State	Type of Storage
2,6-Dimethylphenol homopolymer	Module	123,000 kg	109,293 kg	113,982 kg	118,672 kg	123,000 kg	Within Module [1% by wt]	Solid	Continuously onsite
Copper	Module	123,000 kg	109,293 kg	113,982 kg	118,672 kg	123,000 kg	Within Module [1% by wt]	Solid	Continuously onsite
Graphite	Battery	1,991,000 kg	1,405,412 kg	-1,449,334 kg	-1,496,914 kg	-1,548,152 kg	Within sealed battery cells [16% by wt]	Solid	Continuously onsite
Dimethyl Carbonate	Battery electrolyte	934,000 kg	659,294 kg	-679,899 kg	-702,219 kg	-726,255 kg	Within sealed battery cells [8% by wt]	Liquid	Continuously onsite
Ethylene Carbonate	Battery electrolyte	934,000 kg	659,294 kg	-679,899 kg	-702,219 kg	-726,255 kg	Within sealed battery cells [8% by wt]	Liquid	Continuously onsite
Diethyl Carbonate	Battery electrolyte	934,000 kg	659,294 kg	-679,899 kg	-702,219 kg	-726,255 kg	Within sealed battery cells [8% by wt]	Liquid	Continuously onsite
Lithium hexafluorophosphate solution	Battery electrolyte	311,000 kg	219,529 kg	-226,390 kg	-233,822 kg	-241,826 kg	Within sealed battery cells [3% by wt]	Liquid	Continuously onsite
Carboxymethyl-cellulose Sodium	Battery	311,000 kg	219,529 kg	-226,390 kg	-233,822 kg	-241,826 kg	Within sealed battery cells [3% by wt]	Solid	Continuously onsite
Mineral oil	Insulating oil	39,303 gal 44,907 gal	39,303 gal 44,907 gal	39,303 gal 44,907 gal	39,303 gal 44,907 gal	39,303 gal 44,907 gal	Within transformers	Liquid	Continuously onsite
Sulfur hexafluoride	Circuit breakers	227 kg	227 kg	227 kg	227 kg	227 kg	Within HV breakers	Gas	Continuously onsite
R-513a Opteon XP10	Refrigerant	157 kg 4,950 kg	139 kg 3,494 kg	145 kg 3,603 kg	151 kg 3,722 kg	157 kg 3,849 kg	BESS enclosures	Liquid	Continuously onsite
Ethylene glycol	Coolant	904 kg 10,880 kg	803 kg 7,680 kg	837 kg 7,920 kg	872 kg 8,180 kg	904 kg 8,460 kg	BESS enclosures	Liquid	Continuously onsite
HFC-32 (Difluoromethane)	Coolant	341 kg	303 kg	316 kg	329 kg	341 kg	BESS enclosures	Liquid	Continuously onsite

Notes:

1/ Updates are provided in strikeout and **bold** text for convenience.

BESS = battery energy storage system; gal = gallon; HV = high volkg = kilogram; wt = weight

**Table 3.9-22. Toxicity, Reactivity, and Flammability of Hazardous Materials Onsite<sup>3,4</sup>**

Hazardous Materials	CAS Number	Physical Description	Health Hazard	Reactive & Incompatibles	Flammability <sup>1/</sup>
<b>Construction</b>					
Gasoline	8006-61-9	A clear, colorless to amber-colored liquid with a petroleum odor	Skin, eye, and respiratory irritant. Exposure can cause drowsiness and dizziness. May be fatal if swallowed and enters airways. May be carcinogenic.	Stable at normal conditions. Incompatible with strong oxidizing agents.	Flammable
Diesel	68476-34-6	A straw yellow to dark colored liquid with a petroleum odor.	Skin, eye, and respiratory irritant. May be fatal if swallowed and enters airways. May be carcinogenic.	Stable at normal conditions. Incompatible with strong oxidizing agents.	Flammable
Lubricants	74869-22-0	A viscous and odorless liquid, generally brown to black color.	Skin, eye, and respiratory irritant. Exposure can cause drowsiness and dizziness. May cause nausea if ingested. May be carcinogenic.	Non-reactive. Incompatible with strong acids, strong bases, strong oxidizing agents.	Flammable
<b>Operations</b>					
Carbon	7440-44-0	Solid graphite, black	Minor skin and eye irritant. May cause respiratory irritation in repeated/ prolonged exposure.	Non-reactive	Not flammable
Aluminum	7429-90-5	Metallic solid, white or grey	Skin and eye irritant. Exposure of dust can cause "metal fume fever".	Strong oxidizing agents	Flammable
Copper	7440-50-8	Metallic solid	Eye and respiratory irritant in long-term exposure	Low chemical reactivity	Not flammable
Ethyl Methyl Carbonate	623-53-0	Colorless liquid	Skin, eye, and respiratory irritant.	Strong oxidizing agents, strong acids and strong bases	Flammable
Polyvinylidene Fluoride (1,1-Difluoroethene homopolymer)	24937-79-9	Colorless gas	Skin, eye, and respiratory irritant. Exposure can cause headache, dizziness, nausea and vomiting.	Strong oxidizing agents	Flammable
Lithium iron phosphate Co-Crystallized	15365-14-7	Gray, red-grey, brown or black solid	Hazardous in case of skin contact (irritant), of eye contact (irritant), may cause respiratory irritation and may be carcinogenic	Conductive materials, water, seawater, strong oxidizers and strong acids	Not flammable
Iron	7439-89-6	Metallic solid (gray)	Hazardous in case of skin contact (irritant), of eye contact (irritant), may cause respiratory irritation	Strong oxidizers and strong acids	Not flammable
Carbonic dichloride polymer with 4,4'-	103598-77-2	Solid plastic resin (clear/white pellets)	Hazardous in case of skin contact (irritant), of eye contact (irritant), may	Non-reactive. Incompatible with strong acids.	Combustible

<sup>3</sup> Appendix B (g)(10)(A)<sup>4</sup> Table previously provided as Table 6-2 in Data Response Set #2, DR HAZ-4, TN# 263281

Hazardous Materials	CAS Number	Physical Description	Health Hazard	Reactive & Incompatibles	Flammability <sup>1/</sup>
(1-methylethylidene)bis[phenol], 4-(1,1-dimethylethyl) phenylester			cause respiratory irritation. Molten material may cause thermal burns.		
1-Propene polymer with ethene	9010-79-1	White/translucent solid plastic resin	Dust may irritate eyes, skin, and respiratory tract.	Non-reactive. Incompatible with strong acids.	Combustible
2,6-Dimethylphenol homopolymer	25134-01-4	Off-white to white powder solid	Minor health hazard	Non-reactive. Incompatible with strong acids.	Combustible
Graphite	7782-42-5	Solid graphite, black	Minor skin and eye irritant. May cause respiratory irritation in repeated/prolonged exposure.	Non-reactive	Not flammable
Dimethyl Carbonate	646-38-6	Colorless liquid	Skin, eye, and respiratory irritant. Exposure can cause headache, dizziness, nausea and vomiting, weakness and loss of consciousness.	Vapors may form explosive mixture with air	Flammable
Ethylene Carbonate	96-49-1	White to yellow crystals	Causes severe eye irritation and possible eye injury. May cause respiratory and digestive tract irritation. May cause skin irritation.	Oxidizing agents, reducing agents, acids, bases.	Not flammable
Diethyl Carbonate	105-58-8	Colorless liquid	Skin, eye, and respiratory irritant. Exposure can cause headache, dizziness, nausea and vomiting, weakness and loss of consciousness.	Strong oxidizing agents, strong bases, strong acids, reducing agent	Flammable
Lithium hexafluorophosphate solution	21324-40-3	Colorless to Yellow and Very Faint Red Liquid	Causes burns; Inhalation may cause corrosive injuries to upper respiratory tract and lungs; Harmful by ingestion; Toxic by skin absorption	Incompatible with strong oxidizing agents, strong acid	Flammable
Carboxymethyl-cellulose Sodium	9004-32-4	Beige powder	Skin, eye, and respiratory irritant.	Strong oxidizing agents	Not flammable
Mineral oil	8012-95-1	Oily, clear liquid	Minor health hazard	Sodium hypochlorite; oxidizers	Can be combustible, depending on manufacturer
Sulfur hexafluoride	2551-62-4	Colorless gas	Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant)	Chemically reactive metals: potassium, calcium, powdered aluminum, magnesium, and zinc.	Not flammable
Opteon XP10 (R513a)	754-12-1, 811-97-2	Colorless liquefied gas	Overexposure may cause dizziness and loss of concentration. At higher levels, nervous system depression and cardiac arrhythmia may result from exposure. Vapors displace air and can cause	Non-reactive	Not flammable

Hazardous Materials	CAS Number	Physical Description	Health Hazard	Reactive & Incompatibles	Flammability <sup>1/</sup>
			<b>asphyxiation in confined spaces.</b>		
Ethylene glycol	107-21-1	Colorless liquid	Contact can irritate the eyes and skin, while inhaling it can irritate the throat and nose. Other short-term effects include nausea, vomiting, weakness, and abdominal pain. Higher exposure can lead to headache, dizziness, slurred speech, convulsions, loss of coordination, and coma.	Strong acids and oxidizers	Not flammable
<b>HFC-32 (Difluoromethane)</b>	<b>75-10-5</b>	<b>Colorless liquefied gas</b>	<b>Irritation may cause dizziness, headache, and nausea.</b>	<b>Non-reactive. Incompatible with strong acids.</b>	<b>Flammable</b>

<sup>1/</sup> Per U.S. Department of Transportation regulations, under 49 Code of Federal Regulations 173: "Flammable" liquids have a flash point of not more than 140 degrees Fahrenheit (°F); "Combustible" liquids have a flash point of greater than 140°F.

## 3.9.2 Worker Health and Safety

### 3.9.2.1 Hazard Analysis

Although there will be a change in the manufacturer, the BESS enclosures will continue to consist of self-contained electrochemical battery systems using conventional storage technologies with proven safety and performance records. The BESS enclosures are designed to allow periodic maintenance and replacement of underperforming battery components which can be easily performed as needed without replacing the entire module.

#### **Fire Protection Design**

The Project's fire protection design will comply with California Fire Code (CFC) Chapter 12 Energy Systems, which adopts the 2024 International Fire Code with amendments. The Project will also comply with applicable county and state fire code requirements, standards from Underwriters Laboratories (UL; safety organization), and the National Fire Protection Association (NFPA). Project design will be compliant with NFPA 855 (Standard for the Installation of Stationary Energy Storage Systems), which is the overarching standard governing all Energy Storage System (ESS) installations. A representative fire protection system schematic has been provided as Appendix 2-C of Project Description Update #2, Part 1. All documentation requirements, including plans, specifications, test and evaluation data, an emergency response plan, and all manuals, will be developed in accordance with Chapter 4 of NFPA 855.

#### **Plume Dispersion Modeling**

Accidental releases of material during a battery storage thermal runaway fire incident have the potential to affect surrounding populated areas. Similar to what was prepared for the CATL batteries<sup>5</sup>, a dispersion modeling assessment was conducted for JF2 DC LINK batteries to determine the worst-

<sup>5</sup> Data Request Response Set #2 (TN #263281 and TN #263282) and Data Request Response Set #4 (TN #266307).

case magnitude and areal extent of potential emissions of hazardous air pollutants under a full range of site representative meteorological conditions at the Corby BESS facility. A copy of the plume dispersion modeling is provided herein as Appendix 3.9-A.

The results of the toxic air contaminant acute hazard index modeling from any of the 14 hypothetical locations of thermal runaway events at the Corby BESS, under the meteorological conditions that can produce the highest ground level concentrations, never equal or exceed a hazard index 1.0 at the sensitive receptors (residences). Additionally, the U.S. Environmental Protection Agency's Acute Exposure Guideline Level 1 thresholds were never exceeded at any receptor or sensitive receptor location. Further, the criteria pollutant impacts were all less than the California Ambient Air Quality Standards for the 1-hour nitrogen dioxide, sulfur dioxide, and carbon monoxide averaging periods and for the 8-hour carbon monoxide averaging period at the sensitive receptor locations. The results for the JF2 DC LINK modeling analysis demonstrates reduced distances corresponding to a hazard index of 1.0 compared to the CATL batteries, and continue to demonstrate a hazard index of less than 1.0 at sensitive receptor locations.

### ***Thermal Runaway Protection System***

Thermal runaway is a rapid uncontrollable self-heating state. In typical conditions, heat is able to dissipate from the cells, but during thermal runaway, the cell releases more heat than it can safely dissipate. This state can result in off-gassing, extremely high temperatures, smoke, fire, and even explosion resulting in larger battery fires.

Similar to what was described in the Application, Data Response Set # 2 (TN# 263281) and Data Response Set #4 (TN# 266307), and Project Description Update #1, the latest technology in battery storage has established a design such that in the unlikely scenario of a thermal event, the thermal event would be contained to a single battery container and not result in thermal runaway that could affect neighboring units. Further discussion may be found in Appendix 3.9-B, Hazard Mitigation Analysis.

### ***Hazard Mitigation Analysis***

The hazard mitigation analysis (HMA) was conducted in accordance with Chapter 12 §1207 of the 2022 edition of the CFC as adopted by Solano County, and Chapter 4 §4.4 of the 2023 edition of NFPA 855 to better reflect current accepted industry best practices. The product-level HMA for the JF2DC LINK battery was updated on January 30, 2026. The site-level HMA for the Corby BESS facility was issued on January 15, 2026. The two reports together comprise the full HMA review.

The HMA is intended to be used as a tool for a Fire Code Official or an Authority Having Jurisdiction to assist in their review of the proposed Project, and it includes a review of the Project's site plan and the JF2 DC LINK batteries including construction, design, fire safety features, listings, certifications, UL 9540A fire test data, and Failure Modes and Effects Analysis.

Based on the HMA analysis for both the JF2 DC LINK battery technology and the site-specific BESS system, the design will meet the CFC installation level requirements for an outdoor BESS when it is installed in accordance with the manufacturer's instructions, its listing, the approved drawings, and the CFC. The HMA evaluated the consequences of defined BESS failure and identified safeguards to

either prevent or mitigate the consequences. The HMA identifies safety recommendations, to help ensure safe operation. The HMA's recommendations include development of pre-incident plans, emergency response procedures, fire department coordination, testing, inspections, emergency response plan, and signage plans. These recommendations are consistent with those previously assessed in the Application, Data Response Sets #2 and #4, and Project Description Update #1. A copy of both HMAs is provided in Appendix 3.9-B. The Project, with the changes described, will continue to comply with all applicable LORS.

### ***Large-Scale Burn Test***

A large-scale burn test for the JF2 DC LINK batteries was performed at Anhui Suzhou Thermal Safety Technology National and Local Joint Engineering Research Center (CWN) on January 11, 2025. Similar to the previous battery manufacturer burn test for the CATL- Ener C+ batteries (Data Request Response Set #2, DR WS-1), no thermal runaway propagation to adjacent units (enclosures) was observed for the proposed battery change. Further there were no deflagration or explosion events observed during the test for the JF2 DC LINK batteries. The complete burn test results are provided in Appendix 3.9-C.

### ***NFPA 69***

NFPA 69 is the Standard on Explosion Prevention Systems and provides requirements for designing and implementing systems that prevent explosions in environments where flammable gases, vapors, mists, or combustible dusts may be present.

Explosion risk and prevention are addressed in Appendix 3-D, Explosion Prevention System Design Report. The primary goal of the analysis was to determine if the explosion control measures in place will continue to be in conformance with the applicable requirements of NFPA standards 855 and 69. The BESS uses the explosion mitigation strategy of combustible concentration reduction via exhausting the interior contents upon detection of flammable gases at a pre-determined threshold.

The proposed JF2 DC LINK battery technology for the Project will continue to comply with NFPA 69 standards. NFPA 69 compliance has been completed by the battery manufacturer/vendor, and the model meets the explosion control system requirements of NFPA 69. Additionally, the JF2 DC LINK has deflagration panels on the roof as a redundant layer of protection against a partial deflagration event, providing an additional layer of safety.

### ***NFPA 855***

NFPA 855 is the Standard for the Installation of Stationary Energy Storage Systems, providing mandatory requirements for the safe design, installation, operation, and maintenance of energy storage systems across all technologies. It establishes fire protection, explosion control, ventilation, spacing, and emergency response criteria to reduce hazards such as thermal runaway, fire, and gas buildup in BESS installations.

The new battery technology for the Project will continue to comply with NFPA 855 standards. NFPA 855 compliance completed by the battery manufacturer/vendor and the JF2 DC LINK model meets the explosion control system requirements of NFPA standards 855. NFPA 855 compliance for the proposed technology is documented in the Hazardous Mitigation Assessment provided as Appendix 3.9-B.

**UL 1973**

UL 1973 is the globally recognized standard for stationary batteries and energy storage systems. This certification validates that a battery has passed rigorous safety and performance tests, ensuring it can operate reliably under real-world conditions.

The new battery technology for the Project will continue to comply with UL 1973 testing. UL 1973 certification has been completed by the battery manufacturer/vendor to verify that the battery system meets safety requirements for electrical, mechanical, thermal, and environmental performance, ensuring it can withstand abuse conditions and prevent hazards such as thermal runaway, fire, or mechanical failure. UL 1973 test reports for the proposed technology were provided in Appendix 2-C of Project Description Update #2, Part 1. UL 1973 certification was received on July 8, 2024.

As discussed in the Application, the May 2025 Project Description Update #1, and Data Request Response Set #2 and Set #4, measures will continue to mitigate fire risk under UL 1973 including thermal management, fire detection and alarm systems, deflagration and explosion-prevention design features, and remote monitoring to ensure the battery system can withstand thermal, electrical, and mechanical stress without propagating thermal runaway or creating additional hazards.

**UL 9540**

UL 9540 is a safety standard developed by Underwriters Laboratories that defines requirements for the safe design, construction, installation, and performance of energy storage systems and equipment. It ensures system-level safety by evaluating integrated components such as batteries, inverters, and control systems under both normal and fault conditions.

The new battery technology for the Project will continue to comply with UL 9540, including UL 9540A testing. UL 9540A testing has been performed by a nationally recognized testing laboratory to analyze the ability of the system design to prevent thermal runaway propagation and mitigate fire risk. As discussed in the Application, Project Description Update #1, and Data Request Response Set #2 and Set #4, measures to continue to mitigate fire risk include thermal management system, fire detection system, alarms, deflagration control, and remote monitoring. UL 9540A cell and module test reports for the proposed technology were provided in Appendix 2-C of Project Description Update #2, Part 1. UL 9540 certification was received on June 6, 2025.

In addition, the Project will continue to ensure each enclosure unit will have a fire rating in conformance with the local fire authority and Solano County standards. The Project will continue to use designs and equipment that have undergone UL 9540A testing and meet other applicable UL and NFPA standards. Moreover, the Project will continue to comply with applicable fire codes and standards, such as NFPA 69, NFPA 855, CFC 1207, and UL 9540. Collectively, these standards require use of only batteries that are UL certified and have built-in fail safes designed specifically to prevent thermal runaway and limit propagation.

**Dixon Fire Department**

The Applicant provided an update to the Dixon Fire Protection District on January 21, 2026 regarding the updated battery technology and explained that no anticipated changes would result to the

previously agreed upon proposed Conditions of Certification. A copy of this email is provided as Appendix 3.9-E. As of the date of this filing, no response has been received by the Dixon Fire Protection District.

### 3.9.3 Worker Health and Safety Analysis

Although the closest people or structures are residences located just north of the Project site, across Kilkenny Road, the Project as modified is not expected to expose these residences, or any other people or structures, either directly or indirectly, to a significant risk of loss, injury, or death as a result of the change in equipment. Construction and operation of the modified Project facilities will continue to not emit or create any additional hazards to the public or the environment beyond those previously assessed in the Application, Project Description Update #1, and associated Data Request Responses. The Project, with the revised components, will continue to comply with applicable LORS as related to hazards. Therefore, the Project description changes do not result in a change to the Less Than Significant determination for hazards and hazardous materials.

### 3.13 Noise and Vibration

The Project description updates presented in Section 2.0 will not result in impacts greater than those analyzed in the Application and Project Description Update #1 and will not alter the previously identified findings related to noise. All modified Project components and activities will occur within the Project footprint as previously defined in the Application.

The Project schedule, construction workforce, and construction equipment information previously presented and analyzed in the Project Description Update #1 will not change as a result of the current Project description updates.

Updates to the operational phase of the Project include changes to selected equipment, equipment quantities, and modeled sound levels. A revised modeling analysis is presented in Appendix 3.13-A and is summarized below. The updates to the operational equipment are shown in bold font in Table 3.13-1 (replacing Table 4.13-9 in the Application).

**Table 3.13-1. Modeled Sources Sound Power Levels<sup>1/</sup>**

Equipment	Number of Sources Modeled	Modeled Sound Power Level
<b>Power Electronics PCSM GEN3 Inverter</b>	<b>436 114</b>	<b>402 97 dBA</b>
<b>JF2 DC Link BESS Container</b>	<b>544 341</b>	<b>93 87 dBA</b>
170-MVA Substation Transformer	2	90 dBA
85-MVA Substation Transformer	1	87 dBA
Auxiliary Transformers	<b>47 9</b>	79 dBA

Notes: dBA = A-weighted decibels; HAVAC = heating, ventilation, and air conditioning; MVA = megavolt-ampere  
 1/ Replaces Table 4.13-9 in Application. Updated items are shown in strikeout and **bold text**.

The updates to the modeled operational sound levels, inclusive of the sound barrier Project Design Measure, are shown in bold font in Table 3.13-2 (replacing Table 4.13-10 in the Application). These updated results show a lower modeled sound level compared to what was analyzed in the Application and will not result in a significant noise impact.

**Table 3.13-2. Operational Sound Levels Compared to County Code, dBA L<sub>eq</sub><sup>1/</sup>**

Receiver	Modeled Sound Level (dBA)	Solano County Code Limit (dBA)
Rec01	<del>50</del> <b>49</b>	50
Rec02	<del>49</del> <b>48</b>	50
Rec03	<del>44</del> <b>43</b>	50
Rec04	<del>47</del> <b>45</b>	50
Rec05	<del>46</del> <b>45</b>	50
Rec06	<del>43</del> <b>42</b>	50

1/ Replaces Table 4.13-10 in Application. Updated items are shown in strikeout and **bold text**.

An increase-to-ambient analysis was conducted for the updated Project operational sound levels. Per California Energy Commission guidance, Project increases to ambient sound levels were calculated using the quietest 4 hours of the measured L<sub>90</sub> sound levels, as shown below in Table 3.13-3 (replacing Table 4.13-11 in the Application).

**Table 3.13-3. Estimated Increase to Ambient from Project Operations<sup>1/</sup>**

Receiver	Modeled Sound Level (dBA)	Quietest 4-Hour L <sub>90</sub> Average (dBA)	Project + Ambient (dBA)	Estimated Increase to Ambient (dBA)
Rec01	<del>50</del> <b>49</b>	44	<del>54</del> <b>50</b>	<del>7</del> <b>6</b>
Rec02	<del>49</del> <b>48</b>	43	<del>50</del> <b>49</b>	<del>7</del> <b>6</b>
Rec03	<del>44</del> <b>43</b>	42	46	4
Rec04	<del>47</del> <b>45</b>	44	<del>49</del> <b>48</b>	<del>5</del> <b>4</b>
Rec05	<del>46</del> <b>45</b>	44	48	4
Rec06	<del>43</del> <b>42</b>	44	<del>47</del> <b>46</b>	<del>3</del> <b>2</b>

1/ Replaces Table 4.13-11 in Application. Updated items are shown in strikeout and **bold text**.

Table 3.13-3 shows that the Project has the potential to increase the quietest nighttime sound levels by 2 to 6 dBA. This is lower than what was presented in the Application and does not result in a change to the Less Than Significant determination for operational noise impacts.

# FIGURES

- Figure 3.1-1. KOP 1 Simulation Conditions (Replaces Figure 4.1-7 in Application)**
- Figure 3.1-2. KOP 2a Simulation Conditions With Landscaping After 1 Year (Replaces Figure 4.1-8 in Application)**
- Figure 3.1-3. KOP 2b Simulation Conditions With Landscaping After 1 Year (Replaces Figure 4.1-9 in Application)**
- Figure 3.1-4. KOP 3 Simulation Conditions (Replaces Figure 4.1-10 in Application)**
- Figure 3.1-5. KOP 6 Simulation Conditions (Replaces Figure 4.1-11a in Application)**
- Figure 3.1-6. KOP 6 Simulation Conditions With Indicators (Replaces Figure 4.1-11b in Application)**
- Figure 3.1-7. KOP 2a Simulation Conditions With Landscaping After 5 Years (Replaces Figure 4.1-12 in Application)**
- Figure 3.1-8. KOP 2b Simulation Conditions With Landscaping After 5 Years (Replaces Figure 4.1-13 in Application)**
- Figure 3.1-9. KOP 7a Simulation Conditions With Landscaping After 1 Year**
- Figure 3.1-10. KOP 7a Simulation Conditions With Landscaping After 5 Years**
- Figure 3.1-11. KOP 7b Simulation Conditions With Landscaping After 1 Year**
- Figure 3.1-12. KOP 7b Simulation Conditions With Landscaping After 5 Years**

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBLY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-1

### KOP 1

#### Simulation Conditions

(Replaces Figure 4.1-7)

Kilkenny Road, adjacent to I-80



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	4:02 PM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	EAST
LATITUDE:	38.39513450°
LONGITUDE:	-121.92421902°
DISTANCE TO BESS:	.87 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORB Y BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-2

### KOP 2a

#### Simulation Conditions With Landscaping After 1 Year

(Replaces Figure 4.1-8)

Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	11:59 AM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTH
LATITUDE:	38.39519349°
LONGITUDE:	-121.9058341°
DISTANCE TO BESS:	.12 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-3

### KOP 2b

#### Simulation Conditions With Landscaping After 1 Year

(Replaces Figure 4.1-9)

Intersection of Byrnes Road and Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	11:59 AM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHWEST
LATITUDE:	38.39519349°
LONGITUDE:	-121.9058341°
DISTANCE TO BESS:	.12 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-4

### KOP 3

#### Simulation Conditions

(Replaces Figure 4.1-10)

View North on Byrnes Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	12:06 PM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	NORTH
LATITUDE:	38.3879916°
LONGITUDE:	-121.905764°
DISTANCE TO BESS:	.24 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-5

### KOP 6

#### Simulation Conditions

(Replaces Figure 4.1-11a)

Sacramento Valley National Cemetery



### VICINITY MAP

#### LEGEND



SIMULATED EQUIPMENT



KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	11:31 AM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHWEST
LATITUDE:	38.4113211°
LONGITUDE:	-121.881903°
DISTANCE TO BESS:	1.82 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBAY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-6 KOP 6

### Simulation Conditions With Indicators

(Replaces Figure 4.1-11b)

Sacramento Valley National Cemetery



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	11:31 AM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHWEST
LATITUDE:	38.4113211°
LONGITUDE:	-121.881903°
DISTANCE TO BESS:	1.82 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

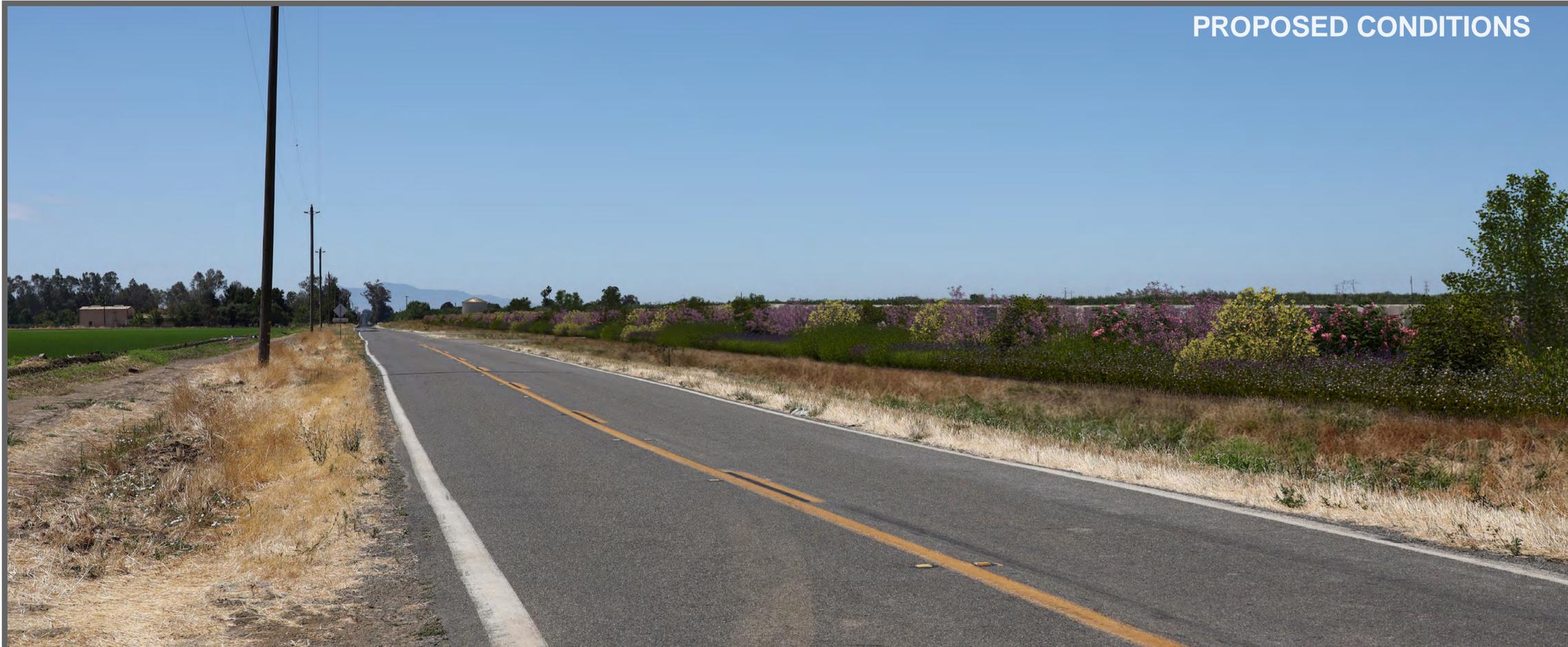
#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-7

### KOP 2a

#### Simulation Conditions With Landscaping After 5 Years

(Replaces Figure 4.1-12)

Intersection of Byrnes Road and Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	11:59 AM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTH
LATITUDE:	38.39519349°
LONGITUDE:	-121.9058341°
DISTANCE TO BESS:	.12 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-8

### KOP 2b

#### Simulation Conditions

#### With Landscaping After 5 Years

(Replaces Figure 4.1-13)

Intersection of Byrnes Road and Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	11:59 AM
DATE:	06/26/2024
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHWEST
LATITUDE:	38.39519349°
LONGITUDE:	-121.9058341°
DISTANCE TO BESS:	.12 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-9

### KOP 7a

Simulation Conditions

With Landscaping After 1 Year

Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	2:38 PM
DATE:	01/22/2025
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHEAST
LATITUDE:	38.395317°
LONGITUDE:	-121.919325°
DISTANCE TO BESS:	.16 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORB Y BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-9

### KOP 7a

Simulation Conditions  
With Landscaping After 1 Year

Kilkenny Road



## VICINITY MAP

### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

## PHOTOGRAPH INFORMATION

TIME:	2:38 PM
DATE:	01/22/2025
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHEAST
LATITUDE:	38.395317°
LONGITUDE:	-121.919325°
DISTANCE TO BESS:	.16 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORBY BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-10

### KOP 7a

#### Simulation Conditions

#### With Landscaping After 5 Years

Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	2:38 PM
DATE:	01/22/2025
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHEAST
LATITUDE:	38.395317°
LONGITUDE:	-121.919325°
DISTANCE TO BESS:	.16 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



# CORBLY BATTERY ENERGY STORAGE SYSTEM PROJECT

Figure 3.1-10

KOP 7a

Simulation Conditions

With Landscaping After 5 Years

Kilkenny Road



## VICINITY MAP

### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

## PHOTOGRAPH INFORMATION

TIME:	2:38 PM
DATE:	01/22/2025
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHEAST
LATITUDE:	38.395317°
LONGITUDE:	-121.919325°
DISTANCE TO BESS:	.16 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## PROPOSED CONDITIONS



## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORB Y BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-11

### KOP 7b

#### Simulation Conditions

#### With Landscaping After 1 Year

Kilkenny Road



### VICINITY MAP

#### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

### PHOTOGRAPH INFORMATION

TIME:	2:38 PM
DATE:	01/22/2025
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHEAST
LATITUDE:	38.395317°
LONGITUDE:	-121.919325°
DISTANCE TO BESS:	.16 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

#### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## EXISTING CONDITIONS



## PROPOSED CONDITIONS



# CORB Y BATTERY ENERGY STORAGE SYSTEM PROJECT

## Figure 3.1-12

### KOP 7b

Simulation Conditions

With Landscaping After 5 Years

Kilkenny Road



## VICINITY MAP

### LEGEND

-  SIMULATED EQUIPMENT
-  KOP LOCATION WITH SIMULATION

## PHOTOGRAPH INFORMATION

TIME:	2:38 PM
DATE:	01/22/2025
WEATHER CONDITION:	SUNNY
VIEWING DIRECTION:	SOUTHEAST
LATITUDE:	38.395317°
LONGITUDE:	-121.919325°
DISTANCE TO BESS:	.16 MILES
CAMERA TYPE:	CANON EOS R5
LENS FOCAL LENGTH:	50MM

### Preliminary Visualization

DISCLAIMER: PRELIMINARY VISUALIZATIONS ARE FOR REFERENCE ONLY; PROJECT LAYOUT IS IN DEVELOPMENT AND SUBJECT TO CHANGE.

## **APPENDIX 3.1-A: BLM VISUAL CONTRAST RATING WORKSHEETS**

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
**VISUAL CONTRAST RATING WORKSHEET**

Date: 01/26/2026

District Office: N/A

Field Office: N/A

Land Use Planning Area: N/A

SECTION A. PROJECT INFORMATION

1. Project Name Corby Battery Energy Storage System Project	4. KOP Location (T.R.S)	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 1, facing east	3. VRM Class at Project Location Unclassified/Not on Federal Land	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat	FG to MG: ruderal veg - low, Row crops - low, regular, trees - tall, irregular	FG: short irrigation canal, linear roadway MG: linear roadway, angular and linear transmission tower and lines
LINE	FG to MG: horizontal	FG to MG: ruderal veg - weak lines, row crops - weak lines, contiguous, trees - horizontal lines, irregular	FG: horizon irrigation canal and roadway MG: horizontal roadway, horizontal and vertical transmission tower and line
COLOR	FG to MG: tan, blue	FG to MG: ruderal veg - green, tan, row crops - green, trees - green, brown	FG: gray, white, rust MG: gray
TEX-TURE	FG: smooth to rough MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - dense	FG: smooth irrigation canal and roadway MG: smooth roadway and transmission tower and lines

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat	FG to MG: ruderal veg - low, Row crops - low, regular, trees - tall, irregular	FG: short irrigation canal, linear roadway MG: linear roadway, angular and linear transmission tower and lines, CLR's
LINE	FG to MG: horizontal	FG to MG: ruderal veg - weak lines, row crops - weak lines, contiguous, trees - horizontal lines, irregular	FG: horizon irrigation canal / roadway MG: horizontal roadway, horizontal / vertical transmission tower, lines, CLR's
COLOR	FG to MG: tan, blue	FG to MG: ruderal veg - green, tan, row crops - green, trees - green, brown	FG: gray, white, rust MG: gray
TEX-TURE	FG: smooth to rough MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - dense	FG: smooth irrigation canal and roadway MG: smooth roadway and transmission tower and lines, CLR's

SECTION D. CONTRAST RATING     SHORT TERM     LONG TERM

1.	DEGREE OF CONTRAST	FEATURES												2. Does project design meet visual resource management objectives? <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  3. Additional mitigating measures recommended <input type="checkbox"/> Yes <input type="checkbox"/> No    (Explain on reverses side)										
		LAND/WATER BODY				VEGETATION				STRUCTURES														
		(1)				(2)				(3)														
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE											
					✓				✓				✓											
ELEMENTS	FORM							LINE					COLOR					TEXTURE					EVALUATOR'S NAMES	DATE
																						Josh Hohn, Paula Fell	06/26/2024	

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SECTION D. (Continued)

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Comments from item 2.

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Additional Mitigating Measures (See item 3)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
**VISUAL CONTRAST RATING WORKSHEET**

Date: 01/26/2026

District Office: N/A

Field Office: N/A

Land Use Planning Area: N/A

**SECTION A. PROJECT INFORMATION**

1. Project Name Corby Battery Energy Storage System Project	4. KOP Location (T.R.S)	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 2a, facing south		
3. VRM Class at Project Location Unclassified/Not on Federal Land	(Lat. Long)	

**SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat BG: mountainous	FG: ruderal veg and row crops - low MG: ruderal veg and row crops - low, regular, trees - tall, irregular	FG: linear roadway, utility poles MG: linear roadway, utility poles, angular agricultural structure, transmission towers
LINE	FG to MG: horizontal BG: silhouette	FG: ruderal veg, row crops - weak lines, MG: ruderal veg and row crops - weak lines, trees – horizontal, irregular lines	FG - MG: horizontal roadway, vertical utility poles, MG: angular structure, towers
COLOR	FG to MG: tan BG: Blue	FG: ruderal veg - green, tan, row crops - green, trees - green, brown MG: row crops - green, trees - green, brown	FG: gray, brown, white, yellow MG: gray, brown
TEX-TURE	FG to MG:: smooth MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - dense	FG to MG: smooth

**SECTION C. PROPOSED ACTIVITY DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat BG: mountainous	FG: ruderal veg and row crops - low MG: ruderal veg and row crops - low, regular, trees - tall, irregular	FG: linear roadway, utility poles, circular water tank, MG: angular agricultural structure, transmission towers
LINE	FG to MG: horizontal BG: silhouette	FG: ruderal veg, row crops - weak lines, MG: ruderal veg and row crops - weak lines, trees – horizontal, irregular lines	FG: horizontal roadway, fencing, vertical utility poles, angular Bess, circular water tank, MG: angular structure, towers
COLOR	FG to MG: tan BG: Blue	FG: ruderal veg - green, tan, row crops - green, trees - green, brown MG: row crops - green, trees - green, brown	FG: gray, brown, white, yellow, green MG: gray, brown
TEX-TURE	FG to MG:: smooth MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - dense	FG to MG: smooth

**SECTION D. CONTRAST RATING     SHORT TERM     LONG TERM**

<b>1.</b>	<b>DEGREE OF CONTRAST</b>	<b>FEATURES</b>												2. Does project design meet visual resource management objectives? <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  3. Additional mitigating measures recommended <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  Evaluator's Names _____ Date _____  <div style="text-align: right;">06/26/2024</div>
		LAND/WATER BODY				VEGETATION				STRUCTURES				
		(1)				(2)				(3)				
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	
		FORM		✓		FORM	✓			FORM	✓			
LINE		✓		LINE	✓			LINE		✓				
COLOR			✓	COLOR	✓			COLOR	✓					
TEXTURE			✓	TEXTURE	✓			TEXTURE			✓			

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SECTION D. (Continued)

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Comments from item 2.

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Additional Mitigating Measures (See item 3)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
**VISUAL CONTRAST RATING WORKSHEET**

Date: 01/26/2026

District Office: N/A

Field Office: N/A

Land Use Planning Area: N/A

**SECTION A. PROJECT INFORMATION**

1. Project Name Corby Battery Energy Storage System Project	4. KOP Location (T.R.S)	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 2b, facing southwest		
3. VRM Class at Project Location Unclassified/Not on Federal Land	(Lat. Long)	

**SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat BG: mountainous	FG: ruderal veg and row crops - low MG: ruderal veg and row crops - low, regular, trees - tall, irregular	FG: linear roadway MG: angular transmission towers
LINE	FG to MG: horizontal BG: silhouette	FG: ruderal veg, row crops - weak lines, MG: ruderal veg and row crops - weak lines, trees – horizontal, irregular lines	FG: horizon roadway MG: angular transmission towers
COLOR	FG to MG: tan BG: tan, blue	FG: ruderal veg, row crops - weak lines, MG: ruderal veg and row crops - weak lines, trees – horizontal, irregular lines	FG: gray, white MG: gray
TEXTURE	FG to MG: smooth MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - dense	FG to MG: smooth

**SECTION C. PROPOSED ACTIVITY DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat BG: mountainous, View partially blocked	FG: landscaping and row crops - low MG: landscaping and row crops - low, regular, trees - tall, irregular	FG: solid, block wall, angular substation, linear roadway MG: angular transmission towers
LINE	FG to MG: horizontal BG: silhouette, View partially blocked	FG: landscaping, row crops - weak lines, MG: landscaping and row crops - weak lines, trees – horizontal, irregular lines	FG: rectangular, block wall, angular substation, linear roadway MG: angular transmission towers
COLOR	FG to MG: tan BG: tan, blue, View partially blocked	FG: landscaping - variety, row crops - green, trees - green, brown MG: row crops - green, trees - green, brown	FG: gray, white MG: gray
TEXTURE	FG to MG: smooth MG: uniform, View partially blocked	FG to MG: landscaping and row crops - dense, trees - dense	G to MG: smooth

**SECTION D. CONTRAST RATING**     SHORT TERM     LONG TERM

<b>1.</b>	<b>DEGREE OF CONTRAST</b>	<b>FEATURES</b>												2. Does project design meet visual resource management objectives? <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  3. Additional mitigating measures recommended <input type="checkbox"/> Yes <input type="checkbox"/> No    (Explain on reverses side)
		LAND/WATER BODY				VEGETATION				STRUCTURES				
		(1)				(2)				(3)				
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	
ELEMENTS	FORM	✓			✓			✓					Evaluator's Names Josh Hohn Paula Fell	Date 06/26/2024
	LINE	✓			✓				✓					
	COLOR	✓			✓				✓					
	TEXTURE	✓			✓						✓			

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SECTION D. (Continued)

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Comments from item 2.

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Additional Mitigating Measures (See item 3)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
**VISUAL CONTRAST RATING WORKSHEET**

Date: 01/26/2026

District Office: N/A

Field Office: N/A

Land Use Planning Area: N/A

**SECTION A. PROJECT INFORMATION**

1. Project Name Corby Battery Energy Storage System Project	4. KOP Location (T.R.S)	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 3, facing north		
3. VRM Class at Project Location Unclassified/Not on Federal Land	(Lat. Long)	

**SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat BG: mountainous	FG: ruderal veg and row crops - low MG: ruderal veg and row crops - low, regular, trees - tall, irregular	FG: linear roadway MG: angular transmission towers
LINE	FG to MG: horizontal BG: silhouette	FG: ruderal veg, row crops - weak lines, MG: ruderal veg and row crops - weak lines, trees – horizontal, irregular lines	FG: horizon roadway MG: angular transmission towers
COLOR	FG to MG: tan BG: tan, blue	FG: ruderal veg - green, tan, row crops - green, trees - green, brown MG: row crops - green, trees - green	FG: gray, white MG: gray
TEX-TURE	FG to MG: smooth MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - dense	FG to MG: smooth

**SECTION C. PROPOSED ACTIVITY DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat BG: mountainous	FG: landscaping and row crops - low MG: landscaping and row crops - low, regular, trees - tall, irregular	FG: angular substation, CLRs and BESS, circular water tank, linear roadway MG: angular transmission towers
LINE	FG to MG: horizontal BG: silhouette	FG: landscaping, row crops - weak lines, MG: landscaping and row crops - weak lines, trees – horizontal, irregular lines	FG: angular substation, CLRs and BESS, circular water tank, linear roadway MG: angular transmission towers
COLOR	FG to MG: tan BG: tan, blue	FG: landscaping - variety, row crops - green, trees - green, brown MG: row crops - green, trees - green	FG: gray, white MG: gray
TEX-TURE	FG to MG: smooth MG: uniform	FG to MG: landscaping and row crops - dense, trees - dense	FG to MG: smooth

**SECTION D. CONTRAST RATING**     SHORT TERM     LONG TERM

<b>1.</b>	<b>DEGREE OF CONTRAST</b>	<b>FEATURES</b>												2. Does project design meet visual resource management objectives? <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  3. Additional mitigating measures recommended <input type="checkbox"/> Yes <input type="checkbox"/> No    (Explain on reverses side)
		LAND/WATER BODY				VEGETATION				STRUCTURES				
		(1)				(2)				(3)				
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	
		FORM		✓				✓			✓			
LINE		✓				✓				✓				
COLOR			✓			✓			✓					
TEXTURE			✓			✓					✓			
<b>ELEMENTS</b>														
												Evaluator's Names Josh Hohn, Paula Fell	Date 06/26/2024	

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SECTION D. (Continued)

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Comments from item 2.

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Additional Mitigating Measures (See item 3)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
**VISUAL CONTRAST RATING WORKSHEET**

Date: 01/22/2025

District Office: N/A

Field Office: N/A

Land Use Planning Area: N/A

SECTION A. PROJECT INFORMATION

1. Project Name Corby Battery Energy Storage System Project	4. KOP Location (T.R.S)	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 7A, facing southeast	3. VRM Class at Project Location Unclassified/Not on Federal Land	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat	FG to MG: ruderal veg - low, Row crops - low, regular, trees - medium, irregular	FG: short canal MG: angular and linear transmission tower and lines
LINE	FG to MG: horizontal	FG to MG: ruderal veg - weak lines, row crops - weak lines, contiguous, trees - horizontal lines	FG: horizontal canal MG: horizontal and vertical transmission tower and lines
COLOR	FG to MG: tan	FG to MG: ruderal veg, row crops - green, tan, trees - brown	FG: brown MG: gray
TEXTURE	FG: rough MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - medium	FG: rough canal MG: smooth transmission tower and lines

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat	FG to MG: ruderal veg - low, Row crops - low, regular, trees - medium, irregular	FG: short canal, angular and linear wall, gen-tie, fiber optic, substation, CLR's MG: vertical transmission tower
LINE	FG to MG: horizontal	FG to MG: ruderal veg - weak lines, row crops - weak lines, contiguous, trees - horizontal lines	FG: horizontal canal, horizontal / vertical wall, gen-tie, fiber optic, substation, CLR's MG: vertical transmission tower
COLOR	FG to MG: tan	FG to MG: ruderal veg, row crops - green, tan, trees - brown	FG: gray, brown MG: gray
TEXTURE	FG: rough MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - medium	FG: rough canal, smooth wall, gen-tie, fiber optic, substation, CLR's MG: smooth transmission tower

SECTION D. CONTRAST RATING     SHORT TERM     LONG TERM

1.	DEGREE OF CONTRAST	FEATURES												2. Does project design meet visual resource management objectives? <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  3. Additional mitigating measures recommended <input type="checkbox"/> Yes <input type="checkbox"/> No    (Explain on reverses side)
		LAND/WATER BODY				VEGETATION				STRUCTURES				
		(1)				(2)				(3)				
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	
		FORM		✓				✓		✓				
LINE		✓				✓				✓				
COLOR		✓				✓				✓				
TEXTURE		✓				✓					✓			
ELEMENTS												Evaluator's Names Josh Hohn, Paula Fell	Date 01/22/2025	

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SECTION D. (Continued)

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Comments from item 2.

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Additional Mitigating Measures (See item 3)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
**VISUAL CONTRAST RATING WORKSHEET**

Date: 01/26/2026

District Office: N/A

Field Office: N/A

Land Use Planning Area: N/A

**SECTION A. PROJECT INFORMATION**

1. Project Name Corby Battery Energy Storage System Project	4. KOP Location (T.R.S)	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 7B, facing south-southeast		
3. VRM Class at Project Location Unclassified/Not on Federal Land	(Lat. Long)	

**SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat	FG to MG: ruderal veg - low, Row crops - low, regular, trees - medium, irregular	FG: short canal
LINE	FG to MG: horizontal	FG to MG: ruderal veg - weak lines, row crops - weak lines, contiguous, trees - horizontal lines	FG: horizontal canal
COLOR	FG to MG: tan	FG to MG: ruderal veg, row crops - green, tan, trees - brown	FG: brown
TEXTURE	FG: rough MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - medium	FG: rough canal

**SECTION C. PROPOSED ACTIVITY DESCRIPTION**

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	FG to MG: flat	FG to MG: ruderal veg - low, Row crops - low, regular, trees - medium, irregular	FG: short canal, angular and linear gen-tie, fiber optic, substation, CLR's
LINE	FG to MG: horizontal	FG to MG: ruderal veg - weak lines, row crops - weak lines, contiguous, trees - horizontal lines	FG: horizontal canal, horizontal / vertical gen-tie, fiber optic, substation, CLR's
COLOR	FG to MG: tan	FG to MG: ruderal veg, row crops - green, tan, trees - brown	FG: gray, brown
TEXTURE	FG: rough MG: uniform	FG to MG: ruderal veg - sparse, fine, row crops - dense, trees - medium	FG: rough canal, smooth gen-tie, fiber optic, substation, CLR's

**SECTION D. CONTRAST RATING**     SHORT TERM     LONG TERM

<b>1.</b>	<b>DEGREE OF CONTRAST</b>	<b>FEATURES</b>												2. Does project design meet visual resource management objectives? <input type="checkbox"/> Yes <input type="checkbox"/> No (Explain on reverses side)  3. Additional mitigating measures recommended <input type="checkbox"/> Yes <input type="checkbox"/> No    (Explain on reverses side)
		LAND/WATER BODY				VEGETATION				STRUCTURES				
		(1)				(2)				(3)				
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	
		FORM		✓				✓		✓				
LINE		✓				✓		✓						
COLOR		✓				✓		✓						
TEXTURE		✓				✓		✓						
<b>ELEMENTS</b>												Evaluator's Names Josh Hohn, Paula Fell	Date 01/22/2025	

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SECTION D. (Continued)

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Comments from item 2.

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Additional Mitigating Measures (See item 3)

## **APPENDIX 3.9-A: THERMAL EVENT PLUME ANALYSIS**

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**Technical Report in Support of  
the CEC Response to Comments**

# **Corby Battery Energy Storage System Project (Revised)**

**Solano County, California**

Submitted to  
**California Energy Commission**

Submitted by  
**Corby Energy Storage, LLC**



Prepared by  
**Atmospheric Dynamics, Inc.**



**ATMOSPHERIC DYNAMICS, INC.**  
Meteorological & Air Quality Modeling

January 2026

## Executive Summary

Corby Energy Storage, LLC plans to construct and operate a 300-megawatt (MW) battery energy storage system (BESS) near the intersections of Killikenny and Byrnes Roads in Solano County, California. This technical report presents revised responses to the July 31<sup>st</sup>, 2025, California Energy Commission (CEC) data requests Rev 1 DR WS/FP/PH-1 through PH-4 which asks for the estimate of the worst-case maximum impacts of thermal runaway/fires at the nearest sensitive receptors. These updated responses address the change in battery supplier to LG Energy Solution, LTD Lithium-Ion-Phosphate batteries as the proposed technology for the Corby BESS facility.

To derive meaningful modeling results from a potential release scenario, several conservative assumptions were made for the inputs to provide an overprediction of concentrations. The proposed project will utilize battery technology from LG Energy Solution, LTD, Lithium-Ion-Phosphate batteries. Emissions test data are based on best estimates of pollutants emitted during the UL 9540A gas composition and release dynamics cell/module/unit levels tests. Because the location of the fire within the facility may affect the concentrations of emissions in immediately adjacent areas, the modeling examined a potential fire at 14 different battery locations within Corby BESS. Additional literature on BESS fire incidents were reviewed to provide supplemental information on potential emissions from these events that were applied to this analysis.

The LG Energy Solution, LTD, Large Scale Fire Test Report (CSA Group-Laboratory Test Data, 01-11-2025) indicated that with the manufacturer specified distances between battery enclosures, a thermal runaway event within one enclosure would not propagate to adjacent enclosures, even with complete combustion of all the cells within the enclosure. For purposes of modeling the offsite impacts, the analysis assumed that the maximum credible fire event presented at the proposed BESS is the combustion of one full container (enclosure) of batteries, made up of 10,080 cells, over a 7.52-hour period based on testing. Fourteen (14) hypothetical locations were assessed at enclosure locations in close proximity to the project boundary, which typically cause the maximum ambient impacts to surrounding receptors.

The CEC's data request required that the concentrations of toxic air contaminants (TACs) that were determined to be emitted should be compared to the California Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) one-hour (1-hr) Reference Exposure Levels (RELs), which are used in facility health risk assessments conducted for the AB2588 Air Toxics "Hot Spots" Program. The data request also requires the calculation that the acute hazard index (HI) of TACs to determine if the significance threshold of 1.0 at sensitive receptors (residences) is exceeded. The data request also asks that for any TAC that did not have an established REL, the comparison was made with the United States Environmental Protection Agency's (EPA) Acute Exposure Guideline Level 1 (AEG-L-1). AEG-Ls were developed by an international coalition of government and non-government scientists and are used worldwide by government and private emergency responders. Thus, the results of the Corby BESS modeling were compared to the following to determine the levels of potential health impacts:



- A Reference Exposure Level (REL) is the concentration level at or below which no adverse non-cancer health effects are anticipated for the specified exposure duration. RELs are based on the most sensitive, relevant, adverse health effects reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of factors that account for uncertainties as well as individual differences in human susceptibility to chemical exposures. The factors used in the calculation of RELs are meant to err on the side of public health protection in order to avoid underestimation of non-cancer hazards. Exceeding the REL does not automatically indicate an adverse health impact. However, increasing concentrations above the REL value increases the likelihood that the health effect will occur.
- AEGL-1 – In areas that exceed AEGL-1, the general population could experience transient and reversible discomfort or irritation. In areas with concentrations below AEGL-1, no members of the general population, including susceptible individuals, are expected to experience any health effects.

The basic premise of the report is the quantification of emissions of criteria pollutants and TACs and the ground level concentrations and acute hazard footprint from a hypothetical fire in one of the battery containers at seven different locations within the BESS.

The results of the HI modeling from any of the 14 hypothetical locations of thermal runaway events at the Corby BESS, under the meteorological conditions that can produce the highest ground level concentrations, never equal or exceed a hazard index 1.0 at the sensitive receptors (residences). Additionally, the AEGL-1 thresholds were never exceeded at any receptor or sensitive receptor location. The criteria pollutant impacts were all less than the California Ambient Air Quality Standards (CAAQS) for the 1-hour nitrogen dioxide (NO<sub>2</sub>) sulfur dioxide (SO<sub>2</sub>) and carbon monoxide (CO) averaging periods and for the 8-hour CO averaging period at the sensitive receptor locations.

## **Background**

Accidental releases of material during a battery storage thermal runaway fire incident have the potential to affect surrounding populated areas. The purpose of this dispersion modeling assessment was to determine the worst-case magnitude and areal extent of potential emissions of hazardous air pollutants under a full range of site representative meteorological conditions at the Corby BESS facility. The modeling assessment and summary report was based on the best estimates of pollutants emitted during laboratory testing of the LG Energy Solution, LTD., Lithium-Ion-Phosphate (LiPo) batteries, as well as laboratory testing of other similarly designed batteries. The modeling results summarized in this report represent the potential worst-case impacts in terms of magnitude and location that are based on five (5) years of representative hourly meteorological data.

The modeled emissions and subsequent public exposure to criteria pollutants and known chemical substances or hazardous air pollutants (HAPs), were converted into potential health



risks which were assessed in accordance with guidance established by the California Office of Environmental Health Hazard Assessment (OEHHA 2015) and the California Air Resources Board.

The U.S. EPA AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee's Dispersion **Model**) was used to assess this event in order to calculate the areal extent of the release such that predictive estimates of potential impacts to human health and safety to the general public could be assessed. Model outputs were based on a five (5) year range of site atmospheric conditions, including similar conditions that occurred during the release. The model outputs were then input into the Hotspots Analysis and Reporting Program (HARP), which is based on the 2015 Air Toxics Hotspots Program Guidance Manual for Preparation of Health Risk Assessments. This procedure follows the California Office of Environmental Health Hazard Assessment (OEHAA) which is designed to improve estimates of potential lifetime cancer and noncancer risks from air toxics by refining data for individuals of all ages, and with adjustments based on new science about the increased childhood sensitivity to air toxics.

### **Uncertainties in the Preliminary Dispersion Modeling Assessment**

The results of this analysis, conducted at the request of Corby BESS, were based on a potential release scenario using data from cell-, module-, and unit-level UL9540A thermal runaway fire propagation testing and large-scale burn testing. In order to derive meaningful modeling results about this specific event, several conservative assumptions were made for the inputs in order to provide an overprediction of concentrations. These include the quantification of emissions, the total mass released during the flaming portion of the fire, and the plume characteristics during the active fire portion.

The cell level UL9540A test involved the thermal runaway of a single cell. Gas composition data from the cell test was extrapolated to a module scenario, and then to a unit scenario. The large scale test burn involved the LG Energy Solution, LTD 5.1 MW enclosure comprised of three (3) M-Link units, with 2 racks per unit, 14 modules per rack, and 120 cells per module, for a total 10,080 cells.

For the large scale test initiation, heaters were applied to three (3) cells within a designated single module. After approximately 37 minutes of heating, the first cell thermal runaways occurred in the initiating module, at which time, the first smoke was seen externally. A propane burner was used to ignite the fire. The fire burned at varying intensities until 7.52 hours into the test at which time no visible flames from the exterior of the initiating unit were documented.

The fire completely consumed two of the three M-LINK enclosures within the container. The fire did not propagate to the remaining M-LINK enclosure. There was no deflagration or explosion events observed during the test. During the test, no fire propagation from unit-to-unit was observed and the internal cells of adjacent units did not reach thermal runaway temperature. Post test examination confirmed that all battery modules in the initiating unit burned completely, with no significant damage was seen in the interior of the adjacent units. This analysis represents



one of the first steps to identify and assess the necessary data required to create an emissions profile and subsequent dispersion pattern for a BESS thermal runaway event at the Corby facility.

An integral part of this analysis is the review of literature data as well as available thermal runaway testing data on cells, modules, and complete units. Typically, uncontrolled fire events do not burn as a steady state process. Uncertainties in the fluctuations in temperature and mass burn rates can produce differences in plume rise and mass emissions. The available test data did contain information on a number of these variables, which were utilized in the dispersion and health risk models. The CEC requested the use of the air quality model, AERMOD, which is a steady-state Gaussian dispersion model. The use of this model requires the use of 1-hour steady state assumptions on meteorology, plume temperature and the mass emission rates.

Lastly, the modeled emissions and resultant concentrations in this assessment are based on estimates and assumptions from the data available at the time this report was generated. The AERMOD and HARP models are considered conservative in that they are designed to overpredict impacts. It is important to recognize that our ability to judge the accuracy of dispersion models is limited by data scarcity: Because only a few field experiments have been conducted in which hazardous gases were released and their concentrations measured, we have few data to measure our models against. Other factors affect our ability to make accurate predictions for any particular release:

- The real world is enormously complex, and many events happen randomly. This complexity and randomness can't be completely captured in any computer program.
- Because the emission estimates and dispersion model make simplifying assumptions about the circumstances of a release, the model results are likely to be more accurate when those assumptions are met than when they are not. For example, the large scale test burn actively burned for approximately 7.52 hours with an estimated loss of mass which resulted in the emission estimates. The modeling results presented in this report then reflect this particular release scenario and these results are more likely to reflect accurate predictions for this release than for a release that has a much shorter or longer duration or involves more than one enclosure (3-M Link units).

In summary, due to the inherent uncertainties in both the cell and large scale burn tests, the modeling analysis accommodated these uncertainties by employing and utilizing conservative assumptions regarding emissions, meteorology, and plume characteristics in order to calculate the ground-based concentrations.

### **AERMOD Model Description**

To estimate ambient air concentrations, the latest version of the AERMOD (Version 24142) dispersion model was used. AERMOD is the preferred U.S. EPA's and California Air Resources Board (CARB) dispersion model for use in assessing health risk when air is the predominant pathway. The California Office of Environmental Health Hazard Assessment (OEHHA) has also



adopted the AERMOD model as the preferred model for assessing health risk impacts from sources of toxic emissions. AERMOD is a steady-state dispersion model that uses planetary boundary layer (PBL) theory to model air pollutant concentrations. The planetary boundary layer is the breathable portion of the atmosphere that is influenced by contact with the ground surfaces or friction. AERMOD was chosen for this assessment as it's a regulatory method for providing conservative (overestimates) of ground-based concentrations from combustion source types. AERMOD requires the pre-processing of surface characteristics in order to then calculate the effects of meteorology and terrain on air pollutant concentrations. Surface characteristics and meteorological data such as wind speed/direction, temperature, cloud cover, etc. are combined with upper air data to compute planetary boundary parameters used by AERMOD to estimate vertical and horizontal pollutant dispersion. Terrain data is also processed to allow the influence of terrain on modeled concentrations. AERMOD currently contains improved algorithms for:

- Dispersion in both the convective and stable boundary layers,
- Plume rise and buoyancy,
- Plume penetration into elevated inversions, such that can occur during foggy conditions,
- Treatment of elevated, near-surface, and surface level sources,
- Computation of vertical profiles of wind, turbulence, and temperature,
- Treatment of receptors on all types of terrain (from the surface up to and above the plume height) and complex terrain modeling computations, and
- Incorporation of the Plume Rise Model Enhancements (PRIME) building downwash algorithms

The AERMOD modeling system consists of two pre-processors and the dispersion model. The meteorological preprocessor (AERMET) provides AERMOD with the meteorological information it needs to characterize the PBL. The terrain pre-processor (AERMAP) both characterizes the terrain and generates receptor grids for the dispersion model (AERMOD).

### **Model Input Options**

Model options refer to user selections that account for conditions specific to the area being modeled or to the emissions source that needs to be examined. Along with the referenced inputs below, land use type is required as input into the model. In the immediate area surrounding the project site is characterized as "rural". This is based on the land uses within the area circumscribed by a three (3) km radius around the project site, which is greater than 50 percent rural.

#### *Meteorology*

Five years of surface meteorological data (2017-2021) collected at the Nut Tree Airport, located 4.3 kilometers (km) west-southwest from the project site along with five years of upper air data



from Oakland International Airport were processed in AERMET (version 22112) and provided by the California Air Resources Board (ARB). This is the identical data set that was used to assess the project construction impacts in the CEC application submittal. Figure 1 presents an annual windrose for the meteorological data period.

### *Receptors and Terrain*

Receptor and source base elevations were determined from United States Geological Survey (USGS) National Elevation Dataset (NED) data. The NED data was processed with the EPA-model AERMAP for the receptor locations selected. All coordinates (both sources and receptors) are referenced to UTM North American Datum 1983 (NAD83, Zone 10). AERMAP is capable of interpolating the elevation data in the NED data for both receptor elevations and hill height scales.

The NED data are available in 1/3arc-second (about 10 meter) and 1arc-second (about 30 meter) grid node spacing. Areas that contain receptor grids with 100-meter spacing or less between adjacent receptors will use 10-meter NED data. Other areas that contain only receptor grids of greater than 100-meter spacing utilized 30-meter NED data. For purposes of determining hill height scales, the NED datasets used were extended 5-km past the outside of the coarse receptor grid described below for 30-meter NED data and 2-km past the outside of the close-in receptor grids described below for 10-meter NED data.

Cartesian coordinate receptor grids were used to provide adequate spatial coverage surrounding the project area for assessing ground-level pollution concentrations, to identify the extent of significant impacts, and to identify maximum impact locations. For the full impact analyses, a nested grid was developed to fully represent the initial location and extent of significance area(s) and maximum impact area(s). The nested grid comprises the following and is presented in Figures 2 and 3:

- Receptors were placed along the project fence line with a spacing of about 10 meters between adjacent receptors.
- A high resolution receptor grid with a receptor spacing of 20 meters was extended from the project fence line out to 300 meters from the project in all directions.
- An intermediate receptor grid with 50-meter receptor spacing was extend from the fence line receptor grid out to 1,000 meters from the project in all directions.
- A coarse receptor grid with 200-meter receptor spacing was extended from the intermediate receptor grid outwards to five (5) kilometers (km) from the project in all directions.
- When maximum impacts occur in areas outside any of the existing receptor grids, additional refined receptor grids with 20-meter resolution will be placed around the maximum impacts and extended as necessary to determine maximum impacts.
- Concentrations within the facility fence line were not calculated.

The nearest residence (sensitive receptor) from one of the hypothetical release points is 285



meters towards the north. A second residence is located approximately 430 meters towards the northwest. Other sensitive receptors are located at further distances and were included in the nested grid as described above.

### *Source Locations*

Given that the hypothetical thermal runaway event and resulting fire could occur at any of the battery containers located within the 12-acre project site, fourteen (14) locations were selected based on the proximity to sensitive receptors and roadways. These locations were selected in part to determine the potential for worst case off-site modeled concentrations. Figure 4 presents these locations.

### **Procedure to Determine the Emissions**

The LG Energy Solution, LTD enclosure is comprised of three (3) M-Link units, each with two (2) in-line vertical racks, each rack containing fourteen (14) modules. Each module contains 120 cells, resulting in 10,080 cells per enclosure. A single cell weighs approximately 2,800 g, or 6.17 lbs. The total weight of the internal mass potentially subject to thermal runaway, i.e., consumption via combustion, is approximately 62,194 lbs. Based on data presented in the RAMBOLL OCA report noted below, the assumed mass (weight) loss during a typical BESS fire ranges from 10-22.5%. For purposes of this analysis the upper value of mass loss (22.5%) was assumed. Therefore, the total mass loss during the LG Energy Solution LSFT is estimated to be 13,994 lbs. In addition, the emissions data from the same RAMBOLL report was evaluated for LiPO batteries to produce emissions factors more appropriate for the BESS technology under evaluation.

The large-scale test (CSA Group, Large Scale Burn Test, 12-6-2024) lasted for approximately 7.52 hours. The test consisted of two phases. For Phase 1, fire was started inside the Initiating Unit and burned for approximately 40 minutes without propagating to the other modules inside the Initiating Unit. The fire began to self-extinguish, and Phase 2 began by re-igniting the propane burner to force a fully developed fire condition. The burner remained on for 7 minutes until the fully developed fire condition was achieved.

During Phase 2, flames extended outside the footprint of the initiating Unit 3. Flames impinged on the target units, causing brief ignition of the painted surface of the container. Fire completely consumed M-LINK 2 and 3 of the Initiating Unit but did not propagate to M-LINK 1 or to the target units. Damage to the target units consisted of scorched paint. No modules in either of the target units vented or entered thermal runaway, indicating that the damage was superficial and unit-to-unit propagation did not occur. Damage to the target walls consisted of scorching and delamination of the wood surface. No explosions or flying parts were observed and the fire did not propagate to the target units using the desired spacing.

The fire in Phase 2 grew in intensity for approximately 2.5 hours before reaching its maximum flaming at 2.6 hours, with two additional spikes at 4.5 hours and 5 hours. After 5.5 hours, the flaming began to subside, self-extinguishing 7 hours and 31 minutes into the test.



The early stage of the battery failure is associated with the accumulation of gases, which is the product of the heating and volatilization of the liquid electrolyte. After ignition, the battery will continue to emit substances, which are then subject to thermal oxidation. The final speciation of the vented gases and battery constituents will depend on various factors.

Gas composition data is based on the single cell thermal runaway test as shown in Table 1 below.

Table 1 Gas Composition (Cell basis)		
Gas Name	Chemical Structure	% Measured
Carbon Monoxide	CO	10.0
Carbon Dioxide	CO <sub>2</sub>	22.4
Hydrogen	H <sub>2</sub>	59.3
Methane	CH <sub>4</sub>	3.68
Acetylene	C <sub>2</sub> H <sub>2</sub>	0.16
Ethylene	C <sub>2</sub> H <sub>4</sub>	2.53
Ethane	C <sub>2</sub> H <sub>6</sub>	0.53
Propylene	C <sub>3</sub> H <sub>6</sub>	0.26
Propane	C <sub>3</sub> H <sub>8</sub>	0.26
Iso-butane	C <sub>4</sub> (total)	0.40
Pentane	C <sub>5</sub> (total)	0.12
Hexane	C <sub>6</sub> (total)	0.39
1-Heptene	C <sub>7</sub> H <sub>14</sub>	0.10
Styrene	C <sub>8</sub> H <sub>8</sub>	0.0
Benzene	C <sub>6</sub> H <sub>6</sub>	0.09
Toluene	C <sub>7</sub> H <sub>8</sub>	0.01
Dimethyl Carbonate	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	0.0
Ethyl Methyl Carbonate	C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	0.0
<b>Total</b>		<b>100</b>

The measured volumetric percentages for each compound was converted into a mass emission rate by first utilizing the total gas volume of 64 liters from the test report and then adjusting each compound by the measured percentage. Based on the molecular weight of each substance in Table 1, the gas density in kilograms/liter was calculated. Noting that there was an assumed number of 10,080 battery cells in thermal runaway, the gas density was used to calculate the mass emissions per cell and mass per total cells consumed in the fire for each compound. A source test duration of 7.52 hours in thermal runaway was used in the conversion to pounds per hour. This data is presented in Table 2. A review of the cell, module, and unit tests, as well as the large-scale burn test did not yield any emissions data on a number of other substances clearly identified as “not sampled” in the test report.

To supplement the test UL data, additional publicly available emissions data from reports on other BESS projects were reviewed and utilized for this analysis. This data included the use of the following sources:



- Vistra MBPP, OCA, Ramboll, 3/2024
- Baseline Environmental, Soda Mtn. Solar AQ Report, 7/2025
- Island Green Power Limited-Cottam Solar Project, Tetra-Tech, 11/2023 (LFP Battery Test)
- Dudek, Viridi Bess Project, 5/2025
- Dudek, Compass Energy Storage Project, May 2025.
- Fisher Engineering, Tesla Megapack 2, Jan 2023.

The emission factors for hydrogen fluoride (HF), hydrogen chloride (HCL), and hydrogen cyanide (HCN), were developed primarily from the RAMBOLL OCA report noted above, and are based on the assumed mass loss of batteries experiencing a thermal event and the duration over which the emission will occur. The data shows that emissions from battery fires are closely related to the mass change from the battery before and after the fire, known as mass loss. As noted above, data specific to LiPo battery test results were evaluated to derive reasonable emissions factors for the LG Solutions technology. The emissions factors represent averages across the tests for each compound and then adjusted for the weights and time period of 7.52 hours to match the UL 9540A Cell Level Test (January 2025). The emissions of both criteria pollutants and hazardous air pollutants were modeled using the average across the tests, for each specific substance. The additional data is presented in Table 3.

### **AERMOD Emission Source Inputs**

Reviewing the LG Energy Solution, LTD Large Scale Burn Test Report (December 2024) and the design information with regards to the spacing of the battery enclosures, the source characteristics focused on a single enclosure thermal runaway fire. While the LG Energy Solution, LTD Large Scale Burn Test Report summarized the fire progression throughout the test, the maximum burn rate of materials was during the period when the enclosure was partially or fully engulfed throughout the test period. The fire and associated combustion gases were emitted through a series of electrical cabinet doors and louvered vent panels that are present on the enclosure. Based on this linear release characteristic, a single buoyant line source of approximately 7.17 meters in length (the length of the enclosure) was used to represent the release of combustion gases. AERMOD can simulate concentrations from these types of releases by utilizing the buoyant line source option within the model. Using techniques from the Buoyant Line and Point (BLP) Source Dispersion Model (Schulman and Scire, 1980), AERMOD assesses buoyant line source attributes in the BLP algorithm to define the geometry of one or more linear structures associated with the emission releases. BLP was originally developed to model linear source releases from aluminum smelters. The coordinates of the beginning and ending locations of the line source was used to determine the geometry of the release as well as the orientation of the line source.

To utilize the BLP option in AERMOD, source inputs also include calculating the buoyancy parameter F, which includes identifying an initial vented plume temperature and exit velocity. Since the modeling focused on the maximum one (1) hour active flame portion of the event, the exit temperature was assumed to be approximate to the temperature of an open flame. Based on data provided in the LG Energy Solution, LTD Large Scale Burn Test Report, the literature noted



that vented gases from a battery cell can exceed 600°C prior to ignition and flame temperatures within combustion sources can typically be in the range of 800° to 1400°C. The exit temperature was conservatively assumed to be at the lower end at 1000°C, which would limit the amount of thermal plume rise which would then tend to increase the ground level concentrations.

The exit velocity was assumed to be one (1) meter per second (m/s) in order to limit the amount of plume rise due to momentum effects. Burn study testing data did provide some velocity data, but this was typically associated with hot gas ventilation prior to the maximum combustion event, and the gas was vented horizontally. Recognizing that the release of pollutants during the fire portion of the event along the length of open cabinet doors would have minimum vertical mechanical momentum, the focus on plume rise was based upon buoyancy effects. Since limiting momentum rise would cause an increase in the ground level concentrations by restricting the side vented plume rise to a lower elevation, a small exit velocity was used at 1.0 meter per second (m/s).

The buoyancy parameter equation (F) takes the form of the following:

Average Buoyancy Parameter ( $m^4/s^3$ )

$$F = \frac{[g L W m w (T_s - T_a)]}{T_s}$$

where:

F = average line source buoyancy parameter (51.124  $m^4/s^3$ )

g = acceleration of gravity (9.81  $m/s^2$ )

L = average line source length (7.17 m)

Wm = average line source width (1.0 m)

w = exit velocity (1.0 m/s)

Ts = exit temperature (1073.15 K)

Ta = ambient air temperature (293.15 K)



Table 2 BESS Fire Emissions Conversions and Calculations

Site Evaluated:		Cell Test Gas Composition Analysis Data					Mass per Total Cells Consumed			Mass per Cell			Modeling
Volume % Calculation		Measured	Sample Volume Gas, L	Gas Molecular Weight	Gas Density kg/m3 *	Gas Density kg/L	kg	lbs	lbs/hr	kg	lbs	lbs/hr	g/sec
Substance	CAS	Vol %											
Methane	74828	3.680	2.355	16.04	0.667	0.00067	1.583E+01	3.490E+01	4.640E+00	1.570E-03	3.462E-03	4.604E-04	5.852E-01
Acetylene	74862	0.160	0.102	26.04	1.082	0.00108	1.117E+00	2.463E+00	3.275E-01	1.108E-04	2.443E-04	3.249E-05	4.130E-02
Ethylene	74851	2.530	1.619	28.05	1.166	0.00117	1.903E+01	4.195E+01	5.578E+00	1.888E-03	4.161E-03	5.534E-04	7.035E-01
Ethane	74840	0.530	0.339	30.07	1.250	0.00125	4.273E+00	9.420E+00	1.253E+00	4.239E-04	9.345E-04	1.243E-04	1.580E-01
Propadiene	463490	0.000	0.000	40.06	1.665	0.00167	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Propene (Propylene)	115071	0.260	0.166	42.08	1.749	0.00175	2.933E+00	6.467E+00	8.600E-01	2.910E-04	6.416E-04	8.531E-05	1.084E-01
Propane	74986	0.260	0.166	44.10	1.833	0.00183	3.074E+00	6.777E+00	9.012E-01	3.050E-04	6.723E-04	8.940E-05	1.136E-01
Butane (C4 total)	106978	0.400	0.256	58.12	2.415	0.00242	6.233E+00	1.374E+01	1.827E+00	6.184E-04	1.363E-03	1.813E-04	2.304E-01
Pentane (C5 total)	109660	0.120	0.077	72.15	2.999	0.00300	2.321E+00	5.118E+00	6.805E-01	2.303E-04	5.077E-04	6.751E-05	8.582E-02
Hexane (C6 total)	110543	0.390	0.250	86.18	3.582	0.00358	9.011E+00	1.987E+01	2.642E+00	8.940E-04	1.971E-03	2.621E-04	3.332E-01
Heptene (C7 + C8)	592767	0.100	0.064	98.19	4.081	0.00408	2.633E+00	5.804E+00	7.718E-01	2.612E-04	5.758E-04	7.657E-05	9.733E-02
CO	630080	10.000	6.400	28.00	1.164	0.00116	7.507E+01	1.655E+02	2.201E+01	7.448E-03	1.642E-02	2.183E-03	2.775E+00
CO2	124389	22.400	14.336	44.01	1.829	0.00183	2.643E+02	5.827E+02	7.749E+01	2.622E-02	5.781E-02	7.687E-03	9.772E+00
Hydrogen	1333740	59.300	37.952	2.02	0.084	0.00084	3.205E+01	7.066E+01	9.397E+00	3.180E-03	7.010E-03	9.322E-04	1.185E+00
Benzene	71432	0.090	0.058	78.11	3.246	0.00325	1.885E+00	4.155E+00	5.526E-01	1.870E-04	4.122E-04	5.482E-05	6.968E-02
Toluene	108883	0.010	0.006	92.14	3.829	0.00383	2.470E-01	5.446E-01	7.242E-02	2.451E-05	5.403E-05	7.185E-06	9.133E-03
Styrene	100425	0.000	0.000	104.15	4.328	0.00433	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Dimethyl Carbonate	616386	0.000	0.000	90.08	3.744	0.00374	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ethylmethyl Carbonate	623530	0.000	0.000	104.10	4.326	0.00433	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
<i>Check Sums</i>		<i>100.2</i>	<i>64.1</i>										
			<i>Total Gas Vol, L</i>	<i>64</i>	<i>from test reports</i>								
													(Per cell test data extrapolated to all modules and cells in the enclosure)
# of M-Link Units per Enclosure	3												
# of Racks per M-Link Unit	2												
# of Modules per Rack	14												
# of Cells per Module	120												
Test Duration, hours	7.52												
# Cells in Thermal Runaway	10080												
<i>References:</i>													
<i>LG Energy Solution, LTD., Cell Test Report #4791256609, 10-9-2024.</i>													
<i>LG Energy Solution, LTD., PackTest Report #4791519232, 12-25-2024.</i>													
<i>LG Energy Solution, LTD., Unit Test Report #4791516927, 12-26-2024.</i>													
<i>LG Energy Solution, LTD., Large Scale Fire Test Report #80236098, 2-25-2025.</i>													



Table 3 BESS Fire Emissions Conversions and Calculations					Site Evaluated: Corby BESS (LG Energy Solution, LTD.)
mg/kg to lb/lb battery weight					
	Substance >>>>	Hydrogen Fluoride	Hydrogen Chloride	Hydrogen Cyanide	
Enter mg/kg value:		3078.75	1651.5	658.5	
mg/lb =		1396.50	749.11	298.69	
lb/lb =		0.00308	0.00165	0.00066	
Total Emissions, lbs		43.0900	23.1143	9.2163	
Total Emissions, lbs/hr		5.7326	3.0751	1.2261	
Modeling, g/sec		0.72294	0.38780	0.15463	
Conversion Factors					
1 mg =	0.000002205	lbs			
1 kg =	2.204623	lbs			
Cell Weight, lbs =		6.17			
Total # of Cells =		10080			
Total Battery Weight Consumed, lbs =		13994	(assumes a mass loss rate of 22.5% per Reference #1 below)		
Total Sampling Period, min =		451			
Total Sampling Period, hrs =		7.52			
<b>References</b>					
RAMBOLL, <i>Vistra Morro Bay BESS Project, OCA, #1690027676, 3-2024. (Mass loss rate based on p.38 data and references. Emissions factors represent the averages computed for typical LFP batteries from Tables 3-2, 3-3)</i>					
LG Energy Solution, LTD., <i>Cell Test Report #4791256609, 10-9-2024.</i>					
LG Energy Solution, LTD., <i>PackTest Report #4791519232, 12-25-2024.</i>					
LG Energy Solution, LTD., <i>Unit Test Report #4791516927, 12-26-2024.</i>					
LG Energy Solution, LTD., <i>Large Scale Fire Test Report #80236098, 2-25-2025.</i>					



## Significance Criteria and Short-Term (Acute) Health Effects

As per the CEC Data Requests, the modeling results were compared with both the acute California Reference Exposure Levels (RELs), and where there are no RELs for specific TACs, to the United States Environmental Protection Agency Acute Exposure Guideline Level-1 for Airborne Chemicals (AEG-1).

Non-cancer health effects can be either chronic or acute. In determining potential non-cancer health risks (chronic and acute) from air toxics, it is assumed there is a dose of the chemical of concern below which there would be no impact on human health. The air concentration corresponding to this dose is called the REL. Non-cancer health risks can be measured in terms of a hazard quotient, which is the calculated exposure of each contaminant divided by its REL. Hazard quotients for pollutants affecting the same target organ are typically summed with the resulting totals expressed as hazard indices for each organ system. A hazard index of less than 1.0 is considered to be an insignificant health risk. For this assessment, the maximum hazard quotient was presented, regardless of target organ. This method leads to a conservative (upper bound) assessment. RELs used in the hazard index calculations were those published in the CARB/OEHHA listings dated January 2025.

Acute toxicity is defined as adverse health effects caused by a brief chemical exposure of no more than 24 hours. For most chemicals, the air concentration required to produce acute effects is higher than the level required to produce chronic effects because the duration of exposure is shorter. Because acute toxicity is predominantly manifested in the upper respiratory system at threshold exposures, all hazard quotients are typically summed to calculate the acute hazard index. One-hour average concentrations are divided by acute RELs to obtain a hazard index for health effects caused by relatively high, short-term exposure to air toxics.

In addition to RELs, the United States Environmental Protection Agency (EPA) developed AEGs for airborne chemicals. AEGs represent threshold exposure limits for the general public and are applicable to emergency exposures ranging from 10 min to 8 hours. Three levels—AEG-1, AEG-2, and AEG-3—are developed for each of five exposure periods (10 min, 30 min, 1-hour, 4-hour, and 8-hour) and are distinguished by varying degrees of severity of toxic effects. While the request for use of AEGs are for Level 1, the three levels are presented below for comparison:

- AEG-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

- AEG-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.



- AEGL-3 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Airborne concentrations above AEGL-1 represent exposure levels that can produce mild and progressively increasing but transient and nondisabling odor, taste, and sensory irritation or certain asymptomatic, non-sensory effects. With increasing airborne concentrations above each AEGL, there is a progressive increase in the likelihood of occurrence and the severity of effects described for each corresponding AEGL. Although the AEGL values represent threshold levels for the general public, including susceptible subpopulations, such as infants, children, the elderly, persons with asthma, and those with other illnesses, it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL. AEGL's were assessed for the Level 1 (AEGL-1) 1, 4 and 8-hour averaging periods based on the limits of the AERMOD model which limits the averaging period to no less than 1-hour. In the modeling results summary section, any concentrations exceeding AEGL-2 or AEGL-3 were noted.

Table 4 presents a REL's and AEGL's (Level 1, 2 and 3) 1-hour concentration significance criteria in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). Note that some of the TACs presented in Table 2 and Table 3 do not have either an REL or AEGL but are presented in Table 4 for completeness.

Table 4 CARB OEHHA RELs and EPA AEGLs Significance Criteria (1-Hour Average)					
Substance	CAS	REL <sup>1</sup> , $\mu\text{g}/\text{m}^3$	AEGL 1 <sup>2</sup> , $\mu\text{g}/\text{m}^3$	AEGL 2, $\mu\text{g}/\text{m}^3$	AEGL 3, $\mu\text{g}/\text{m}^3$
Hydrogen Chloride	7647010	2100	2684	32807	149121
Hydrogen Fluoride	7664393	240	818	19462	36010
Hydrogen Cyanide	74908	340	2210	7848	16580
Hydrogen Bromide	10035106	-	3309	132369	426889
Methane	74828	-	-	-	-
Acetylene	74862	-	-	-	-
Ethylene	74851	-	-	-	-
Ethane	74840	-	-	-	-
Propadiene	463490	-	-	-	-
Propene (Propylene)	115071	-	-	-	-
Propane	74986	-	9920	-	-
Butane (C4 total)	106978	-	13074	-	-
Pentane (C5 total)	109660	-	-	-	-
Hexane (C6 total)	110543	-	10222	10000000	-
Heptene	592767	-	-	-	-
Ammonia	7664417	3200	20,859	111,248	764,830
Carbon Dioxide	124389	-	-	-	-
Hydrogen	1333740	-	-	-	-
Formaldehyde	50000	55	1105	17,195	68,781
Benzene	71432	27	170000	2600000	-



<b>Toluene</b>	108883	5000	250000	2100000	-
<b>Styrene</b>	100425	21000	85000	550000	-
<b>Dimethyl Carbonate</b>	616386	-	-	-	-
<b>Nitrogen Dioxide</b>	10102440	470	941	22581	37620
<b>Carbon Monoxide</b>	630080	23000	-	95450	379500
<b>Sulfur Dioxide</b>	7446095	660	524	1965	78600

1. Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values (CARB, 08/2025)  
2. EPA Access Acute Exposure Guideline Levels Values (EPA August 2025)

For each acute OEHHA REL, Table 5 lists the target organs that would be affected by exposure to a particular TAC or criteria pollutant. When multiple TACs affect the same target organ or system, their hazard quotients are summed to estimate combined risks for that organ system.

<b>Table 5 OEHHA Acute REL Target Organ Summary</b>					
<b>Pollutant</b>	<b>Acute Cardiovascular Effects</b>	<b>Acute Respiratory Effects</b>	<b>Acute Eye Effects</b>	<b>Developmental, Immune, Hematologic</b>	<b>Central Nervous System</b>
<b>Hydrogen Fluoride</b>		Y	Y		
<b>Hydrogen Chloride</b>		Y	Y		
<b>Hydrogen Cyanide</b>					Y
<b>Formaldehyde</b>			Y		
<b>Nitrogen Dioxide</b>		Y			
<b>Ammonia</b>		Y			
<b>Benzene</b>				Y	
<b>Toluene</b>		Y			
<b>Styrene</b>		Y	Y		
<b>Carbon Monoxide</b>	Y				
<b>Nitrogen Dioxide</b>		Y			
<b>Sulfur Dioxide</b>		Y			

Concentrations of these pollutants in air associated with the emissions were calculated using the AERMOD dispersion model with the results input into the HARP2 Risk Assessment (Version 22118) program to calculate the HI. The AERMOD output was also compared with the AEGL-1 for those TACS that do not have RELs. This included:

- Propane
- Butane



- Hexane

Given the short duration of the 7.52-hour event, long term chronic and cancer (annual) exposure estimates were not assessed as the exposure periods for this event were less than a single day. Chronic exposure is typically based on annual average concentrations which would be negligible for this event based on the single day's duration of exposure. For cancer, the increased risk periods are based on 30 years of exposure which for the single day's short duration of exposure, would also be negligible when prorated over a 30-year exposure period.

### Model Results and Summary of Impacts

Table 6 presents the results of the acute exposure concentrations (RELs, AEGL-1) and the HI at the maximum impacted sensitive receptor (residence) for the thermal runaway scenario as defined earlier.

Table 6 Acute 1-Hour Risk Results				
Pollutant	REL (ug/m3)	AEGL-1 (ug/m3)	Acute Hazard Quotient (HI)	Sensitive Receptor x,y (meters)
Hydrogen Chloride*	31.624	-	0.01506	595420.0, 4250270.0
Hydrogen Fluoride*	58.833	-	0.2451	595420.0, 4250270.0
Hydrogen Cyanide	12.629	-	0.0371	595420.0, 4250270.0
Benzene	5.688	-	0.2103	595420.0, 4250270.0
Toluene	4.226	-	0.000148	595420.0, 4250270.0
Propane	-	9.257	-	-
Butane	-	18.775	-	-
Hexane	-	27.055	-	-
		<b>Hazard Index</b>	<b>0.2604*</b>	595420.0, 4250270.0
* The total HI is based on the target organ "eyes" and represents the sum of HI hazard quotients for hydrogen chloride, hydrogen fluoride, formaldehyde, and styrene. Sensitive receptor number = 986				

The results of the HI modeling were plotted on a map to identify any areas that may result modeled hazard indexes above 1.0 and aid emergency responders in quickly identifying areas where exposed individuals may experience health impacts. The results of this are depicted in



Figure 5 and represent the maximum distance of the HI equaling or exceeding 1.0 from any of the 14 hypothetical locations of unexpected thermal runaways at the BESS under meteorological conditions that can produce the highest ground level concentrations. The HI of 1.0 was not exceeded at any sensitive receptor while the AEGL-1 thresholds were never exceeded at any receptor.

Table 7 presents the results of the criteria pollutant modeling at the location of the maximum impacted sensitive receptor.

Table 7 Modeled Concentrations and Ambient Air Quality Standards					
Pollutant	Averaging Period	Maximum Concentration ( $\mu\text{g}/\text{m}^3$ )	Back-ground ( $\mu\text{g}/\text{m}^3$ )	Total ( $\mu\text{g}/\text{m}^3$ )	Ambient Air Quality Standards ( $\mu\text{g}/\text{m}^3$ )
					CAAQS
NO <sub>2</sub>	1-hour maximum	27.30	50.81	78.1	339
CO	1-hour maximum	121.50	13,225	13,346.5	23,000
	8-hour maximum	37.19	2070	2107.2	10,000
SO <sub>2</sub>	1-hour maximum	45.39	296.32	341.71	655

The criteria pollutant impacts were under the California Ambient Air Quality Standards (CAAQS) for all modeled criteria pollutants.

## Conclusion

The results of the HI modeling demonstrate that the maximum distance to any receptor equaling or exceeding the HI of 1.0 is less than the distances to the two nearest sensitive receptors. The modeled concentrations of any of the pollutants do not exceed the REL's or the AEGL's at any of the sensitive receptors. The distance from the closest hypothetical source to the nearest sensitive receptor towards the north is 285 meters while the distance to the sensitive receptor towards the northwest is 430 meters. The maximum extent (distance) of any of the 14 HI isopleths that are equal to or greater than 1.0 never exceeds 150 meters from each point of release. Thus, no sensitive receptors would be exposed to hazard indexes equal to or greater than 1.0.

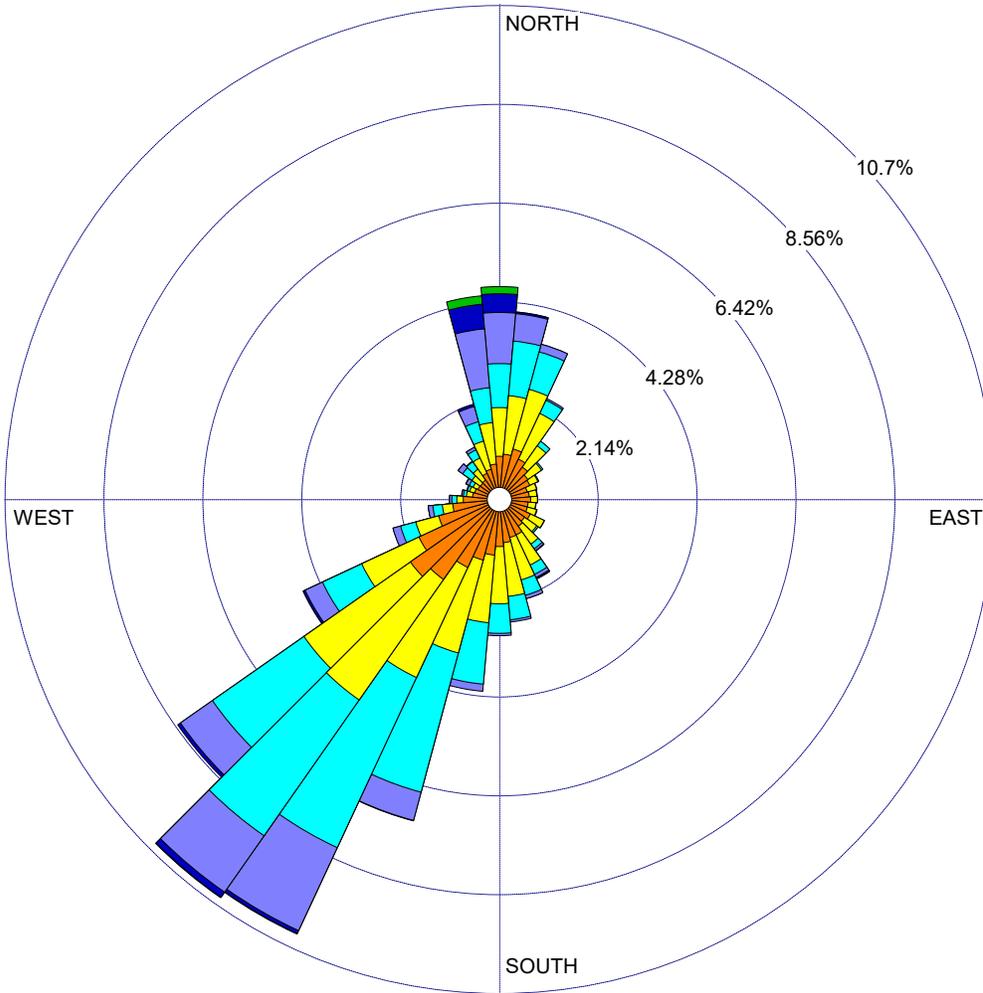


WIND ROSE PLOT:

**Figure 1**  
**5-Year Nut Tree Airport Wind Rose (2017-2021)**

DISPLAY:

**Wind Speed**  
**Direction (blowing from)**



WIND SPEED  
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 1.12%

COMMENTS:

DATA PERIOD:

**Start Date: 1/1/2017 - 00:00**  
**End Date: 12/31/2021 - 23:59**

COMPANY NAME:

**Atmospheric Dynamics, Inc.**

MODELER:

**Alfred E. Neuman**

CALM WINDS:

**1.12%**

TOTAL COUNT:

**43535 hrs.**

AVG. WIND SPEED:

**3.25 m/s**

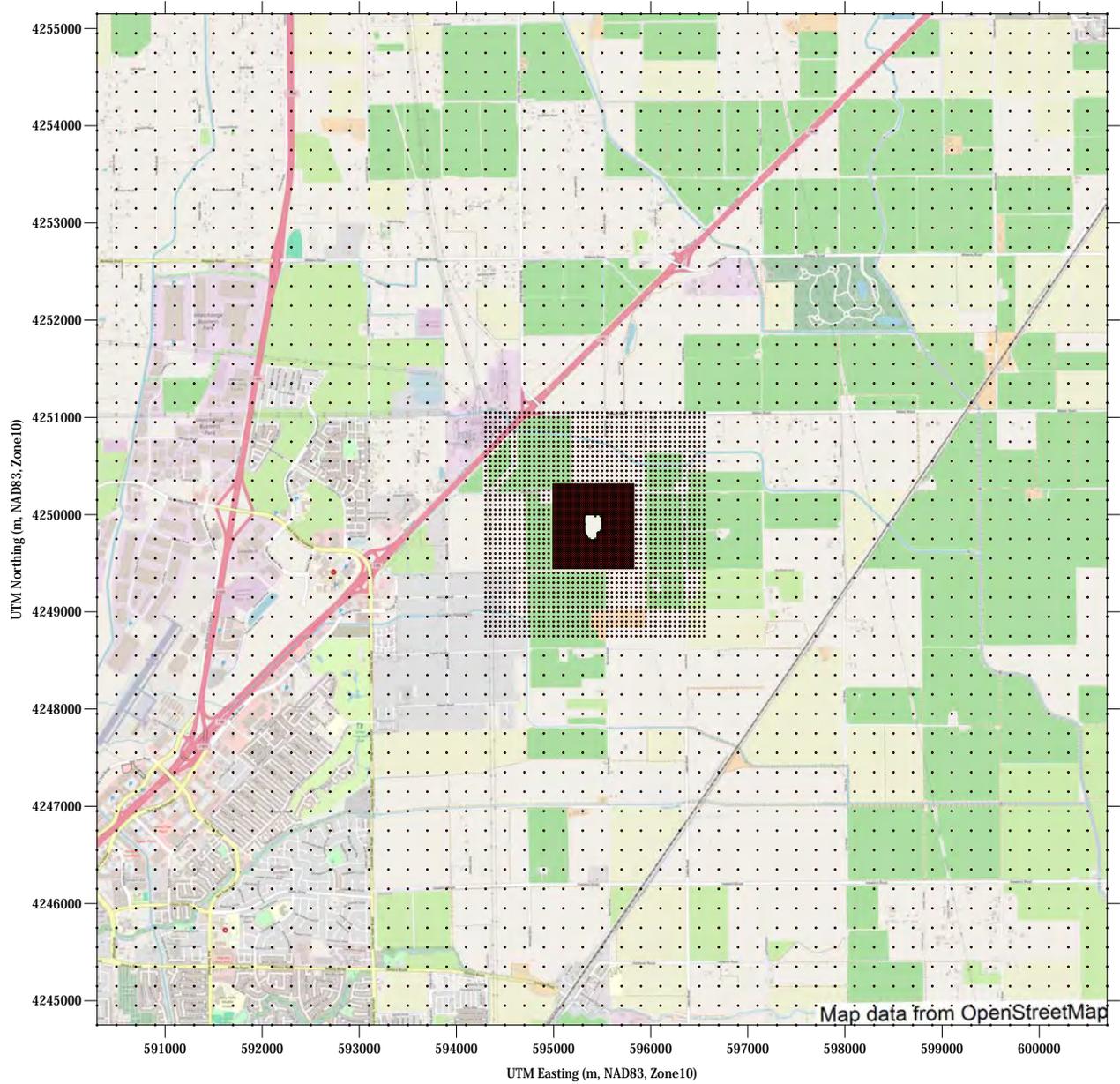
DATE:

**9/29/2025**

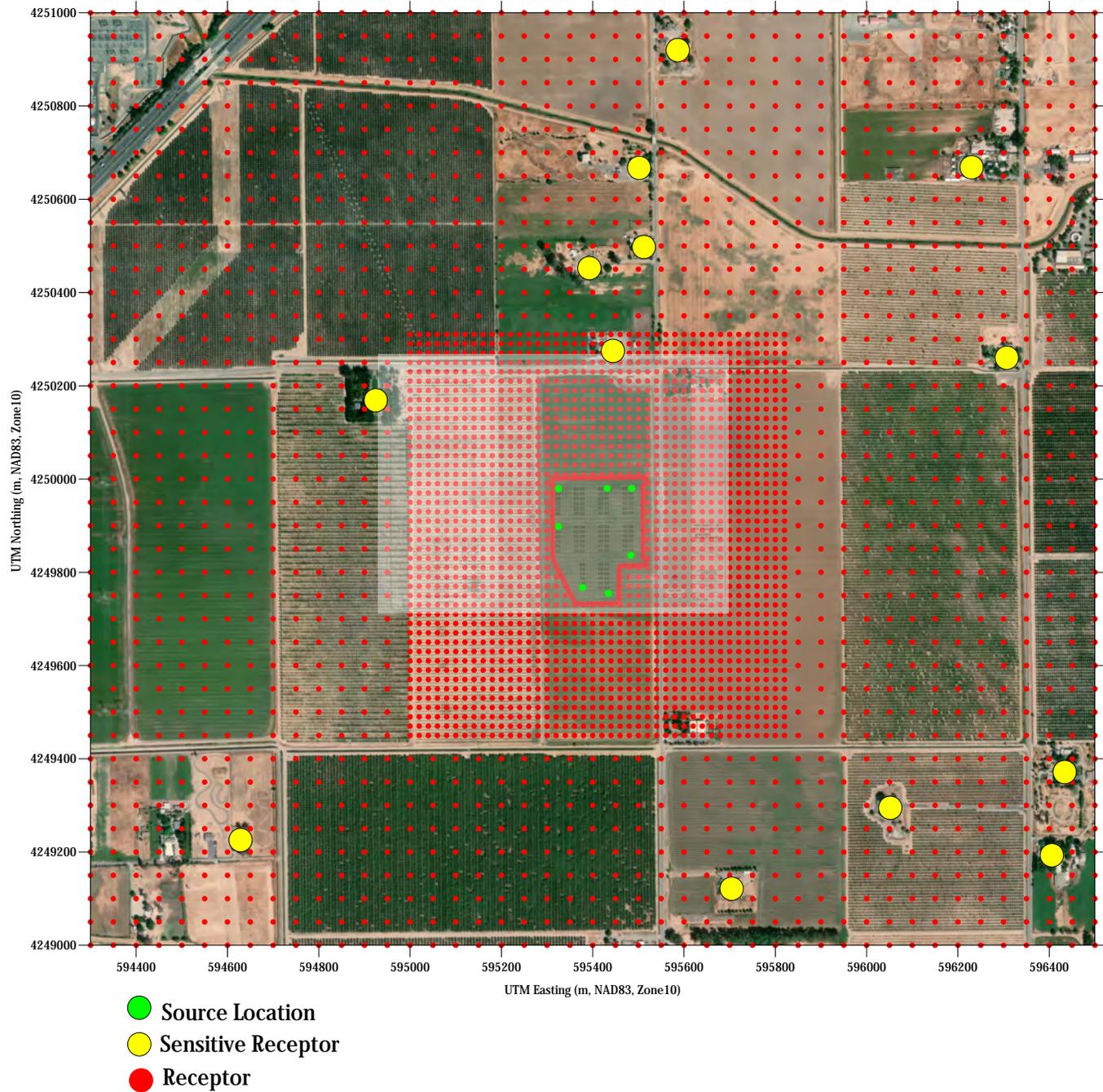
PROJECT NO.:



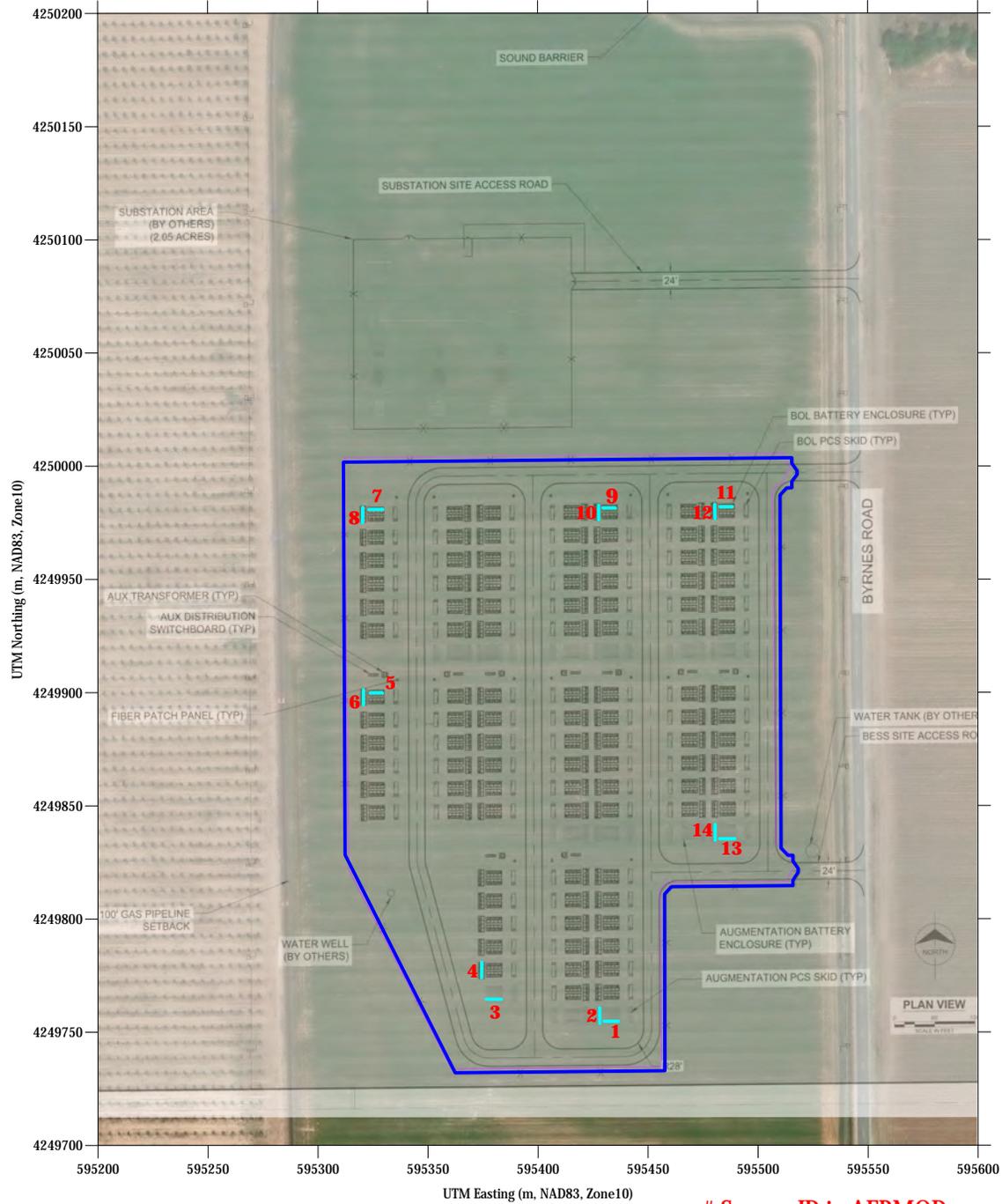
**Figure 2**  
**Corby BESS Nested Receptor Grids**



**Figure 3**  
**Corby BESS High Resolution Receptor Grids**



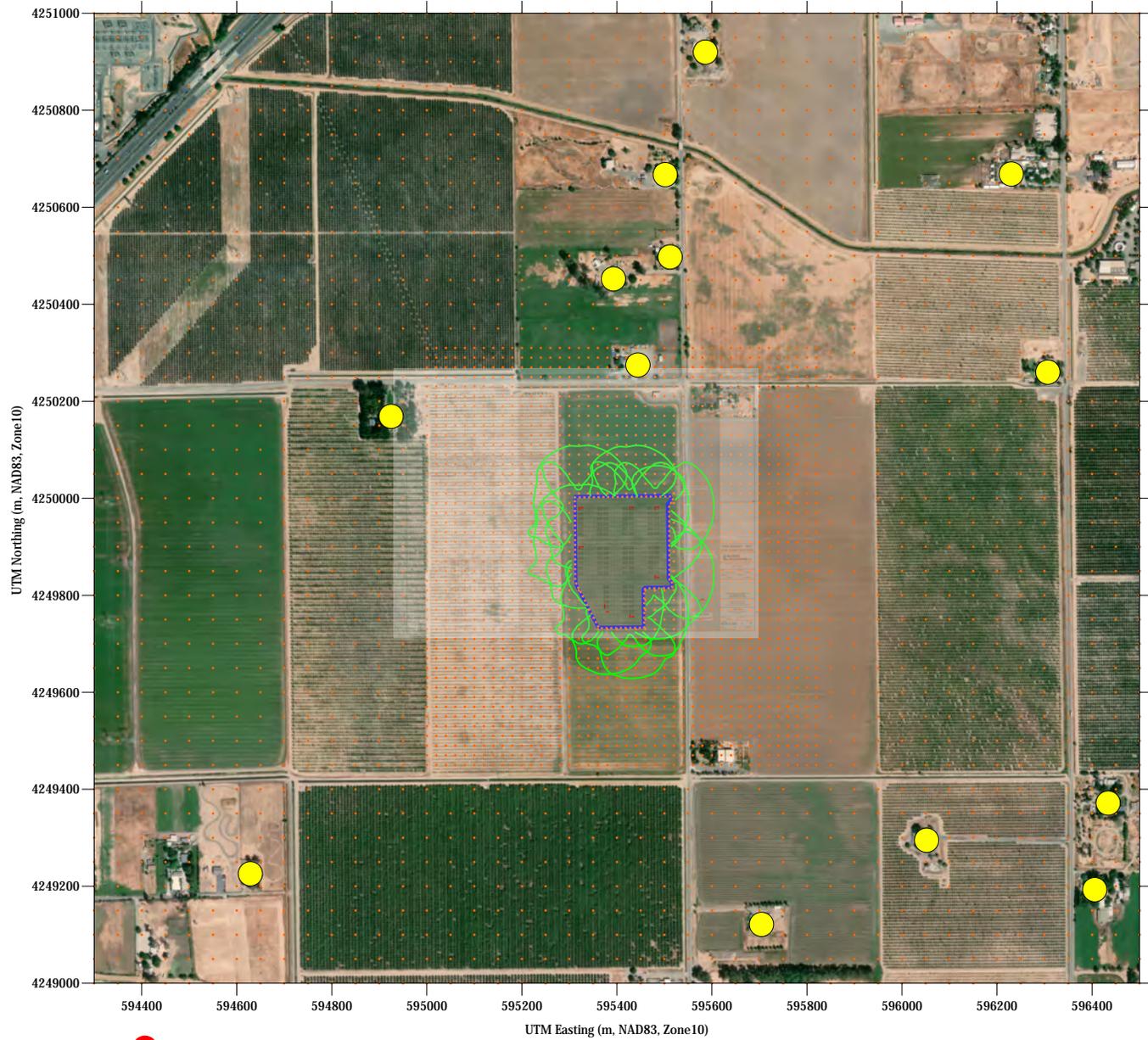
**Figure 4**  
**Corby BESS Thermal Runaway Source Locations**



— Source Location

# Source ID in AERMOD

**Figure 5**  
**Corby BESS Acute HI > 1.0**



- Source Location
- Sensitive Receptor
- Receptor

## **APPENDIX 3.9-B: HAZARD MITIGATION ANALYSIS**

REPORT

# NEXTERA ENERGY – BATTERY ENERGY STORAGE SYSTEM AT CORBY ENERGY STORAGE SITE

## *Hazard Mitigation Analysis*

### PREPARED FOR

NextEra Energy Resources, LLC  
700 Universe Blvd  
Juno Beach, FL 33408-2657

Proposal #: 1KAP00025  
Report #: 1KAP00025-RPT54  
Revision #: Rev 0  
Date: 1/15/2026

### PREPARED BY

Patrick O'Brien  
One Research Drive, Suite 305C  
Westborough, MA, 01581 USA

Patrick.obrien@jensenhughes.com



**JENSEN HUGHES**

---

*Name*

---

*Preparer(s):* Patrick O'Brien

---

*Reviewer(s):* Kushal Mistri  
Jihan El Ouaragli

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*Revision Record Summary*

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<i>Revision</i>	<i>Date</i>	<i>Revision Summary</i>
Rev 0	1/15/2026	Initial use

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## Executive Summary

Jensen Hughes has completed a site-level Hazard Mitigation Analysis (HMA) for the 300 MW / 1200 MWh battery energy storage system (BESS) project at the Corby Energy Storage Center Resources, LLC (Corby Energy Storage) site on behalf of NextEra Energy. The Corby Energy Storage BESS project is located in Vacaville, Solano County, California, and utilizes the LG Energy Solution (LGES) JF2 DC LINK Battery Energy Storage System (JF2 BESS).

The HMA was conducted in accordance with Chapter 12 §1207 of the 2022 edition of the California Fire Code (2022 CFC) [1] as adopted by Solano County, California and Chapter 4 §4.4 of the 2023 edition of NFPA 855 [2] to better reflect current accepted industry best practices.

The HMA resulted in safety recommendations, summarized in Section 4.1 of this report, to address aspects of the documentation and installation of LGES JF2 BESS as part of the Corby Energy Storage BESS project to help ensure safe operation.

This report serves as a site-level review. The Corby Energy Storage BESS installation and its associated components were analyzed based on site plans and product-related documentation provided by NextEra Energy. A product-level review of the LGES JG2 BESS has been conducted by Jensen Hughes and is referenced in this report [26]. The full HMA review requires both reports. All identified non-compliance items are noted in this report.

This report was based solely upon and limited to the available information provided by NextEra Energy. Information not provided by NextEra Energy was not considered part of this analysis.

## 1.0 Introduction

This report provides a site-level Hazard Mitigation Analysis (HMA) for the 300 MW / 1200 MWh Corby Energy Storage battery energy storage system (BESS) project in Solano County, California. The BESS utilizes the LG Energy Solution (LGES) JF2 DC LINK BESS (JF2 BESS). The HMA was conducted in accordance with Chapter 12 §1207 of the 2022 California Fire Code (2022 CFC) [1] and §4.4 of the 2023 edition of NFPA 855 [2].

The HMA evaluates the consequences of defined BESS failure modes per 2022 CFC §1207.1.4.1 and 2023 NFPA 855 §4.4.2 and identifies safeguards that either prevent or mitigate the consequences. Where existing safeguards do not adequately prevent or mitigate consequences, recommendations were made.

This report references the product-level HMA [26]; therefore, a complete description of the BESS, related testing data, and product-level hazards and recommendations is not provided here. This report presents the analysis and recommendations pertaining to the site and equipment, which are not part of the product-level analysis.

This report serves as a site-level review based on documentation provided by NextEra Energy. Any non-compliance findings and recommendations are documented in this report.

The main sections of the report and their descriptions are provided in Table 1-1.

*Table 1-1: Report Organization*

<i>Section</i>	<i>Description</i>
<b>1 – Introduction</b>	Presents the scope and outline of the report.
<b>2 – Site and BESS Description</b>	Provides an overview of the facility site and the BESS. Describes site-level components of the system and identifies applicable certifications and safety features.
<b>3 – Hazard Mitigation Analysis</b>	Provides an evaluation of the consequences of the required failure modes per 2022 CFC §1207.1.4.1 and 2023 NFPA 855 §4.4.2, and an assessment of existing safeguards against these failure modes, along with recommendations for additional safeguards based on the current design.
<b>4 – Conclusion and Recommendations</b>	Summarizes the HMA and recommended actions.
<b>5 – References</b>	Lists the references used in developing and completing the analysis.

## 2.0 Site and BESS Description

### 2.1 GENERAL PROJECT INFORMATION

NextEra Energy is developing a 300 MW / 1200-MWh BESS installation for the Corby Energy Storage BESS project in Vacaville, Solano County, California. The project site is located near the Dwight D. Eisenhower Highway, as shown in the site plans. The address registered to the site is 6865 Byrnes Road, Vacaville, California 95687. The geographical coordinates of the site are 38.394853" N and -121.906260" W.

The BESS installation utilizes LGES JF2 DC LINK 5.1 BESS (JF2 BESS) containerized enclosures, Model LINK-FDF2JR13 and LINK-FDF2LL13, each with a nominal energy capacity of 5.112 MWh.

Each JF2 BESS container consists of three (3) battery enclosures (M-LINKs) and one (1) panel interface cabinet (E-PANEL). Each M-LINK contains two (2) battery racks wired in parallel in a 6.8 feet wide x 8.4 feet deep x 9 feet high enclosure. Each rack contains fourteen (14) battery modules wired in series and one (1) Battery Protection Unit (BPU) located at the bottom of the rack with a Rack-level Battery Management System (RBMS). Each battery module contains (120) cells arranged in a 30S4P configuration (4 parallel sets of 30 cells in series) and a Pack-level Battery Management System (PBMS). The battery modules use 159 Ah Lithium Iron Phosphate (LFP) pouch cells. This results in a total nominal energy capacity of 61.13 kWh per module, 855 kWh per rack, 1.7 MWh per M-LINK, and 5.112 MWh per BESS container.

The JF2 BESS models used for this project are identical in configuration; the only distinction is the E-PANEL location relative to the access doors, with the "TYPE A (LINK-FDF2JR13)" using a right-hand E-PANEL and the "TYPE C (LINK-FDF2LL13)" using a left-hand E-PANEL when viewed from the access side.

There are (303) JF2 BESS containers planned for the project at the Beginning of Life (BOL), with (38) additional JF2 BESS containers planned to be installed in future expansion projects. This results in a total of (341) JF2 BESS containers at End-of-Life (EOL).

Additionally, the project utilizes Power Electronics (PE) FREEMAQ PCSM GEN 3 (Model FP4200M) as the Power Conversion System (PCS) or inverter system to manage energy flow between the BESS enclosures and the electrical grid. There are (101) PCS skids planned for the project at BOL, with (13) additional PCS skids planned to be installed in future expansion projects. This results in a total of (114) PCS skids at EOL.

General project information is provided in Table 2-1.

*Table 2-1: Product Information*

<b>Facility Name</b>	Corby Energy Storage
<b>Facility Owner</b>	Corby Energy Storage, LLC
<b>Physical Address, City, and State</b>	6865 Byrnes Road, Vacaville, California 95687
<b>County</b>	Solano County
<b>Geographical Coordinates</b>	38.394853" N and -121.906260" W
<b>BESS Product Name</b>	LG Energy Solution (LGES) JF2 DC LINK 5.1
<b>Battery Chemistry / Form Factor</b>	Lithium Iron Phosphate (LFP) / Pouch Cells
<b>PCS Product Name</b>	Power Electronics (PE) FREEMAQ PCSM GEN 3 (FP4200M)
<b>Design Basis System Power</b>	300 MW at Point of Interconnection (POI)
<b>Design Basis System Capacity</b>	1200 MWh (300 MW x 4 hr) at Point of Interconnection (POI)
<b>Actual System Capacity</b>	1,548.93 MWh (based on 303 containers at 5.112 MWh per container)
<b>BESS Function</b>	Grid-scale energy storage
<b>System Configuration</b>	Outdoor non-walk-in style enclosures/containers

## 2.2 SITE OVERVIEW AND NEARBY EXPOSURES

### 2.2.1 Location and Nearby Exposures

The Corby Energy Storage BESS project site is marked in Figure 2-1. Bynes Rd is to the east direction of the property, which is accessed from Weber Road through an exit of the Dwight D. Eisenhower Highway. The BESS yard will be located at the south end of the existing property, measuring about 745 feet wide and 910 feet long. The BESS yard fence runs 745 feet south of the north property line and 141 feet from the east property line. The planned site Substation fence is proposed to be approximately 47 feet north of the BESS yard fence.



**Figure 2-1: Aerial View of Corby Energy Storage BESS Site (From Google Earth).**

As shown in Figure 2-2 [28], the BESS installation is divided into two phases. The initial installation will include four (4) BESS installation pads with a total of (303) JF2 BESS containers and (101) PCS skids. A "BESS installation pad" refers to a defined BESS equipment area within the BESS yard, consisting of one or more groups of BESS containers and PCS skids and auxiliary equipment, and bounded by service roads and/or site fencing. Future capacity can accommodate an addition of (38) JF2 BESS skids and (13) PCS skids to the existing pads. All future BESS containers and PCS skids are shown in halftone line type.

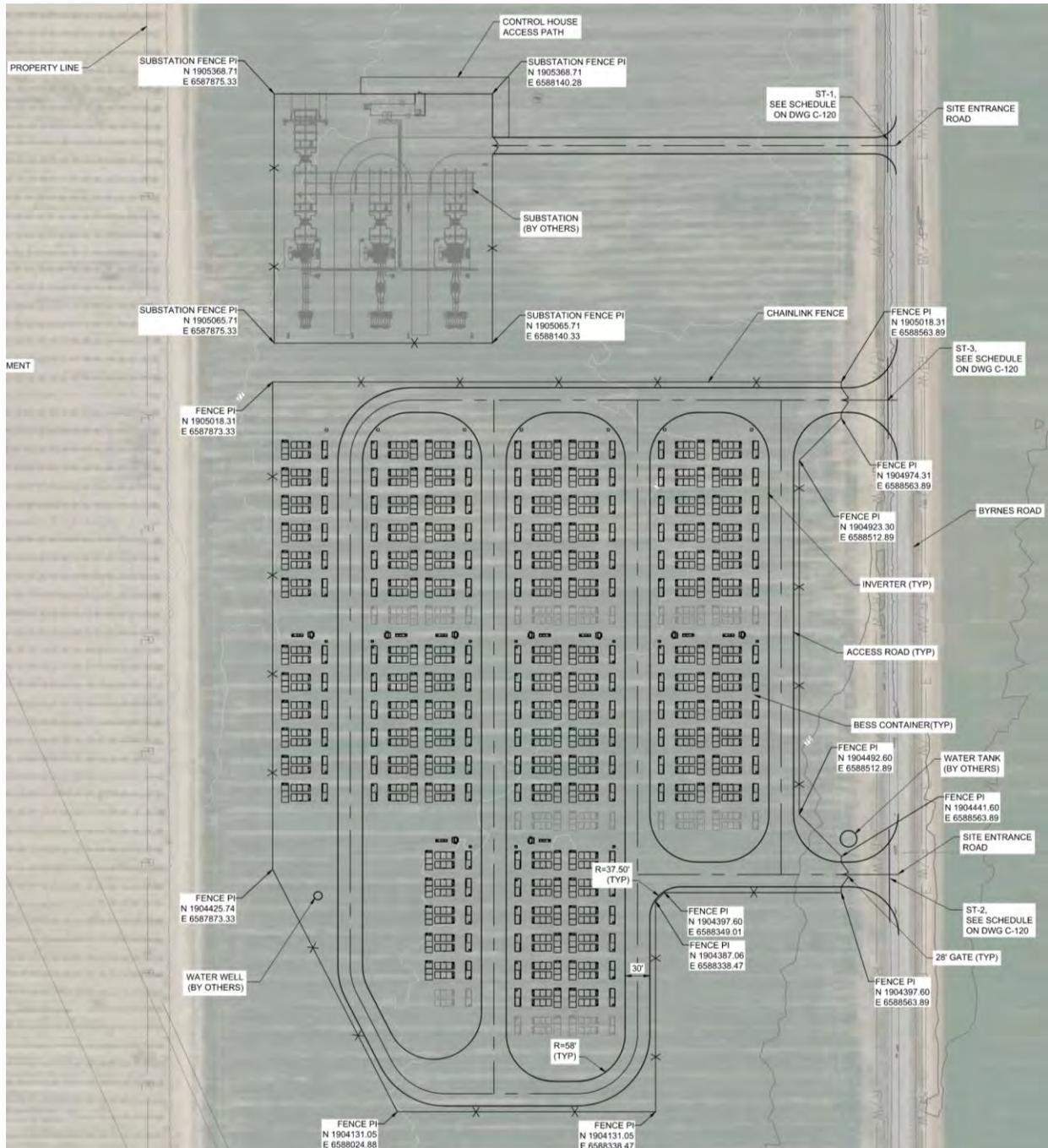
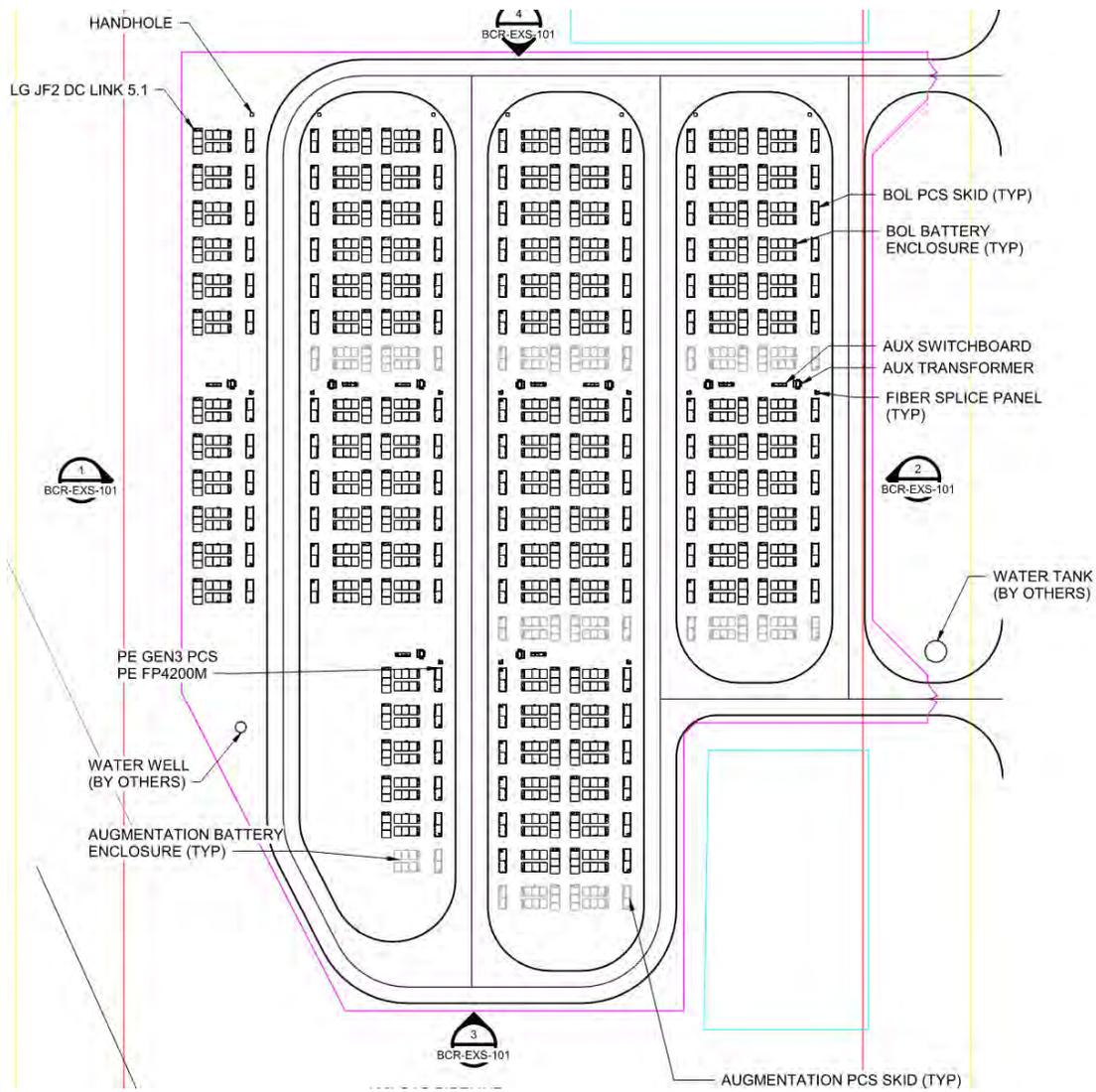


Figure 2-2: Site Plan for Corby Energy Storage BESS.

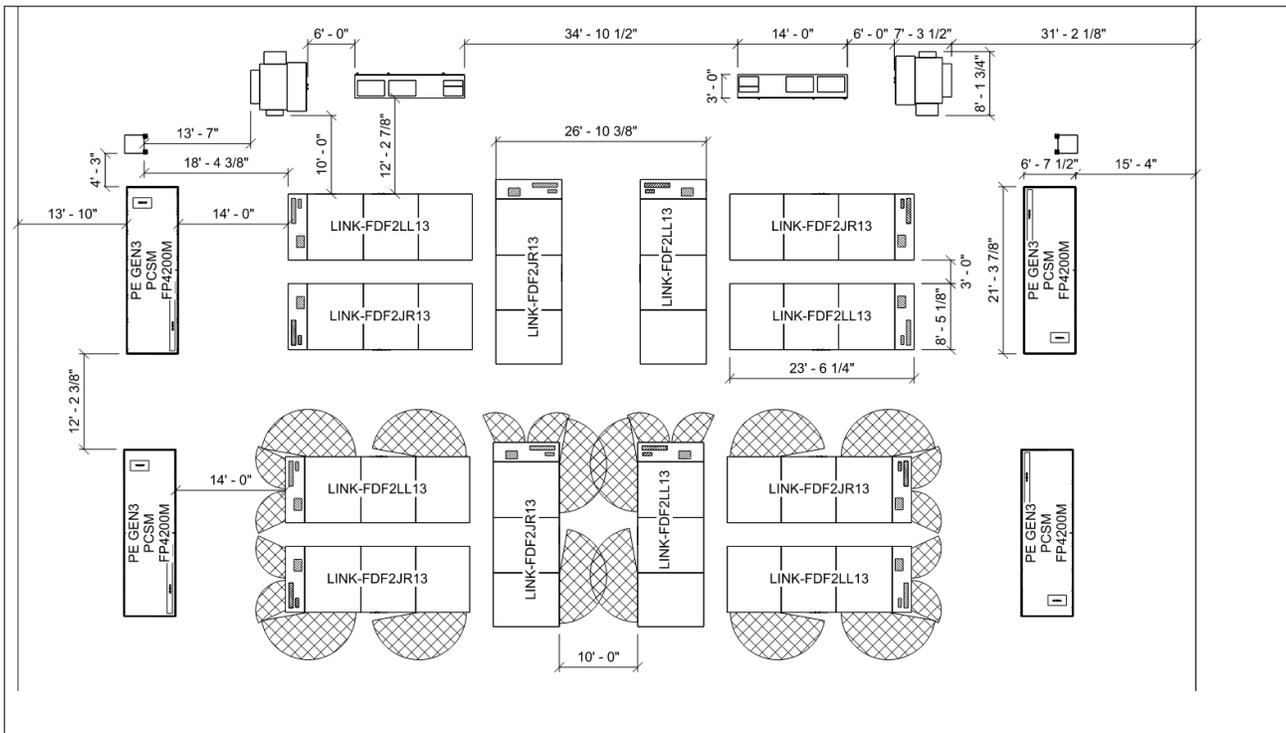
As shown in Figure 2-3 [28], the BESS yard has four (4) BESS installation pads. Each pad contains groups of JF2 BESS containers. Each group contains three (3) JF2 BESS containers served by one (1) PCS skid. The groups are arranged with two (2) horizontal BESS containers and one (1) vertical BESS container. The number of JF2 BESS containers and PCS skids varies by pad.

Starting from left to right, the first pad has (36) JF2 BESS containers, (12) PCS skids, (1) auxiliary switchboard, (1) fiber junction box, and (1) auxiliary transformer. The second pad has (87) JF2 BESS containers, (29) PCS skids, (3) auxiliary switchboards, (3) fiber junction boxes, and (3) auxiliary transformers. There is space for an additional (9) JF2 BESS containers and (3) PCS skids planned for future expansion projects. The third pad has (108) JF2 BESS containers, (36) PCS skids, (3) auxiliary switchboards, (4) fiber junction boxes, and (3) auxiliary transformers. There is space for an additional (18) JF2 BESS containers, and (6) PCS skids planned for future expansion projects. The fourth pad has (72) JF2 BESS containers, (24) PCS skids, (2) auxiliary switchboards, (2) fiber junction boxes, and (2) auxiliary transformers. There is space for additional (12) JF2 BESS containers, and (4) PCS skids planned for future expansion projects.



**Figure 2-3: Equipment Plan for Corby Energy Storage BESS.**

Separation distances between BESS containers, PCS skids, and auxiliary equipment are shown in Figure 2-4 [29]. Each PCS skid is connected to a group of (3) JF2 BESS containers. Within a group, BESS containers are arranged with 3 feet of clearance between containers back-to-back and back-to-non-E-panel side. Approximately 10-foot aisles are provided between adjacent groups, separating BESS containers front-to-front. Each BESS container is separated from its associated PCS skid by 14 feet of clearance. Each BESS container is separated from the nearest auxiliary equipment by 10 feet of clearance.



**Figure 2-4: Equipment Spacing of Corby Energy Storage BESS.**

Around each pad is a 30-foot-wide perimeter road, which leads to a 28-foot-wide exit gate at the Southeast corner of the BESS yard. These dimensions are shown in Figure 2-2. The nearest BESS container to the property line is approximately 164 feet away, and the nearest BESS container to the project substation is approximately 112 feet away. The project site's service road exits onto Byrnes Road. The substation site has a separate service road that also exits to Byrnes Road. The nearest off-site buildings are residential buildings located approximately 850 ft north of the BESS fence line.

This site is classified as a "remote location" per 2022 CFC §1207.8.1 and 2023 NFPA 855 §9.3.2(1). This means that all BESS containers are located more than 100 feet from buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not related to the electrical grid infrastructure. Toxic gases released during a BESS failure event typically do not pose a significant hazard for sites in a generally remote location such as the project site.

## 2.2.2 Fire Department Access and Support

The Corby Energy Storage BESS project site is within the Dixon Fire Department's jurisdiction. However, based on proximity and response time, the City of Vacaville Fire Department is anticipated to be the primary responding agency. The nearest responding fire station is the City of Vacaville Fire Station 72 located at 2001 Ulatis Dr, Vacaville, CA 95687, approximately 5.3 mi or an 8-minute drive from the site. The second nearest fire station is the City of Vacaville Fire Station 73, located at 650 Eubanks Ct, Vacaville, CA 95688, approximately 4.4 miles or an 8-minute drive from the site. The third nearest fire department is the Dixon Fire Department located at 205 Ford Way, Dixon, CA 95620 and 7.8 miles or a 13 min from the site. The appropriate responding fire department will access the site through the service and perimeter roads shown on the site plans.

The progression of thermal runaway may lead to fire. In the event of a fire involving the BESS, no automatic or manual suppression will be used. The approach used for this site is to allow the fire to self-terminate. Fire hydrants will not be installed. A water tank will be installed, but its purpose is not for suppression; it is solely for containment. This will be an on-site, 24,000-gallon water tank, which will be available to respond to a PCS, vehicle, or Control House Enclosure (CHE) fire. This water tank is sized to provide an initial water supply for up to two (2) hours for cooling exposures, controlling smoke, or extinguishing small vegetation fires.

NextEra Energy has a template fire department orientation presentation (not referenced in this report and to be provided by NextEra Energy), which includes an outline of the emergency response plan. The orientation presentation contains a brief description of the BESS installation, including its hazards, safety features, and certifications; the site plan and signage; a description of the detection and communication systems; a brief outline of the emergency response plan; and a list of contacts in case of an emergency. The emergency contacts listed are NextEra Energy's Renewable Operations Control Center (ROCC), Energy Resources Control Center (ERCC), and the Site Leader/Manager. The ROCC is the primary contact for notification in the event of an emergency, and the ERCC is the primary contact for remote isolation of power to the site in the event of an emergency. The Site Leader/Manager is to be identified prior to the construction of the BESS site.

For first responder emergency response, the general strategy for the local fire department handling a fire event at the site is to establish a safe perimeter to monitor the fire and let it self-terminate. During a fire, deflagration of flammable gases may occur. It should be noted that the JF2 BESS container is equipped with an NFPA 69 concentration-reduction-based explosion prevention system to mitigate the explosion hazard [18]. The ROCC will electrically isolate the affected BESS container or grouping, inform the local fire department of any known hazards, and provide Safety Data Sheets (SDS). A site representative will direct the local fire department and deploy a site cleanup crew once the site is free of electrical hazards. At no point will a BESS container be occupied by personnel/first responders, as these containers are non-walk-in style enclosures. The standard emergency response guideline specified by NextEra Energy for first responders is to wear appropriate Personal Protective Equipment (PPE) and secure the perimeter, but not to approach or use water on any BESS container or open any BESS container doors.

## 2.3 BESS DESCRIPTION

The JF2 DC LINK 5.1 BESS (JF2 BESS) comprises three (3) battery enclosures (M-LINKs) and one (1) panel interface cabinet (E-PANEL). Each M-LINK contains two (2) battery racks wired in parallel in a 6.8 feet wide x 8.4 feet deep x 9 feet high enclosure. Each rack contains fourteen (14) battery modules wired in series and one (1) Battery Protection Unit (BPU) located at the bottom of the rack with a Rack-level Battery Management System (RBMS). Each battery module contains (120) cells arranged in a 30S4P configuration (4 parallel sets of 30 cells in series) and a Pack-level Battery Management System (PBMS). The battery modules use 159 Ah

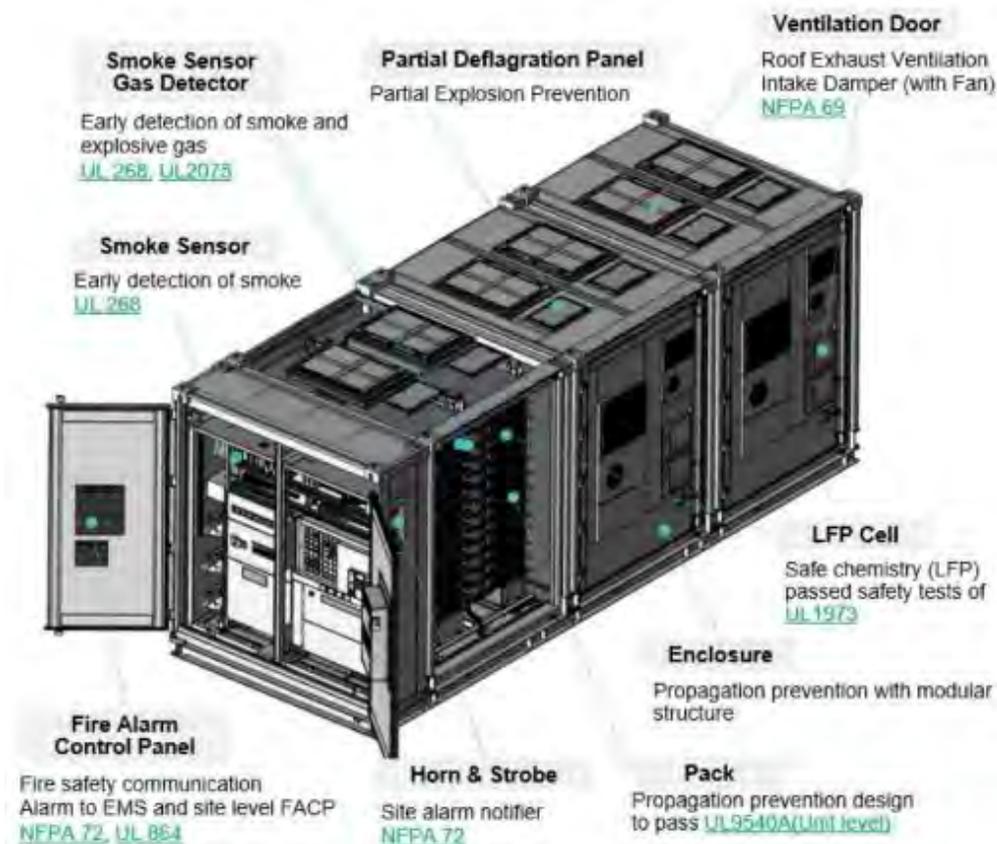
Lithium Iron Phosphate (LFP) pouch cells. This results in a total nominal energy capacity of 61.13 kWh per module, 855 kWh per rack, 1.7 MWh per M-LINK, and 5.112 MWh per BESS container.

The M-LINK enclosure features a concentration-reduction-based explosion prevention system designed in accordance with NFPA 69 [3], with two (2) door intake fans and two (2) roof exhaust vents that allow active exhaust ventilation based on gas detection of hydrogen (H<sub>2</sub>) or smoke detection within the enclosure [18].

Each M-LINK enclosure may be equipped with an optional open sprinkler at the top of the battery racks with a dry pipe connection and with water being provided from outside with a fire department connection located on-site; however, this feature will not be utilized at the Corby Energy Storage Site, consistent with the exception in 2022 CFC Table 1207.8(c) and 2023 NFPA 855 §9.5.2.5 for remote outdoor installations and subject to approval by the Authority Having Jurisdiction (AHJ).

The E-PANEL cabinet contains a disconnect means for the AC/DC distribution board, a Fire Alarm Control Panel (FACP) with a backup battery, distinct horns & strobes for gas and smoke detection in M-LINK enclosures. The E-PANEL serves as an interface between the battery, grid, and PCS sides to effectively manage the functions and safety features of the M-LINK enclosures.

Figure 2-4 [19] shows a rendering of the JF2 DC LINK BESS with 3 M-LINK units and one E-Panel unit.



**Figure 2-4: Rendering of the LGES JF2 DC LINK BESS (with 3 M-LINK units).**

Each M-LINK is equipped with smoke and gas detectors that are monitored by NextEra Energy ROCC. Any alarm state communicated from a BESS container is seen at the full site network's energy storage management system/programmable logic controller (ESMS/PLC). The ESMS/PLC is certified to IEC 61131-2 [4] and IEC/UL 61010-2-201 [5] <sup>1</sup>. The ESMS/PLC then transmits signals and alarms to NextEra Energy ROCC, which qualifies as a proprietary supervising station. The ROCC is staffed 24/7/365 and located in a building designed to withstand a Category 5 hurricane with a backup power supply.

The RBMSs within each M-LINK in a JF2 BESS container communicate to the site ESMS/PLC, which then transmits signals to the ROCC. If any abnormal condition is detected, the shutdown of the affected BESS container is triggered. The ESMS/PLC is also able to communicate with the PCS skids and control the lineup level (e.g., which components are discharging electricity to the grid/load).

### 2.3.1 Energy Storage Management System (ESMS)/Programmable Logic Controller (PLC)

Table 2-2 summarizes key information on the Energy Storage Management System (ESMS)/Programmable Logic Controller (PLC) used for the Corby Energy Storage BESS site.

*Table 2-2: Energy Storage Management System (ESMS)/Programmable Logic Controller (PLC) Information*

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	N/A
<b>Function</b>	Executes all control functions for the project site, executes site-level protection mechanisms, provides third-party supervisory, control, and data acquisition (SCADA) interfaces, and performs local data storage
<b>Emergency Function</b>	Real-time monitoring of overcurrent, overvoltage, temperature, Fire Alarm Control Panel (FACP) trouble, faults, etc. Transmitting signals and alarms to NextEra Energy ROCC. Shutdown of any BESS container if an abnormal condition is detected.
<b>Certifications<sup>2</sup></b>	IEC 61131-2 [4] IEC/UL 61010-2-201 [5]
<b>Known Hazards During Normal Operations</b>	Electrical shock

<sup>1</sup> Certifications for the listed standards were not provided to Jensen Hughes for review, as an ESMS/PLC model is not currently selected.

<sup>2</sup> Certifications for the listed standards were not provided to Jensen Hughes for review, as an ESMS/PLC model is not currently selected.

### 2.3.2 Power Conversion System (PCS)

Table 2-3 summarizes key information on the Power Conversion System (PCS) (or inverter) used for the Corby Energy Storage BESS site with the JF2 DC LINK BESS [20].

Table 2-3: Power Conversion System Information

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	Power Electronics FREEMAQ PCSM GEN 3 (FP4200M)
<b>Function</b>	Contains up to four (4) DC inputs with inverters that convert DC and AC power between the battery and grid sides, respectively. Low-voltage generated by the inverters is transformed by a medium-voltage transformer to a higher-voltage level and fed into the power grid.
<b>UL Listing</b>	UL 1741 [6] (Certification [21])
<b>Additional Listings and Compliance</b>	IEC 62109-1 / IEC 62109-2 [9][10] (Certification [22]) IEC 62116 [11] (Certification [23]) IEC 60529 [12] (Certification [24])
<b>Support of Safe Operation</b>	Medium-voltage AC switchgear (configurable) DC switch-disconnector AC and DC overvoltage protection (surge protection for AC, DC, and auxiliary circuits) Ground-fault detection via isolation monitoring device NEMA 3R outdoor-rated cabinet Forced-air cooling system
<b>Emergency Function</b>	Insulation monitoring device alarms or trips the system when a ground-fault or insulation fault is detected. DC switch-disconnector can be manually or electronically activated to disconnect the DC line from the inverter. Current interrupt devices, breakers, fuses, or other passive surge-arresting elements that may open the circuit in the case of failure.
<b>Known Hazards During Normal Operations</b>	Electrical shock

### 2.3.3 Signage and Warning Labels

Signs and warning labels to alert site personnel, emergency responders, and the public of safety hazards are required by the 2022 CFC §1207.4.8 and 2023 NFPA 855 §4.7.4 to be placed on entrance gates to BESS areas and on doors of BESS containers. The signs and warning labels alert to the presence of a battery energy storage system (BESS), electric shock hazards, fire and explosion hazards, and provide warnings against trespassing and other hazard information for anyone who may approach the BESS site.

The signage on the entrance gates to BESS areas and doors of BESS containers should comply with 2022 CFC §1207.4.8, which requires compliance with NFPA 70 [13] and the following information on the label:

1. "Energy Storage System", "Battery Storage System", or the equivalent.
2. The identification of the electrochemical BESS technology present (i.e., lithium-ion battery).
3. "Energized Electrical Circuits"
4. Where water-reactive electrochemical BESS are present, the signage shall include "Apply No Water"
5. Current contact information, including phone number for personnel authorized to service the equipment and for fire mitigation personnel required by 2022 CFC §1207.1.6.1.

In addition, 2022 CFC §1207.4.1 requires installing placards or directories at the main electrical service disconnecting means when the BESS disconnecting means is not within sight. These placards or directories must indicate the location of the BESS disconnecting means in accordance with NFPA 70 [13].

The signage on entrance gates to BESS areas and doors of BESS containers should comply with 2023 NFPA 855 §4.7.4.2, which requires compliance with ANSI Z535 [14], and the following information on the sign/label:

1. "Energy Storage System" with the symbol of a lightning bolt in a triangle
2. The identification of the type of technology associated with the BESS (i.e., lithium-ion battery)
3. Special hazards associated as identified in 2023 NFPA 855 §9 (i.e., fire and explosion hazards)
4. Type of suppression system installed in the area of the BESS (none if not installed)
5. Emergency contact information.

In addition, 2023 NFPA 855 §4.7.4.3 requires installing a permanent plaque or directory, denoting the location of the disconnecting means for all BESS on or in the premises. This plaque or directory should be located at each service equipment location and at the location(s) of the system disconnect(s) for all BESS capable of being interconnected.

Actual signage for the Corby Energy Storage BESS site has not been identified. It is recommended to review the signage plan for this site to ensure it complies with the code requirements listed above.

The signage information in this section is based on standard required signage for lithium-ion BESS sites provided by NextEra Energy [30]. It is recommended to create a site-specific signage plan detailing the exact signage used and their locations on the entrance gate(s), perimeter fence sections, and BESS containers doors. It is also recommended to include the disconnecting means signage details, including the required permanent plaques and directories indicating the location of all BESS disconnecting means on the premises.

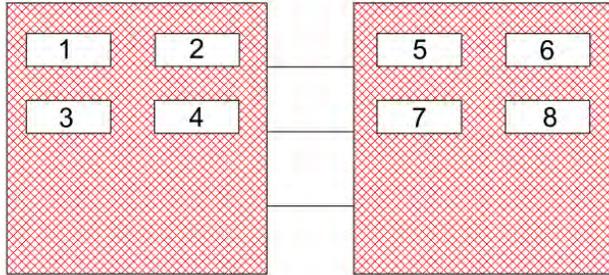
Figure 2-5 [30] shows standard signage as it should be placed on entrance gates and perimeter fences.

**NOTES**

1. SIGNS SHALL BE PLACED AT A HEIGHT OF 6 FT.

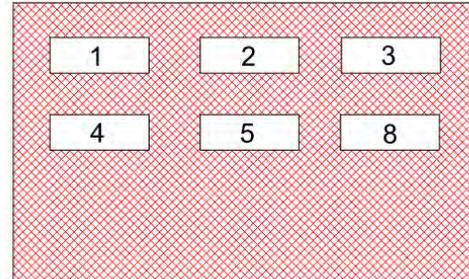
**NOTES**

1. PLACE SIGNS IN GROUPS AS SHOWN, EVERY 300 FT FENCE SECTION OR ON EACH PERIMETER SIDE, WHICHEVER IS GREATER. SIGNS SHALL BE PLACED AT A HEIGHT OF 6 FT.



**DETAIL ARRANGEMENT**

1. DETAIL 7
2. DETAIL 8
3. DETAIL 9
4. DETAIL 10
5. DETAIL 11
6. DETAIL 12
7. DETAIL 13
8. DETAIL 14



**DETAIL ARRANGEMENT**

1. DETAIL 7
2. DETAIL 8
3. DETAIL 9
4. DETAIL 10
5. DETAIL 11
8. DETAIL 14

**LAYOUT OF SECURITY AND SAFETY SIGNS ON ACCESS GATES**

NOT TO SCALE



**LAYOUT OF BESS PERIMETER WALLS/FENCE SECURITY AND SAFETY SIGNS**

NOT TO SCALE



<p><b>Detail 7</b></p>	<p><b>Detail 8</b></p>	<p><b>Detail 9</b></p>	<p><b>Detail 10</b></p>
<p><b>Detail 11</b></p>	<p><b>Detail 12</b></p>	<p><b>Detail 13</b></p>	<p><b>Detail 14</b></p>

Figure 2-5: Standard Signage Arrangement and Content on Site Access Gates and Perimeter Fence.

Figure 2-6 [30] shows standard signage to be mounted on each BESS container/enclosure doors.

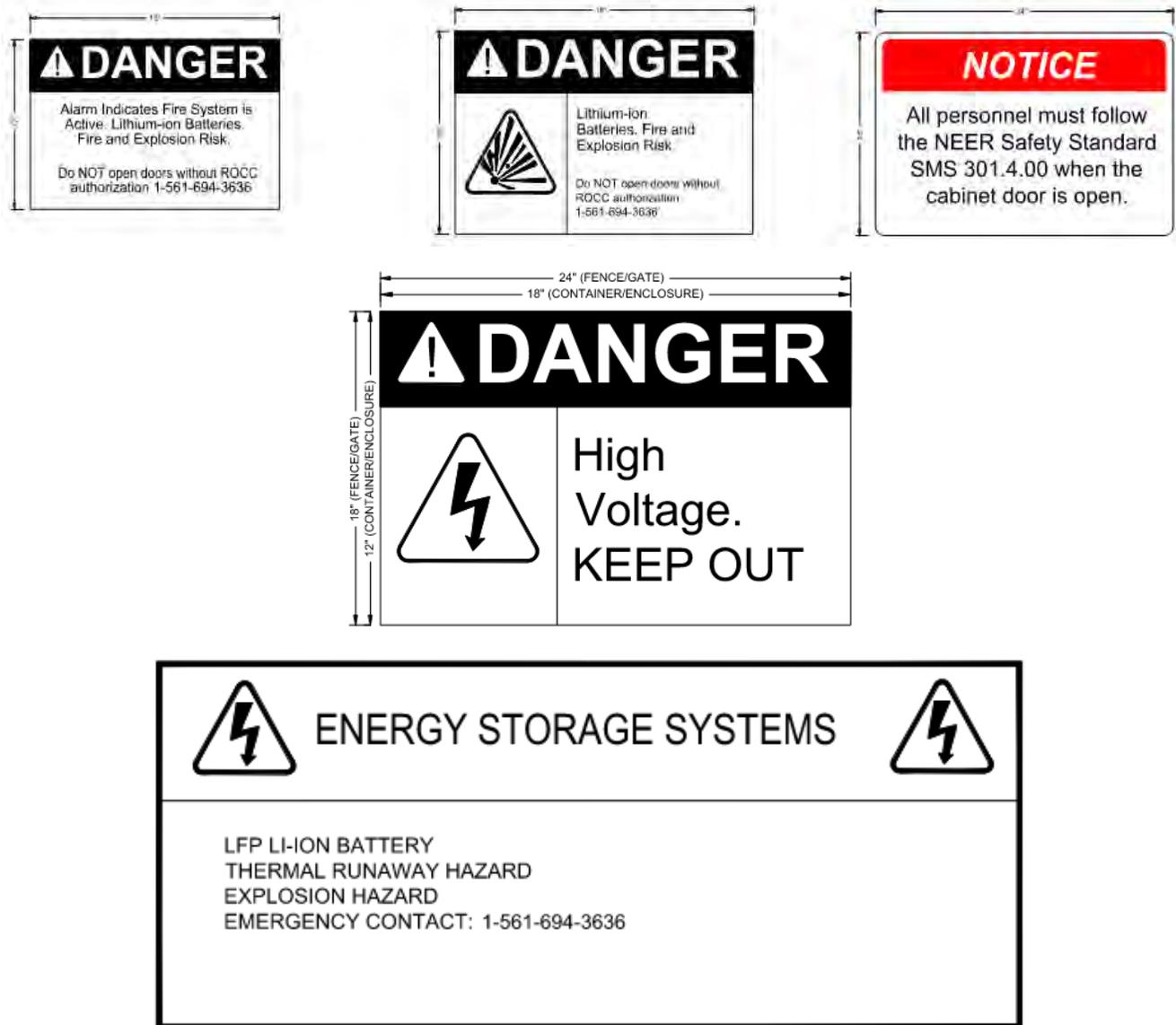


Figure 2-6: Standard Signage on BESS Enclosure/Container Doors.

### 3.0 Hazard Mitigation Analysis

This section details the HMA that was performed for the JF2 BESS installation at the Corby Energy Storage BESS site. The following sub-sections provide an overview of the applicable codes for this site and the analysis of the BESS failure modes that are prescribed by these applicable codes and standards.

#### 3.1 CODES AND STANDARDS

Table 3-1 provides an overview of the primary codes and standards used for this evaluation and their relationship to other referenced codes, standards, and requirements. Specifically, failure modes identified in 2022 CFC and 2023 NFPA 855 were considered in the analysis. Fire protection requirements for BESS per 2022 CFC and 2023 NFPA 855 were used to inform the evaluation of the BESS installation.

*Table 3-1: Applicable Codes and Standards*

<i>Code or Standard</i>	<i>Commentary/Compliance</i>
<i>California Fire Code CFC (2022) [1]</i>	2022 CFC §1207.1.4 lists the requirements for the HMA
<i>NFPA 855: Standard for the Installation of Stationary Energy Storage Systems (2023) [2]</i>	2023 NFPA 855 §4.4.2 lists the requirements for the HMA
<i>UL 9540: Standard for Safety – Energy Storage Systems and Equipment (2023) [7]</i>	2022 CFC §1207.3.1 and 2023 NFPA 855 §5.6.1 require that BESS shall be listed in accordance with UL 9540 The JF2 BESS is UL 9540 listed (Certification [17])

#### 3.2 FAILURE MODES ANALYSIS

This section addresses the failure modes identified in 2022 CFC §1207.1.4.1 and 2023 NFPA 855 §4.4.2 applicable to lithium-ion batteries, which are in general agreement with industry best practices:

2022 CFC §1207.1.4.1 requires an evaluation of the following failure modes:

- (1) A thermal runaway condition in a single BESS rack, module, or unit, addressed in Section 3.2.1.
- (2) Failure of any battery (energy) management system, addressed in Section 3.2.2.
- (3) Failure of any required ventilation or exhaust system, addressed in Section 3.2.3.
- (4) Voltage surges on the primary electric supply, addressed in Section 3.2.2.
- (5) Short circuits on the load side of the BESS, addressed in Section 3.2.2.
- (6) Failure of the smoke detection, fire detection, fire suppression, or gas detection system, addressed in Section 3.2.3.
- (7) Required spill neutralization not being provided or failure of a required secondary containment system.

Item (7) listed above was not analyzed as part of this HMA because lithium-ion battery cells are sealed, and there is no spill component associated with this battery chemistry. Secondary containment and spill neutralization are not applicable for lithium-ion battery technologies per the 2022 CFC Table 1207.6.

2023 NFPA 855 §4.4.2 requires an evaluation of the following failure modes:

- (1) A thermal runaway or mechanical failure condition in a single BESS unit, addressed in Section 3.2.1.
- (2) Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA), addressed in Section 3.2.2.
- (3) Failure of a required protection system, including, but not limited to, ventilation (HVAC), exhaust ventilation, smoke detection, fire suppression, or gas detection, addressed in Section 3.2.3.

While not explicitly required by the 2022 CFC or 2023 NFPA 855 as one of the failure modes, failure of firefighting response is also evaluated and addressed in Section 3.2.4.

Only single failure modes were considered for each scenario. The evaluation includes a written description of the failure mode, the safeguards in place to prevent or mitigate the failure, and the consequences of the failure. Where existing safeguards do not adequately prevent or mitigate consequences, recommendations were made. This written evaluation is analogous to a generic bowtie evaluation. It should be noted that this is a consequence-based analysis, meaning that the likelihood of the event is not considered.

### **3.2.1 Thermal Runaway Condition in a Single BESS Rack, Module, or Unit**

#### *3.2.1.1 Description*

Thermal runaway is the condition in which an electrochemical battery cell increases its temperature through self-heating in an uncontrollable fashion and progresses when the cell's heat generation is at a higher rate than it can dissipate. This leads to the release of flammable gas and can result in a fire or explosion.

Section 3.2.1.1 of the JF2 BESS product-level HMA [24] provides a detailed discussion of thermal runaway mechanisms, potential ignition scenarios, and pathways for thermal runaway propagation. Section 2.3 of the JF2 BESS product-level HMA [26] provides a summary of the UL 9540A [8] thermal runaway propagation testing for JF2 BESS at the cell, module, and unit levels. The unit-level test met all UL 9540A performance criteria and did not show thermal runaway propagation outside the initiating unit.

At the site level, the hazard assessment considers the consequences of a BESS container fire under abnormal or worst-case conditions. Unchecked thermal runaway within a BESS container may lead to the BESS container burning or result in a deflagration. A fire involving the BESS container can release toxic gases into the environment. A generic toxic plume release analysis is available for the JF2 BESS product [15]; however, a site-specific analysis is not available.

#### *3.2.1.2 Safeguards*

Safeguards are put in place to help prevent batteries from entering thermal runaway, cope with the byproducts of thermal runaway, and limit the propagation of thermal runaway to other cells within a module and/or a rack. The product-level safeguards are listed in Section 3.2.1.2 of the JF2 BESS product-level HMA [26].

At the site-level, the PCS includes current-interrupt devices, breakers, fuses, and other passive surge-arresting elements that may open the circuit in the event of failure. If potentially hazardous temperatures or other hazardous conditions are detected, the BESS components or containers will be electrically isolated by operators monitoring the signals transmitted to the ROCC.

For the Corby Energy Storage BESS site, each JF2 BESS container is separated from other containers by 3 feet of spacing between the ends and between the long side walls. Separation between containers helps to prevent container-to-container fire spread. Each group of three (3) JF2 BESS containers and one (1) PCS skid has at least 10 feet aisles between other groups of BESS containers and PCS skids, and each BESS pad is surrounded by a 24-foot-wide road, providing additional separation in the event of a fire.

### 3.2.1.3 Consequences

The consequences of a thermal runaway event occurring in the JF2 BESS container are discussed in the product-level HMA [26]. To summarize, failure of the safety systems to mitigate a thermal runaway event could cause a large-scale fire or explosion. In the event of a large-scale fire, multiple BESS containers may become involved, although the separation distance between containers and the results of UL 9540A and large-scale fire testing make this a lower likelihood scenario.

The Corby Energy Storage BESS site is considered remote; a large fire is not expected to impact critical infrastructure, and the site is typically unoccupied. A large fire may produce significant smoke, which can pose health effects to surrounding populations. In the incident literature, smoke plumes from BESS fires have not been observed to pose greater health risks than those from conventional fires, although this remains an ongoing research topic.

Spacing between BESS containers can reduce the risk of fire spread between containers. The separation distance between the JF2 BESS containers at the Corby Energy Storage site is at least 3 feet. There are no prescriptive size and separation code requirements applicable to the Corby Energy Storage site, as it is classified as a remote installation per 2022 CFC or 2023 NFPA 855, and the consequence of a fire involving multiple BESS containers has a low risk to life safety, as the site is normally unoccupied. For property protection, spacing recommendations from large-scale fire testing of the JF2 BESS [16], which demonstrated no propagation at 3 feet spacing, can be used to inform separation strategies and justify site-specific risk mitigation.

LGES recommends maintaining minimum clearances around the JF2 BESS container consistent with those evaluated during the large-scale fire test (LSFT) for the JF2 BESS product. These distances are considered acceptable based on the LSFT results, which demonstrated that a spacing of 3 feet between adjacent containers (Back-to-Back and Side-to-Side) effectively prevented fire propagation, with only minor surface scorching observed on neighboring containers. Similarly, clearances of 5 feet (E-panel-to-Wall) and 10 feet (Front-to-Wall) prevented fire spread or structural ignition [16].

Industry incident investigations have shown that strong winds can influence flame behavior and contribute to fire spread between closely spaced BESS containers. In a one large-scale BESS incident involving a different BESS product than the one used for the project [27], a container fire spread from one unit to an adjacent unit, with the investigation determining that the spread mechanism was driven by wind-blown flames and hot gas entering vents or openings on the adjacent container rather than conductive heat transfer between the containers. The event highlighted how wind direction and flame impingement can affect external fire behavior. It should be noted that JF2 BESS containers have normally closed dampers on all air inlets/outlets, along with a controlled exhaust venting system designed to comply with NFPA 69 [3], to limit internal gas accumulation and external flame exposure. This design, as demonstrated in the LSFT, may reduce the likelihood of flame ingress and fire propagation between adjacent containers.

The outline emergency response plan applicable to the Corby Energy Storage BESS site (not referenced in this report and to be provided by NextEra Energy) does not prescribe active firefighting, and first responders have a

responsibility to set a perimeter and let any event self-terminate. NextEra Energy personnel will provide guidance on the status of electrical hazards and will perform cleanup operations. The emergency response plan is thus partially developed, addressing recommendation (1) from the product-level HMA [26]. Thermal management through firefighting will not be performed for the Corby Energy Storage BESS site. However, part of the recommendation remains applicable, as coordination and training of the local fire department(s) are necessary to ensure the safety of first responders.

Toxic gases released from a fire event at the BESS are typically not an issue for remote sites, like the Corby Energy Storage BESS site, which are separated by at least 100 feet from buildings, lot lines, or public ways. The Corby Energy Storage site is not typically manned and is surrounded by a fence (at least 54 feet away from any BESS container) to keep out trespassers and is at least 100 feet away from the closest building (i.e., the substation fence line is at least 100 feet from the closest BESS container).

#### 3.2.1.4 Recommendations

See Section 3.2.1.4 of the JF2 BESS product-level HMA [26] for product-level recommendations to mitigate the thermal runaway hazard. In addition to the product-level HMA recommendations,

1. Coordinate with the local fire department(s) to ensure first responders are familiar with the specific hazards and proper response procedures to a fire event at the BESS installation.

As noted in the prior section, recommendation (1) is partially addressed by the outline emergency response plan along with the fire department orientation presentation.

### 3.2.2 Energy Storage Management System Failure

#### 3.2.2.1 Description

The Energy Storage Management System (ESMS) is defined in 2022 CFC §1202 and 2023 NFPA 855 §3.3.8 as *“a system that protects energy storage systems from operating outside their safe operating parameters and disconnects electrical power to the BESS or places it in a safe condition if potentially hazardous temperatures or other conditions are detected.”* This definition implies that the ESMS encompasses the combined performance of the PCS, the site-level ESMS, and the container-level ESMS. This section addresses potential failures in these subsystems. A discussion of the container-level ESMS components (i.e., PBMSs and RBMSs) can be found in the JF2 BESS product-level HMA [26].

Each failure mode can be addressed based on overall function expectations. Each PCS unit is connected to up to three (3) JF2 BESS containers and converts the low-voltage DC power from the BESS to high-voltage AC power that can feed the power grid. The site-level ESMS transmits signals and alarms to the ROCC and can trigger container shutdown if an abnormal condition is detected. 2022 CFC §1207.3.4 and 2023 NFPA 855 §9.2.3.2 require the ESMS to disconnect electrical connections to the BESS or otherwise place it in a safe condition if potentially hazardous temperatures or other conditions, such as short circuits, overvoltage, or undervoltage, are detected.

- + The PCS may fail to detect ground fault, insulation degradation, wiring faults, abnormal current or voltage conditions, internal temperature increases, communication failures with the ESMS, or internal component malfunctions. This can result in an inability to shut down, report adverse conditions, properly monitor, balance, and protect the system, resulting in failure of other components in the BESS.

- + The site-level ESMS may fail to report abnormal conditions to the ROCC, resulting in a delayed or prolonged response from the ROCC to notify the local fire department. Failure to shut down the BESS under abnormal conditions can result in further damage to BESS components.

#### 3.2.2.2 Safeguards

Safeguards against failure of the PCS include:

- + The insulation monitoring device alarms or trips the system when a ground-fault or insulation fault is detected.
- + The DC switch-disconnector can be manually or electronically activated to disconnect the DC line from the inverter.
- + Current interrupt devices, breakers, fuses, or other passive surge-arresting elements that may open the circuit in the case of failure.

The site ESMS/PLC is certified to IEC 61131-2 [4] and IEC/UL 61010-2-201 [5]<sup>3</sup>. IEC 61010-2-201 requires an overload test (higher current by a factor of 1.5, higher voltage by a factor of 1.1) and an endurance test to be performed on the equipment. Thus, the device certified to IEC 61010-2-201 is designed to operate in conditions exceeding its voltage and current ratings.

#### 3.2.2.3 Consequences

Failure to shut down the system given potentially hazardous temperatures or other conditions, such as short circuits or voltage surges, may result in damage to the battery cells. This damage could ultimately lead to a thermal runaway event. The consequences of a thermal runaway event are described in Section 3.2.1.3 and the product-level HMA [26].

#### 3.2.2.4 Recommendations

In the event of an ESMS failure, the worst-case consequence is a thermal runaway. Therefore, the same recommendations as provided in Section 3.2.1.4 of the JF2 BESS product-level HMA [26] apply. In addition to the product-level HMA recommendations,

2. All manual and automatic system functions, alarms, and interlocks should be tested during site/system commissioning.
3. Periodic inspection, testing, and maintenance should be performed on all equipment and instrumentation tied to the PCS in accordance with manufacturer recommendations and industry standard practices.

### 3.2.3 Failure of a Required Protection System, including, but not Limited to, Ventilation (HVAC), Exhaust Ventilation, Smoke Detection, Fire Detection, Fire Suppression, or Gas Detection

The site does not have any protection systems in addition to what is already provided in the JF2 BESS container. For a discussion of the product-level protection systems, see Section 3.2.3 to Section 3.2.7 of the JF2 BESS product-level HMA [26].

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<sup>3</sup> Certifications for the listed standards were not provided to Jensen Hughes for review, as an ESMS/PLC model is not currently selected.

## 3.2.4 Firefighting Response

### 3.2.4.1 Description

Manual firefighting response by the local fire department will be a "defensive approach" and will be outlined in a site-specific emergency response plan and orientation presentation to be given by NextEra Energy to the local fire department(s). NextEra Energy has an outline emergency response plan and a template orientation presentation (not referenced in this report and to be provided by NextEra Energy) that will need to be finalized in coordination with the local fire department(s). The site-specific emergency response plan should be prepared during the permitting stage and finalized prior to commissioning. Site-specific fire department orientation should be initiated during the permitting stage, and site-specific training should be conducted prior to commissioning.

Activation of the smoke or gas detection systems in a JF2 BESS container will send an alarm signal from the FACP to the ROCC supervising station, which will notify the local fire department(s). On-site, the fire department handling the fire event should establish a safe perimeter to monitor the fire and allow it to burn out. The ROCC should isolate the affected BESS container or grouping, inform the local fire department of any known hazards, and provide Safety Data Sheets (SDS). A site representative will direct the local fire department and deploy a site cleanup crew once the site is free of electrical hazards. At no point will a BESS container be occupied by personnel/first responders, as these containers are non-walk-in style enclosures. The standard emergency response guideline specified by NextEra Energy for first responders is to wear appropriate Personal Protective Equipment (PPE) and secure the perimeter, but not to approach or use water on any BESS container or open any BESS container doors.

### 3.2.4.2 Safeguards

The template emergency action plan (not referenced in this report and to be provided by NextEra Energy) calls for safety training of site personnel annually, when the plan is instated, and when the plan changes.

### 3.2.4.3 Consequences

Lack of adequate emergency action and response planning, training, and/or site familiarity may result in harm to site personnel and emergency responders.

### 3.2.4.4 Recommendations

4. Prepare and coordinate the emergency response plan with the local fire department(s). Host site familiarization and training sessions annually and when there are appropriate site changes to ensure first responders understand the emergency response procedures, including maintaining a safe perimeter, monitoring fire events without approaching or using water on any BESS container or opening any BESS container doors.
5. Develop a site-specific signage plan detailing the design and placement of all signage installed on the site, in compliance with 2022 CFC §1207.4.8 and §1207.4.1 and 2023 NFPA 855 §4.7.4.2 and §4.7.4.3. Refer to Section 2.3.3 for required signage details and examples.

## 4.0 Conclusions

A site-level hazard mitigation analysis (HMA) was performed for the JF2 BESS installation at the Corby Energy Storage BESS site. The failure modes provided in 2022 CFC §1207.1.4.1 and 2023 NFPA 855 §4.4.2 were used to conduct a consequence-based analysis, which determined how well the provided safeguards would reduce the severity of the hazard. The likelihood of events was not assessed, and only single failure modes were considered. Where existing safeguards do not adequately prevent or mitigate consequences, recommendations were made.

### 4.1 RECOMMENDATIONS

The HMA resulted in the recommendations presented in Table 4-1.

*Table 4-1: Site-Level HMA Recommendations*

<i>No.</i>	<i>Category</i>	<i>Description</i>
1	Fire Department Coordination	Coordinate with the local fire department(s) to ensure first responders are familiar with the specific hazards and proper response procedures to a fire event at the BESS installation.
2	Testing During Commissioning	All manual and automatic system functions, alarms, and interlocks should be tested during site/system commissioning.
3	Periodic Inspection, Testing, and Maintenance of PCS	Periodic inspection, testing, and maintenance should be performed on all equipment and instrumentation tied to the PCS in accordance with manufacturer recommendations and industry standard practices.
4	Emergency Response Plan Coordination	Prepare and coordinate the emergency response plan with the local fire department(s). Host site familiarization and training sessions annually and when there are appropriate site changes to ensure first responders understand the emergency response procedures, including maintaining a safe perimeter, monitoring fire events without approaching or using water on any BESS container or opening any BESS container doors.
5	Compliant Site-Specific Signage Plan	Develop a site-specific signage plan detailing the design and placement of all signage installed on the site, in compliance with 2022 CFC §1207.4.8 and §1207.4.1 and 2023 NFPA 855 §4.7.4.2 and §4.7.4.3. Refer to Section 2.3.3 for required signage details and examples.

## 4.2 HMA APPROVAL

The local AHJ may approve the HMA provided that the conditions stated in 2022 CFC § 1207.1.4.2 and 2023 NFPA 855 §4.4.3 are demonstrated. These conditions are summarized in Table 4-1..

Table 4-1: Approval of HMA

<i>Conditions Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
<p>1. Fires will be contained within unoccupied BESS rooms or areas for the minimum duration of the fire-resistance-rated separations identified in CFC § 1207.7.4, which states that <i>rooms or spaces containing BESS shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating, constructed in accordance with the International Building Code [2022 CFC §1207.1.4.2(1)].</i></p>	N/A	<p>The Corby BESS meets the intent of this requirement.</p> <p>The JF2 BESS containers are non-walk-in, non-occupiable enclosures installed outdoors, not within unoccupied BESS rooms or indoor areas.</p> <p>However, it should be noted that the JF2 BESS has several mitigation measures in place that may reduce the likelihood of fire spreading to an adjacent container. As demonstrated in the LSFT of the JF2 BESS, fire was contained to a single container and did not propagate to adjacent containers when spaced at 3 feet.</p>
<p>2. Fires will be contained within unoccupied BESS rooms for the minimum duration of the fire resistance rating specified in NFPA 855 §9.6.4, which states that <i>rooms or spaces containing BESS shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating, constructed in accordance with the local building code. [2023 NFPA 855 §4.4.3(1)]</i></p>		<p>Although this requirement applies to unoccupied BESS rooms rather than outdoor installations, the Corby BESS still meets the intent of the requirement by limiting the risk of a fire event to a single JF2 BESS container. The site's spacing strategy, which provides a minimum of 3 feet of separation between containers, is consistent with and supported by the LSFT results, which demonstrated no fire propagation between containers at this distance.</p>

<i>Conditions Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
3. Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate [2022 CFC §1207.1.4.2(2)].	N/A	The Corby BESS meets the intent of this requirement.
4. Fires and products of combustion will not prevent occupants from evacuating to a safe location [2023 NFPA 855 §4.4.3(2)].		The JF2 BESS containers are non-walk-in, non-occupiable enclosures installed outdoors on a regularly unmanned, remotely located site, not within occupied work centers or indoor areas.
		However, it should be noted that the JF2 BESS container is provided with numerous internal sensors monitored by the BMS that can detect abnormal conditions in the container, along with smoke and gas detection. These detection systems can activate the horn/strobe installed on the exterior of the JF2 BESS container to provide local notification to promptly inform anyone who may be performing work on or nearby the container.
		Additionally, the remote outdoor location helps mitigate the impact of fire and combustion products on the ability of those working on or nearby the container to evacuate.
		Although this requirement applies to occupied work centers and not to outdoor installations, the Corby BESS still meets the intent of the requirement via the internal sensors + BMS, detection and alarm systems, and the site's outdoor remote location.

<i>Conditions Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
5. Toxic and highly toxic gasses released during fires will not reach concentrations in excess of the Immediately Dangerous to Life or Health (IDLH) level in the building or adjacent means of egress routes during the time deemed necessary to evacuate occupants from any affected area [2022 CFC §1207.1.4.2(3)].	N/A	<p>The Corby BESS meets the intent of this requirement.</p> <p>The JF2 BESS containers are non-walk-in, non-occupiable enclosures installed outdoors. The Corby BESS is classified as a remote, outdoor BESS installation, with no occupied buildings or public exposures within 100 feet of the nearest JF2 BESS container. Therefore, the Corby BESS is not located within a building or adjacent to a building's means of egress routes. As such, no toxic or highly toxic gases released during a fire would reach IDLH levels in buildings or adjacent means of egress routes.</p> <p>However, it should be noted that gases released during a fire may result in a localized concentration in excess of IDLH levels, as illustrated by the generic JF2 BESS product plume analysis performed by LGES for the JF2 BESS product [15]. Therefore, first responders should wear proper personal protective equipment (PPE) when responding to a Corby BESS fire.</p>
6. Flammable gases released from the BESS during charging discharging, discharging, and normal operation will not exceed 25 percent of their Lower Flammability Limit (LFL) [2022 CFC §1207.1.4.2(4)].	Y	<p>The Corby BESS meets this requirement.</p> <p>The JF2 BESS container uses lithium-ion batteries, which do not release flammable gases during normal charging, discharging, and operation. Gases are vented from the batteries only under abnormal conditions.</p>
7. Flammable gases released from BESS during fire, overcharging, and other abnormal conditions will be controlled through the use of ventilation of the gases, preventing accumulation, or by deflagration venting [2022 CFC §1207.1.4.2(5)].	Y	<p>The Corby BESS meets this requirement.</p> <p>Explosion control is provided in the JF2 BESS container via an NFPA 69 concentration-reduction-based explosion prevention system.</p>
8. Deflagration hazards will be addressed by an explosion control or other system [2023 NFPA 855 §4.4.3(3)].		

This report was based solely upon and limited to the available information provided and/or presented. Details and/or information not presented or provided on the documentation provided by the Client are not considered a part of this analysis. This report is not intended to verify or guarantee that the final installation complies with the applicable codes and standards and the recommendations of the HMA.

If you have any questions about this report, please do not hesitate to contact us.

Sincerely,

**Jensen Hughes**

Prepared by:



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Patrick O'Brien  
Associate  
patrick.obrien@jensenhughes.com

Reviewed by:



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Kushal Mistri  
Staff Engineer  
kushal.mistri@jensenhughes.com



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Jihan El Ouaragli  
Staff Engineer  
jihan.ouaragli@jensenhughes.com

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REPORT

# NEXTERA ENERGY– BATTERY ENERGY STORAGE SYSTEM JF2 DC LINK 5.1

## *Hazard Mitigation Analysis*

### PREPARED FOR

NextEra Energy Resources, LLC  
700 Universe Blvd  
Juno Beach, FL 33408-2657

Proposal #: 1KAP00025  
Report #: 1KAP00025-RPT4  
Revision # Rev. 1  
Date: 1/30/2026

### PREPARED BY

Jensen Hughes, LLC  
3610 Commerce Drive, Suite 820  
Baltimore, MD 21227

[akapahi@jensenhughes.com](mailto:akapahi@jensenhughes.com)



**JENSEN HUGHES**

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*Name*

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*Preparer(s):*                      **Jacob Witlin, EIT**

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*Reviewer(s):*                      **Jihan El Ouaragli**

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*Revision Record Summary*

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<i>Revision</i>	<i>Date</i>	<i>Revision Summary</i>
0	2/28/2025	Initial use
1	1/30/2026	Updated based on listing/certifications

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## Executive Summary

Jensen Hughes has completed a product-level Hazard Mitigation Analysis (HMA) of the LG Energy Solution (LGES) JF2 DC LINK 5.1 Battery Energy Storage System (BESS) design for NextEra Energy.

The product-HMA was conducted in accordance with the 2023 Edition of NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems (2023 NFPA 855)*, the 2021 Edition of the *International Fire Code (2021 IFC)*, and the 2022 Edition of the *California Fire Code (2022 CFC)*.

The HMA resulted in safety recommendations, summarized in Section 4.1 of this report, to address aspects of documentation and installation of JF2 DC LINK 5.1 BESS across NextEra Energy sites to ensure safe operation.

It should be noted that a dispersion analysis may be required for some site installations, depending on the setback distance from public receptors to satisfy NFPA 855 §4.4.3(2). Typically, a dispersion analysis is not required when the site is considered a remote outdoor installation in accordance with NFPA 855 §9.3.2(1).

This report serves as a product-level review. Site-level or installation-level analysis outside the scope of this report may be required in certain jurisdictions. The JF2 DC LINK 5.1 BESS design and its associated components were analyzed based on information in the LGES documentation provided by NextEra Energy. All identified non-compliance items are noted in this report.

This report was based solely upon and limited to the available information provided by NextEra Energy. Information not provided by NextEra Energy was not considered as part of this analysis.

## 1.0 Introduction

This report provides a product-level Hazard Mitigation Analysis (HMA) for the JF2 DC LINK 5.1 BESS in accordance with the 2023 Edition of NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems (2023 NFPA 855)*, the 2021 Edition of the *International Fire Code (2021 IFC)*, and the 2022 Edition of *California Fire Code (2022 CFC)*.

The HMA evaluates the consequences of defined BESS failure modes per 2023 NFPA 855 §4.4.2 and identifies safeguards that either prevent or mitigate the consequences. Where existing safeguards do not adequately prevent or mitigate consequences, recommendations are made. In addition to the failure modes listed by the 2023 NFPA 855, the 2021 IFC fault conditions listed in §1207.1.4.1 are also considered in this analysis. These are identical to those listed in the 2022 CFC §1207.1.4.1.

This report serves as a product-level review based on documentation from LGES provided by NextEra Energy. Additional site-level or installation-level analysis outside the scope of this report may be required in certain jurisdictions. Any non-compliance findings and recommendations are documented in this report.

The main sections of the report and a description of the content are provided in Table 1-1.

*Table 1-1: Report Organization*

<i>Section</i>	<i>Description</i>
<b>1 – Introduction</b>	Presents the scope and outline of the report.
<b>2 – BESS Description</b>	Provides an overview of the LGES JF2 DC LINK 5.1 BESS product. Describes components of the system and identifies applicable certifications and safety features.
<b>3 – Hazard Mitigation Analysis</b>	Evaluation of the consequences of the failure modes required per 2023 NFPA 855, 2021 IFC, and 2022 CFC. Assessment of existing safeguards against failure modes and recommendation of additional safeguards based on the current design.
<b>4 – Conclusions and Recommendations</b>	Summary of analysis and list of recommendations.
<b>5 – References</b>	Lists the references used for the analysis.

## 2.0 BESS Description

### 2.1 GENERAL PRODUCT INFORMATION

A rendering of the JF2 DC LINK 5.1 is shown in Figure 2-1, and product information is provided in Table 2-1.

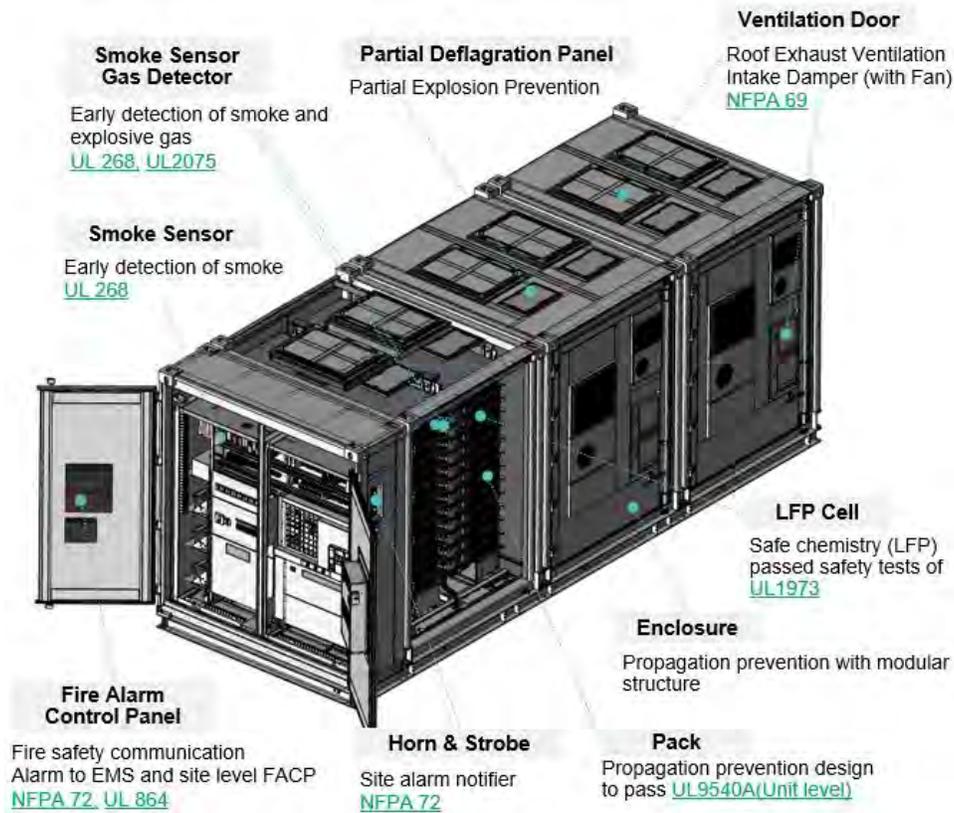


Figure 2-1: Rendering of LGES JF2 DC LINK 5.1 BESS (with 3 M-LINK units).

Table 2-1: Product Information

<b>Product Manufacturer</b>	LG Energy Solutions (LGES)
<b>Product Name and Version</b>	JF2 DC LINK 5.1
<b>Battery Cell Chemistry / Form Factor</b>	LFP Lithium Iron Phosphate (LiFePO4) / Pouch
<b>Design Basis System Output</b>	5.112 MWh (3 battery enclosures or M-LINKs 1.7 MWh each)
<b>BESS Function</b>	Grid-scale energy storage
<b>System Configuration</b>	Outdoor non-walk-in style enclosures/containers

## 2.2 BESS SUBSYSTEMS

The JF2 DC LINK 5.1 BESS is comprised of three (3) battery enclosures (M-LINKs) and one (1) panel interface cabinet (E-PANEL), as shown in Figure 2-1.

Each M-LINK contains two (2) battery racks/units (Model NR27N414L\_P15190NB3) wired in parallel in a 6.8 x 8.4 x 9 feet enclosure. Each rack/unit contains fourteen (14) battery packs/modules (Model EP096636PFB1) wired in series, one (1) Battery Protection Unit (BPU) located at the bottom of the rack, Rack-level Battery Management Systems (RBMS), liquid cooling system, chiller, HVAC system, and ventilation door.

Each battery module/pack contains 120 cells arranged in a 30S4P configuration (30 cells in series, four groups in parallel) and a Pack-level Battery Management System (PBMS). The cells used in the battery packs/modules are 159 Ah lithium-iron-phosphate (LFP) pouch cells (Model JF2). This results in a total nominal energy capacity of 61.13 kWh per module/pack, 855 kWh per rack, and 1.7 MWh per M-LINK.

The M-LINK enclosure features a concentration-reduction-based explosion prevention system, with panels opening to allow active ventilation based on gas detection of hydrogen (H<sub>2</sub>) or smoke within the enclosure. If requested by the installer, each M-LINK enclosure may be equipped with an optional open sprinkler at the top of the battery racks with a dry pipe connection and with water being provided from outside with a fire department connection located on-site.

The JF2 DC LINK 5.1 BESS also features an E-PANEL cabinet that contains a disconnect means for the AC/DC distribution board, a Fire Alarm Control Panel (FACP) with a backup battery, distinct horns & strobes for gas and smoke detection in M-LINKs. The E-PANEL is an interface between the battery side and the grid and power conversion system (PCS) sides to effectively manage the functions and the necessary safety features of the M-LINK enclosures.

Although this is not a site-specific HMA, it is assumed, based on communication from NextEra Energy, that the sites where the JF2 DC LINK 5.1 BESS will be installed will be classified as "remote locations" per 2023 NFPA 855 §9.3.2(1), 2021 IFC §1207.8.1, and 2022 CFC §1207.8.1. This means that all BESS containers will be located more than 100 feet from buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure.

**2.2.1 Cell**

A picture of the cell used in the JF2 DC LINK 5.1 BESS is shown in Figure 2-2, and key information is summarized in Table 2-2.



**Figure 2-2: LGES JF2 Battery Cell as shown in UL 9540A test report.**

*Table 2-2: Battery Cell Information*

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	JF2
<b>Electrical Ratings</b>	159.2 Ah / 3.2 V / 509.44 Wh
<b>Function</b>	Store chemical energy that can be converted to electrical energy
<b>UL Listing</b>	UL 1973:2022 Annex E (Certificate #: UL-US-2426857-0) [20] IEC 62619: 2022 (Certificate #: KR-KTL-12076) [21]
<b>Emergency Function</b>	Withstand abuse (e.g., high temperature, overcharge) without entering thermal runaway
<b>Known Hazards During Normal Operations</b>	Electrical shock

**2.2.2 Module/Pack**

A picture of the module/pack used in the JF2 DC LINK 5.1 BESS is shown in Figure 2-3, and key information is summarized in Table 2-3.



**Figure 2-3: LGES EP096636PFB1 Battery Module/Pack as shown in UL 9540A test report.**

*Table 2-3: Battery Module/Pack Information*

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	EP096636PFB1
<b>Electrical Ratings</b>	636.8 Ah / 96 V / 61.13 kWh
<b>Function</b>	Each module contains 4 parallel sets of 30 cells in series, for a total of 120 cells.
<b>UL Listing</b>	UL 1973:2022 (Certificate #: UL-US-2551497-0) [18]
<b>Emergency Function</b>	Each module includes three (3) aerogel pads and a Mica sheet to limit the rate and/or extent of thermal runaway propagation between battery cell(s). Additionally, a liquid coolant system (50% ethylene glycol, 50% water) for the battery packs is provided at the rack level.
<b>Known Hazards During Normal Operations</b>	Electrical shock

**2.2.3 Rack/Unit**

A picture of the rack/unit used in the JF2 DC LINK 5.1 BESS is shown in Figure 2-4, and key information is summarized in Table 2-4.



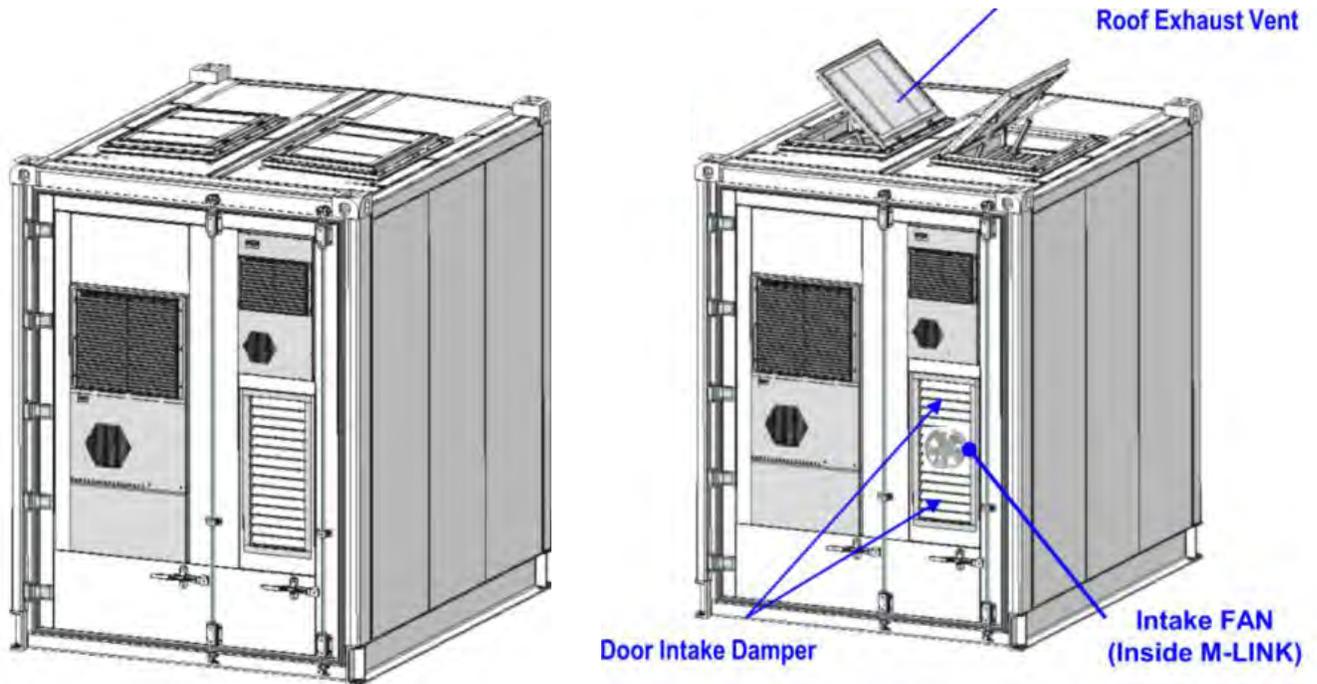
**Figure 2-4: LGES NR27N414L\_P15190NB3 Battery Rack as shown in UL 9540A test report.**

*Table 2-4: Battery Rack/Unit Information*

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	NR27N414L_P15190NB3
<b>Electrical Ratings</b>	636.8 Ah / 1,344 Vdc / 855.82 kWh
<b>Function</b>	Each rack/unit houses 14 battery modules/packs connected in series.
<b>UL Listing</b>	UL 1973:2022 (Certificate #: UL-US-2551498-0) [23]
<b>Certifications and/or Support of Safe Operation</b>	Construction of the rack is intended to safely hold the modules in place during normal operations
<b>Emergency Function</b>	None
<b>Known Hazards During Normal Operations</b>	Electrical shock

### 2.2.4 Battery Enclosure (M-LINK)

An illustration of the battery enclosure (M-LINK) of the JF2 DC LINK 5.1 BESS is shown in Figure 2-5, and key information is summarized in Table 2-5.



**Figure 2-5: JF2 M-LINK battery enclosure (design of the explosion prevention system is shown)**

*Table 2-5: Battery Enclosure (M-LINK) Information*

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	JF2 M-LINK
<b>Energy Capacity</b>	1.7 MWh (855 kWh per rack)
<b>Function</b>	Each M-LINK holds two (2) battery racks/units with 14 battery modules/packs each, for a total of 28 battery modules/packs.
<b>UL Listing</b>	Certified to UL 9540 as part of the JF2 DC LINK (Certificate #: UL-US-2559786-0) [24]
<b>Certifications and/or Support of Safe Operation</b>	IP55 (NEMA 3R)

<i>Parameter</i>	<i>Description</i>
<b>Emergency Function</b>	A concentration-reduction-based explosion prevention system, with panels opening to allow active ventilation based on gas detection of hydrogen (H <sub>2</sub> ) or smoke within the enclosure. The design includes two (2) exhaust vents on the roof, two (2) intake dampers, and an intake fan on the front door as per NFPA 69 requirements. This concept is designed to exhaust combustible gas that is produced during a failure, maintaining the overall environment of the M-LINK below 25% of the Lower Flammability Limit (LFL)
<b>Known Hazards During Normal Operations</b>	Electrical shock

**2.2.5 Battery Management System (BMS)**

Table 2-6 summarizes the key information on the JF2 DC LINK 5.1 BESS Battery Management System (BMS).

*Table 2-6: Battery Management System Information*

<i>Parameter</i>	<i>Description</i>
<b>Acronym / Name</b>	Unit/Rack BMS (RBMS) Module/Pack BMS (PBMS)
<b>Function</b>	Monitor, control, and optimize the performance of battery modules, and disconnect them from the system in the event of abnormal (fault) conditions. The BMS monitors cell voltage, current, and module temperature, and performs energy management, thermal management, fault diagnosis, and communication with the Energy Management System (EMS), Power Conversion System (PCS), or Power Management System (PMS).
<b>UL Listing</b>	Per NFPA 855 Table 9.6.5, thermal runaway protection is permitted to be part of a BMS that has been evaluated with the battery as part of the evaluation to UL 1973 or UL 9540. The JF2 pack with PBMS is UL 1973-listed [18] The JF2 rack with RBMS is UL 1973-listed [19] The JF2 DC LINK 5.1 BESS is UL 9540-listed [24]

<i>Parameter</i>	<i>Description</i>
<b>Certifications and/or Support of Safe Operation</b>	The BMS provides charge and discharge management of the batteries. Additionally, the BMS has safety features for cases of undervoltage or overvoltage, overtemperature, or overcurrent conditions, and it will alarm and then limit the charge and discharge current or power.
<b>Emergency Function</b>	Under emergency conditions, the BMS will cease charge/discharge operations and electrically disconnect the affected battery rack(s).
<b>Known Hazards During Normal Operations</b>	Electrical shock

**2.2.6 Panel Interface Cabinet (E-PANEL)**

Table 2-7 summarizes the key information on the JF2 DC LINK 5.1 BESS E-PANEL.

*Table 2-7: E-PANEL Information*

<i>Parameter</i>	<i>Description</i>
<b>Model</b>	EPNL_1200A(Type A) or EPNL_1200B(Type B)
<b>Function</b>	The E-PANEL serves as an interface for power and communication between PCS and M-LINK. Type A includes an industrial PC, while Type B does not and has a mirrored layout.
<b>UL Listing</b>	Certified to UL 9540 as part of the JF2 DC LINK [24]
<b>Emergency Function</b>	Disconnect switch, circuit protectors, auxiliary transformer, fuses, fire alarm control panel (FACP), and HVAC.
<b>Known Hazards During Normal Operations</b>	Electrical shock hazard

## 2.2.7 Fire Protection and Explosion Control Systems

Table 2-8 summarizes the key fire protection and explosion control systems for the JF2 DC LINK 5.1 system.

*Table 2-8: Fire Protection and Explosion Control Systems Information*

<i>System</i>	<i>Model/Type</i>	<i>Function</i>
<b>Gas Detection</b>	Honeywell Sensepoint XCL	One (1) hydrogen gas detector per M-LINK is provided. Upon detection of flammable gas, the explosion venting system is automatically activated.
<b>Smoke Detection</b>	FSP-951/B501-White	One (1) smoke detector per M-LINK is provided. Upon detection of smoke, the explosion venting system is automatically activated.  One (1) smoke detector located in the E-PANEL.
<b>Explosion Venting System</b>	Not Indicated (NFPA 69 Approach)	Gas and smoke detection systems are interlocked to activate the explosion venting system.  Upon activation, two (2) intake dampers will open, two (2) exhaust roof vents will open, and an intake fan will turn on.  The design has been evaluated in accordance with NFPA 69.
<b>Chiller &amp; HVAC</b>	Not Indicated	Each M-LINK is equipped with one BPU per rack (two in total), BMS, a liquid cooling system, and HVAC. The HVAC system conditions the air inside the container. HVAC is provided with Auxiliary Power for optimal battery life.
<b>Dry-Pipe Sprinkler</b>	Non-Indicated (Optional)	FDC provided to manually connect the hose to the open-head sprinkler system. Water suppression provides cooling to the system in the event of thermal runaway.
<b>Horn &amp; Strobe</b>	P2GRKLED & P2GWLKLED-P	Located outside the E-PANEL  Activates audible and visual alarms in the event that a fire is detected in M-LINK.  One horn & strobe is provided for smoke detection, and another horn & strobe is provided for gas detection.
<b>Fire Alarm Control Panel (FACP)</b>	NFS-320E	Located in the E-PANEL.  The FACP manages fire safety communication from the detection systems in M-LINK and alarms to EMS and the site-level FACP.  The FACP is provided with a battery backup of 24 hours (standby power) and 2 hours (alarm power)

## 2.3 THERMAL RUNAWAY FIRE PROPAGATION TESTING (UL 9540A)

BESS(s) that are certified to UL 9540 are required to be tested in accordance with UL 9540A, Testing the fire safety hazards associated with propagating thermal runaway within battery systems. Testing is typically performed at the cell, module, and unit (rack) level. While UL 9540A is not a “listing standard,” this test method allows for an assessment of the flammability and thermal runaway hazard of the battery system. The JF2 DC LINK 5.1 BESS is UL 9540 certified [24].

Testing of lithium-ion batteries used in BESS is required for installations per NFPA 855 §4.2.1.3(1). The governing testing standard is the 4<sup>th</sup> Edition of UL 9540A, published November 12, 2019. The BESS is required to be tested using this method, per NFPA 855 §9.1.5. The JF2 DC LINK 5.1 BESS has completed testing in accordance with UL 9540A [17][18][19].

In general, this form of full-scale testing is a data-gathering exercise. The obtained data can be used to assess the hazards that originate from the batteries. The testing serves to identify the battery gas composition, how quickly flammable gases are being generated and released, and how much flammable gas volume to expect in total. The test series is important to quantify the flammability and explosion hazard.

Table 2-9 provides definitions for battery components and the purpose of the different UL 9540A test levels.

*Table 2-9: Definition and Purpose of UL 9540A Test Levels*

<i>Type</i>	<i>Definition</i>	<i>Test Purpose</i>
<b>Cell</b>	The basic functional electrochemical unit containing an assembly of electrodes, electrolytes, separators, containers, and terminals	Establish an effective method for forcing a cell into thermal runaway in a repeatable manner
<b>Module</b>	A subassembly that is a component of a BESS that consists of a group of cells or electrochemical capacitors connected either in series and/or parallel configuration (sometimes referred to as a block) with or without devices and monitoring circuitry	Assess the module’s ability to contain thermal runaway
<b>Unit</b>	A frame, rack, or enclosure that consists of a functional BESS that includes components and subassemblies such as cells, modules, battery management systems, ventilation devices, and other ancillary equipment	Assess the ability of the unit to contain thermal runaway to the initiating unit and prevent a fire from spreading to adjacent target units

UL 9540A testing reports were provided for the cell, module, and rack/unit levels for JF2 DC LINK 5.1 BESS . In each test, external heating was applied to a single cell to induce thermal runaway. Various observations and measurements were made during the thermal runaway events to determine whether specific performance criteria from UL 9540A were satisfied and whether subsequent testing at the next level was required.

The following sections provide a high-level summary of the UL 9540A testing results for JF2 DC LINK 5.1 BESS by level. Test results that are listed as “Fail” indicate that the performance criterion was not met, and results listed as “Pass” indicate that the performance criterion was met.

### 2.3.1 Cell

Table 2-10 summarizes the applicable performance criteria for cell-level testing per UL 9540A §7.7. Since the performance criteria were not satisfied, module-level testing is required.

*Table 2-10: UL 9540A Cell-Level Performance Criteria and Test Results*

<i>Performance Criteria</i>	<i>Test Result</i>
Thermal runaway was not induced in the cell	Fail
The cell vent gas did not present a flammability hazard when mixed with any volume of air, as determined in accordance with ASTM E918 at both ambient and vent temperatures	Fail

### 2.3.2 Module

Table 2-11 summarizes the applicable performance criteria for module-level testing per UL 9540A §8.4. Since the performance criteria were not satisfied, unit-level testing is required.

*Table 2-11: UL 9540A Module-Level Performance Criteria and Test Results*

<i>Performance Criteria</i>	<i>Test Result</i>
The effects of thermal runaway were contained by the module design	Pass
Cell vent gas (based upon the cell level test) is not flammable	Fail

### 2.3.3 Rack/Unit

Table 2-12 summarizes the applicable performance criteria for unit-level testing per UL 9540A Table 9.1 for indoor-floor-mounted nonresidential units. Since the performance criteria were all satisfied, installation-level testing is not required.

*Table 2-12: UL 9540A Unit-Level Performance Criteria and Test Results*

<i>Performance Criteria</i>	<i>Test Result</i>
Flaming outside the initiating BESS unit was not observed	Pass
Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit did not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8	Pass

<i>Performance Criteria</i>	<i>Test Result</i>
For BESS units intended for installation in locations with combustible constructions, surface temperature measurements on wall surfaces did not exceed 97°C (175°F) of temperature rise above ambient per UL 9540A §9.2.15	N/A, as stated in the test report. JF2 DC LINK 5.1 BESS is intended for outdoor installation
Explosion hazards were not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases	Pass
Heat flux in the center of the accessible means of egress did not exceed 1.3 kW/m <sup>2</sup>	Pass (Note JF2 DC LINK is unoccupied BESS)

## 2.4 LARGE SCALE FIRE TESTING (LSFT)

Large scale fire testing (LSFT) of the JF2 DC LINK 5.1 BESS was performed as part of CSA Project 80236098 on January 11, 2025, at the Anhui Suzhou Thermal Safety Technology National and Local Joint Engineering Research Center, an ISO 17025-accredited laboratory. The test was conducted in accordance with CSA TS-800:24 – Large Scale Fire Test Procedure and observed by CSA Group.

The purpose of this test was to evaluate the system's behavior under fully developed fire conditions and assess the potential for thermal propagation within and between units. The initiating event involved driving a selected module into thermal runaway using a film heater, followed by the application of a propane burner to promote a fully developed fire. The JF2 DC LINK was tested in a high SOC condition with all components installed, and airflow configuration included open top ventilation panels and front louvers.

The test samples consisted of one complete JF2 DC LINK 5.1 BESS, which included 3 M-LINK battery enclosures, one E-Panel interconnection cabinet, and one SKID that served as the support structure and wiring hub for the BESS. A Rear Target Unit was positioned behind the Initiating Unit at a separation distance of 914.4 mm (3 ft) and consisted of a dummy E-panel, SKID, two empty M-LINK containers, and one populated M-LINK aligned with the initiating M-LINK. A Side Target Unit, comprising a single M-LINK and SKID, was located 3 ft to the right of the Initiating Unit. The leftmost rack of this M-LINK (closest to the initiating fire) was populated, while the other rack remained empty. Additionally, a Target Wall was positioned 1524 mm (5 ft) to the left of the E-Panel, and another wall was located 3040 mm (10 ft) in front of the Initiating Unit.

The test proceeded in two distinct phases:

1. Phase 1: Initiation using film heaters to induce thermal runaway. Approximately 3 seconds after thermal runaway was confirmed, the propane burner was activated to promote sustained combustion. The fire burned internally within M-LINK 2 for about 40 minutes without spreading to other modules.
2. Phase 2: Re-ignition using a propane burner at 1 hour and 18 minutes into the test to simulate extreme thermal conditions. The burner remained active for 7 minutes, creating a fully developed fire scenario, eventually consuming both M-LINK 2 and M-LINK 3.

During Phase 2, flames reached approximately 9 feet in height and extended 3 feet horizontally beyond the Initiating Unit. The fire completely consumed two of the three M-LINK enclosures (M-LINK 2 and 3) within the Initiating Unit. However, no fire propagation occurred to M-LINK 1 or to the two adjacent target units, which experienced only scorched paint and no internal damage. There were no explosions, no venting of modules in target units, and no evidence of cell-to-unit propagation beyond the initiating components.

Flaming activity intensified for approximately 2.5 hours, with additional heat spikes noted at 4.5 and 5 hours. The fire began to self-extinguish at approximately 7 hours and 31 minutes after test initiation. Heat flux sensors recorded a peak value of 48.7 kW/m<sup>2</sup>, measured 5 feet in front of M-LINK 2.

The LSFT results for the JF2 DC LINK 5.1 BESS container demonstrated that a minimum separation distance of 3 feet between adjacent containers (back-to-back and side-to-side) effectively prevented fire propagation, with only minor surface scorching observed on the adjacent target containers. In addition, minimum clearances of 5 feet between the E-panel side and adjacent walls and 10 feet between the front side and adjacent walls prevented fire spread or structural ignition and limited thermal exposure to the nearby structure.

### 3.0 Hazard Mitigation Analysis

This section details the HMA that was performed for the JF2 DC LINK 5.1 BESS . The following sub-sections provide an overview of the applicable codes and standards, the failure modes required to be addressed by applicable codes and standards, their consequences, and product-level fire safety recommendations.

#### 3.1 CODES AND STANDARDS

Table 3-1 provides an overview of the codes and standards used for this evaluation and their relationships. Specifically, failure modes identified in the 2023 NFPA 855 were considered in the analysis. Fire protection requirements for BESS per NFPA 855 were used to inform the evaluation of the battery system.

*Table 3-1: Applicable Codes and Standards*

<i>Code or Standard</i>	<i>Commentary/Compliance</i>
NFPA 855: <i>Standard for the Installation of Stationary Energy Storage Systems (2023)</i>	NFPA 855 § 4.4.2 lists the required failure modes for consideration in the HMA
UL 9540: <i>Standard for Safety – Energy Storage Systems and Equipment (2023)</i>	NFPA 855 § 4.6.1 requires that BESS shall be listed in accordance with UL 9540. The JF2 DC LINK 5.1 BESS is UL 9540 certified [24].
UL 9540A: <i>Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems (2019)</i>	Provides the standard to which the thermal propagation tests on JF2 DC LINK 5.1 BESS components were conducted, as described in Section 2.3 of this report.
<i>2021 International Fire Code (2021 IFC)</i>	Chapter 12 §1207.1.4 contains requirements for performing an HMA of a given BESS.
<i>2022 California Fire Code (2022 CFC)</i>	Chapter 12 §1207.1.4 contains requirements for performing an HMA of a given BESS, which aligns with the 2021 IFC.

### 3.2 FAILURE MODES, CONSEQUENCES, AND RECOMMENDATIONS

The HMA aids in identifying and mitigating hazards stemming from the BESS technology. This section addresses the failure modes identified in the 2023 NFPA 855 §4.4.2, which are in general agreement with industry best practices:

- (1) A thermal runaway or mechanical failure condition in a single BESS unit
- (2) Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA)
- (3) Failure of a required protection system, including, but not limited to, ventilation (HVAC), exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection.

The JF2 DC LINK 5.1 BESS will be used in jurisdictions covered by the 2021 IFC and 2022 CFC. In addition to the fault conditions listed by 2023 NFPA 855, the 2021 IFC fault conditions listed in §1207.1.4.1 are also considered in this analysis. These are identical to the fault conditions listed in the 2022 CFC §1207.1.4.1.

The failure modes are shown in Table 3-2 with applicable code sections as well as relevant report sections

*Table 3-2: HMA Fault Conditions*

<i>Fault Condition</i>	<i>Code Section</i>	<i>Report Section</i>
1. A thermal runaway condition in a single BESS rack, module, or unit.	2023 NFPA 855 §4.4.2(1) 2021 IFC §1207.1.4(1) 2022 CFC §1207.1.4(1)	3.2.1
2. Failure of any battery (energy) management system.	2023 NFPA 855 §4.4.2(2) 2021 IFC §1207.1.4(2) 2022 CFC §1207.1.4(2)	3.2.2
3. Failure of any required ventilation or exhaust system. <i>This addresses the failure of the thermal management system and the explosion venting system.</i>	2023 NFPA 855 §4.4.2(3) 2021 IFC §1207.1.4(3) 2022 CFC 1207.1.4(3)	3.2.3
4. Voltage surges on the primary electric supply.	2021 IFC §1207.1.4(4) 2022 CFC §1207.1.4(4)	3.2.4
5. Short circuits on the load side of the BESS.	2021 IFC §1207.1.4(5) 2022 CFC §1207.1.4(5)	3.2.5
6. Failure of the smoke detection, fire detection, fire suppression, or gas detection system.	2023 NFPA 855 §4.4.2(3) 2021 IFC §1207.1.4(6) 2022 CFC §1207.1.4(6)	3.2.6

The sections below address the required modes as established in 2023 NFPA 855, 2021 IFC, and 2022 CFC. Only single failure modes were considered for each scenario. The evaluation includes a written description of the failure mode, the safeguards in place to prevent the event, and the consequences of the event. This written evaluation is analogous to a generic bowtie evaluation. It should be noted that this is a consequence-based analysis, meaning that the likelihood of the event is not considered.

### 3.2.1 Thermal Runaway in Single BESS Rack, Pack (Module) or Unit

#### 3.2.1.1 Description

Thermal runaway is a condition in which an electrochemical cell increases its temperature through self-heating in an uncontrollable fashion. This phenomenon typically progresses to a point at which the cell's heat generation is higher than the rate at which it can dissipate, potentially leading to the release of flammable gas, fire, or explosion. Once thermal runaway has started in a cell, it cannot be stopped. Thermal runaway can produce a significant amount of volatile gas that causes increased pressure within the cell housing [1] and eventually leads to forceful venting. If there is oxygen and a competent ignition source, these cell vent gases may ignite [2].

Thermal runaway can be caused by physical damage (puncture, crushing), electrical issues (deep discharge, overcharging), exposure to elevated ambient temperatures, and manufacturer defects (imperfections, contaminants).

For this BESS, the most likely causes of a single-cell thermal runaway include malfunctioning of electrical equipment, manufacturing defects, or degradation of aging cells (i.e., dendrite growth, Solid Electrolyte Interphase (SEI) layer decomposition, lithium plating, etc.), leading to internal short-circuiting. The heat from fires caused by external exposures and electrical equipment may also lead to internal cell failures.

Cells in thermal runaway can cause adjacent cells to also undergo thermal runaway in a phenomenon known as thermal runaway propagation. A cell may cause thermal runaway in adjacent cells through one of several heat transfer mechanisms:

- + Conductive heat transfer via direct contact between cells.
- + Overcurrent caused by damaged circuitry.
- + Impingement of hot or flaming vent gases.

Cells may also cause thermal runaway in adjacent cells due to the effects of the cell depressurization (thermally from the fireball or mechanically from the force) or due to the original cell swelling and deforming adjacent cells.

Sustained cell-to-cell thermal propagation can lead to four primary hazardous scenarios:

1. Rapid ignition of flammable gases, sustained propagation, and resultant full-scale fire.
2. Multiple cells venting flammable gases without sufficient temperature for ignition.
3. Multiple cells venting flammable gases but delayed ignition, leading to a deflagration or explosion.
4. Multiple cells venting flammable gases without sufficient temperature for ignition until after flammable gas concentrations have exceeded the Upper Flammable Limit (UFL). This condition can create a hazard known as 'backdraft' or 'flashover' in which opening the container and introducing fresh oxygen can cause deflagration.

### 3.2.1.2 Safeguards

Mitigation strategies are put in place to help prevent batteries from entering thermal runaway, cope with the byproducts of thermal runaway, and provide cooling to slow the cascading effects of propagation to other cells within a pack and/or an array. These barriers include:

- + Cell abuse tolerance is the ability of the cells to withstand thermal and electrical abuse without going into failure themselves. The cells are listed to UL 1973 and IEC 62619 to withstand some degree of thermal abuse (e.g., high temperature, overcharge).
- + Passive battery pack or module protection via fully sealed metal enclosure with aerogel pads and mica sheets that resist thermal runaway propagation through and outside the pack, as shown in the UL 9540A module-level test.
- + Thermal management provided by a liquid cooling system maintains battery cells within their operating temperature limits, preventing the cells from overheating or rapidly degrading
- + Unit or rack electrical overcurrent protection, including current interrupt devices, breakers, fuses, contactors, or other passive surge-arresting elements that may open the circuit in the case of failure.
- + Multi-level BMS protection with pack and rack level BMS (PBMS and RBMS) provides temperature and voltage monitoring, will disconnect cells and or packs under specific fault conditions, and is to be monitored by the on-site control center (EMS).
- + HVAC system controls container air temperature and humidity to prevent corrosion, as well as malfunctioning and overheating of equipment
- + Smoke and hydrogen detection with fire alarm notification (distinct local visual and audible) activation and central station monitoring via the FACP. The FACP and the horn & strobes are located in the E-PANEL adjacent to the M-LINK enclosures. Smoke or Hydrogen detection also actuates the explosion prevention system. Additionally, an internal dry pipe system may be optionally provided within the BESS.
- + No passive ratings can be formally accredited to the enclosure; however, the structural steel frame is anticipated to provide a degree of passive fire/thermal protection, which can be evaluated as part of a full-scale fire test.
- + Open-head, dry-pipe sprinkler system in the M-LINK enclosure (if installed) can be manually connected to a water supply via the FDC and provides cooling to the battery modules

### 3.2.1.3 Consequences

Thermal runaway of a lithium-ion battery cell can propagate to adjacent cells, packs, racks, and equipment, and can expose neighboring areas to flammable and toxic gases. The following are some of the consequences of thermal runaway:

#### **Full-Scale Fire**

Cell-to-cell thermal runaway propagation is a well-documented phenomenon in which failure of a single cell induces failure of neighboring cells through heat transfer, physical damage, and electrical short-circuiting. As additional cells fail, their cumulative heat release can accelerate propagation, resulting in a self-sustaining event. While the probability of an individual cell entering thermal runaway is low, installations containing

thousands of cells, such as the system evaluated in this analysis, present an increased likelihood of occurrence over time, particularly as systems age and undergo repeated charge-discharge cycles.

The development and severity of a full-scale fire are strongly influenced by the total fire load and the response time of the fire department. In limited scenarios, such as enclosures containing fewer cells, systems with sufficient separation, or batteries maintained at low state of charge (SOC), the available fire load may be insufficient to produce a major fire event.

### **BESS Container to Adjacent Equipment Exposures**

UL 9540A testing has been performed on representative samples of the cell, module, and unit (rack) levels of the JF2 DC-LINK 5.1 BESS. Based on the unit-level UL 9540A test results, no external flaming, flying debris, or post-test re-ignition was observed from the initiating unit.

As a best practice, safe separation distances and clearances between the BESS and adjacent equipment should be informed by the results of the large-scale fire testing (LSFT) performed on the BESS [15].

The LSFT results for the JF2 DC LINK 5.1 BESS container demonstrated that a minimum separation distance of 3 feet between adjacent containers (back-to-back and side-to-side) effectively prevented fire propagation, with only minor surface scorching observed on the adjacent target containers. In addition, minimum clearances of 5 feet between the E-panel side and adjacent walls and 10 feet between the front side and adjacent walls prevented fire spread or structural ignition and limited thermal exposure to the nearby structure.

Fire response to a sustained BESS fire would primarily rely on defensive firefighting tactics focused on preventing fire spread to adjacent equipment. Due to the steel enclosure construction, direct application of water to internal battery racks would be limited. As a result, a thermal runaway event could plausibly be self-sustaining for an extended duration, potentially exceeding 24 hours, and may require significant volumes of water to support prolonged defensive operations.

### **Explosion & Backdraft Hazards**

Lithium-ion batteries are known to vent flammable gases during thermal runaway. A propagating event could lead to the accumulation of flammable gases within the BESS enclosure. If an ignitable concentration is reached, one or more of the following outcomes may occur:

1. Flammable gases reach an ignition source inside the enclosure, resulting in a deflagration or explosion, and rapid structural failure of the enclosure.
2. Ventilation conditions limit available oxygen while flammable gases continue to accumulate, creating a hazardous environment for first responders. If the enclosure is subsequently opened and fresh oxygen is introduced, a rapid ignition event (commonly referred to as a backdraft) may occur, leading to a deflagration or explosion

### **Toxic Gas Exposure**

Thermal runaway events generate both flammable and toxic gases. Toxic gases may accumulate within the BESS enclosure, posing a potential exposure hazard to nearby personnel. During a full-scale fire, hot combustion gases and smoke are expected to rise and disperse due to buoyancy and atmospheric mixing.

The JF2 DC-LINK 5.1 BESS is expected to be installed in a remote outdoor location with a minimum separation distance of approximately 100 feet from occupied exposures, which significantly reduces the potential for off-site toxic gas impacts.

### **External Fires**

In addition to internal failure modes, there is also a possibility for a fire originating from adjacent equipment (i.e., inverters/PCS, and transformers) to propagate to the BESS or expose the BESS to external thermal radiation.

The U.S. Nuclear Regulatory Commission (NUREG) has performed a study to characterize heat release rates from electrical enclosure fires. Based on NUREG guidance, a representative upper-bound fire intensity for inverter-type electrical equipment is taken as a 98th-percentile heat release rate of  $\dot{Q} = 200$  kW [30].

To evaluate the potential for thermal exposure to the BESS from an external inverter fire, the required separation distance  $R$  was estimated using a point-source radiant heat transfer model, as shown in Equation 1. A critical radiant exposure of  $\dot{q} = 3$  kW/m<sup>2</sup> was selected, consistent with NUREG guidance for damage thresholds to sensitive electrical and electronic equipment. NUREG typically cites 3 kW/m<sup>2</sup> as the critical value for sensitive electronic equipment, with values for less-sensitive equipment ranging from 6 to 11 kW/m<sup>2</sup>. This value is conservative for metallic enclosures, for which higher damage thresholds (approximately 6–11 kW/m<sup>2</sup>) are commonly cited.

Using a radiative fraction  $X_r = 0.2$  (consistent with values reported in the SFPE Handbook 2016, Fig. 36.24), the calculated radial distance required to limit radiant exposure to  $\dot{q} = 3$  kW/m<sup>2</sup> is 1 meter (3.4 feet).

$$R = \sqrt{\frac{X_r \dot{Q}}{4\pi \dot{q}}} \quad \text{Equation 1}$$

Where:

- +  $R$  = radial distance from the fire, treated as a point source
- +  $X_r$  = radiative fraction (0.2)
- +  $\dot{Q}$  = heat release rate (200 kW)
- +  $\dot{q}$  = critical radiant heat flux (3 kW/m<sup>2</sup>)

This calculation incorporates conservatism through the use of an upper-percentile fire size, a point-source assumption, and a low radiant heat flux criterion relative to ignition thresholds commonly used for exterior wall assemblies (e.g., NFPA 285, NFPA 80A). These exterior wall criteria (typically on the order of 12 kW/m<sup>2</sup>) are based on piloted ignition testing of combustible materials and are generally higher damage or ignition thresholds applicable to non-combustible BESS enclosures [31].

For transformer-related exposures, IEEE Standard 493 indicates that the probability of a liquid-filled transformer failure is approximately 0.0062 failures per unit-year. In the unlikely event of a transformer failure, it is likely that site personnel would quickly be aware of the event, and the fire department response would be expected to control the event before the BESS is involved. Due to the potential severity of such an event, if the event is not noticed in incipient stages by site personnel and the fire department response is delayed, it is plausible that the transformer fire could spread to the BESS and lead to thermal runaway within the container.

Based on the above, it is recommended that JF2 DC-LINK BESS be separated from adjacent equipment he musing the more conservative of: (1) the minimum separation distance derived from the external fire exposure analysis (approximately 3.4 feet), or (2) the separation distances established in the large-scale fire test (LSFT) of the BESS [15]. These distances should be confirmed and evaluated as part of the site-specific Hazard Mitigation Analysis (HMA), considering site layout, equipment arrangement, and applicable code requirements.

#### 3.2.1.4 Recommendations

**Recommendation 1:** It is recommended to develop site-specific pre-incident plans and emergency response procedures specific to the hazards presented by this BESS installation. It is recommended to also coordinate with the local fire departments to ensure fire fighters are familiar with the specific hazards and proper mitigation of an event. The plans should identify measures for thermal management during a fire (e.g., utilizing nearby fire hydrants) to reduce the likelihood of enclosure-to-enclosure propagation based on the BESS layout and spacing at each site

Regardless of fire size, the inability to ventilate the enclosure creates significant deflagration and explosion hazards and complicates fire response strategies. Approach of the BESS after or during a suspected thermal runaway or propagation event should be done with extreme caution. Standoff distances around the enclosure should be established on the ERP based on the full-scale fire test results for first responders and trained personnel until the fire department can clear the container of flammable gases. Pre-planning is considered necessary to ensure that fire responders can appropriately respond to plausible deflagration and backdraft hazards.

The pre-incident plans and procedures should be updated at regular intervals and minimally address the following elements:

1. Purpose, with any limitation, the facility description, and all plan reviews and revisions
2. Product description and provided signage
3. Incident command points and organizational structure, all emergency contacts and subject matter experts, and Fire Department contact information
4. Fire protection system descriptions and functionality
5. Emergency manual shutdown/electrical isolation instructions
6. Fire department access locations & water supplies
7. Alarm panels and sequence of operations
8. Backdraft and deflagration hazard considerations
9. Medical emergency procedures
10. Considerations as determined necessary by the local authority

**Recommendation 2:** ANSI Z535 compliant signage should be provided on the doors to the BESS container and on the installation site, indicating all of the following [NFPA 855 § 4.7.4.2]:

1. “Energy storage systems” with the symbol of a lightning bolt in a triangle.
2. Indicating the ‘Explosion Hazard.’
3. Emergency contact information.

4. A placard or directory should be installed denoting the location of all disconnecting means for the BESS [NFPA 855 § 4.7.4.3].

**Recommendation 3:** The BESS separations from any near-exposure items should be determined based on the large-scale fire test data (LSFT) and evaluated as part of the site-specific HMA

### 3.2.2 Failure of any Battery (Energy) Management System

#### 3.2.2.1 Description

Battery management systems (BMSs) protect the components of the BESS from operating outside their operating parameters and generate an alarm or trouble signal for off-normal conditions.

The Energy Storage Management System (ESMS) is defined in NFPA 855 § 3.3.8 as “a system that monitors, controls, and optimizes the performance and safety of an energy storage system.” This definition implies that, at a minimum, the ESMS encompasses the combined performance of the module and rack-level BMS. This section addresses potential failures in these subsystems.

The Pack-level and Rack-level BMS (PBMS and RBMS) monitor cell voltages, currents, and state of charge, and cell and pack temperatures for operation within the manufacturer’s specifications. Signals are periodically transmitted to a constantly attended control station or the site controller (EMS) at the installation site.

The multi-level BMS may fail to provide monitoring or control at the cell/pack level, resulting in an inability to shut down, report adverse conditions, properly monitor, balance, or protect the system, resulting in adverse conditions.

#### 3.2.2.2 Safeguards

- + The battery pack and rack are both UL 1973 listed, but the JF2 DC LINK 5.1 BESS is UL 9540 listed. UL 1973 requires that “the Energy management system (EMS) shall maintain cells within the specified cell voltage region from over-charge and over-discharge of the cell voltage, and it shall maintain cells within the specified cell temperature region providing protection from overheating and under temperature operation. Additionally, it shall maintain batteries within the specified battery current region from over charge of current and prevent high-rate discharge exceeding the cell specification.” UL 9540 serves a similar purpose to UL 1973 to ensure the energy management system operates to protect the batteries.
- + The JF2 DC LINK 5.1 BESS can be shut down remotely via the disconnect switch in the E-PANEL, but also locally via an E-Stop button on the E-PANEL exterior wall. In the event of a fault-detected condition (e.g., overvoltage, overcurrent, overtemperature, communication, etc.), both hardware and software disconnect the battery racks, preventing stored energy from discharging into a fault. The system has provisions via contactors and circuit breakers to disconnect on both the AC and DC sides during fault mode.

#### 3.2.2.3 Consequences

Failure to shut down the system given potentially hazardous temperatures or other conditions, such as short circuits and over- or under-voltage conditions, may result in damage to the battery cells. This damage could ultimately lead to a thermal runaway event. The consequences of a thermal runaway event are described in Section 3.2.1.3 of this report.

### 3.2.2.4 Recommendations

**Recommendation 4:** All manual and automatic system functions, alarms, and interlocks should be tested during system commissioning according to the LGES commissioning report. Periodic inspection, testing, and maintenance should be performed on all equipment and instrumentation tied to the BMS and EMS in accordance with the LGES Operation & Maintenance Manual and industry standard practices.

In the event of a BMS failure, the worst-case consequence is a thermal runaway. See Section 3.2.1.4 of this report for recommendations relating to thermal runaway mitigation.

## 3.2.3 Failure of any Required Ventilation or Exhaust System

### 3.2.3.1 Description

Each M-LINK container is provided with two (2) exhaust vents on the roof of the enclosure. These vents serve the purpose of explosion prevention and are not open during normal operation. Upon detection of either hydrogen gas or smoke within the enclosure, the signal is sent to Battery System Controller (BSC) via Fire Alarm Control Panel (FACP) to actuate the roof exhaust vents with the use of a linear actuator.

Thermal management is provided via an internal HVAC system and 50/50 water/ethylene glycol liquid cooling that is designed to maintain the battery cells within their operating limits. If a thermal management system fails, the battery cells may be exposed to elevated ambient temperature (i.e., above the operating temperature range). When this occurs, the cell cannot dissipate heat efficiently, which, in turn, leads to increased internal temperatures. If the internal temperature rises out of the tolerance of the separator, the separator can degrade. Long-term aging and degradation of the separator is often a precursor to a thermal runaway event.

Failure of the liquid battery cooling system or HVAC system may occur due to the following causes:

- + The liquid coolant pump fails to operate due to a faulty temperature sensor, blown fuse, or other failure mode associated with the pump
- + The HVAC unit fails due to a faulty compressor, heat exchanger, or other failure mode
- + A leak occurs in the system, causing drainage of the liquid coolant.

### 3.2.3.2 Safeguards

Computational Fluid Dynamics (CFD) analysis has been performed in accordance with NFPA 69 to evaluate the installed ventilation system in the JF2 DC LINK 5.1 BESS. The results of this analysis indicate that the M-LINK ventilation system, as currently designed, will limit the global concentration of flammable battery gas in a thermal runaway scenario to below 25% of LFL. The M-LINK enclosure features redundancy based on the number of roof exhaust vents it employs. Hydrogen concentration is expected to remain 25% LFL with roof exhaust vents, door intake dampers, and door intake fan activating. The NFPA 69 report studied scenarios with failures of a single roof exhaust vent and a single intake fan, which showed that the concentration of hydrogen gas within the enclosure would be maintained below 25 % of the LFL.

The BMS monitors the temperature at the pack level, which activates the HVAC system and sends a warning signal to a constantly attended location when the temperature exceeds the normal operating limit. Warning signals are sent to the monitoring system when the temperature sensor is not properly operating.

### 3.2.3.3 Consequences

Failure of several roof exhaust vents and door intake dampers would allow flammable gas concentration within the M-LINK enclosure to build to an ignitable concentration.

The worst-case ambient temperature conditions that exist at expected installation sites are significantly less than the temperature required for significant degradation of the separator or organic solvent 80°C (175°F) [32]. It is presumed that failure of the thermal management systems would be remedied in time to prevent notable degradation of the battery or electrical equipment.

### 3.2.3.4 Recommendations

**Recommendation 5:** Maintain and inspect the explosion venting system and associated equipment per the manufacturer's recommendations. The JF2 DC LINK 5.1 BESS Operation and Maintenance (O&M) manual provided by LGES includes an inspection methodology for the explosion venting system, which should be included in the overall regular inspections and maintenance of the BESS at a given site. Functionally test the system during commissioning and periodically thereafter.

**Recommendation 6:** Maintain and inspect the HVAC system and associated equipment per the manufacturer's recommendations. The JF2 DC LINK 5.1 BESS Operation and Maintenance (O&M) manual provided by LGES includes an inspection methodology for the HVAC system, which should be included in the overall regular inspections and maintenance of the BESS at a given site.

## 3.2.4 Voltage Surges on the Primary Electrical Supply

### 3.2.4.1 Description

A voltage surge on the primary electric supply system can potentially expose the batteries to hazardous voltages.

### 3.2.4.2 Safeguards

The BMS system monitors voltage at the battery level and will display warning signals when the measured voltage is outside of the permissible limit.

The main primary electric supply can be manually disconnected from the BESS through the electric disconnects remotely located from the BESS installation.

The electric supply and inverter are equipped with current interruption services, breakers, fuses, and/or other passive surge-arresting elements that are designed to open the circuit in the case of failure and the general resilience of the design to withstand adverse electrical conditions.

Falling under the UL 9540 listing of the JF2 DC LINK 5.1 BESS, the inverter or PCS to be used with the BESS on site must be UL 1741 listed as required by the codes and standards in Section 3.1 of this report.

### 3.2.4.3 Consequences

Hazardous voltage conditions may damage the cells and lead to a thermal runaway event. The consequences of a thermal runaway event are described in Section 3.2.1.3 of this report.

#### 3.2.4.4 *Recommendations*

There are no specific recommendations for this failure mode. See recommendations in Section 3.2.1.4 of this report for recommendations relating to thermal runaway.

### 3.2.5 **Short Circuit on the Load Side of the BESS**

#### 3.2.5.1 *Description*

Hazardous current conditions include short circuits on the load side of the battery energy storage systems. These high current conditions may be due to power converter systems or interconnection issues.

#### 3.2.5.2 *Safeguards*

The BESS electrical system is designed with fusible links between the AC power supply and each battery rack to prevent overcurrent. The electrical system is also designed with circuit breakers and fuses throughout. The BMS system monitors overcurrent and will display warning signals when the charging or discharging current of batteries is outside of the permissible limit.

#### 3.2.5.3 *Consequences*

The BESS must be UL 9540-listed for the construction and reliability of the electrical system. UL 9540 provides specific construction requirements to prevent short circuits and ensure the durability of the system to withstand short circuits when they do occur. Without this listing, the construction and reliability of the electrical system would be unknown. The JF2 DC LINK 5.1 BESS is UL 9540 certified [24].

Based on the UL 9540 listing, it is expected that a short circuit will cause a fusible link or circuit breaker to trip, cutting power to the specific rack. Cutting power will reduce the energy draw and, subsequently, reduce excess heat generation. The BMS system should alert operators and isolate the affected battery packs.

#### 3.2.5.4 *Recommendations*

There are no additional recommendations for this failure mode.

### 3.2.6 **Failure of the Smoke Detection, Fire Detection, Fire Suppression or Gas Detection System**

#### 3.2.6.1 *Description*

This scenario considers the possibility of a failure of the smoke detection system or the gas detection system.

The JF2 DC LINK 5.1 BESS features an optional dry pipe system for the interior of the enclosure. The failure of the dry pipe system through leakage can create a thermal runaway event when water is introduced in the battery rack. A failure of either gas or smoke detection could lead to the failed deployment of roof exhaust vents, door intake dampers, and the door intake fan.

Failure of the fire alarm system to report alarm signals to the central station would also lead to delays in fire department response.

#### 3.2.6.2 *Safeguards*

Gas and smoke detectors used in the JF2 DC LINK 5.1 BESS are UL-listed.

Regular inspection, testing, and maintenance are performed on the fire alarm system in accordance with applicable codes and standards. The backup power of the fire alarm system is per NFPA 72 standard.

M-LINK ventilation doors, intake dampers, and fans are operated by the activation of a single gas detector or a single smoke detector within the enclosure. The backup power requirements must be followed based on local jurisdiction requirements.

### 3.2.6.3 Consequences

If the smoke detection system fails, a fire could continue to grow uninhibited. Additionally, the previously described hazards of backdraft and explosion remain plausible. The consequences of failure of the ventilation doors, intake dampers, and fan are described in Section 3.2.3.3 of this report. Similarly, a failure of the fire alarm system to alert the central station and the fire department could result in more severe damage to the surrounding electrical infrastructure.

### 3.2.6.4 Recommendations

**Recommendation 7:** Ensure that alarm, supervisory, and trouble signals from the smoke and gas detection system are communicated to an approved central supervising station. Additionally, the FACP should provide local notification if any part of the gas detection system loses power or experiences a fault. Ensure that the gas and smoke detection system is calibrated and maintained in accordance with manufacturer recommendations

**Recommendation 8:** The inclusion of water-based fire protection systems is typically not required for installations located in remote outdoor locations at least 100 ft from exposure. If the BESS is to be installed in a location near exposures (buildings, lot lines, paths of travel, etc.), then consideration must be taken as to whether water-based suppression is required. The near-exposure installation situation must be evaluated as part of a site-specific HMA. In this case, it is recommended to:

1. Verify and document that the basis of design for the sprinkler system is appropriate for the protection of BESS systems in accordance with NFPA 855 §4.9.2.
2. For each site, perform an analysis that identifies the available water supply, fire department access, and distance from water supply sources to the containers.
3. Develop and coordinate an emergency response plan with the local fire department for each site that specifies the actions to be taken by responders depending on the type of emergency, and whether connection to the FDC should be made.
4. Maintain the sprinkler system in accordance with NFPA 25: *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

See the recommendations in Section 3.2.1.4 of this report for recommendations resulting from thermal runaway.

## 4.0 Conclusions

An HMA was performed for the JF2 DC LINK 5.1 BESS to determine compliance with NFPA 855, as well as IFC 2021 and CFC 2022. The failure modes in NFPA 855 §4.4.2 were used to conduct a consequence-based analysis, which determined how well the provided safeguards would reduce the severity of the hazard. The likelihood of events was not specifically assessed, and only single failure modes were considered. Where existing safeguards do not adequately prevent or mitigate consequences, recommendations were made.

### 4.1 RECOMMENDATIONS

The recommendations resulting from the HMA are listed in Table 4-1.

*Table 4-1: Product-Level HMA Recommendations*

<i>No.</i>	<i>Category</i>	<i>Description</i>
1	Emergency Response Planning and Training	Develop site-specific pre-incident plans and emergency response procedures specific to the hazards presented by this installation. Coordinate with the local fire departments to ensure firefighters are familiar with the specific hazards and proper mitigation of an event. The plans should identify measures for thermal management during a fire (e.g., utilizing nearby fire hydrants) to reduce the likelihood of enclosure-to-enclosure propagation based on the BESS layout and spacing at each site. See Section 3.2.1.4 and NFPA 855 § 4.3 for more detailed requirements.
2	Signage and documentation	ANSI Z535 compliant signage should be provided on the doors to the BESS container and on the installation site, indicating all of the following [NFPA 855 § 4.7.4.2]: 5. “Energy storage systems” with the symbol of a lightning bolt in a triangle. 6. Indicating the ‘Explosion Hazard’ 7. Emergency contact information. 8. A placard or directory should be installed denoting the location of all disconnecting means for the BESS [NFPA 855 § 4.7.4.3]. See Section 3.2.1.4 and NFPA 855 §4.7.4.2 for more detailed requirements.
3	Installation Site Clearances and Separations	The BESS separations from any near-exposure items should be determined based on the large-scale fire test (LSFT) data and evaluated as part of the site-specific HMA.
4	Inspection documentation – BMS and Controls	All manual and automatic system functions, alarms, and interlocks should be tested during system commissioning in accordance with the LGES commissioning report. Periodic inspection, testing, and maintenance should be performed on all equipment and instrumentation tied to the BMS and EMS in accordance with the LGES Operation & Maintenance Manual and industry standard practices.

No.	Category	Description
5	Inspection documentation – Explosion Venting	Maintain and inspect the explosion venting system and associated equipment per the manufacturer's recommendations. The JF2 DC LINK Operation and Maintenance (O&M) manual provided by LGES includes an inspection methodology for the explosion venting system, which should be included in the overall regular inspections and maintenance of the BESS in a given site. Functionally test the system during commissioning and periodically thereafter.
6	Inspection documentation – HVAC system	Maintain and inspect the HVAC system and associated equipment per the manufacturer's recommendations. The JF2 DC LINK Operation and Maintenance (O&M) manual provided by LGES includes an inspection methodology for the HVAC system, which should be included in the overall regular inspections and maintenance of the BESS in a given site.
7	Smoke and Gas Detection Systems	Ensure that alarm, supervisory, and trouble signals from the smoke and gas detection system are communicated to an approved central supervising station. Additionally, the FACP should provide local notification if any part of the gas detection system loses power or experiences a fault. Ensure that the gas and smoke detection system is calibrated and maintained in accordance with manufacturer recommendations
8	Dry-Pipe Suppression System	<p>If the BESS is to be installed near exposures (buildings, lot lines, paths of travel, etc.), consideration must be given to installing the optional dry-pipe suppression system in the BESS. In this case, it is recommended to:</p> <ol style="list-style-type: none"> <li>1. Verify and document that the basis of design for the sprinkler system is appropriate for the protection of BESS systems in accordance with NFPA 855 §4.9.2.</li> <li>2. For each site, perform an analysis that identifies the available water supply, fire department access, and distance from water supply sources to the containers.</li> <li>3. Develop and coordinate an emergency response plan with the local fire department for each site that specifies the actions to be taken by responders depending on the type of emergency, and whether connection to the FDC should be made.</li> <li>4. Maintain the sprinkler system in accordance with NFPA 25: <i>Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems</i>.</li> </ol>
9	Site-Specific Analysis	Perform site-specific analysis for all proposed sites. The required content of the site-specific analysis may vary by jurisdiction, but should generally include a "remote location" review per NFPA 855 9.3.2(1), a spacing strategy, and an emergency response plan review. A dispersion analysis may also be required in some jurisdictions.

## 4.2 HMA APPROVAL

The local AHJ may approve the HMA provided that the conditions stated in NFPA 855 §4.4.3 are demonstrated. These conditions are summarized in Table 4-2.

Table 4-2: Approval of HMA – NFPA 855

<i>Conditions Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
<p>1. Fires will be contained within unoccupied BESS rooms for the minimum duration of the fire resistance rating specified in 2023 NFPA 855 §9.6.4, which states that <i>rooms or spaces containing BESS shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating, constructed in accordance with the local building code.</i> [2023 NFPA 855 §4.4.3(1)]</p>	TBD	<p>The JF2 DC LINK 5.1 BESS is a non-walk-in, non-occupiable enclosure to be installed outdoors, not within unoccupied BESS rooms or indoor areas.</p> <p>The JF2 DC LINK 5.1 BESS has several mitigation measures in place that may reduce the likelihood of fire spreading to an adjacent BESS container. As demonstrated in the LSFT, the fire was contained to a single BESS container and did not propagate to adjacent containers spaced 3 feet apart.</p> <p>Although this requirement applies to unoccupied BESS rooms rather than outdoor installations, the BESS design still meets the intent of the requirement by limiting the risk of a fire event to a single BESS container.</p> <p>The site’s spacing strategy, separation between BESS containers, should be evaluated as part of the site-level HMA.</p>

<i>Conditions Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
<p>2. Fires and products of combustion will not prevent occupants from evacuating to a safe location</p>	<p>TBD</p>	<p>The JF2 DC LINK 5.1 BESS is a non-walk-in, non-occupiable enclosure to be installed outdoors, not within unoccupied BESS rooms or indoor areas.</p> <p>The JF2 DC LINK 5.1 BESS has numerous internal sensors monitored by the BMS that can detect abnormal conditions in the container, along with smoke and gas detection. These detection systems can activate the horn/strobe installed on the exterior of the BESS container to provide local notification to promptly inform anyone who may be performing work on or nearby the container.</p> <p>Sites will be selected to meet the classification of a remote, outdoor BESS installation, with no occupied buildings or public exposures within 100 feet of the BESS. As such, the impact of fire and combustion products on the ability of those working on or nearby the container to evacuate will be limited.</p> <p>A site-level HMA should be conducted to ensure that the BESS fire safety strategy and installation provide adequate occupant egress.</p>
<p>3. Deflagration hazards will be addressed by an explosion control or other system</p>	<p>Y</p>	<p>The JF2 DC LINK 5.1 BESS is provided with an NFPA 69 concentration-reduction-based explosion prevention system in accordance with NFPA 69. The system is designed to limit the global concentration of flammable battery gas in a thermal runaway condition to below 25% of LFL.</p>

In addition, for those jurisdictions where IFC 2021 or CFC 2022 applies,

Table 4-3 lists the approval criteria.

*Table 4-3: Approval of HMA – IFC 2021 CFC 2022.*

<i>Condition Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
<p>1. Fires will be contained within unoccupied BESS rooms or areas for the minimum duration of the fire-resistance-rated separations identified in 2021 IFC §1207.7.4, which states that rooms or spaces containing BESS shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating, constructed in accordance with the International/ California Building Code [2021 IFC / 2022 CFC §1207.1.4.2(1)].</p>	<p>TBD</p>	<p>The JF2 DC LINK 5.1 BESS is a non-walk-in, non-occupiable enclosure to be installed outdoors, not within unoccupied BESS rooms or indoor areas.</p> <p>The JF2 DC LINK 5.1 BESS has several mitigation measures in place that may reduce the likelihood of fire spreading to an adjacent BESS container. As demonstrated in the LSFT, the fire was contained to a single BESS container and did not propagate to adjacent containers spaced 3 feet apart.</p> <p>Although this requirement applies to unoccupied BESS rooms rather than outdoor installations, the BESS design still meets the intent of the requirement by limiting the risk of a fire event to a single BESS container.</p> <p>The site’s spacing strategy, separation between BESS containers, should be evaluated as part of the site-level HMA.</p>

<i>Condition Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
<p>2. Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate [2021 IFC/ 2022 CFC §1207.1.4.2(2)].</p>	<p>TBD</p>	<p>The JF2 DC LINK 5.1 BESS is a non-walk-in, non-occupiable enclosure to be installed outdoors, not within occupied work centers or indoor areas.</p> <p>The JF2 DC LINK 5.1 BESS has numerous internal sensors monitored by the BMS that can detect abnormal conditions in the container, along with smoke and gas detection. These detection systems can activate the horn/strobe installed on the exterior of the BESS container to provide local notification to promptly inform anyone who may be performing work on or nearby the container.</p> <p>Sites will be selected to meet the classification of a remote, outdoor BESS installation, with no occupied buildings or public exposures within 100 feet of the BESS. As such, the impact of fire and combustion products on the ability of those working on or nearby the container to evacuate will be limited.</p> <p>A site-level HMA should be conducted to ensure that the BESS fire safety strategy and installation provide adequate occupant egress.</p>

<i>Condition Demonstrated</i>	<i>(Y/N)</i>	<i>Comment</i>
<p>3. Toxic and highly toxic gases released during fires will not reach concentrations in excess of the Immediately Dangerous to Life or Health (IDLH) level in the building or adjacent means of egress routes during the time deemed necessary to evacuate occupants from any affected area [2021 IFC / 2022 CFC §1207.1.4.2(3)].</p>	TBD	<p>The JF2 DC LINK BESS is a non-walk-in, non-occupiable enclosure to be installed outdoors.</p> <p>Sites will be selected to meet the classification of a remote, outdoor BESS installation, with no occupied buildings or public exposures within 100 feet of the BESS. The BESS will not be located within a building or adjacent to a building's means of egress. As such, no toxic or highly toxic gases released during a fire would reach IDLH levels in buildings or in adjacent means of egress.</p> <p>It should be noted that gases released during a fire may result in a localized concentration in excess of IDLH levels, as illustrated by the generic BESS product plume analysis [13]. Therefore, first responders should wear proper personal protective equipment (PPE) when responding to a JF2 DC LINK 5.1 fire.</p> <p>Compliance with this condition should be evaluated as part of the site-level HMA.</p>
<p>4. Flammable gases released from BESS during charging, discharging, and normal operation will not exceed 25 percent of their lower flammability limit (LFL).[2021 IFC / 2022 CFC §1207.1.4.2(4)].</p>	N/A	<p>The JF2 DC LINK 5.1 BESS uses lithium-ion batteries, which do not release flammable gases during normal charging, discharging, and operation. Gases are released from the batteries only under fire or other abnormal conditions.</p>
<p>5. Flammable gases released from BESS during fire, overcharging, and other abnormal conditions will be controlled through the use of ventilation of the gases, preventing accumulation, or by deflagration venting.[2021 IFC / 2022 CFC §1207.1.4.2(5)].</p>	Y	<p>The JF2 DC LINK 5.1 BESS is provided with an NFPA 69 concentration-reduction-based explosion prevention system in accordance with NFPA 69. The system is designed to limit the global concentration of flammable battery gas in a thermal runaway condition to below 25% of LFL.</p>

This report was based solely upon and limited to the available information provided and/or presented. Details and/or information not presented or provided on the documentation provided by the Client are not considered a part of this analysis. This report is not intended to verify or guarantee that the installation complies with the provisions of any local codes, nor is it meant to cover specific site installations.

If you have any questions about this report, please do not hesitate to contact us.

Sincerely,

**Jensen Hughes**

Prepared by:

Reviewed by:



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Jacob Witlin, EIT  
Associate  
jacob.Witlin@jensenhughes.com

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Jihan El Ouaragli, PhD  
Staff Engineer  
jihan.ouaragli@jensenhughes.com

## 5.0 References

The following references were used in the development of this report:

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8. Canadian Standards Association (CSA Group), 2025. *CSA/ANSI C800:25: Testing protocol for energy storage system reliability and quality assurance program*.
9. LGES JF2 DC LINK: F2D4-5.1US-MN04\_DC LINK Installation Manual\_V2.0
10. LGES JF2 DC LINK: F2D4-5.1US-MN07\_DC LINK Operational & Maintenance Manual\_V1.0
11. LGES JF2 DC LINK: F2D4-5.1US-MN06\_DC LINK Commissioning Plan\_V1.0
12. LGES JF2 DC LINK: F2X4-5.1US-FS05\_AC&DC LINK Fire Safety Component Specification\_V2.0
13. LGES JF2 DC LINK: *F2XX-5.1US-FS06\_AC&DC LINK Explosion Control CFD Analysis\_V6.0*
14. LGES JF2 DC LINK: F2X4-5.1US-RP10\_AC&DC LINK Plume Analysis Report\_V1.0
15. LGES JF2 DC LINK: *F2X4-5.1US-FS08\_AC&DC LINK Large Fire Test Report\_V1*.
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## **APPENDIX 3.9-C: LARGE-SCALE BURN TEST**



CSA GROUP  
Laboratory Test Data - Large Scale Fire Test Report

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Master Contract: N/A	Model: JF2 DC LINK 5.1	Page number 1 of 82
Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

<b>Customer:</b>	<u>LG Energy Solution, Ltd.</u>
<b>Customer Address:</b>	<u>Parc1 Tower1, 108, Yeoui-daero, Yeongdeungpo-gu, Seoul, Seoul 07335 South Korea</u>
<b>Attention:</b>	<u>Juno Sohn</u>
<b>Subject:</b>	<u>JF2 DC LINK 5.1 Large-Scale Fire Test</u>

<b>Tested By:</b> <u>Jiaming Huang, Test Engineer</u> <i>Name, Title</i> <u>Anhui Suzhou Thermal Safety Technology National and Local Joint Engineering Research Center</u> <i>Testing Lab Name</i> <u>East Road, 200 meters north of the intersection of 206 National Road and Yanshan Road, Suxu Modern Industrial Park, Caocun Town, Yongqiao District, Suzhou City, Anhui Province, China</u> <i>Testing Lab Address</i> <u>Signature on File                      2025-01-11</u> <i>Signature                                      Date (YYYY-MM-DD)</i>	<b>Witnessed By:</b> <u>Chris Reed, Product Safety Engineer II</u> <i>Name, Title</i> <u>CSA Group – Cleveland</u> <i>CSA Group Laboratory</i> <u>8801 East Pleasant Valley Road</u> <u>Cleveland, OH 44131</u> <i>CSA Group Laboratory Address</i> <u>Signed on approval                      2025-02-25</u> <i>Signature                                      Date (YYYY-MM-DD)</i>
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**Executive Summary**

CSA Project 80236098 is a large-scale fire test based on CSA TS-800:24 to assess the performance of the LG Energy Solution, Ltd. JF2 DC LINK 5.1 product when exposed to fully developed fire conditions. This custom test project was conducted on the samples provided by LG Energy Solution, Ltd. at 5:27 PM on January 11<sup>th</sup>, 2025, at Anhui Suzhou Thermal Safety Technology National and Local Joint Engineering Research Center (hereafter referred to as CWN), an ISO 17025 accredited test laboratory.

The test consisted of two phases. For Phase 1, fire was started inside the Initiating Unit and burned for approximately 40 minutes without propagating to the other modules inside the Initiating Unit. The fire began to self-extinguish, and Phase 2 began by re-igniting the propane burner to force a fully developed fire condition. The burner remained on for 7 minutes until the fully developed fire condition was achieved.

During Phase 2, flames extended up into the hood approximately 9 feet, and extended outside the footprint of the Initiating Unit 3 feet. Flames impinged on the target units, causing brief ignition of the painted surface of the container. Fire completely consumed M-LINK 2 and 3 of the Initiating Unit, but did not propagate to M-LINK 1 or to the target units. Damage to the target units consisted of scorched paint. No modules in either of the target units vented or entered thermal runaway, indicating that the damage was superficial and unit-to-unit propagation did not occur. Damage to the target walls consisted of scorching and delamination of the wood surface. No explosions or flying parts were observed from the DUT, and the fire did not propagate to the target units using the desired spacing.

The fire in Phase 2 grew in intensity for approximately 2.5 hours before reaching its maximum flaming, with two additional spikes at 4.5 hours and 5 hours. After 5.5 hours, the flaming began to subside, self-extinguishing 7 hours and 31 minutes into the test.



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Master Contract:	N/A	Model:	JF2 DC LINK 5.1	Page number 2 of 82
Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Large Scale Fire Test Summary**

CSA Group project 80236098 is a large-scale fire test, performed for LG Energy Solution Ltd. This custom test project was performed on 2025-01-11 at Anhui Suzhou Thermal Safety Technology National and Local Joint Engineering Research Center, an ISO 17025 accredited laboratory.

Manufacturer:	LG Energy Solution Ltd.	
Brand name / Trademark:	N/A	
Model number:	JF2 DC LINK 5.1	
Nominal voltage rating, (Vdc)	1,344	
Nominal capacity rating, (Ah)	3,804	
Rated Energy, (kWh)	5,112	
Electrical configuration of module in BESS:	14s-6p	
Number of modules in BESS:	84	
Method used to initiate fire condition:	Film heaters used to drive initiating module into thermal runaway, followed by a liquid propane gas burner impinging directly on surface of module to ignite the vent gas.	
Location of fire condition initiator:	Burner positioned to impact the surface of Pack #2 in Rack 2 of M-LINK #1 (second pack from the bottom in the right rack of the middle M-LINK enclosure)	
Configuration of DUT for airflow:	Top ventilation panels on all 3 Initiating Unit M-LINKs were open at the start of the test, as well as the front louvers on the doors.	
Cell to cell propagation condition:	Occurred	
Unit to unit propagation condition:	Did not Occur	
Start of testing, (YYYY-MM-DD, HH:MM AM/PM)	2025-01-11 5:27 PM	
End of testing, (YYYY-MM-DD, HH:MM AM/PM)	2025-01-15 2:10 PM	
Time elapsed to reach peak flaming (HH:MM:SS)	02:37:04	
Extent of flame spread:	Flame Height	Horizontal Extension
	Approximately 9 ft	Approximately 3 ft
Maximum measured heat flux, (kW/m <sup>2</sup> )	Location	Max. Heat Flux (kW/m <sup>2</sup> )
	HF5- Aisleway 5 ft in front of M-LINK 2	48.70



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Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Large Scale Fire Test Summary**

	Location	Max. Temperature (°C)
Maximum measured temperature on target units, (°C)	Rear Target Unit M-LINK 2 top-left exterior corner (TC 215)	663.9
Damage to target units:	Superficial damage to paint and scorching were observed on the roof and backside of the Rear Target Unit. The roof and side facing the initiating unit were scorched on the Side Target Unit. There was some light burn marks in the interior of the Rear Target Unit. No modules in either of the Target Units vented or entered thermal runaway, indicating that the damage was superficial and unit-to-unit propagation did not occur.	
Additional Information:	Testing was performed according to the Large-Scale Fire Test (LSFT) procedure in CSA TS-800:24.	



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Master Contract: N/A	Model: JF2 DC LINK 5.1	Page number 4 of 82
Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

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Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

## Glossary

For the purposes of this assessment, the following definitions apply based on those defined in the Fourth Edition of *UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*. Any additional terminology not defined below has been adopted from UL 9540A:2019.

**BATTERY ENERGY STORAGE SYSTEM (BESS)** – In addition to its UL 9540A definition, this term is used when referring to a fully populated container system.

**INITIATING BATTERY ENERGY STORAGE SYSTEM (INITIATING BESS)** – A BESS unit which has been equipped with the equipment needed to create the internal fire condition.

**TARGET BATTERY ENERGY STORAGE SYSTEM (TARGET BESS)** – The enclosure and/or rack hardware that physically supposed and/or contains the components that comprise a BESS. The target BESS does not contain energy storage components but serves to enable instrumentation to measure thermal exposure from the initiating BESS.

**CONTAINER** – This term is used to refer to the container without any additional components (battery modules, power condition systems (PCS), battery management system (BMS), etc.

**UNIT** – A frame or rack that consists of a functional BESS which includes components and subassemblies such as cells, modules battery management systems, ventilation devices, and other ancillary equipment. These may also be referred to as a RACK.

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Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

### Setup and Instrumentation



Figure 1: DUT installed at CWN

Testing was initiated using film heaters on 3 cells, as seen in Figure 2.24. Once thermal runaway was initiated, a liquid propane gas burner placed in front of the initiating module was ignited to initiate the fire condition. The placement of the gas burner can be seen in Figure 2.48.

The test samples consisted of one complete JF2 DC LINK 5.1 BESS comprised of 3x M-LINK battery enclosures, one E-Panel interconnection cabinet, and one SKID that served as the support structure and wiring hub for the BESS. A target unit was placed to the rear of the Initiating Unit at a separation distance of 914.4mm (3 ft). The Rear Target Unit was comprised of a Dummy E-panel, SKID, 2x empty M-LINK containers, and one populated M-LINK container, in line with the initiating M-LINK. A single M-LINK enclosure with its SKID was placed to the right side of the Initiating Unit at a separation distance of 914.4mm (3 ft) to serve as the Side Target Unit. It was populated with modules in the leftmost rack, closest to the Initiating Unit. The other rack was left empty. A Target Wall was placed to the left of the Initiating Unit, at a separation distance of 1524mm (5 ft) from the E-Panel. Another Target Wall was placed in front of the Initiating Unit at a separation distance of 3040mm (10 ft)

Thermocouples were placed on the sides of live modules, on the racks near the modules, on the interior and exterior surfaces of the enclosure, on the doors, and on the equipment installed on the doors. See Figures 2.24 through 2.45 to see detailed locations of thermocouple placement. Additionally, thermocouples and heat flux gauges were placed on trees at varying distances to the initiating unit. One tree at the surface of the unit, one at a middle distance, and one at the end of the aisleway. See Figure 2.45 for details of aisleway and wall instrumentation.



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### Pre-Conditioning

DUT was charged by rack at a rate of 0.25 CP until the rack voltage either reached 1499 Vdc, or any cell voltage reached 3.57 Vdc, as measured by the BMS.

### DUT Configuration

The actuated ventilation panels on the top of each M-LINK in the Initiating Unit were open at the start of the test. The intake louvers on the doors of each M-LINK in the initiating Unit were also open at the start of the test, to allow for maximum airflow through the unit.

### Test Observations

Testing began at 5:27 PM local time. Observations from testing are shown below:

Elapsed Time (HH:MM:SS)	Local Time (HH:MM:SS)	Comment
00:00:00	17:27:00	Power applied to heaters, test start
00:08:00	17:35:00	Heating of CMA #2 stopped due to PID controller failure
00:13:00	17:40:00	Heating of CMA #2 resumed when other cells reached the same control temperature
00:29:32	17:56:32	1st vent observed with pop sounds, slight temperature decrease was observed and the 03 thermocouple indicated temperature of 200°C
00:30:31	17:57:31	2nd cell vent with pop sounds observed, and the temperature decreased slightly on TC 01
00:36:45	18:03:45	Thermal runaway initiated, heater turn off.
00:37:45	18:04:45	Burner activated 3S after thermal runaway initiated, and turned off 5s later.
00:37:50	18:04:50	Burner turn off
00:37:50	18:04:50	Fire ignited successfully inside the Initiating M-LINK
00:38:11	18:05:11	Fire sustained inside the initiating M-LINK without spreading out of the enclosure.
00:41:00	18:08:00	Gas Collection switched from in-cabinet to main hood
00:44:50	18:11:50	Flame observed obviously from the louver
00:48:01	18:15:01	Dense smoke observed from the deflagration panel of the initiating BESS



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Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Test Observations**

00:54:40	18:21:40	Camera at the left side of initiating BESS damaged
01:03:10	18:30:10	Flame reduction observed from the louver
01:03:10	18:30:10	fire has been steady inside the base but propagation to the other modules has not occurred and some other module temperatures are dropping
01:11:02	18:38:02	Fire abated continuously
01:17:00	18:44:00	Add fuel to support the sustain fire for about 10 seconds
01:18:00	18:45:00	Propane fuel supplied continuously to drive fire growth
01:20:20	18:47:20	Flame grew up slightly
01:25:00	18:52:00	Propane fuel supply stopped.
01:27:06	18:54:06	Fire became slightly larger.
01:35:37	19:02:37	Fire grew up and was observed spread out the enclosure
01:35:55	19:02:55	Fire grew up continuously.
01:37:08	19:04:08	Fire growth continuing
01:45:01	19:12:01	Large amount of gas and smoke observed, flames extended higher.
01:46:57	19:13:57	Intense fire observed inside the initiating unit.
01:49:48	19:16:48	Gaskets of the 2 M-LINKs close to initiating unit caught fire
01:53:44	19:20:44	Smoke was observed obviously from camera 14
01:56:15	19:23:15	Cameras 17 and 18 damaged
02:04:09	19:31:09	Large amount of smoke observed on camera 14
02:05:54	19:32:54	Flames visible on the top of Camera 12, may be due to fire blowing over from top panel
02:08:50	19:35:50	Large amount of smoke visible on Camera 12
02:11:09	19:38:09	Continued fire growth
02:12:34	19:39:34	Fire was observed inside the M-LINK at the right side of the initiating unit, fire on the plastic cooling lines
02:14:00	19:41:00	Fire was observed from the inner side of the M-LINK at the right side of Initiating unit.
02:18:11	19:45:11	Sustained combustion observed from the inner of M-LINK at the right side of initiating unit.
02:19:30	19:46:30	A lot of smoke observed from the inner side of M-LINK at the right side of initiating unit



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Master Contract:	N/A	Model:	JF2 DC LINK 5.1	Page number 9 of 82
Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Test Observations**

02:29:30	19:56:30	A small amount of smoke observed inside the M-LINK at the left side of initiating unit.
02:35:20	20:02:20	Increased fire observed on M-link in the right side of initiating BESS
02:44:00	20:11:00	Fire has mostly consumed initiating M-LINK, primarily consuming M-LINK 3
02:49:40	20:16:40	Slight flame observed on the enclosure of target M-LINK at the right side.
02:52:48	20:19:48	A lot of smoke observed from the inner side of the target M-LINK located at the right side.
03:47:11	21:14:11	Maximum enclosure temperature 277°C measured on M-LINK at the left side of initiating M link
03:51:16	21:18:16	Fire weakened slightly
04:10:10	21:37:10	Fire grew up
04:17:01	21:44:01	Fire grew up continuously, possible because lower module began to burn
05:26:32	22:53:32	Fire weakened slightly
05:36:29	23:03:29	Faint purple flame was visible from the external
05:56:57	23:23:57	Very little flames observed with flash fire.
06:00:43	23:27:43	Fire dying out from the top deflagration panel
06:35:15	00:02:15	Very little flame observed from the inside
07:31:04	00:58:04	No fire observed from external
92:43:34	2025-01-15 14:10:34	All temperatures returned to ambient, test concluded

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Master Contract: N/A	Model: JF2 DC LINK 5.1	Page number 10 of 82
Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

### Post-Test Analysis



Figure 2: DUT post-test

Post-test analysis consisted of opening the units and taking photographs to document the damage. Modules in the target units were removed and examined for spread of thermal runaway and for damage.

Thermocouple data collection was stopped at 2:10 PM on 2025-01-15 based on return to ambient conditions. Teardown and post-test analysis was performed by CWN and LG at their discretion on 2025-02-04 through 2025-02-05 – photos are in Attachment 2.

### End of Test Conditions

DUT burned completely without intervention until all fuel is exhausted, and the fire self-extinguished. Testing concluded once all functional thermocouples returned to ambient temperatures.



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Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

## Conclusions

Testing was performed at Anhui Suzhou Thermal Safety Technology National and Local Joint Engineering Research Center (CWN) on [2025-01-11, at 5:27 PM](#). All equipment was verified by CSA Group personnel to be in calibration and acceptable for testing.

The DUT was ignited using the prescribed methodology until a self-sustained fire was achieved and burned without intervention until no fuel remained. Testing concluded on [2025-01-15 at 2:10 PM](#).

The initiating module was heated using the film heaters until thermal runaway occurred, at 35 minutes into the test. 2 venting events were observed prior to thermal runaway. The propane burner was activated 3 seconds after thermal runaway was confirmed, and fire was successfully ignited 37 minutes, 50 seconds into the test. Fire burned internally inside of M-LINK 2 for approximately 40 minutes without propagating to the other modules, and began to die out. As fire was dying out, the propane burner was turned on again to force a fully developed fire condition. The burner was turned on again 1 hour and 18 minutes into the test and left on for 7 minutes until the fire had begun to engulf all of M-LINK 2. The burner was shut off at 1 hour and 25 minutes elapsed and remained off for the rest of the test.

The fire grew in intensity for 24 minutes until the gasket in M-LINK 3, to the right of the initiating M-LINK, caught fire. The fire of the gasket caused propagation to jump from M-LINK 2 to M-LINK 3, both eventually being completely consumed by the flames. The fire reached peak intensity 2 hours and 37 minutes into the test, as determined by heat flux measurement, with further peaks at 4.5 hours and 5 hours respectively. After 5.5 hours, the flames began to subside. The fire burned completely without intervention until it self-extinguished 7 hours and 31 minutes into the test.

The fire completely consumed both M-LINK 2 and M-LINK 3. The fire did not propagate to M-LINK 1, to the left of the initiator. The E-Panel was also undamaged. Flames impinged on both the Side Target Unit and corner and roof of the Rear Target Unit, igniting the paint on the Side Target Unit. Scorching was visible on the exterior surface of both target units. However, the modules in the target units did not go into thermal runaway, indicating that unit-to-unit propagation did not occur. The front target walls exhibited scorching and delamination of the wood surface. Additionally, there were no deflagration or explosion events observed during the test.



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Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

Cell Specifications	
Manufacturer:	LG Energy Solution Ltd.
Brand name / Trademark:	JF2
Model number:	JF2
Nominal cell voltage, (V)	3.2
Cell capacity, (Ah)	159.2
Cell chemistry:	LFP
Physical format of cell:	Pouch
Approximate dimension, (mm)	125.0 x 18.1 x 601.0
Module Specifications	
Manufacturer:	LG Energy Solution Ltd.
Brand name / Trademark:	JF2
Model number:	JF2 Pack
Nominal voltage rating, (V)	96
Nominal capacity rating, (Ah)	636.8
Approximate dimension, (mm)	2,085 x 825 x 145
Module weight, (kg)	410
Electrical configuration	30s-4p
Number of cells in DUT	120
Unit Specifications	
Manufacturer:	LG Energy Solution Ltd.
Brand name / Trademark:	N/A
Model number:	JF2 DC LINK 5.1
Nominal voltage rating, (V)	1334
Nominal capacity rating, (kWh)	5,112
Approximate unit dimensions, (mm)	7,170 x 2,570 x 2,896
Unit weight, (ton)	48
Electrical configuration	14s-6p

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**Attachment 1 – Unit charge conditioning graphs**

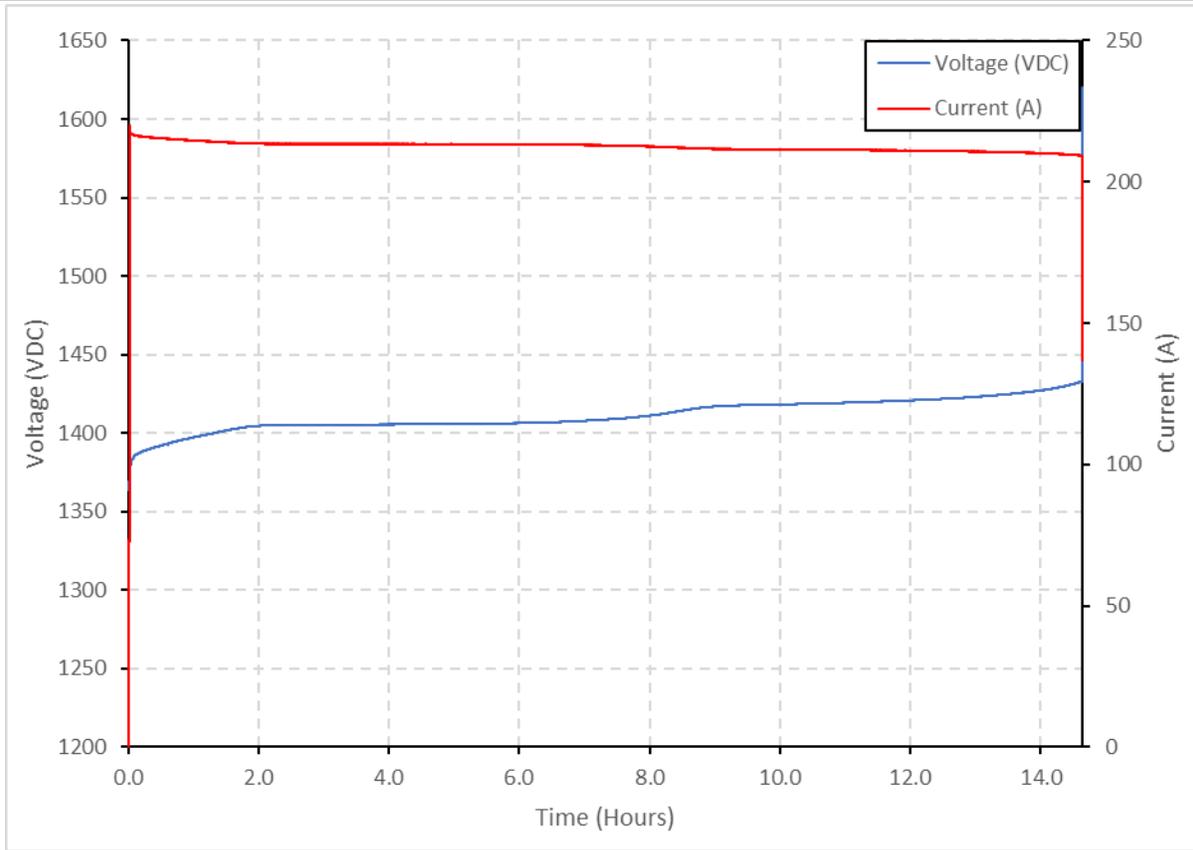


Figure 1.1: Initiating Unit Charge

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### Attachment 2 – Photos

#### General sample photos



Figure 2.1: Initiating Unit, showing M-LINK 1 to M-LINK 3 from left to right.



Figure 2.2: View of Initiating Unit front aisle, showing instrumentation and target wall



Figure 2.3: Initiating Unit E-Panel



Figure 2.4: Initiating Unit E-Panel Interior

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**Attachment 2 – Photos**



Figure 2.5: Initiating Unit M-LINK 1 Interior



Figure 2.6: Representative photo of M-LINK exterior



Figure 2.7: Initiating Unit M-LINK 2 Interior



Figure 2.8: Initiating Unit M-LINK 3 Interior

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### Attachment 2 – Photos



Figure 2.9: Rear Target Unit Dummy E-Panel



Figure 2.10: Rear Target Unit Dummy E-Panel Interior



Figure 2.11: Rear Target Unit M-LINK 1 Interior



Figure 2.12: Rear Target Unit M-LINK 2 Interior

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### Attachment 2 – Photos



Figure 2.13: Rear Target Unit M-LINK 3 Interior



Figure 2.14: Rear corner view of test setup, Side Target Unit on left, Rear Target Unit on right

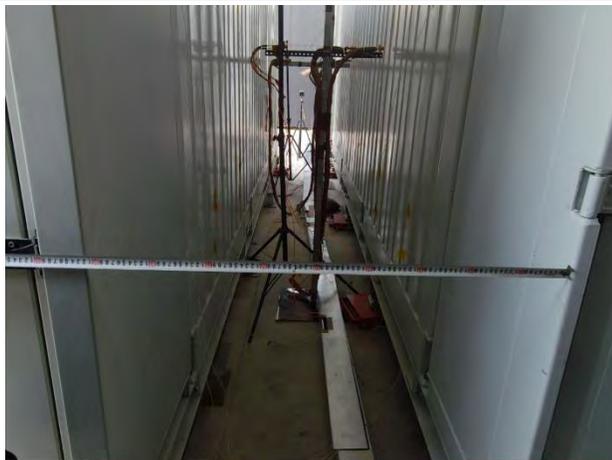


Figure 2.15: Initiating Unit to Rear Target Unit separation distance



Figure 2.16: Initiating Unit to Side Target Unit separation distance

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### Attachment 2 – Photos

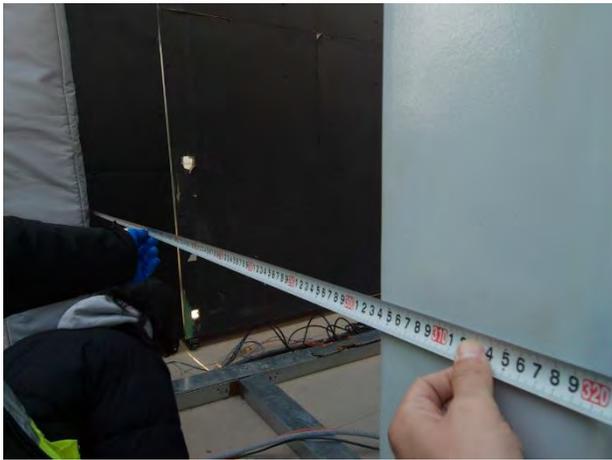


Figure 2.17: Initiating Unit to Front Target Wall separation distance



Figure 2.18: Initiating Unit to Left Target Wall separation distance



Figure 2.19: Initiating Unit Rear to HF gauges



Figure 2.20: Initiating Unit E-Panel to left HF gauges

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### Attachment 2 – Photos



Figure 2.21: Side Target Unit Aisle HF gauges



Figure 2.22: Initiating Unit Front Aisle HF gauges



Figure 2.23: Overall view of rear of test setup, showing Rear Target Unit and Side Target Unit

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### Attachment 2 – Photos

#### Photos with heater and thermocouple installation

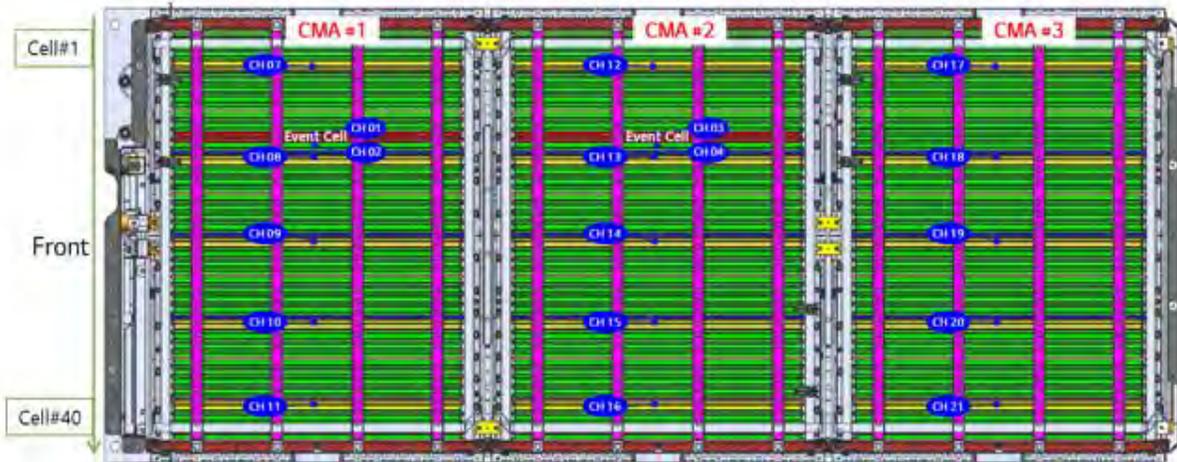


Figure 2.24: Initiating Module Heater and internal TC locations

#### Test Layout

CH22~30

##### Initiating Pack TC MAP – Outside(Pack Surface)

No.	Location
22	CMA#1_EndPlate(L)
23	CMA#2_EndPlate(L)
24	CMA#3_EndPlate(L)
25	CMA#1_EndPlate(R)
26	CMA#2_EndPlate(R)
27	CMA#3_EndPlate(R)
28	CMA#1_Pack Bottom
29	CMA#2_Pack Bottom
30	CMA#3_Pack Bottom

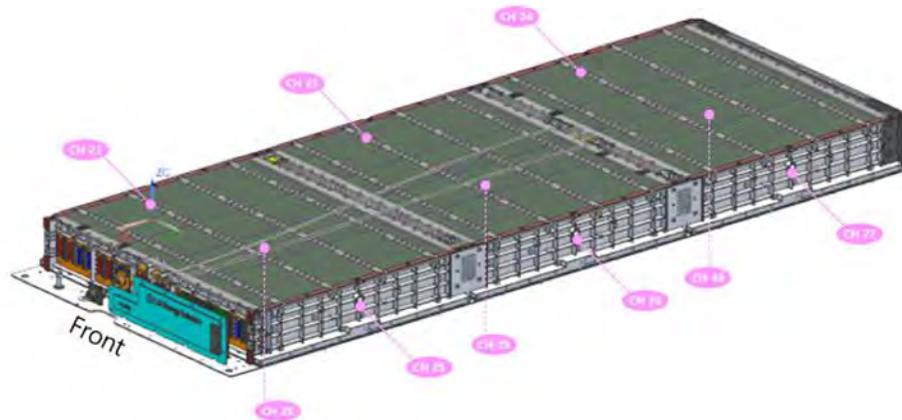
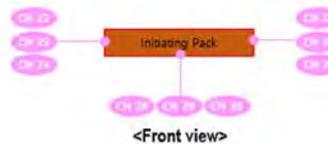


Figure 2.25: Initiating Module external TC locations

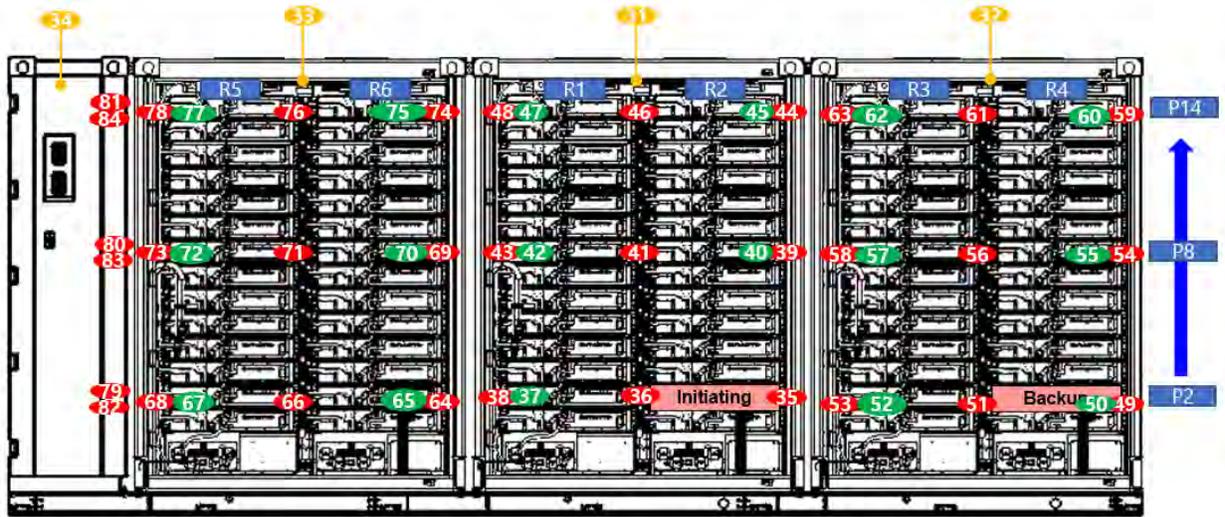
ORIGINAL TEST DATA

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Attachment 2 – Photos



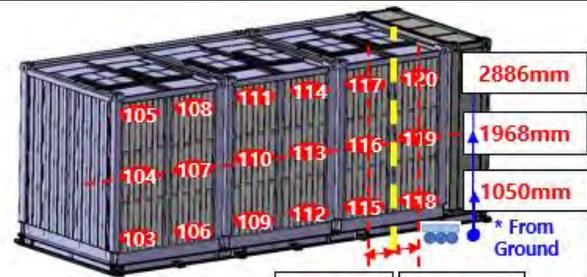
Front View (without Door)

Figure 2.26: Initiating Unit interior instrumentation



Front View - Inside

Figure 2.27: Initiating Unit rear wall interior instrumentation



Rear View - Outside

Figure 2.28: Initiating Unit rear wall exterior instrumentation

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### Attachment 2 – Photos

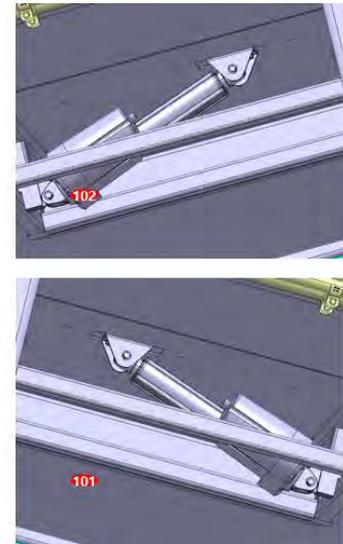
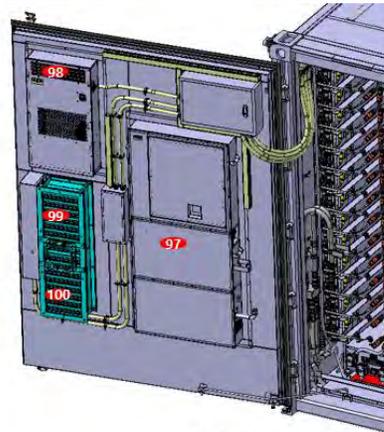


Figure 2.29: Initiating Unit door instrumentation

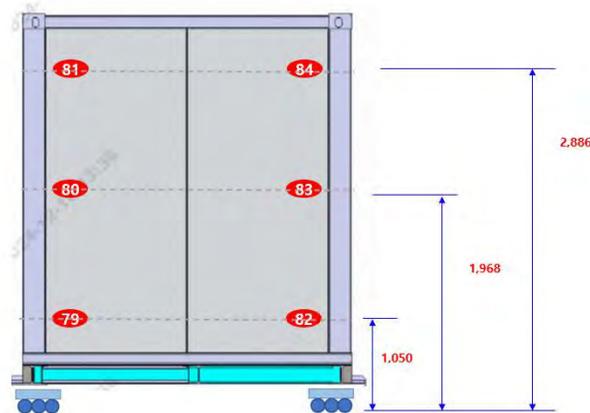


Figure 2.30: Initiating Unit E-Panel TCS

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### Attachment 2 – Photos

#### Test Layout

CH281-330

Enclosure Thermal Coupler Setting – **Initiating Unit**

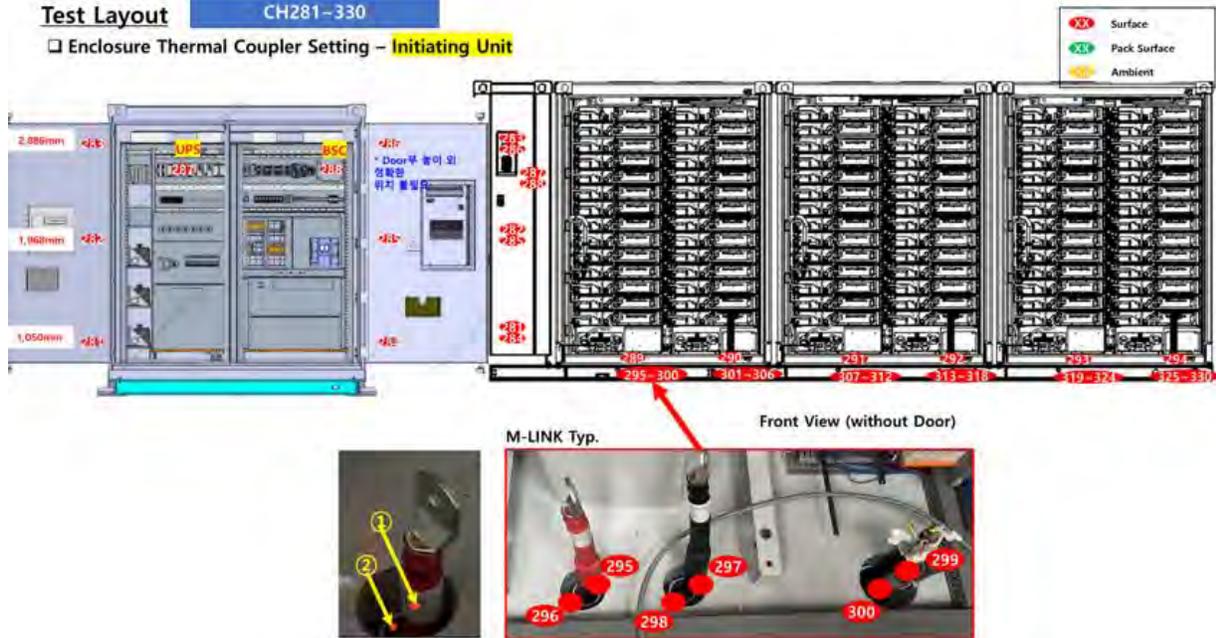


Figure 2.31: Initiating Unit SKID and E-Panel Door TCs

#### Test Layout

CH446-471

Enclosure Thermal Coupler Setting – **Initiating Unit – M-LINK#1**

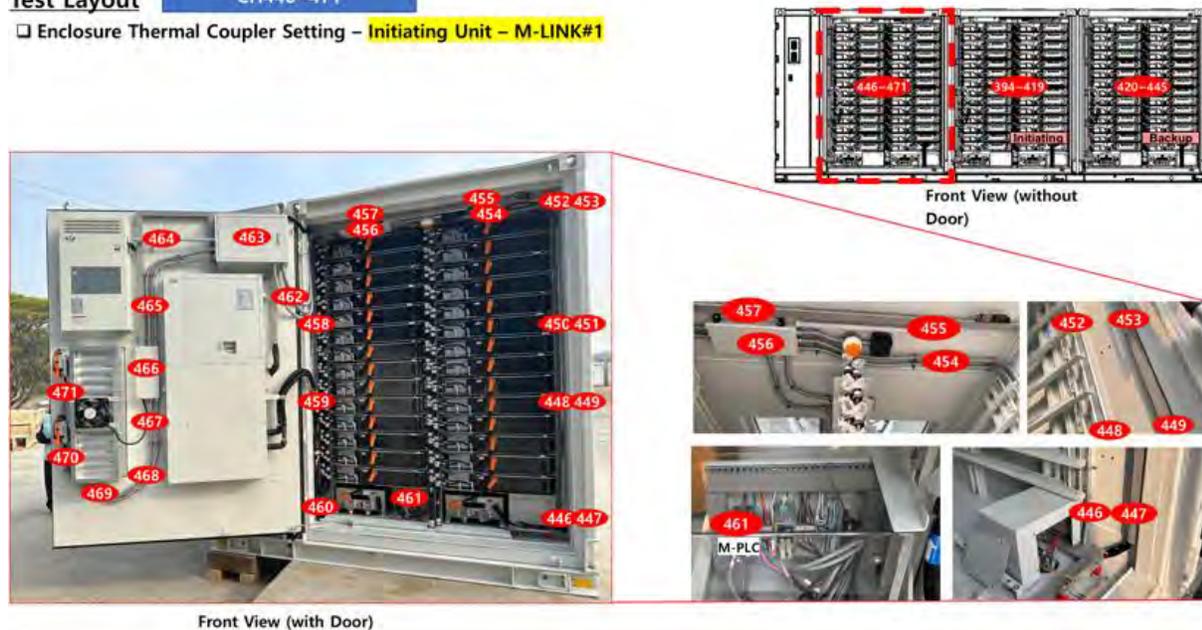


Figure 2.32: Initiating Unit M-LINK 1 equipment instrumentation

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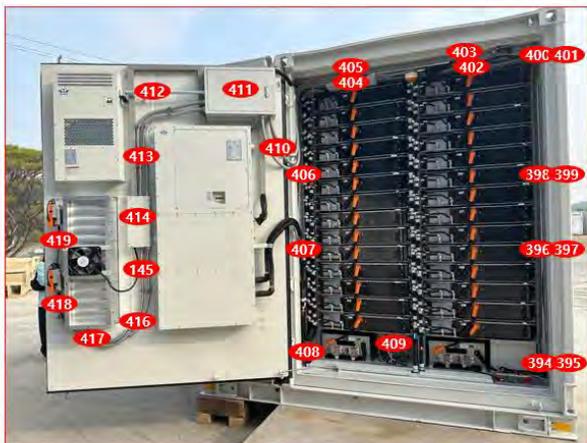
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### Attachment 2 – Photos

#### Test Layout

CH394~419

□ Enclosure Thermal Coupler Setting – **Initiating Unit – M-LINK#2**



Front View (with Door)



Front View (without Door)



Figure 2.33: Initiating Unit M-LINK 2 equipment instrumentation

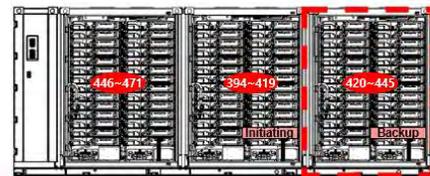
#### Test Layout

CH420~445

□ Enclosure Thermal Coupler Setting – **Initiating Unit – M-LINK#3**



Front View (with Door)



Front View (without Door)

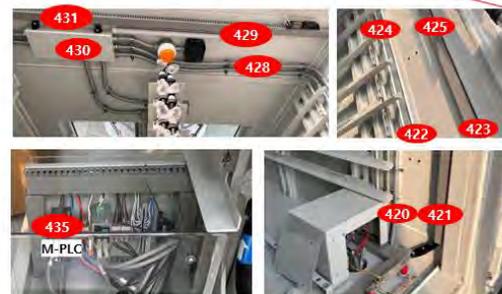


Figure 2.34: Initiating Unit M-LINK 3 equipment instrumentation

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### Attachment 2 – Photos

#### Test Layout

CH472~477

Enclosure Thermal Coupler Setting - **Initiating**

Unit

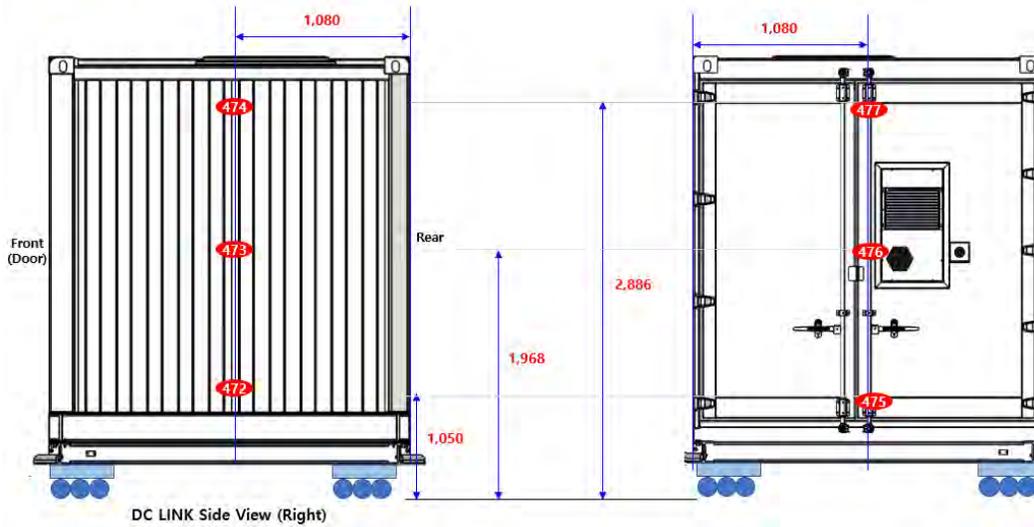


Figure 2.35: Initiating Unit exterior side and door TCs

#### Test Layout

CH139~231

Enclosure Thermal Coupler Setting - **Target Unit (Rear)** \*All of detailed TC locations are same as Initiating unit

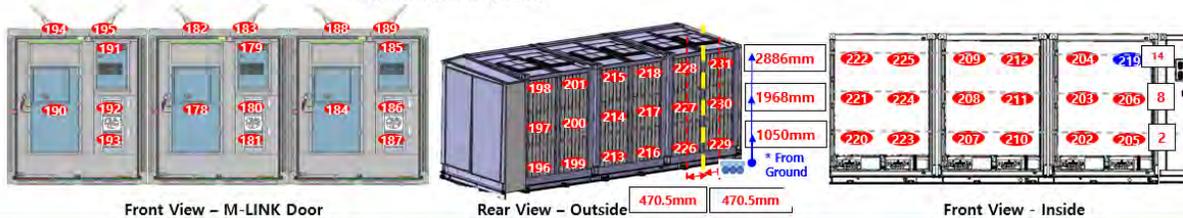
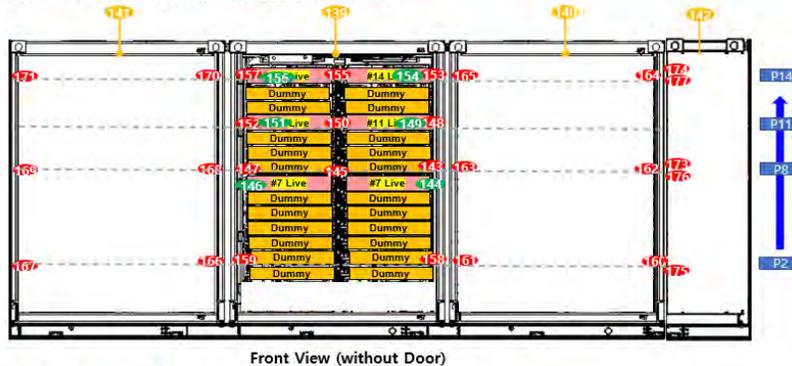


Figure 2.36: Rear Target Unit instrumentation

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### Attachment 2 – Photos

#### Test Layout

Enclosure Thermal Coupler Setting – Target Unit (Dummy E-Panel)

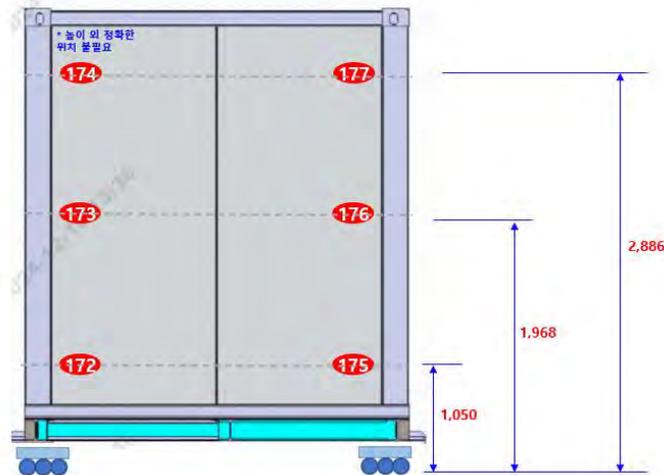


Figure 2.37: Rear Target Unit Dummy E-panel instrumentation

#### Test Layout

CH261~280

Enclosure Thermal Coupler Setting – Target Unit (Rear)

\*All of detailed TC locations are same as Initiating unit

- Surface
- Pack Surface
- Ambient
- Pack inside(CMA)

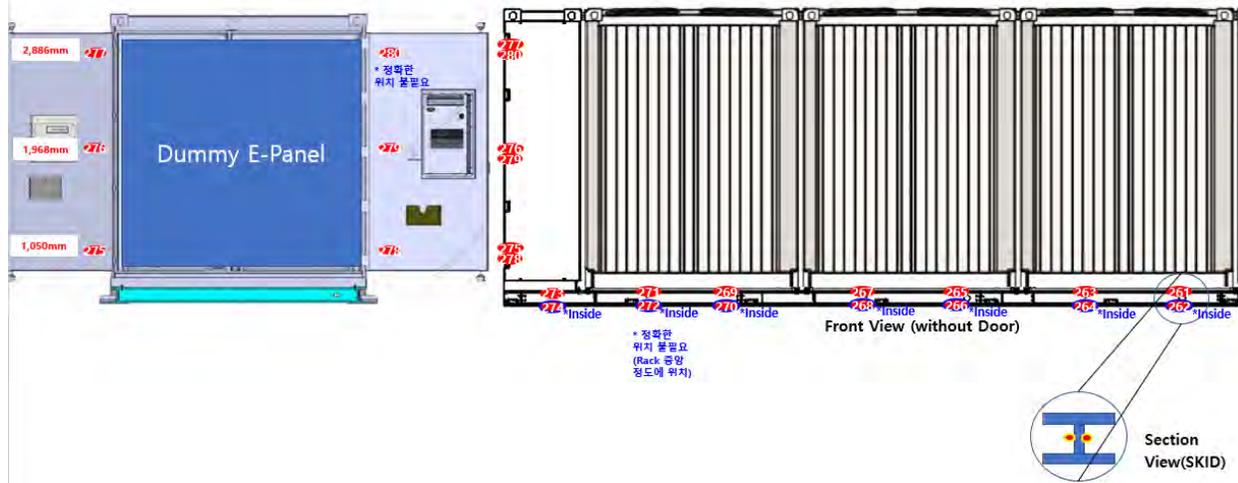


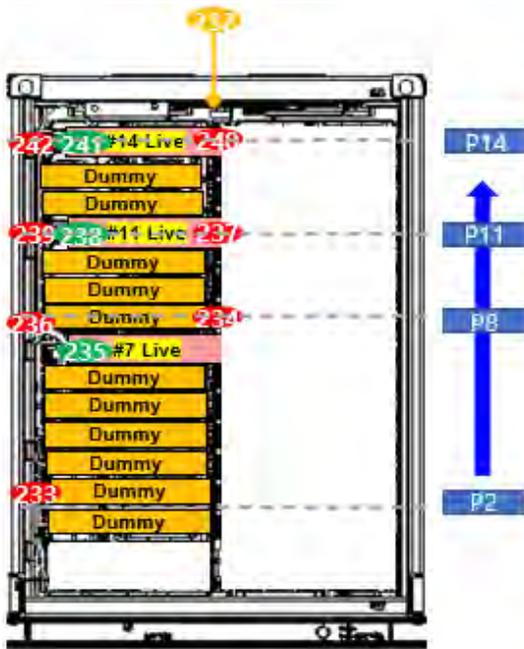
Figure 2.38: Rear Target Unit SKID and Dummy E-Panel Door TCs

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**Attachment 2 – Photos**



Front View (without Door)



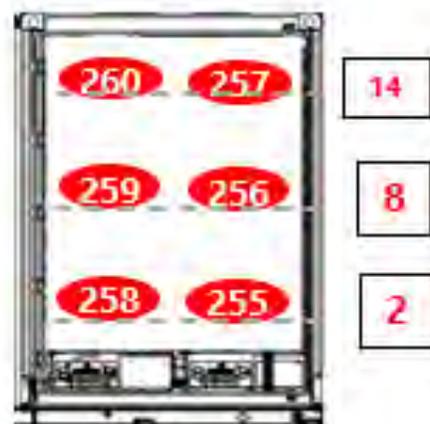
Front View – M-LINK Door

Figure 2.39: Side Target Unit Instrumentation

Figure 2.40: Side Target Unit Door TCs



Figure 2.41: Side Target Unit rear exterior TCs



Front View - Inside

Figure 2.42: Side Target Unit rear wall interior TCs

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### Attachment 2 – Photos

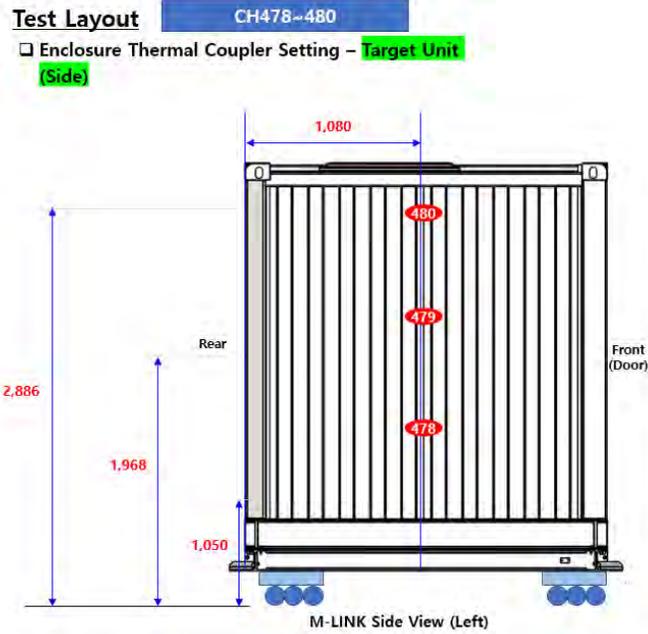


Figure 2.43: Side Target Unit exterior side TCs, facing Initiating Unit

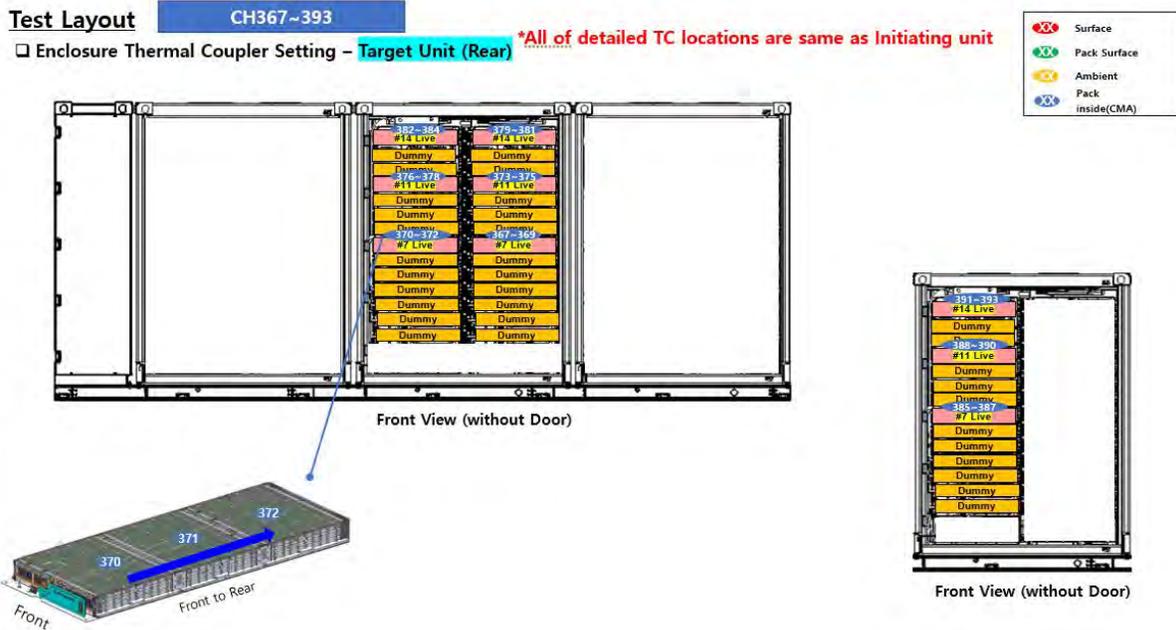


Figure 2.44: Target Unit Module Instrumentation

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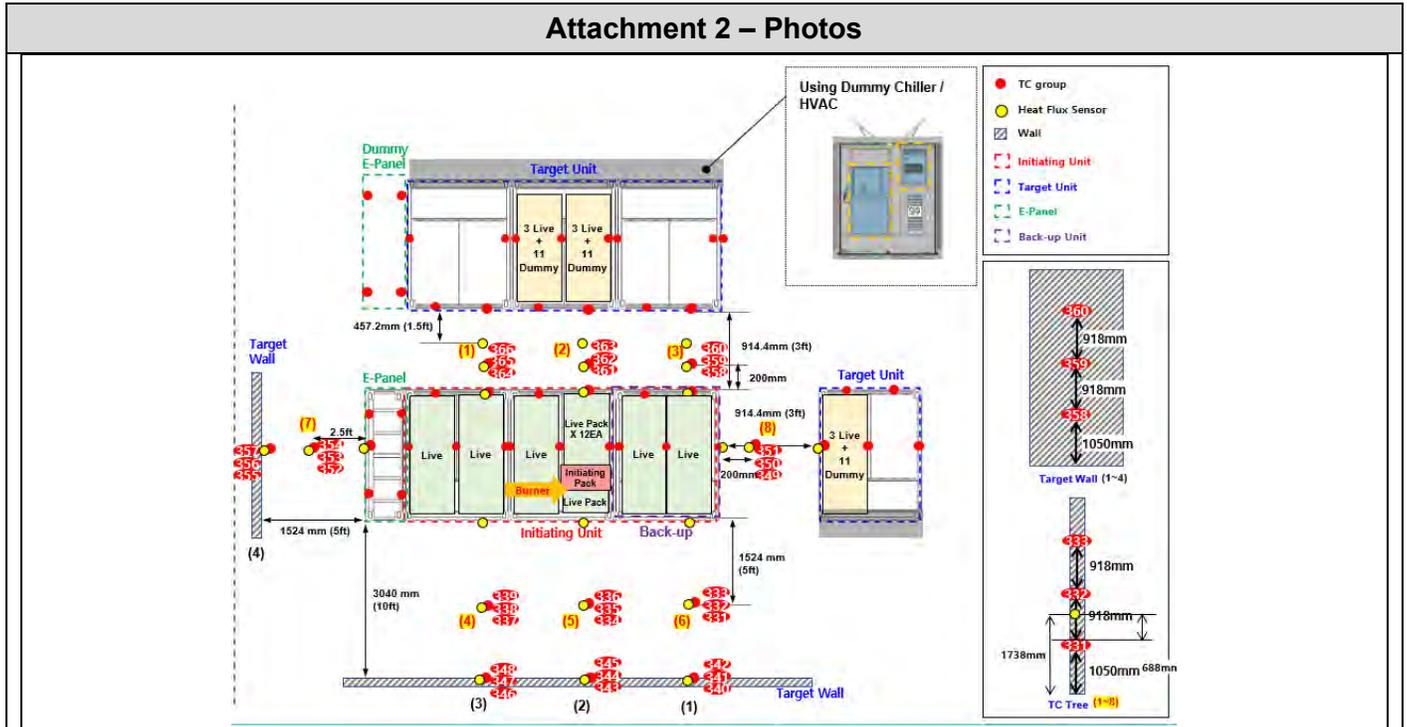


Figure 2.45: Overall Test Setup and Aisle Instrumentation

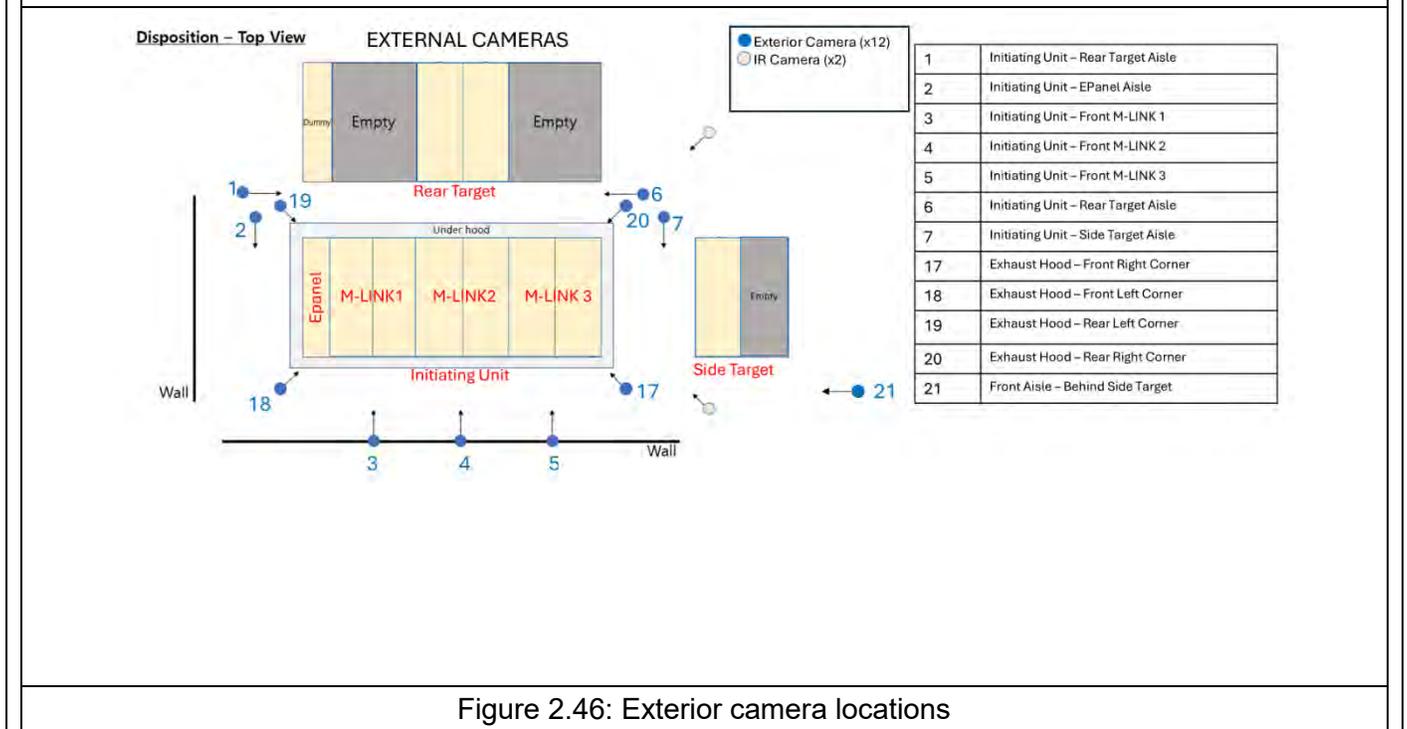


Figure 2.46: Exterior camera locations

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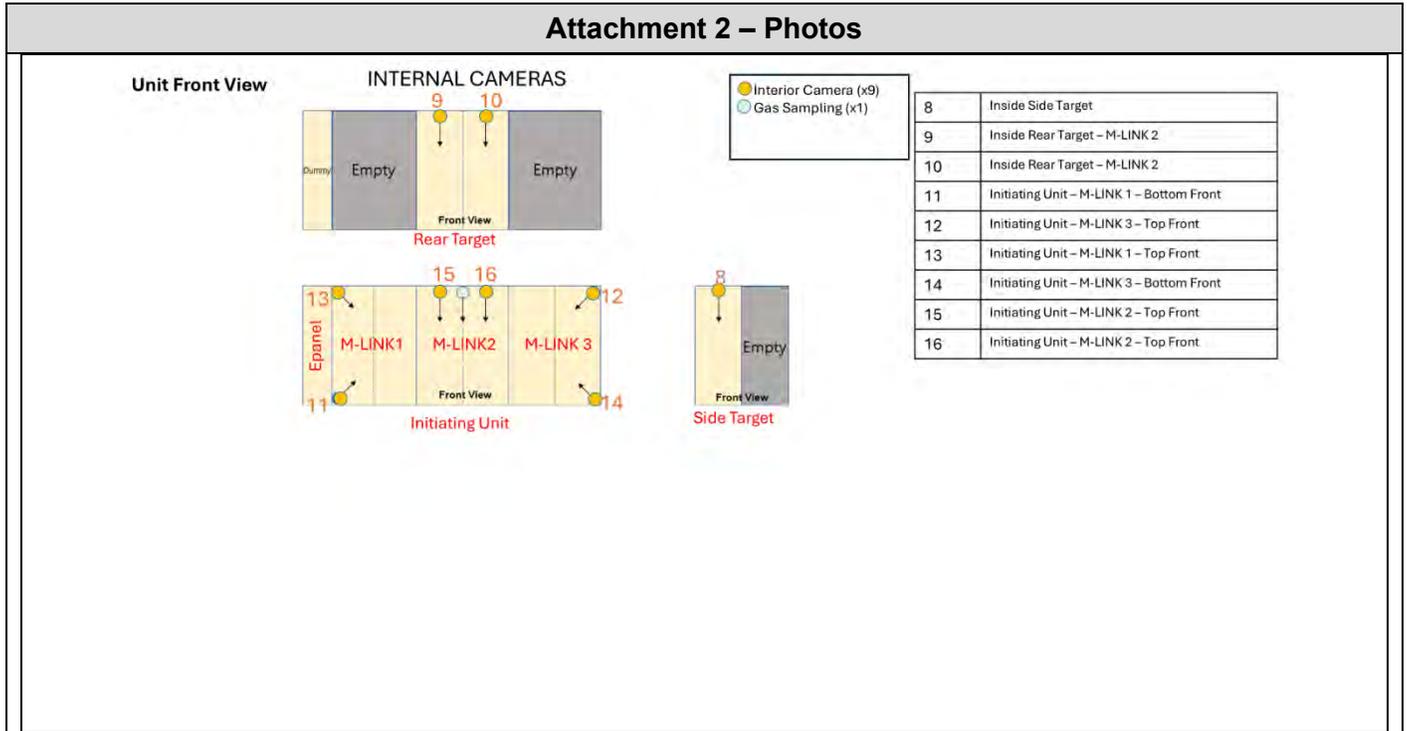


Figure 2.47: Internal camera locations



Figure 2.48: Propane burner for fire condition ignition placement in M-LINK 2

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### Attachment 2 – Photos

#### Photos during test in progress



Figure 2.49: Test Start (00:00:00)



Figure 2.50: Visible vent gas inside M-LINK 2 (00:36:56)



Figure 2.51: Burner successfully ignites fire inside M-LINK 2 (00:37:50)



Figure 2.52: Internal fire visible through louvers on M-LINK 2 (00:44:50)



Figure 2.53: Fire going out inside M-LINK 2 without module-to-module propagation (01:25:51)



Figure 2.54: Burner turned back on to force fully developed fire condition (01:29:50)

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### Attachment 2 – Photos



Figure 2.55: Fire growing outside M-LINK 2 from constant gas flow to burner (01:35:43)



Figure 2.56: Large amount of external flaming from M-LINK 2 (01:48:40)



Figure 2.57: Flames visible inside M-LINK 3, indicating fire propagation from M-LINK 2 to M-LINK 3 (02:03:00)



Figure 2.58: Internal wiring inside M-LINK 3 on fire (02:18:03)



Figure 2.59: Peak flaming, as determined by heat flux measurement (02:37:04)



Figure 2.60: Intense external flaming (02:48:34)

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### Attachment 2 – Photos



Figure 2.61: Side Target Unit paint ignites, small amount of fire on external surface (02:49:40)



Figure 2.62: Fire reducing (03:51:16)



Figure 2.63: External flaming flare-up (04:17:01)



Figure 2.64: Fire dying down (05:26:32)

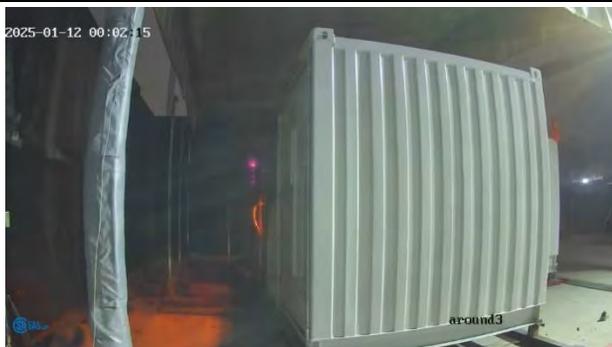


Figure 2.65: Very little flaming visible (06:35:15)



Figure 2.66: End of active test observation, no further events (06:59:58)

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**Attachment 2 – Photos**

**Photos after test**



Figure 2.67: Initiating Unit M-LINK 2 condition



Figure 2.68: Initiating Unit M-LINK 3 condition



Figure 2.69: Initiating Unit M-LINK 1 condition



Figure 2.70: Initiating Unit M-LINK interior

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### Attachment 2 – Photos



Figure 2.71: Initiating Unit M-LINK 3 interior



Figure 2.72: Initiating Unit M-LINK 1 interior



Figure 2.73: Initiating Unit E-Panel interior



Figure 2.74: Overall Initiating Unit condition

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### Attachment 2 – Photos



Figure 2.75: Initiating Unit roof condition



Figure 2.76: Initiating Unit M-LINK 1 & E-Panel roof



Figure 2.77: Side Target Unit front condition



Figure 2.78: Side Target Unit roof

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**Attachment 2 – Photos**



Figure 2.79: Side Target Unit, side facing Initiating Unit



Figure 2.80: Side Target Unit interior



Figure 2.81: Rear Target Unit condition



Figure 2.82: Rear Target Unit, top of M-LINK 1

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**Attachment 2 – Photos**



Figure 2.83: Rear Target Unit, M-LINK 2 top



Figure 2.84: Rear Target Unit, M-LINK 3 top



Figure 2.85: Rear Target Unit M-LINK 2 interior



Figure 2.86: Rear Target Unit M-LINK 1 interior

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### Attachment 2 – Photos



Figure 2.87: Rear Target Unit M-LINK 3 Interior



Figure 2.88: Damage to Front Target Wall



Figure 2.89: Segment of wall directly in front of Initiating Unit M-LINK 2



Figure 2.90: Overall test setup, post-test

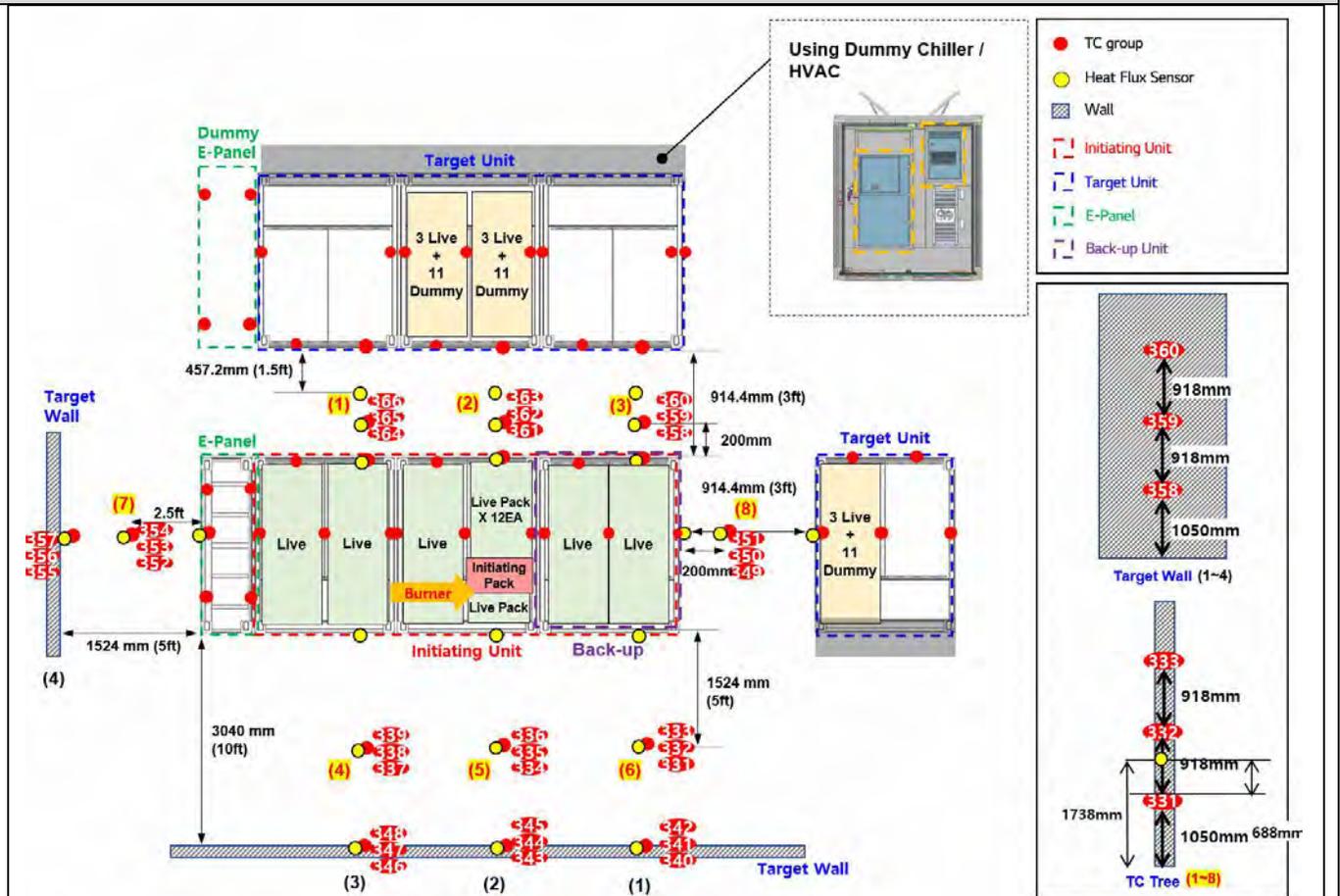
ORIGINAL TEST DATA

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### Attachment 3 - Diagram and dimension of test setup



**Separation distance and other critical dimension detail**

Location	Required by manufacturer (mm)	Measured (mm)
Initiating Unit to Right Target Unit	914.4	914.4
Initiating Unit to Rear Target Unit	914.4	914.4
Initiating Unit to Side Target Wall	1,524	1,524
Initiating Unit to Front Target Wall	3,040	3,040
Initiating Unit to TC Trees 4-6	1,524	1,524
Initiating Unit to TC Tree 8	200	200
Initiating Unit to TC Trees 1-3	200	200
Rear Target Unit to Heat Flux Gauges 16-18	457.2	457.2
Initiating Unit to TC Tree 7	762	762

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### Attachment 4 – Temperature graph during testing

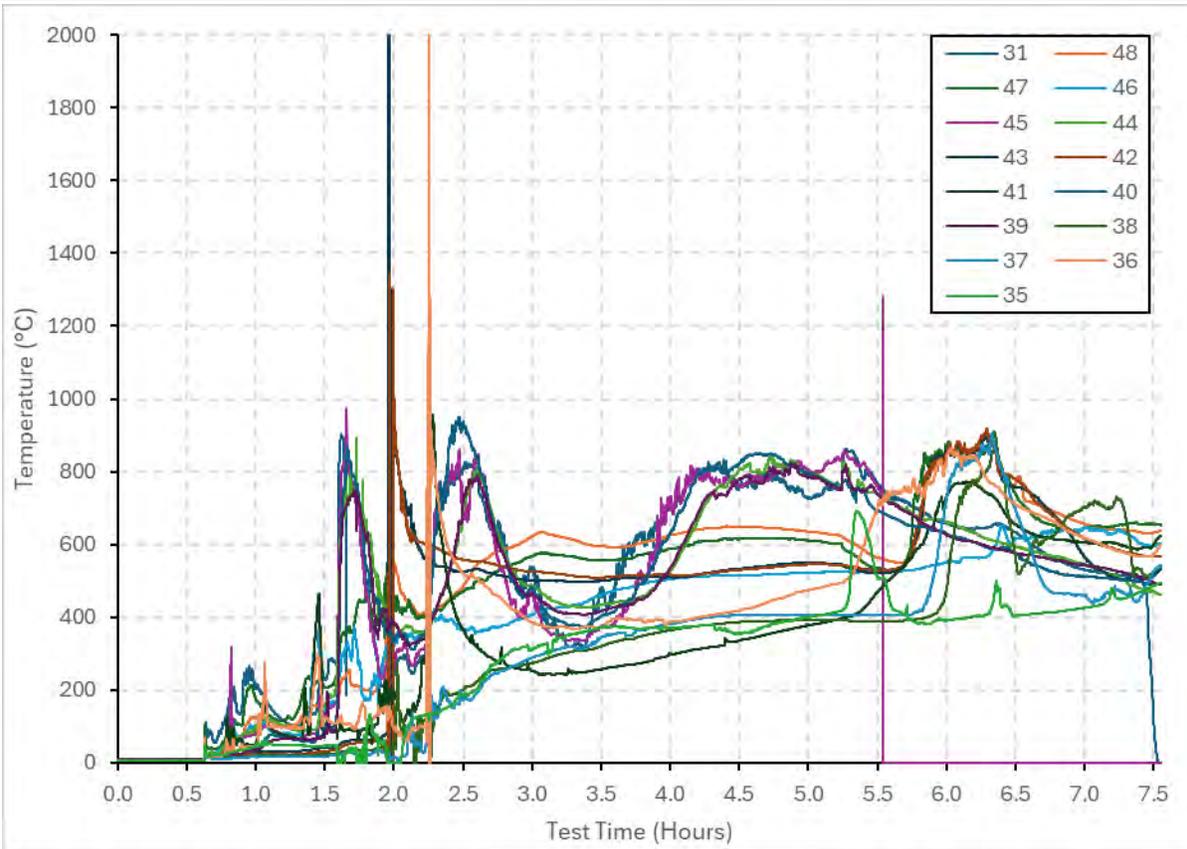


Figure 4.1: M-LINK 2 Module Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
31	M-LINK 2 Interior Ambient	905.1	41	M-LINK 2 Center Rack Surface near Pack #8	1301.3
48	M-LINK 2 Left Rack Surface near Pack #14	900.6	40	M-LINK 2 Rack 2, Pack #8 Surface	949.1
47	M-LINK 2 Rack 1, Pack #14 Surface	911.1	39	M-LINK 2 Right Rack Surface near Pack #8	822.9
46	M-LINK 2 Center Rack Surface near Pack #14	652.6	38	M-LINK 2 Left Rack Surface near Pack #2	870.3
45	M-LINK 2 Rack 2, Pack #14 Surface	1283.4	37	M-LINK 2 Rack 1, Pack #2 Surface	903.6
44	M-LINK 2 Right Rack Surface near Pack #14	891.7	36	M-LINK 2 Center Rack Surface Temperature near Initiating Pack	2153.7*
43	M-LINK 2 Left Rack Surface near Pack #8	2153.7*	35	M-LINK 2 Right Rack Surface Temperature near Initiating Pack	693.7
42	M-LINK 2 Rack 1, Pack #8 Surface	1341.4			

**\*Note: Thermocouple potentially compromised**

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### Attachment 4 – Temperature graph during testing

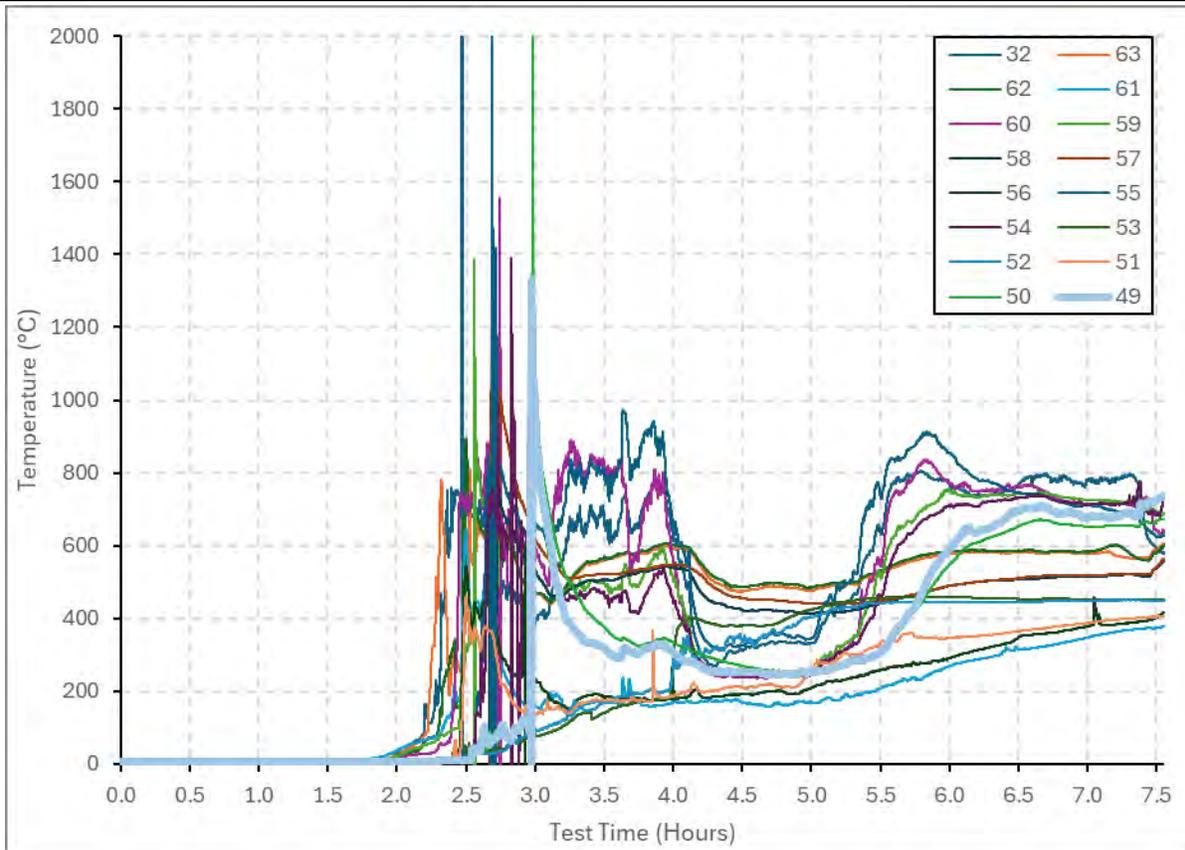


Figure 4.2: M-LINK 3 Module Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
32	M-LINK 3 Interior Ambient	2151.2*	56	M-LINK 3 Center Rack Surface near Pack #8	608.9
63	M-LINK 3 Left Rack Surface near Pack #14	808.2	55	M-LINK 3 Rack 4, Pack #8 Surface	2144.8*
62	M-LINK 3 Rack 3, Pack #14 Surface	893.4	54	M-LINK 3 Right Rack Surface near Pack #8	1390.4
61	M-LINK 3 Center Rack Surface near Pack #14	644.8	53	M-LINK 3 Left Rack Surface near Pack #2	460.2
60	M-LINK 3 Rack 4, Pack #14 Surface	1555.7	52	M-LINK 3 Rack 3, Pack #2 Surface	450.4
59	M-LINK 3 Right Rack Surface near Pack #14	1387.4	51	M-LINK 3 Center Rack Surface near Pack #2	459.3
58	M-LINK 3 Left Rack Surface near Pack #8	867.1	50	M-LINK 3 Rack 4, Pack #2 Surface	2151.8*
57	M-LINK 3 Rack 3, Pack #8 Surface	1374.5	49	M-LINK 3 Right Rack Surface near Pack#2	1329.8

**\*Note: Thermocouple potentially compromised**

ORIGINAL TEST DATA

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**Attachment 4 – Temperature graph during testing**

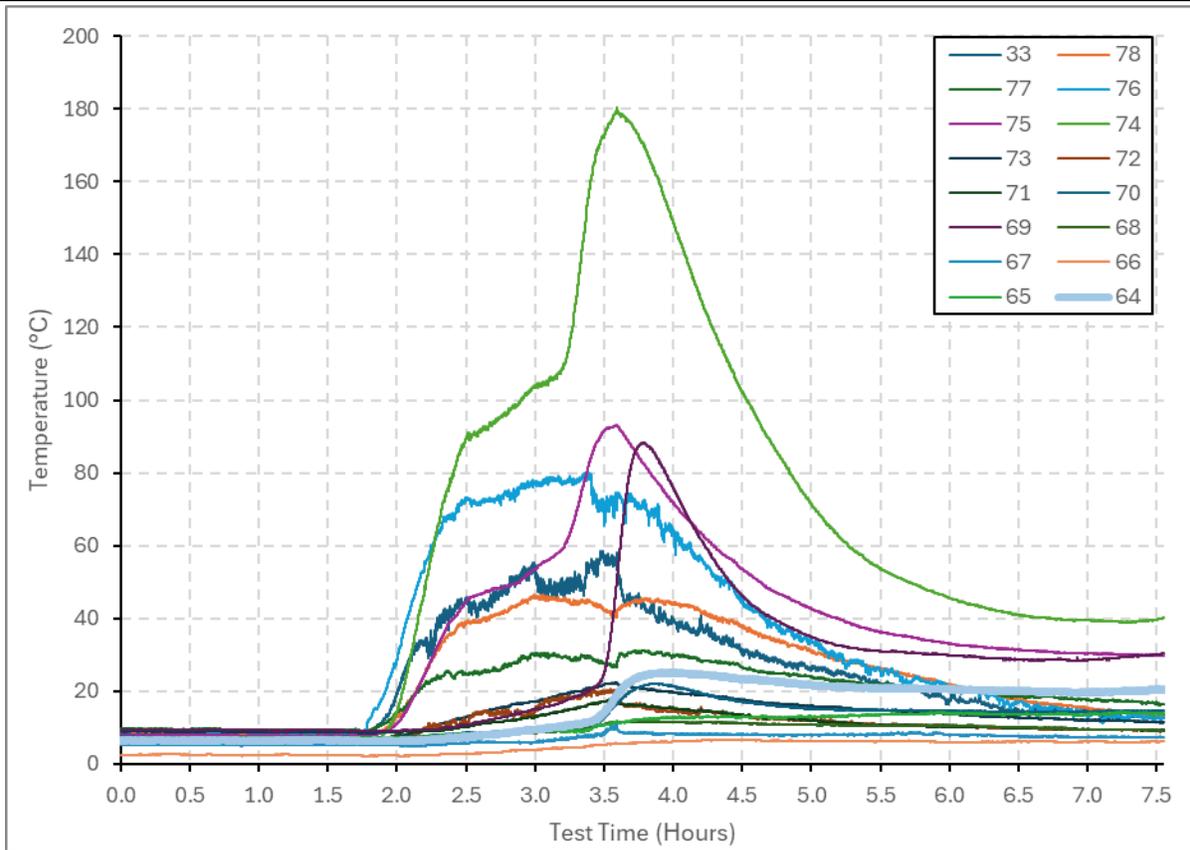


Figure 4.3: M-LINK 1 Module Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
33	M-LINK 1 Interior Ambient	58.6	71	M-LINK 1 Center Rack Surface near Pack #8	18.1
78	M-LINK 1 Left Rack Surface near Pack #14	46.4	70	M-LINK 1 Rack 6, Pack #8 Surface	22.1
77	M-LINK 1 Rack 5, Pack #14 Surface	31.3	69	M-LINK 1 Right Rack Surface near Pack #8	88.3
76	M-LINK 1 Center Rack Surface near Pack #14	80	68	M-LINK 1 Left Rack Surface near Pack #2	11.9
75	M-LINK 1 Rack 6, Pack #14 Surface	93.1	67	M-LINK 1 Rack 5, Pack #2 Surface	11.1
74	M-LINK 1 Right Rack Surface near Pack #14	180.3	66	M-LINK 1 Center Rack Surface near Pack #2	6.7
73	M-LINK 1 Left Rack Surface near Pack #8	22.4	65	M-LINK 1 Rack 6, Pack #2 Surface	14.3
72	M-LINK 1 Rack 5, Pack #8 Surface	20.7	64	M-LINK 1 Right Rack Surface near Pack#2	25.2

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#### Attachment 4 – Temperature graph during testing

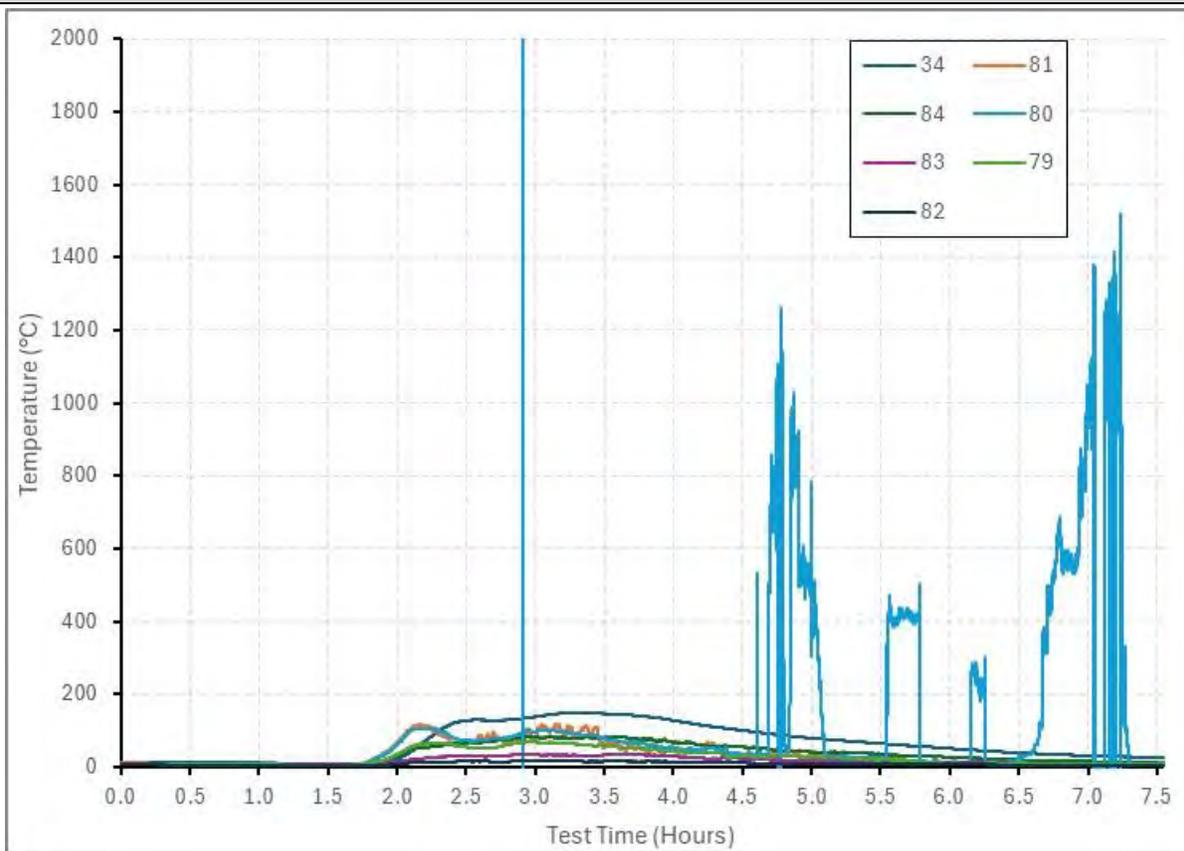


Figure 4.4: Initiating Unit E-Panel Interior Temperatures

TC	Location	Max (°C)
34	E-Panel Interior Ambient	149.0
81	E-Panel interior, left side, 2,886 mm from ground	118.4
84	E-Panel interior, right side, 2,886 mm from ground	85.3
80	E-Panel interior, left side, 1,968 mm from ground	2014.5*
83	E-Panel interior, right side, 1,968 mm from ground	35.6
79	E-Panel interior, left side, 1,050 mm from ground	74.0
82	E-Panel interior, right side, 1,050 mm from ground	17.7

**\*Note: Thermocouple potentially compromised**

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### Attachment 4 – Temperature graph during testing

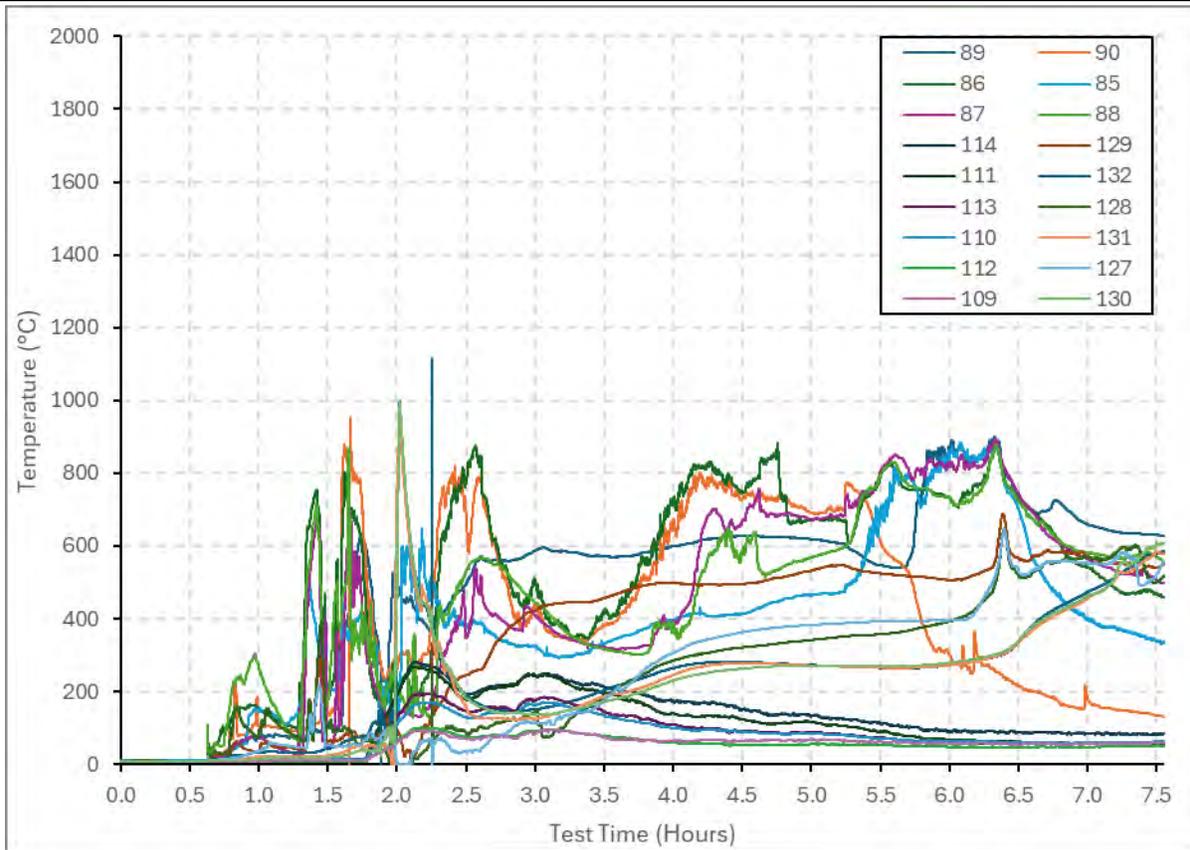


Figure 4.5: M-LINK 2 Interior & Exterior Surface and Door Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
89	M-LINK 2 - left ventilation panel strut (89)	900.2	132	M-LINK 2-Interior Rear Left Side, behind Pack #14	1114.3
90	M-LINK 2 - right ventilation panel strut (90)	953.0	113	M-LINK 2-Exterior Rear Right Side, 1968 mm from ground (113)	194.9
86	M-LINK 2 - Inside Door on HVAC (86)	883.6	128	M-LINK 2-Interior Rear Right Side, behind Pack #8	647.3
85	M-LINK 2 - Inside Door on Chiller (85)	885.2	110	M-LINK 2-Exterior Rear Left Side, 1968 mm from ground (110)	171.2
87	M-LINK 2 - Inside Door upper intake fan (87)	894.8	131	M-LINK 2-Interior Rear Left Side, behind Pack #8	959.5
88	M-LINK 2 - Inside Door lower intake fan (88)	879.5	112	M-LINK 2-Exterior Rear Right Side, 1050 mm from ground (112)	100.9
114	M-LINK 2-Exterior Rear Right Side, 2886 mm from ground (114)	281.5	127	M-LINK 2-Interior Rear Right Side, behind Pack #2	645.2
129	M-LINK 2-Interior Rear Right Side, behind Pack #14	686.9	109	M-LINK 2-Exterior Rear Left Side, 1050 mm from ground (109)	95.7
111	M-LINK 2-Exterior Rear Left Side, 2886 mm from ground (111)	268.5	130	M-LINK 2-Interior Rear Left Side, behind Pack #2 (130)	994.2

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### Attachment 4 – Temperature graph during testing

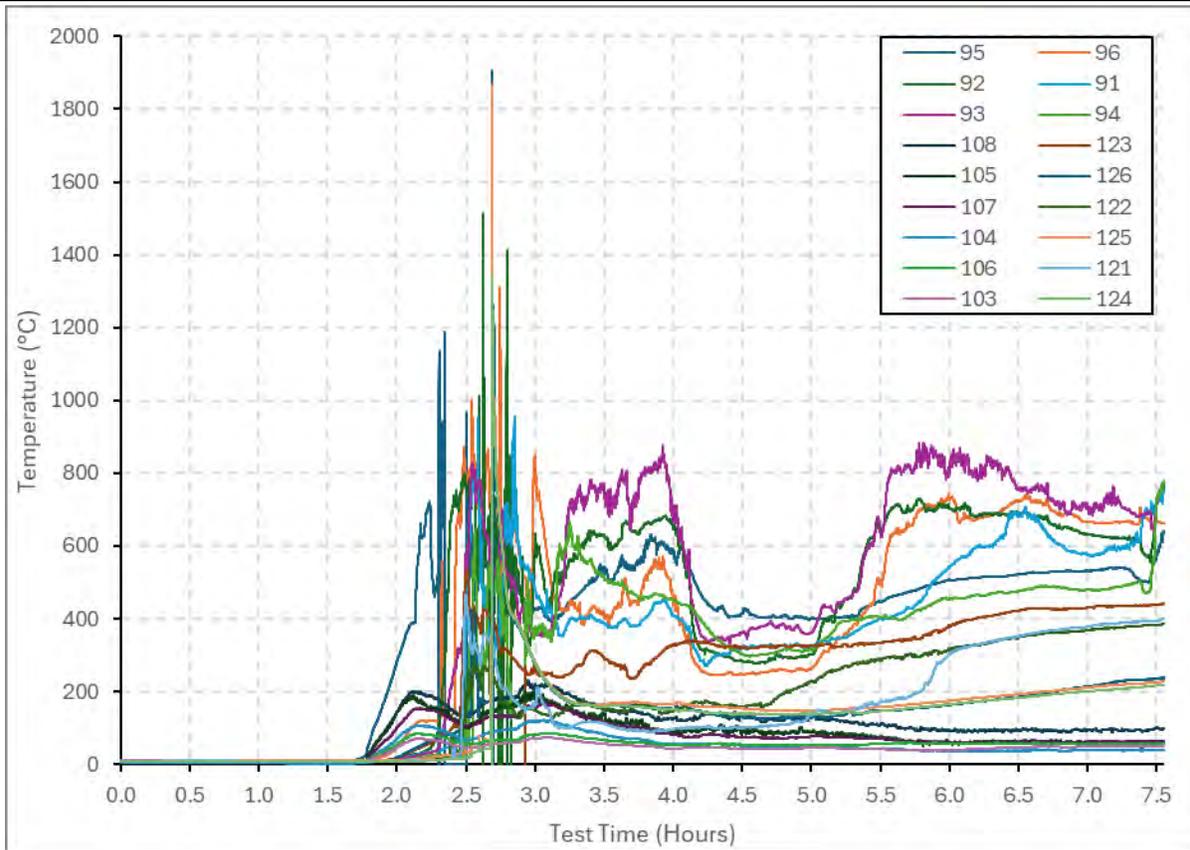


Figure 4.6: M-LINK 3 Interior & Exterior Surface and Door Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
95	M-LINK 3 - left ventilation panel strut (95)	1187.7	126	M-LINK 3-Interior Rear Left Side, behind Pack #14	1904.9
96	M-LINK 3 - right ventilation panel strut (96)	1310.6	107	M-LINK 3-Exterior Rear Right Side, 1968 mm from ground (107)	168.3
92	M-LINK 3 - Inside Door on HVAC (92)	1513.8	122	M-LINK 3-Interior Rear Right Side, behind Pack #8	385.4
91	M-LINK 3 - Inside Door on Chiller (91)	957.7	104	M-LINK 3-Exterior Rear Left Side, 1968 mm from ground (104)	122.8
93	M-LINK 3 - Inside Door upper intake fan (93)	884.5	125	M-LINK 3-Interior Rear Left Side, behind Pack #8	1869
94	M-LINK 3 - Inside Door lower intake fan (94)	776.8	106	M-LINK 3-Exterior Rear Right Side, 1050 mm from ground (106)	85.6
108	M-LINK 3-Exterior Rear Right Side, 2886 mm from ground (108)	231.6	121	M-LINK 3-Interior Rear Right Side, behind Pack #2	467
123	M-LINK 3-Interior Rear Right Side, behind Pack #14	538.4	103	M-LINK 3-Exterior Rear Left Side, 1050 mm from ground (103)	73.7
105	M-LINK 3-Exterior Rear Left Side, 2886 mm from ground (105)	201.2	124	M-LINK 3-Interior Rear Left Side, behind Pack #2	1346.8

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**Attachment 4 – Temperature graph during testing**

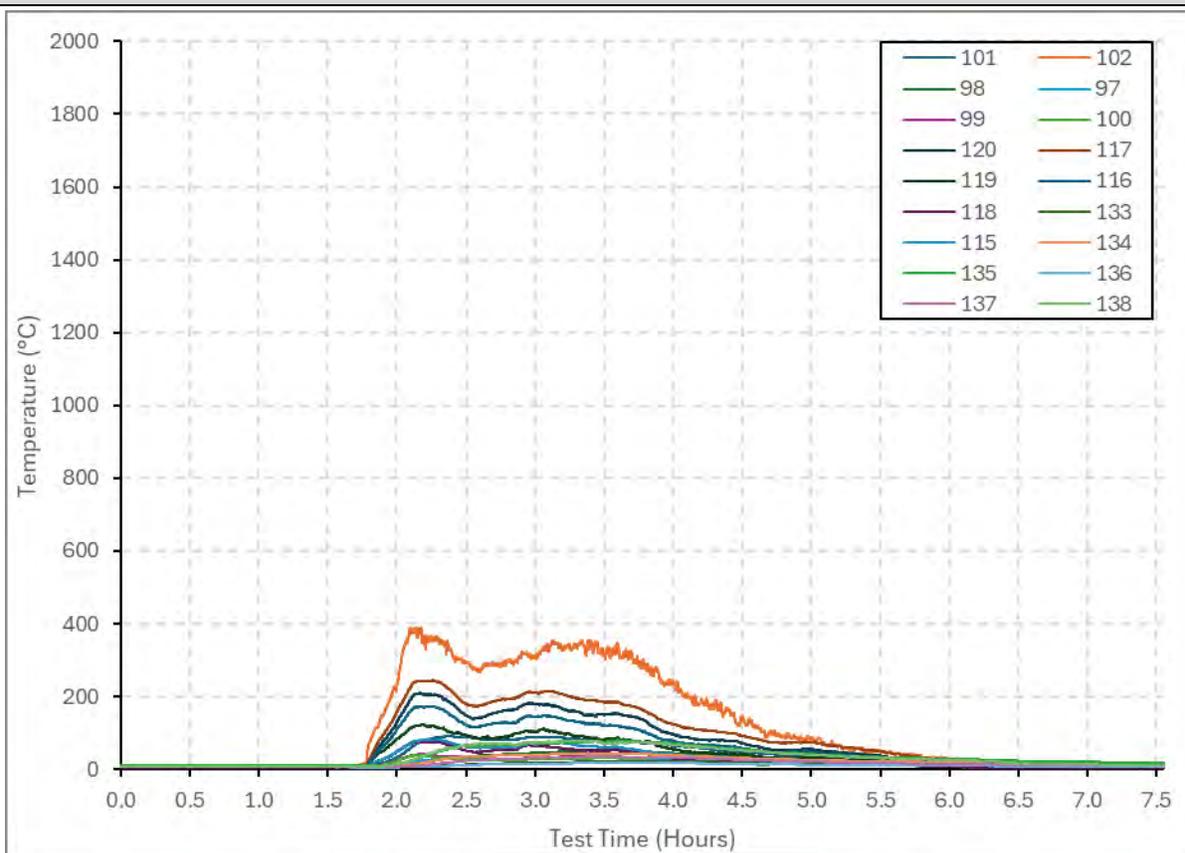


Figure 4.7: M-LINK 1 Interior & Exterior Surface Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
101	M-LINK 1 - left ventilation panel strut (101)	91.0	116	M-LINK 1-Exterior Rear Left Side, 1968 mm from ground (116)	173.9
102	M-LINK 1 - right ventilation panel strut (102)	390.3	118	M-LINK 1-Exterior Rear Right Side, 1050 mm from ground (118)	76.4
98	M-LINK 1 - Inside Door on HVAC (98)	56.4	133	M-LINK 1-Interior Rear Right Side, behind Pack #2 (133)	22.0
97	M-LINK 1 - Inside Door on Chiller (97)	35.0	115	M-LINK 1-Exterior Rear Left Side, 1050 mm from ground (115)	82.6
99	M-LINK 1 - Inside Door upper intake fan (99)	43.0	134	M-LINK 1-Interior Rear Right Side, behind Pack #8 (134)	43.6
100	M-LINK 1 - Inside Door lower intake fan (100)	40.8	135	M-LINK 1-Interior Rear Right Side, behind Pack #14 (135)	80.2
120	M-LINK 1-Exterior Rear Right Side, 2886 mm from ground (120)	209.5	136	M-LINK 1-Interior Rear Left Side, behind Pack #2 (136)	17.9
117	M-LINK 1-Exterior Rear Left Side, 2886 mm from ground (117)	244.6	137	M-LINK 1-Interior Rear Left Side, behind Pack #8 (137)	34.5
119	M-LINK 1-Exterior Rear Right Side, 1968 mm from ground (119)	124.9	138	M-LINK 1-Interior Rear Left Side, behind Pack #14 (138)	78.9

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**Attachment 4 – Temperature graph during testing**

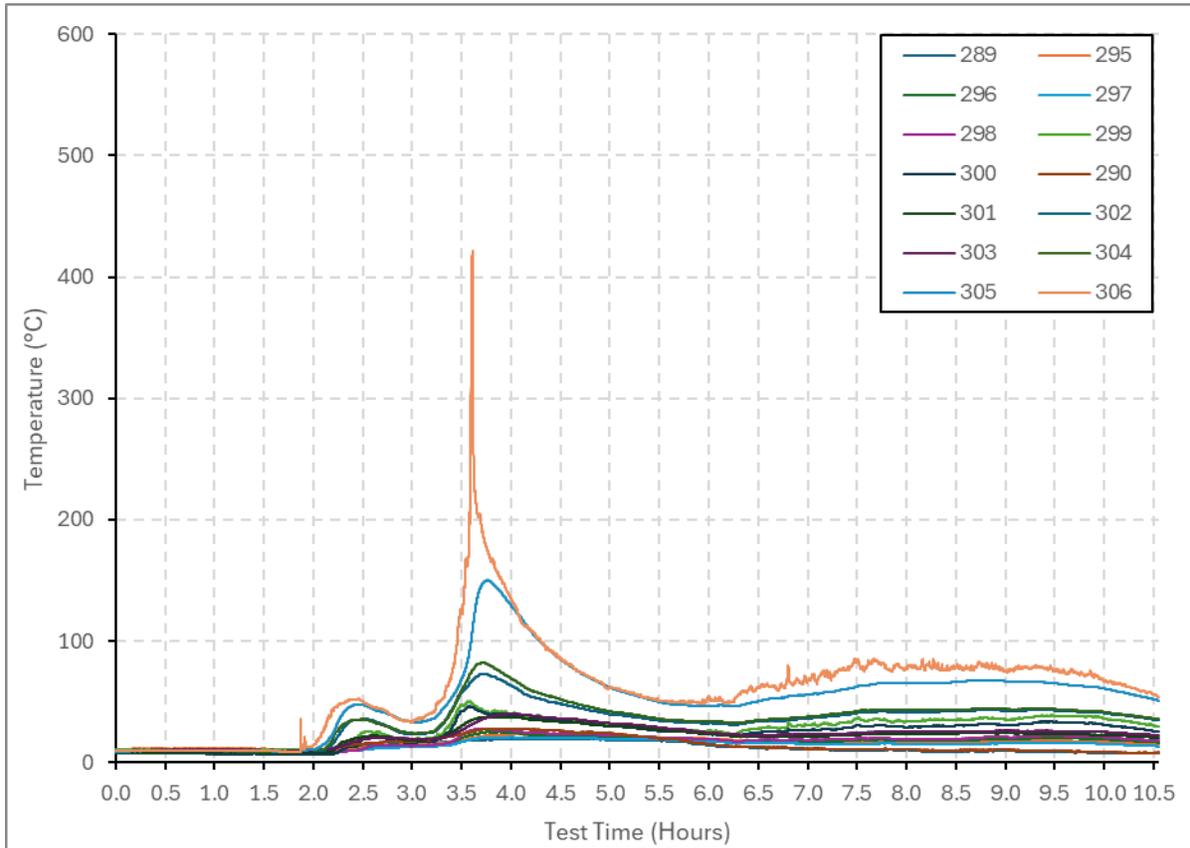


Figure 4.8: Initiating Unit M-LINK 1 SKID Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
289	SKID surface, M-LINK 1 Left (289)	19.3	290	SKID surface, M-LINK 1 Right (290)	27.8
295	M-LINK 1 Rack 1 Positive Cable (295)	23.1	301	M-LINK 1 Rack 2 Positive Cable (301)	37.7
296	M-LINK 1 Rack 1 Positive Cable Grommet (296)	25	302	M-LINK 1 Rack 2 Positive Cable Grommet (302)	73
297	M-LINK 1 Rack 1 Negative Cable (297)	20.7	303	M-LINK 1 Rack 2 Negative Cable (303)	40
298	M-LINK 1 Rack 1 Negative Cable Grommet (298)	27.8	304	M-LINK 1 Rack 2 Negative Cable Grommet (304)	82.4
299	M-LINK 1 Rack 1 Comm Cable (299)	50.3	305	M-LINK 1 Rack 2 Comm Cable (305)	150
300	M-LINK 1 Rack 1 Comm Cable Grommet (300)	46.3	306	M-LINK 1 Rack 2 Comm Cable Grommet (306)	421.8

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**Attachment 4 – Temperature graph during testing**

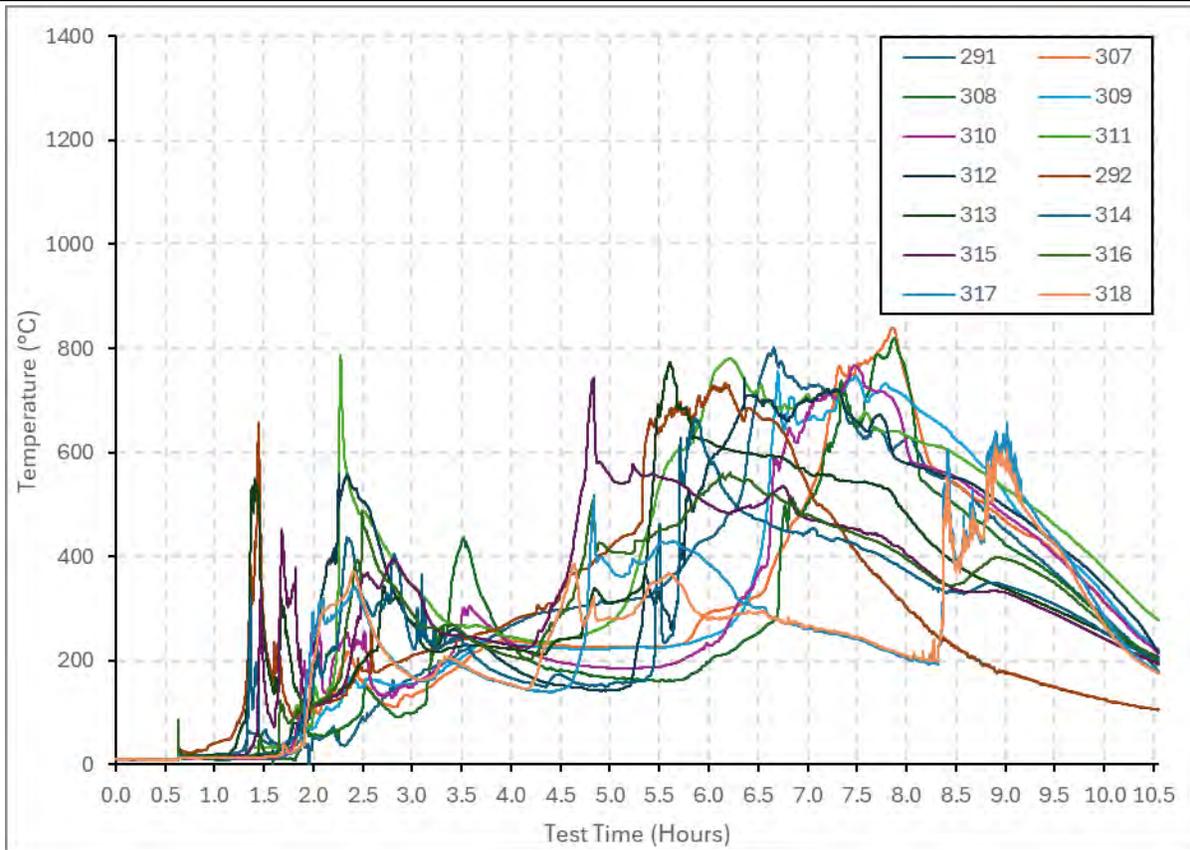


Figure 4.9: Initiating Unit M-LINK 2 SKID Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
291	SKID surface, M-LINK 2 Left (291)	802.8	292	SKID surface, M-LINK 2 Right (292)	732.6
307	M-LINK 2 Rack 3 Positive Cable (307)	840.2	313	M-LINK 2 Rack 4 Positive Cable (313)	771.9
308	M-LINK 2 Rack 3 Positive Cable Grommet (308)	819.4	314	M-LINK 2 Rack 4 Positive Cable Grommet (314)	665.2
309	M-LINK 2 Rack 3 Negative Cable (309)	755	315	M-LINK 2 Rack 4 Negative Cable Grommet (315)	743.6
310	M-LINK 2 Rack 3 Negative Cable Grommet (310)	767.4	316	M-LINK 2 Rack 4 Negative Cable Grommet (316)	561.6
311	M-LINK 2 Rack 3 Comm Cable (311)	788.1	317	M-LINK 2 Rack 4 Comm Cable (317)	657.6
312	M-LINK 2 Rack 3 Comm Cable Grommet (312)	743.7	318	M-LINK 2 Rack 4 Comm Cable Grommet (318)	614.4

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**Attachment 4 – Temperature graph during testing**

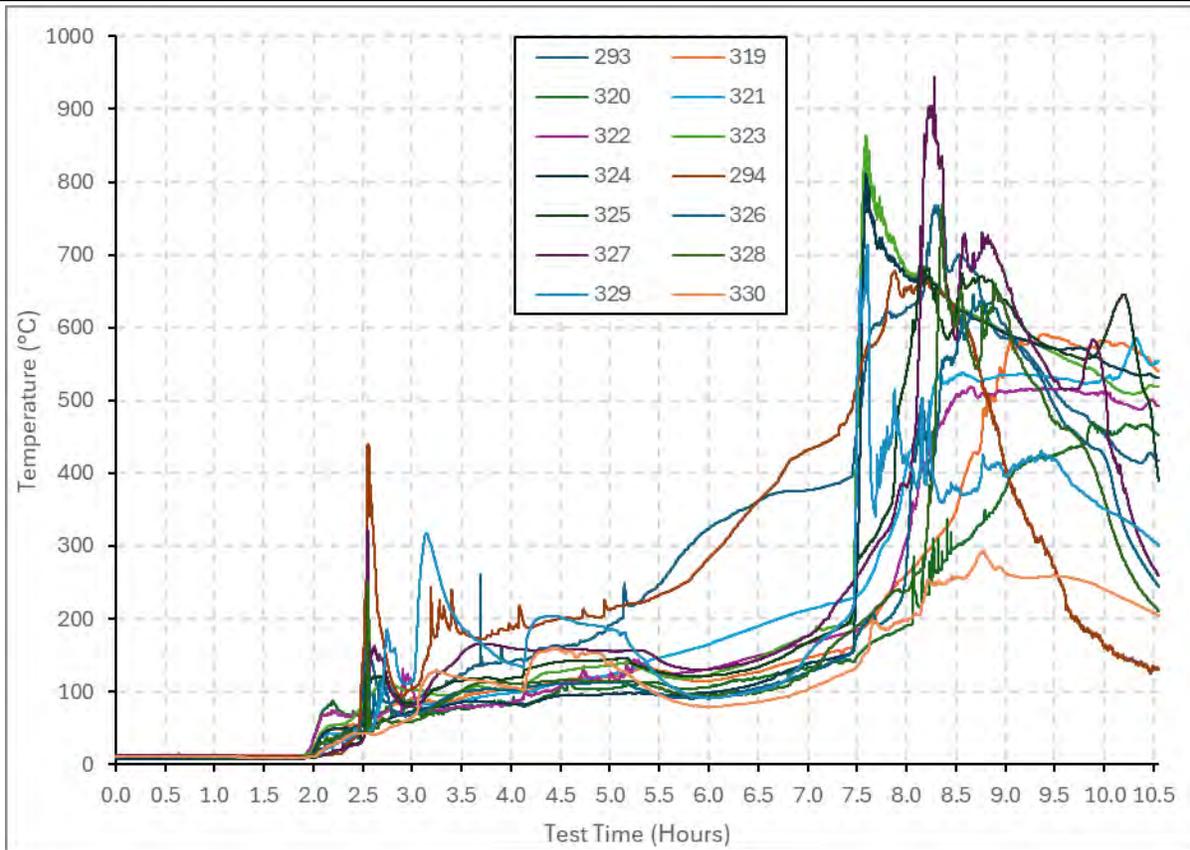


Figure 4.10: Initiating Unit M-LINK 3 SKID Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
293	SKID surface, M-LINK 3 Left (293)	767.3	294	SKID surface, M-LINK 3 Right (294)	677.9
319	M-LINK 3 Rack 5 Positive Cable (319)	591.1	325	M-LINK 3 Rack 6 Positive Cable (325)	691.7
320	M-LINK 3 Rack 5 Positive Cable Grommet (320)	470.0	326	M-LINK 3 Rack 6 Positive Cable Grommet (326)	645.7
321	M-LINK 3 Rack 5 Negative Cable (321)	585.3	327	M-LINK 3 Rack 6 Negative Cable (327)	945.2
322	M-LINK 3 Rack 5 Negative Cable Grommet (322)	518.1	328	M-LINK 3 Rack 6 Negative Cable Grommet (328)	770
323	M-LINK 3 Rack 5 Comm Cable (323)	863.5	329	M-LINK 3 Rack 6 Comm Cable (329)	713.9
324	M-LINK 3 Rack 5 Comm Cable Grommet (324)	811.8	330	M-LINK 3 Rack 6 Comm Cable Grommet (330)	295.2

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**Attachment 4 – Temperature graph during testing**

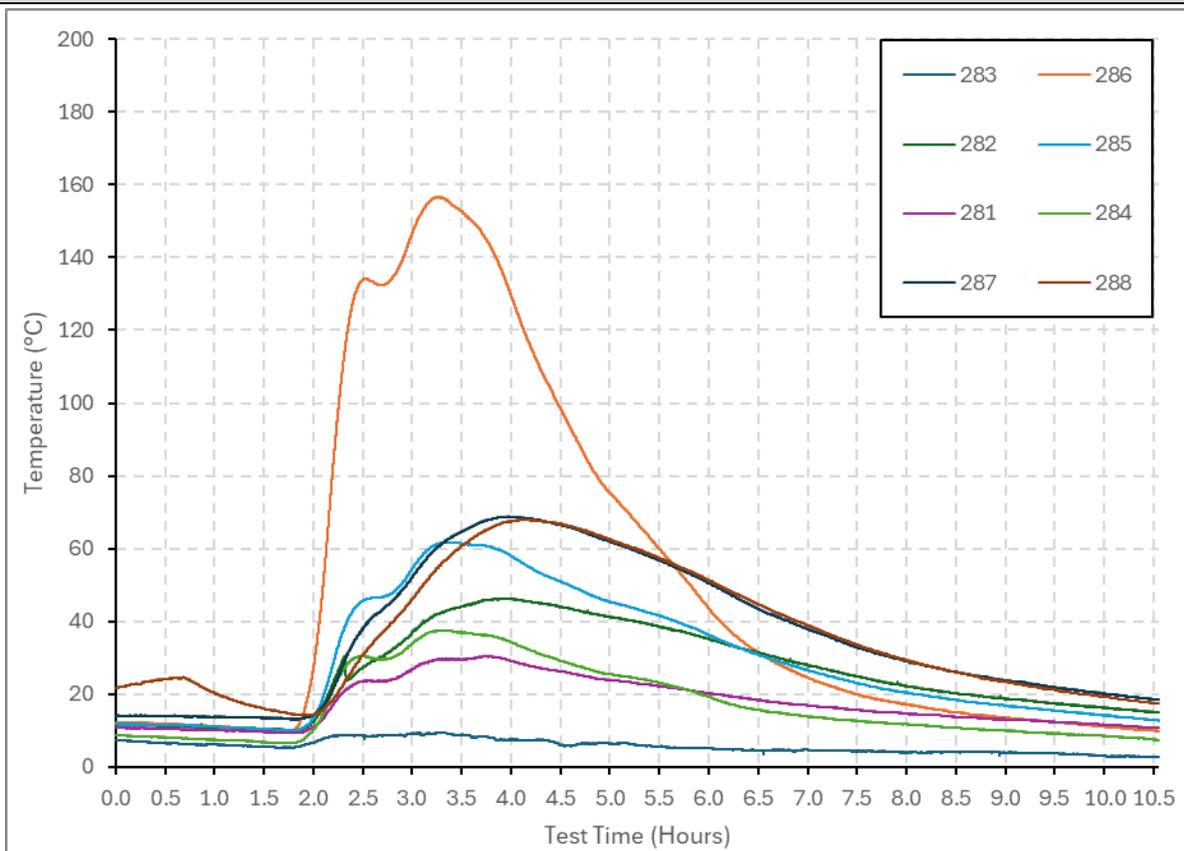


Figure 4.11: Initiating Unit E-PANEL Door Temperatures

TC	Location	Max (°C)
283	E-Panel Left Door Interior, 2886 mm from ground (283)	9.5
286	E-Panel Right Door Interior, 2886 mm from ground (286)	156.6
282	E-Panel Left Door Interior, 1968 mm from ground (282)	46.3
285	E-Panel Right Door Interior, 1968 mm from ground (285)	61.8
281	E-Panel Left Door Interior, 1050 mm from ground (281)	30.4
284	E-Panel Right Door Interior, 1050 mm from ground (284)	37.5
287	UPS Surface (287)	68.9
288	BSC Surface (288)	67.9

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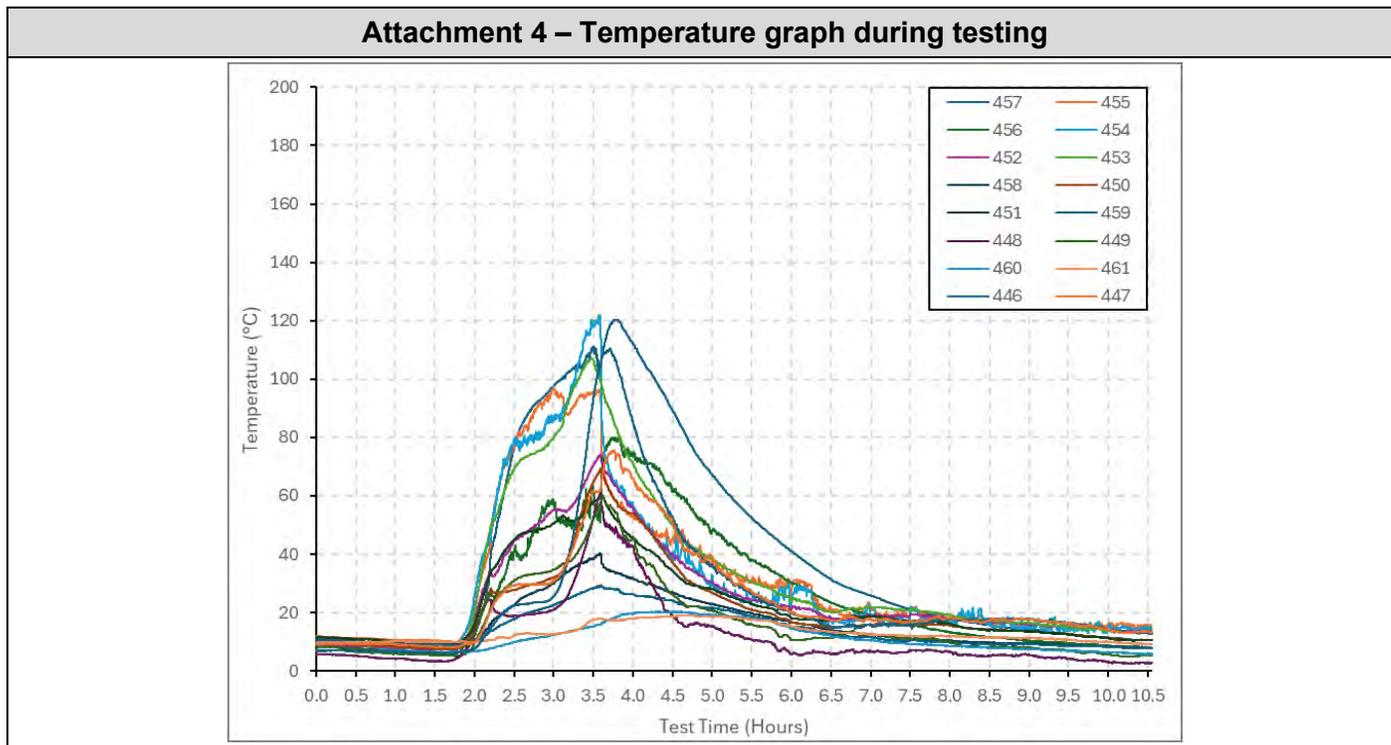


Figure 4.12: Initiating Unit M-LINK 1 Door Frame Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
457	M-LINK 1 Top Left Door Edge (457)	120.3	451	M-LINK 1 Right Side Cable Tray, 2/3 height (451)	60.1
455	M-LINK 1 Top Right Door Edge (455)	96.8	459	M-LINK 1 Left Side Door Frame, 1/3 height (459)	29.4
456	M-LINK 1 Cable Junction Box (456)	80.1	448	M-LINK 1 Right Side Door Frame, 1/3 height (448)	61.4
454	M-LINK 1 Roof cabling (454)	122.1	449	M-LINK 1 Right Side Cable Tray, 1/3 height (449)	60.2
452	M-LINK 1 Right Side Door Frame, Top (452)	74.4	460	M-LINK 1 Left Side Door Frame, bottom (460)	20.3
453	M-LINK 1 Right Side Cable Tray, Top (453)	107.3	461	M-LINK 1 M-PLC Surface (461)	19.1
458	M-LINK 1 Left Side Door Frame, 2/3 height (458)	40.3	446	M-LINK 1 Right Side Door Frame, Bottom (446)	110.4
450	M-LINK 1 Right Side Door Frame, 2/3 height (450)	69.4	447	M-LINK 1 Right Side Cable Tray, Bottom (447)	75.6

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Master Contract: <b>N/A</b>	Model: <b>JF2 DC LINK 5.1</b>	Page number 53 of 82
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**Attachment 4 – Temperature graph during testing**

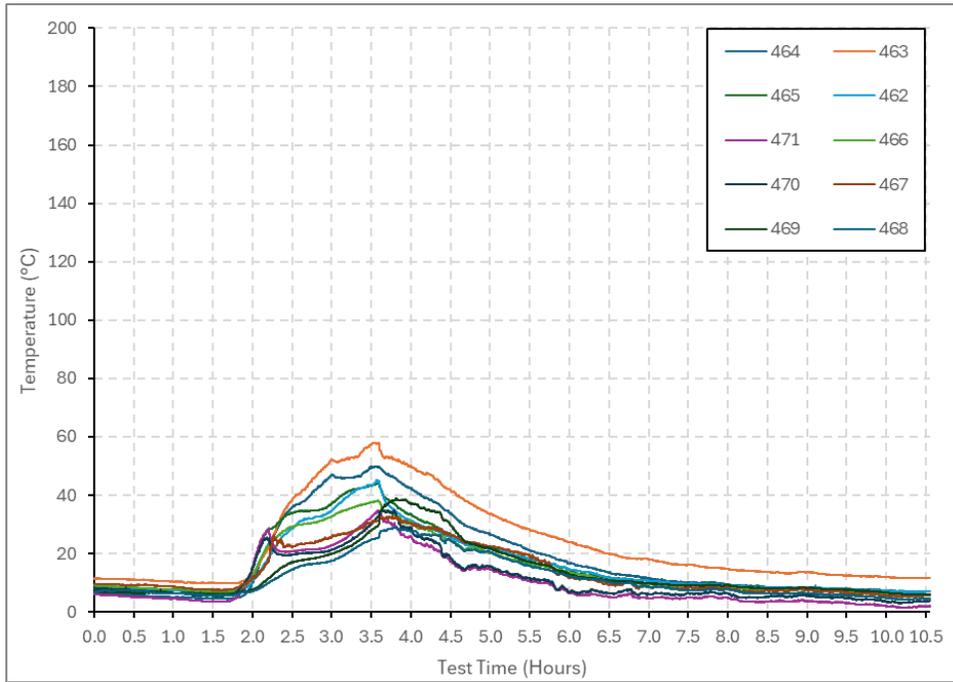


Figure 4.13: Initiating Unit M-LINK 1 Door Equipment Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
464	M-LINK 1 HVAC Pipe (464)	49.9	466	M-LINK 1 Middle Junction Box (466)	38.1
463	M-LINK 1 Door Upper Right Junction Box (463)	57.9	470	M-LINK 1 Beside Lower Louver (470)	35.1
465	M-LINK 1 Cable between Upper Right and Middle Junction Box (465)	44.0	467	M-LINK 1 Cable under Middle Junction Box (467)	32.9
462	M-LINK 1 Door Hinge Cabling (462)	45.2	469	M-LINK 1 Cable Below Louvers (469)	39.1
471	M-LINK 1 Beside Upper Louver (471)	34.8	468	M-LINK 1 Cable Between Chiller and Louvers (468)	29

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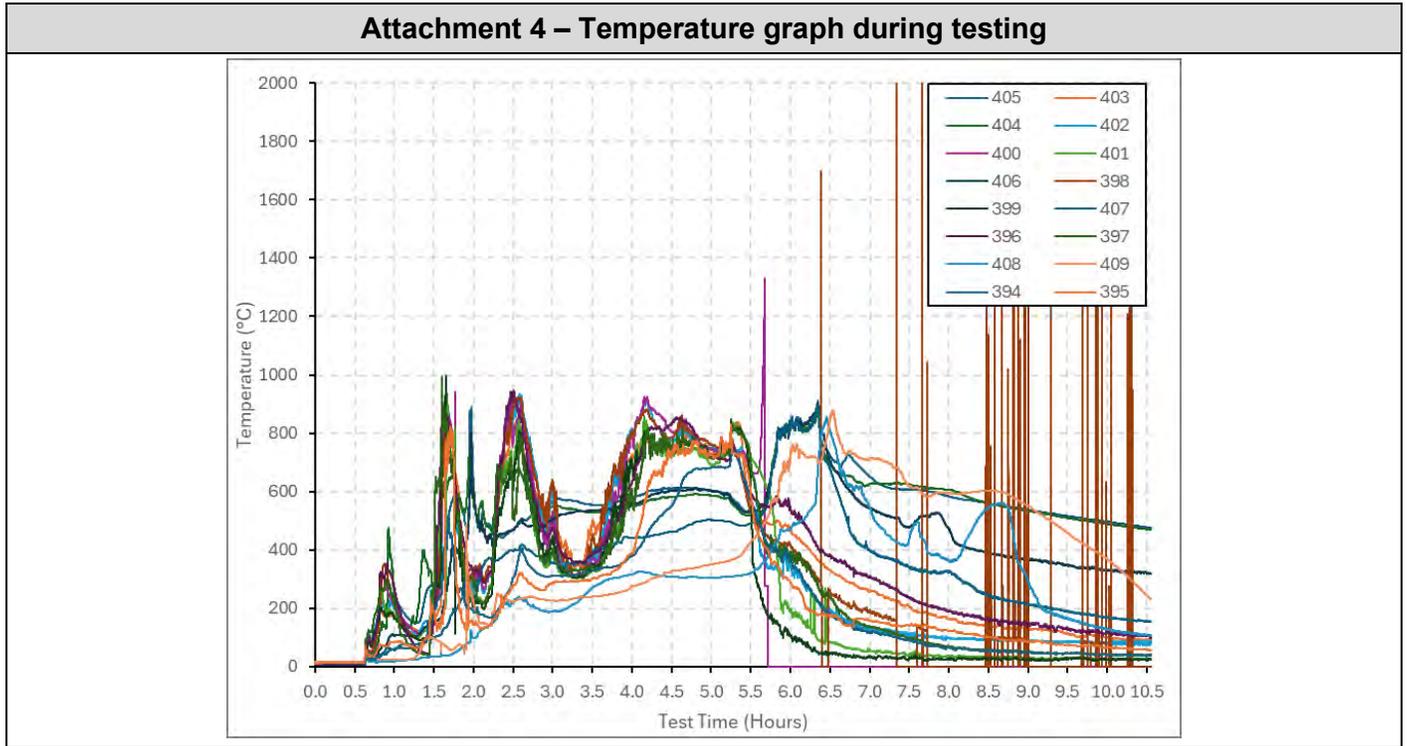


Figure 4.14: Initiating Unit M-LINK 2 Door Frame Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
405	M-LINK 2 Top Left Door Edge (405)	900.2	399	M-LINK 2 Right Side Cable Tray, 2/3 height (399)	999.0
403	M-LINK 2 Top Right Door Edge (403)	904.5	407	M-LINK 2 Left Side Door Frame, 1/3 height (407)	896.7
404	M-LINK 2 Cable Junction Box (404)	881.5	396	M-LINK 2 Right Side Door Frame, 1/3 height (396)	945.6
402	M-LINK 2 Roof cabling (402)	936	397	M-LINK 2 Right Side Cable Tray, 1/3 height (397)	995.0
400	M-LINK 2 Right Side Door Frame, Top (400)	1331	408	M-LINK 2 Left Side Door Frame, bottom (408)	855.9
401	M-LINK 2 Right Side Cable Tray, Top (401)	931.4	409	M-LINK 2 M-PLC Surface (409)	878.9
406	M-LINK 2 Left Side Door Frame, 2/3 height (406)	909.7	394	M-LINK 2 Right Side Door Frame, Bottom (394)	740.3
398	M-LINK 2 Right Side Door Frame, 2/3 height (398)	2156.8*	395	M-LINK 2 Right Side Cable Tray, Bottom (395)	829.8

**\*Note: Thermocouple potentially compromised**

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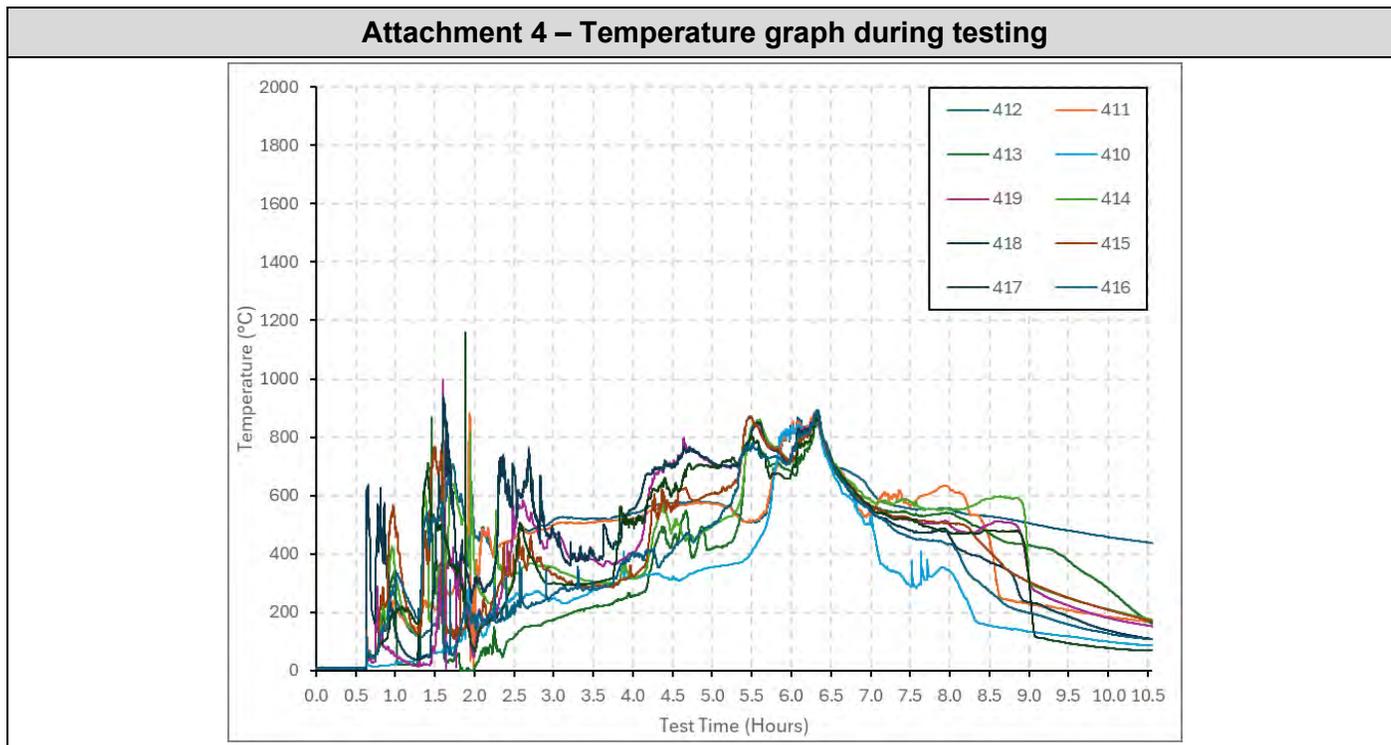


Figure 4.15: Initiating Unit M-LINK 2 Door Equipment Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
412	M-LINK 2 HVAC Pipe (412)	869.3	414	M-LINK 2 Middle Junction Box (414)	881.3
411	M-LINK 2 Door Upper Right Junction Box (411)	894.2	418	M-LINK 2 Beside Lower Louver (418)	938.8
413	M-LINK 2 Cable between Upper Right and Middle Junction Box (413)	872.9	415	M-LINK 2 Cable under Middle Junction Box (415)	885.7
410	M-LINK 2 Door Hinge Cabling (410)	894.9	417	M-LINK 2 Cable Below Louvers (417)	1160.1
419	M-LINK 2 Beside Upper Louver (419)	997.2	416	M-LINK 2 Cable Between Chiller and Louvers (416)	893.3

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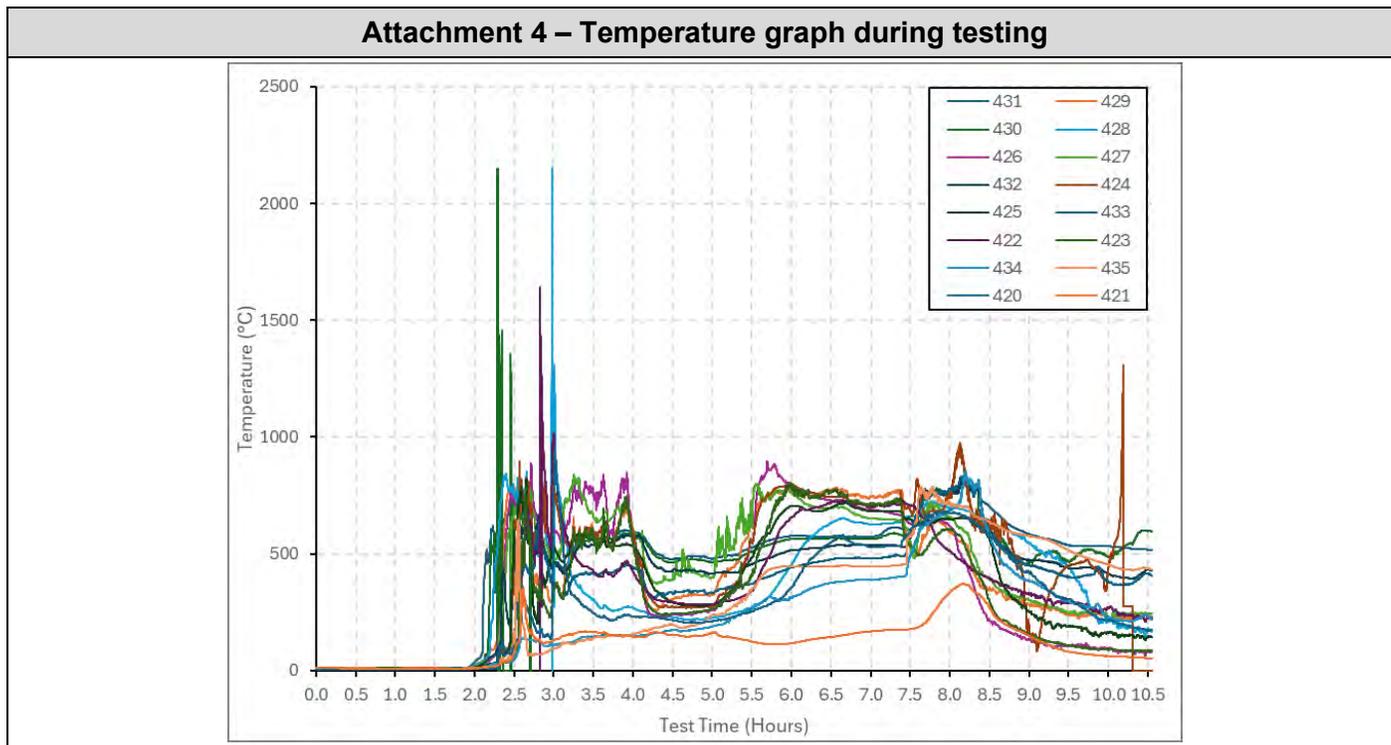


Figure 4.16: Initiating Unit M-LINK 3 Door Frame Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
431	M-LINK 3 Top Left Door Edge (431)	2146.0	425	M-LINK 3 Right Side Cable Tray, 2/3 height (425)	821.8
429	M-LINK 3 Top Right Door Edge (429)	849.6	433	M-LINK 3 Left Side Door Frame, 1/3 height (433)	830.1
430	M-LINK 3 Cable Junction Box (430)	2149.0*	422	M-LINK 3 Right Side Door Frame, 1/3 height (422)	1640.6
428	M-LINK 3 Roof cabling (428)	2155.0*	423	M-LINK 3 Right Side Cable Tray, 1/3 height (423)	804.9
426	M-LINK 3 Right Side Door Frame, Top (426)	894.7	434	M-LINK 3 Left Side Door Frame, bottom (434)	851.5
427	M-LINK 3 Right Side Cable Tray, Top (427)	837.6	435	M-LINK 3 M-PLC Surface (435)	788.9
432	M-LINK 3 Left Side Door Frame, 2/3 height (432)	816.2	420	M-LINK 3 Right Side Door Frame, Bottom (420)	942.4
424	M-LINK 3 Right Side Door Frame, 2/3 height (424)	1488.5	421	M-LINK 3 Right Side Cable Tray, Bottom (421)	369.9

**\*Note: Thermocouple potentially compromised**

ORIGINAL TEST DATA

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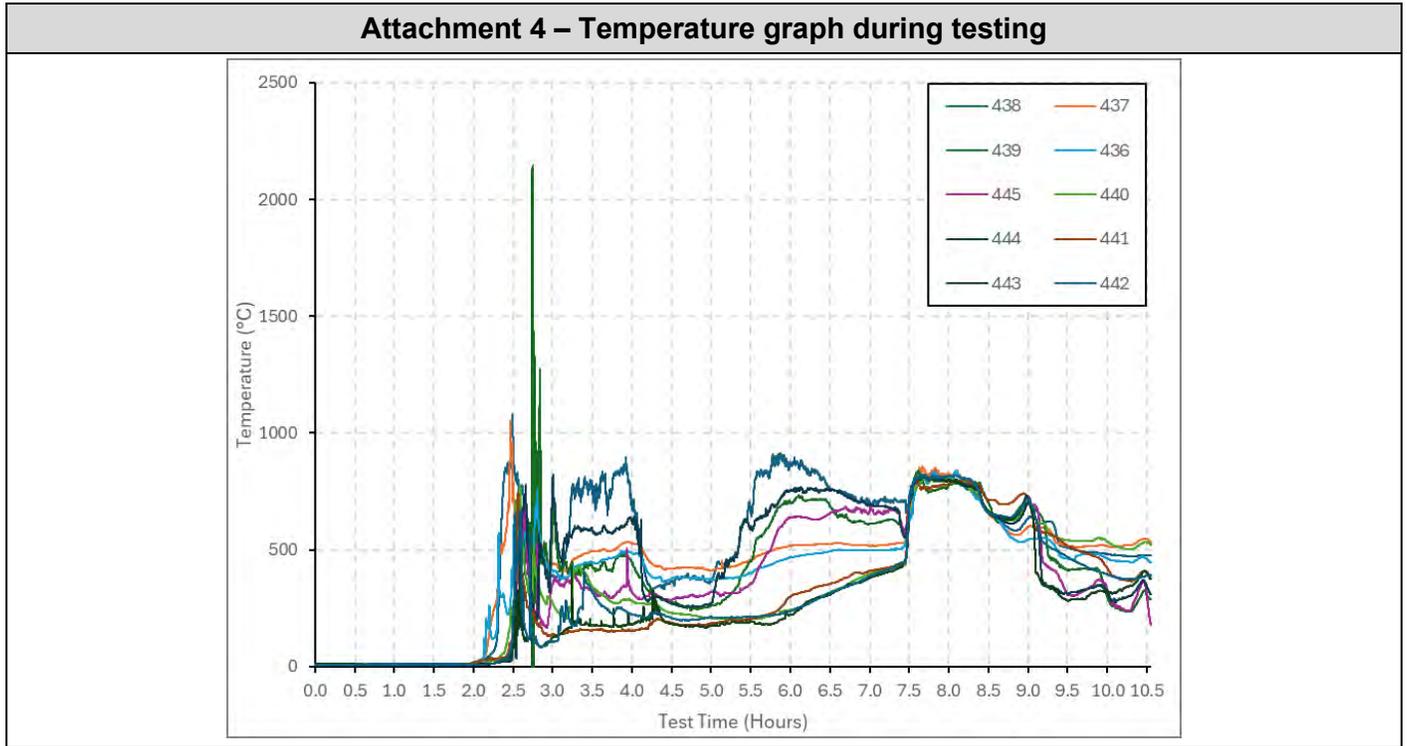


Figure 4.17: Initiating Unit M-LINK 3 Door Equipment Temperatures

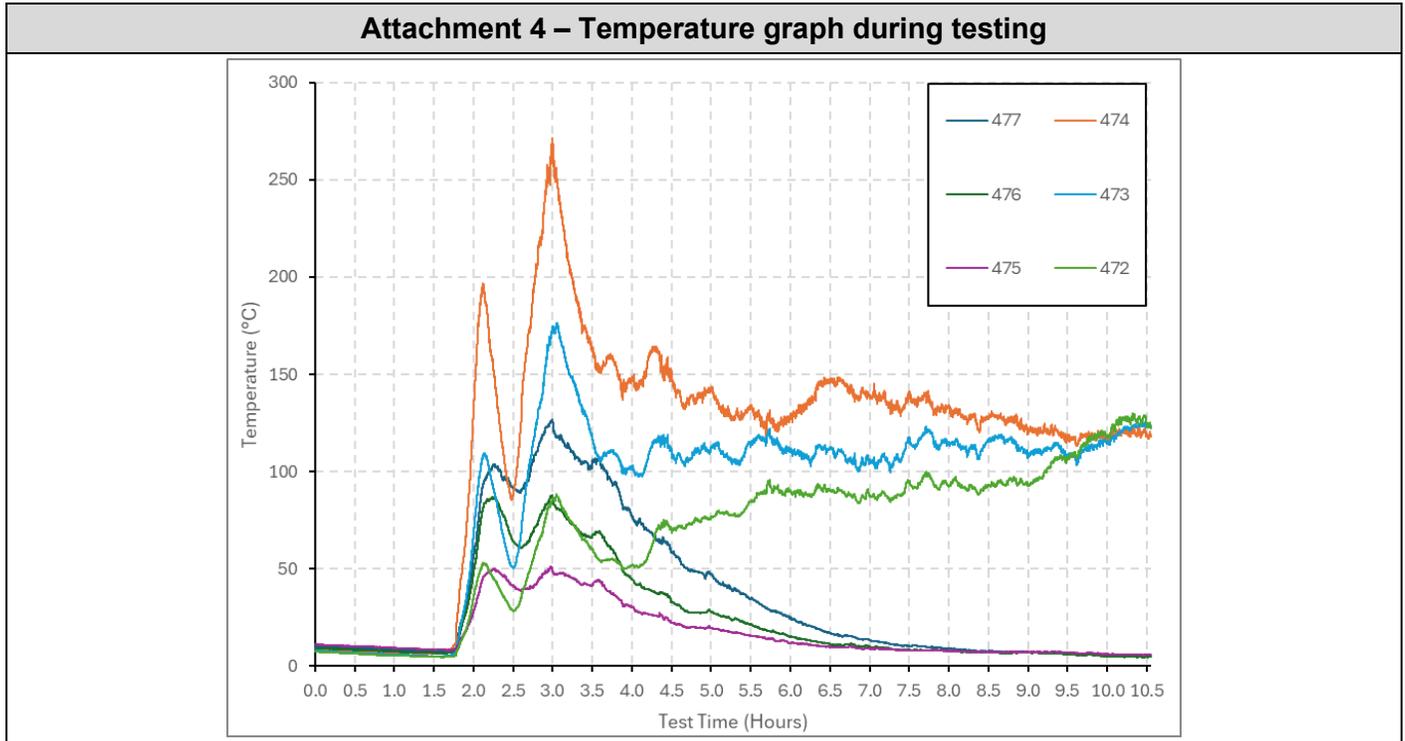
TC	Location	Max (°C)	TC	Location	Max (°C)
438	M-LINK 3 HVAC Pipe (438)	1082.5	440	M-LINK 3 Middle Junction Box (440)	815.9
437	M-LINK 3 Door Upper Right Junction Box (437)	1052.6	444	M-LINK 3 Beside Lower Louver (444)	822.4
439	M-LINK 3 Cable between Upper Right and Middle Junction Box (439)	2145.7*	441	M-LINK 3 Cable under Middle Junction Box (441)	804.3
436	M-LINK 3 Door Hinge Cabling (436)	838.1	443	M-LINK 3 Cable Below Louvers (443)	817
445	M-LINK 3 Beside Upper Louver (445)	814.2	442	M-LINK 3 Cable Between Chiller and Louvers (442)	820.5

**\*Note: Thermocouple potentially compromised**

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**Figure 4.18: Initiating Unit Exterior Door and Side Temperatures**

TC	Location	Max (°C)
477	EPANEL Initiating Unit Door Seam, 2886 mm from ground (477)	126.7
474	M-LINK 3 Initiating Unit Exterior Side, 2886 mm from ground (474)	271.4
476	EPANEL Initiating Unit Door Seam, 1968 mm from ground (476)	87.9
473	M-LINK 3 Initiating Unit Exterior Side, 1968 mm from ground (473)	176.5
475	EPANEL Initiating Unit Door Seam, 1050 mm from ground (475)	51.2
472	M-LINK 3 Initiating Unit Exterior Side, 1050 mm from ground (472)	130.1

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**Attachment 4 – Temperature graph during testing**

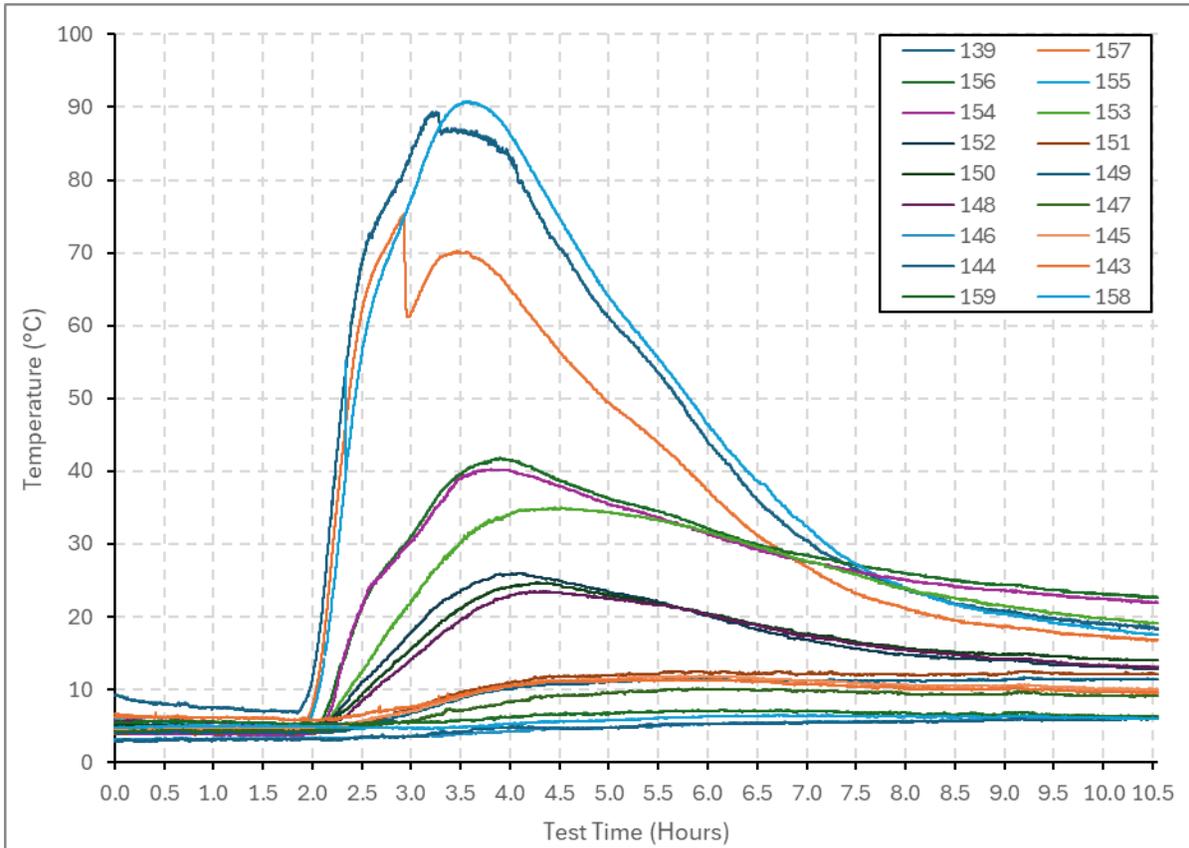


Figure 4.19: Rear Target Unit M-LINK 2 Module Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
139	Target Unit Rear-M-LINK 2 Interior Ambient (139)	89.4	149	Target Unit Rear-M-Link 2 Rack 2, Pack #11 Surface (149)	11.7
157	Target Unit Rear-M-Link 2 Left Rack Surface near Pack #14 (157)	75.4	148	Target Unit Rear-M-Link 2 Right Rack Surface near Pack #11 (148)	23.5
156	Target Unit Rear-M-Link 2 Rack 1, Pack #14 Surface (156)	41.9	147	Target Unit Rear-M-Link 2 Left Rack Surface near Pack #8 (147)	10.2
155	Target Unit Rear-M-Link 2 Center Rack Surface near Pack #14 (155)	90.7	146	Target Unit Rear-M-Link 2 Rack 1, Pack #7 Surface (146)	6.2
154	Target Unit Rear-M-Link 2 Rack 2, Pack #14 Surface (154)	40.3	145	Target Unit Rear-M-Link 2 Center Rack Surface near Pack #8 (145)	11.9
153	Target Unit Rear-M-Link 2 Right Rack Surface near Pack #14 (153)	35	144	Target Unit Rear-M-Link 2 Rack 2, Pack #7 Surface (144)	6.1
152	Target Unit Rear-M-Link 2 Left Rack Surface near Pack #11 (152)	26	143	Target Unit Rear-M-Link 2 Right Rack Surface near Pack #8 (143)	11.9
151	Target Unit Rear-M-Link 2 Rack 1, Pack #11 Surface (151)	12.5	159	Target Unit Rear-M-Link 2 Left Rack Surface near Pack #2 (159)	7.2
150	Target Unit Rear-M-Link 2 Center Rack Surface near Pack #11 (150)	24.7	158	Target Unit Rear-M-Link 2 Right Rack Surface near Pack#2 (158)	6.6

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**Attachment 4 – Temperature graph during testing**

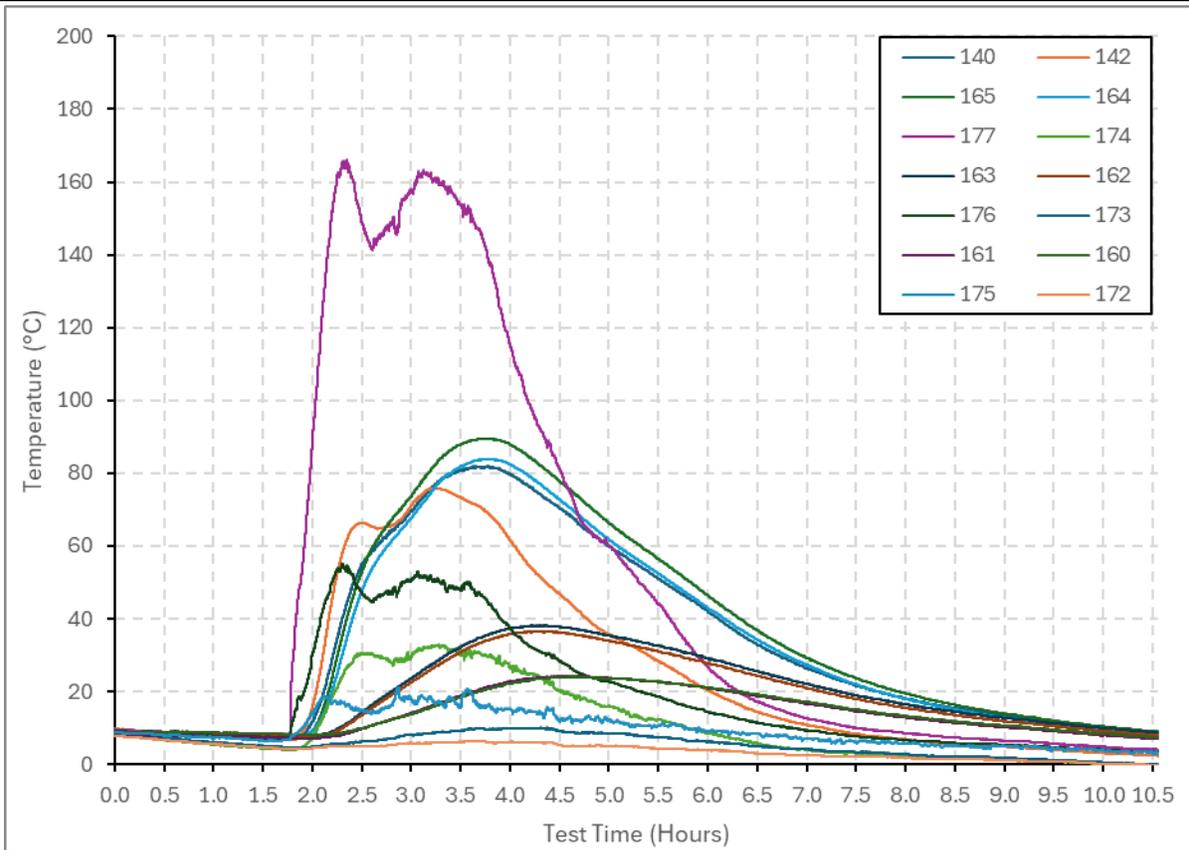


Figure 4.20: Rear Target Unit M-LINK 3 and Dummy E-Panel Interior Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
140	Target Unit Rear-M-LINK 3 Interior Ambient (140)	82.0	162	Target Unit Rear-M-LINK 3 Right Rack Surface near Pack#8 (162)	36.6
142	Target Unit Rear-Dummy E-Panel E-Panel Interior Ambient (142)	75.9	176	Target Unit Rear-Dummy E-Panel E-Panel interior, right side, 1,968 mm from ground (176)	55.0
165	Target Unit Rear-M-LINK 3 Left Rack Surface near Pack #14 (165)	89.5	173	Target Unit Rear-Dummy E-Panel interior, left side, 1,968 mm from ground (173)	10.1
164	Target Unit Rear-M-LINK 3 Right Rack Surface near Pack#14 (164)	83.9	161	Target Unit Rear-M-LINK 3 Left Rack Surface near Pack #2 (161)	24.3
177	Target Unit Rear-Dummy E-Panel interior, right side, 2,886 mm from ground (177)	166.3	160	Target Unit Rear-M-LINK 3 Right Rack Surface near Pack#2 (160)	24.1
174	Target Unit Rear-Dummy E-Panel interior, left side, 2,886 mm from ground (174)	32.9	175	Target Unit Rear-Dummy E-Panel interior, right side, 1,050 mm from ground (175)	21.2
163	Target Unit Rear-M-LINK 3 Left Rack Surface near Pack #8 (163)	38.2	172	Target Unit Rear-Dummy E-Panel interior, left side, 1,050 mm from ground (172)	7.9

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**Attachment 4 – Temperature graph during testing**

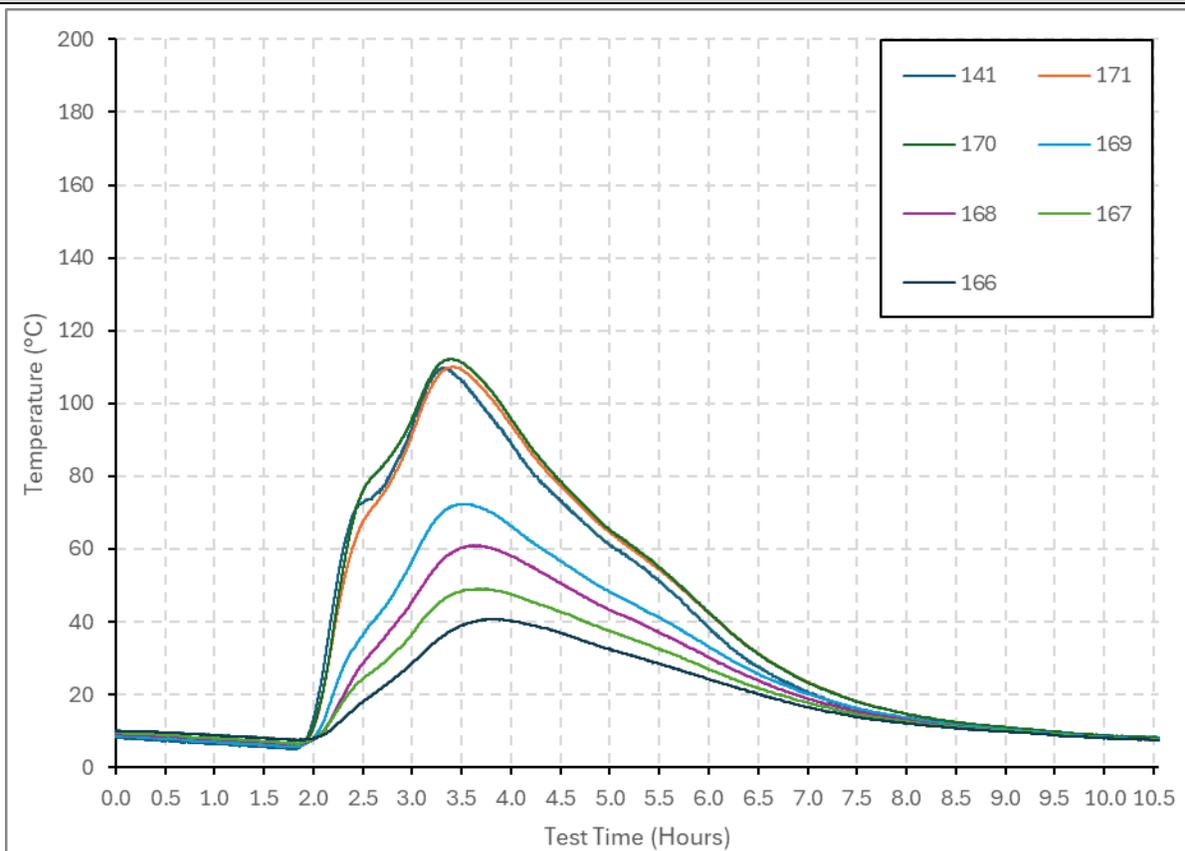


Figure 4.21: Rear Target Unit M-LINK 1 Interior Temperatures

TC	Location	Max (°C)
141	Target Unit Rear-M-LINK 1 Interior Ambient (141)	109.8
171	Target Unit Rear-M-LINK 1 Left Rack Surface near Pack #14 (171)	110.0
170	Target Unit Rear-M-LINK 1 Right Rack Surface near Pack#14 (170)	112.3
169	Target Unit Rear-M-LINK 1 Left Rack Surface near Pack #8 (169)	72.4
168	Target Unit Rear-M-LINK 1 Right Rack Surface near Pack#8 (168)	61.0
167	Target Unit Rear-M-LINK 1 Left Rack Surface near Pack #2 (167)	49.0
166	Target Unit Rear-M-LINK 1 Right Rack Surface near Pack#2 (166)	40.8

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**Attachment 4 – Temperature graph during testing**

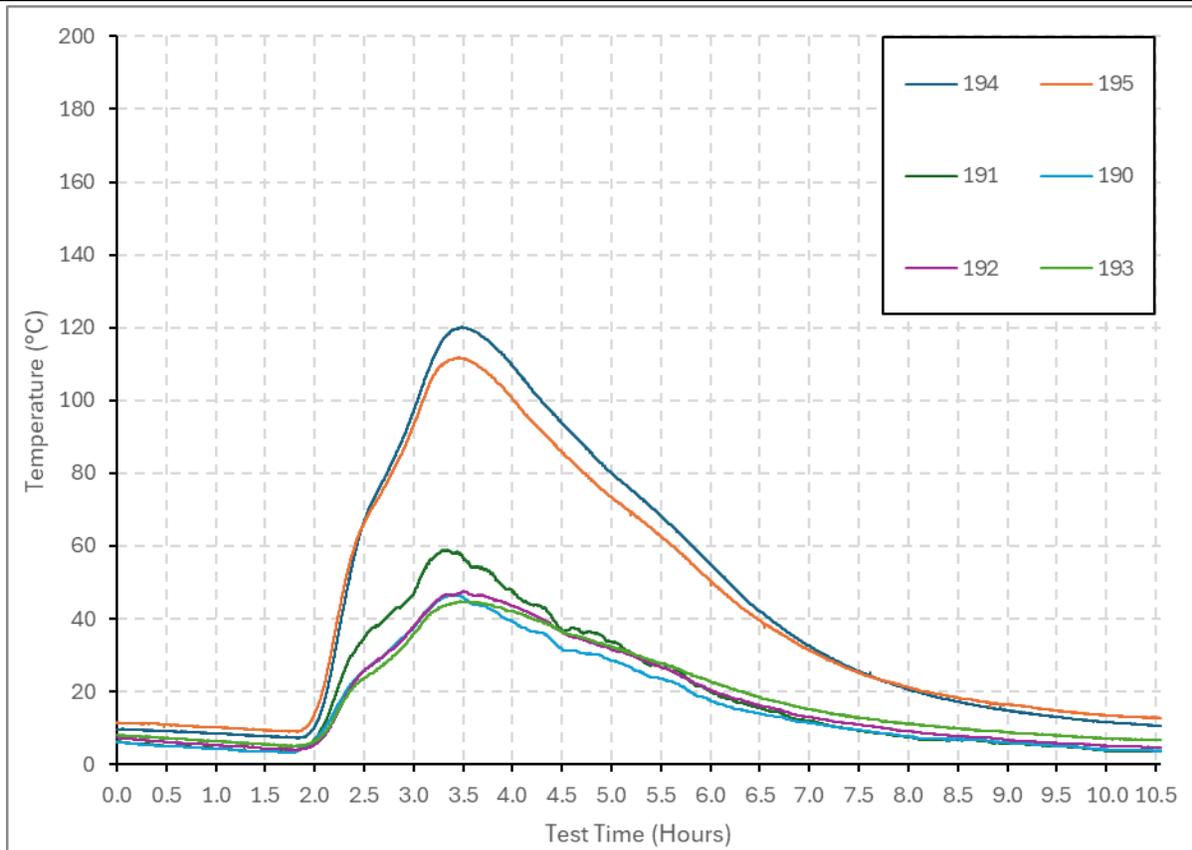


Figure 4.22: Rear Target Unit M-LINK 1 Door Temperatures

TC	Location	Max (°C)
194	Target Unit Rear-M-LINK 1 Left ventilation panel strut (194)	120.1
195	Target Unit Rear-M-LINK 1 Right ventilation panel strut (195)	111.8
191	Target Unit Rear-M-LINK 1 Inside of Door, on HVAC (191)	59.0
190	Target Unit Rear-M-LINK 1 Inside of Door, on Chiller (190)	46.6
192	Target Unit Rear-M-LINK 1 Inside of Door, upper intake fan (192)	47.6
193	Target Unit Rear-M-LINK 1 Inside of Door, lower intake fan (193)	44.8

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**Attachment 4 – Temperature graph during testing**

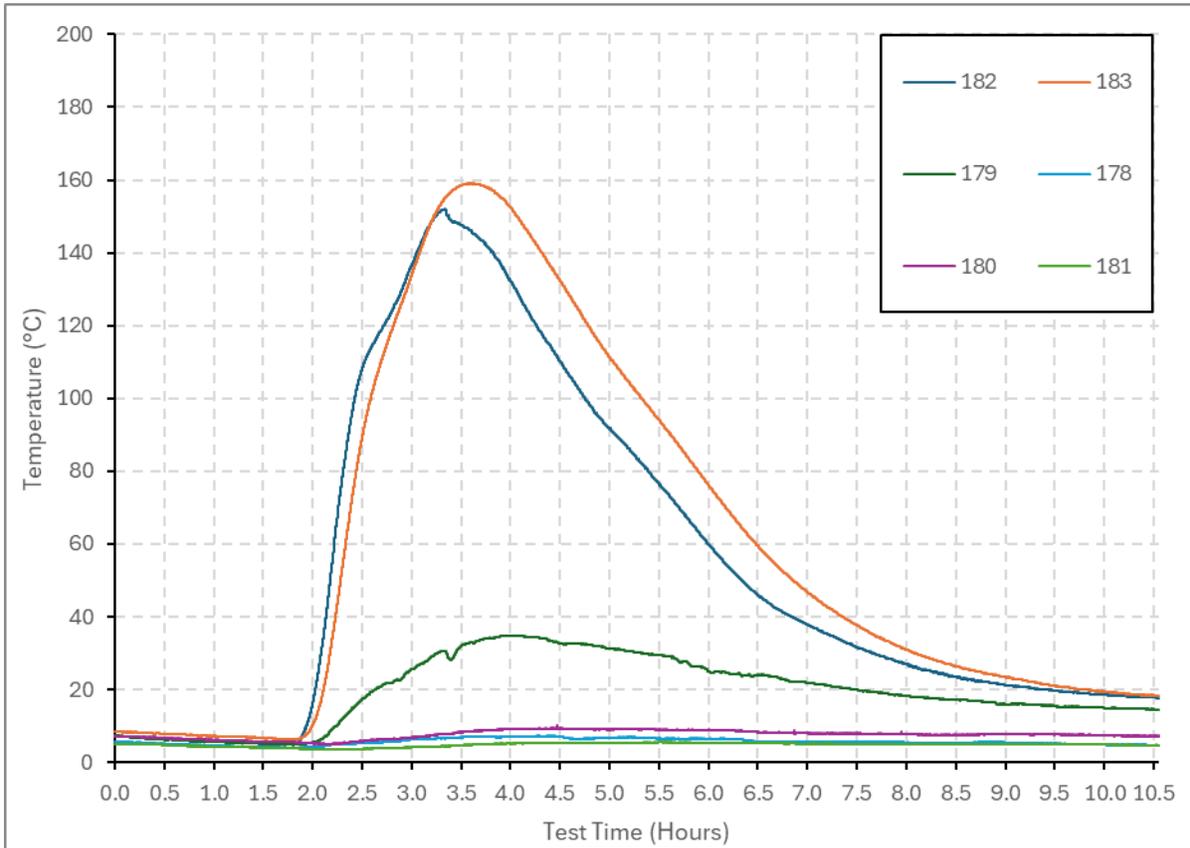


Figure 4.23: Rear Target Unit M-LINK 2 Door Temperatures

TC	Location	Max (°C)
182	Target Unit Rear-M-LINK 2 left ventilation panel strut (182)	152.1
183	Target Unit Rear-M-LINK 2 right ventilation panel strut (183)	159.1
179	Target Unit Rear-M-LINK 2 Inside of Door, on HVAC (179)	34.8
178	Target Unit Rear-M-LINK 2 Inside of Door, on Chiller (178)	7.4
180	Target Unit Rear-M-LINK 2 Inside of Door, upper intake fan (180)	10.3
181	Target Unit Rear-M-LINK 2 Inside of Door, lower intake fan (181)	5.5

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**Attachment 4 – Temperature graph during testing**

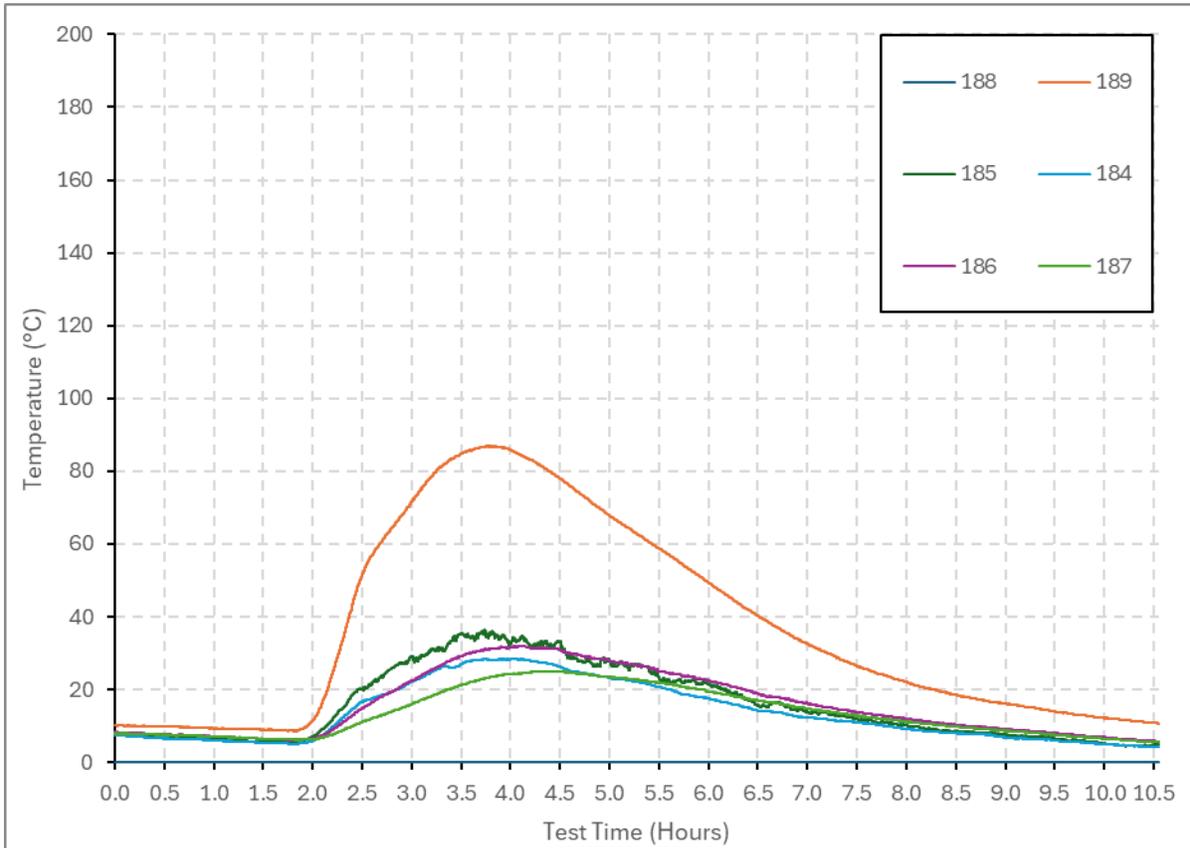


Figure 4.24: Rear Target Unit M-LINK 3 Door Temperatures

TC	Location	Max (°C)
188	Target Unit Rear-M-LINK 3 left ventilation panel strut (188)	--*
189	Target Unit Rear-M-LINK 3 right ventilation panel strut (189)	86.9
185	Target Unit Rear-M-LINK 3 Inside of Door, on HVAC (185)	36.4
184	Target Unit Rear-M-LINK 3 Inside of Door, on Chiller (184)	28.4
186	Target Unit Rear-M-LINK 3 Inside of Door, upper intake fan (186)	32.1
187	Target Unit Rear-M-LINK 3 Inside of Door, lower intake fan (187)	25.0

**\*Note: Thermocouple potentially compromised**

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### Attachment 4 – Temperature graph during testing

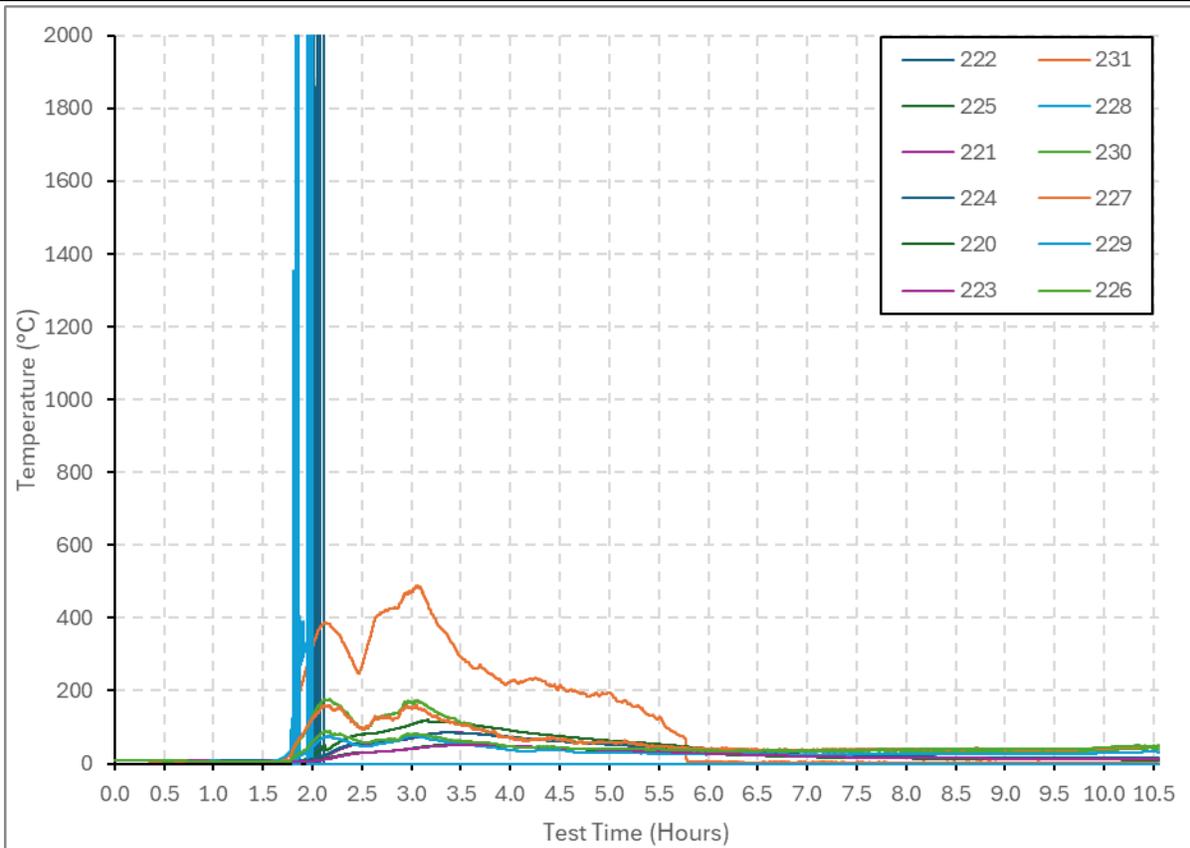


Figure 4.25: Rear Target Unit M-LINK 1 Rear Wall Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
222	Target Unit Rear-M-LINK 1 Interior Rear Left Side, behind Pack #14 (222)	2153.3*	224	Target Unit Rear-M-LINK 1 Interior Rear Right Side, behind Pack #8 (224)	84.8
231	Target Unit Rear-M-LINK 1 Exterior Rear Right Side, 2886 mm from ground (231)	489.1	227	Target Unit Rear-M-LINK 1 Exterior Rear Left Side, 1968 mm from ground (227)	161.5
225	Target Unit Rear-M-LINK 1 Interior Rear Right Side, behind Pack #14 (225)	120.3	220	Target Unit Rear-M-LINK 1 Interior Rear Left Side, behind Pack #2 (220)	51.3
228	Target Unit Rear-M-LINK 1 Exterior Rear Left Side, 2886 mm from ground (228)	2146.3*	229	Target Unit Rear-M-LINK 1 Exterior Rear Right Side, 1050 mm from ground (229)	78.5
221	Target Unit Rear-M-LINK 1 Interior Rear Left Side, behind Pack #8 (221)	85.2	223	Target Unit Rear-M-LINK 1 Interior Rear Right Side, behind Pack #2 (223)	50.6
230	Target Unit Rear-M-LINK 1 Exterior Rear Right Side, 1968 mm from ground (230)	177.1	226	Target Unit Rear-M-LINK 1 Exterior Rear Left Side, 1050 mm from ground (226)	89.0

**\*Note: Thermocouple potentially compromised**

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### Attachment 4 – Temperature graph during testing

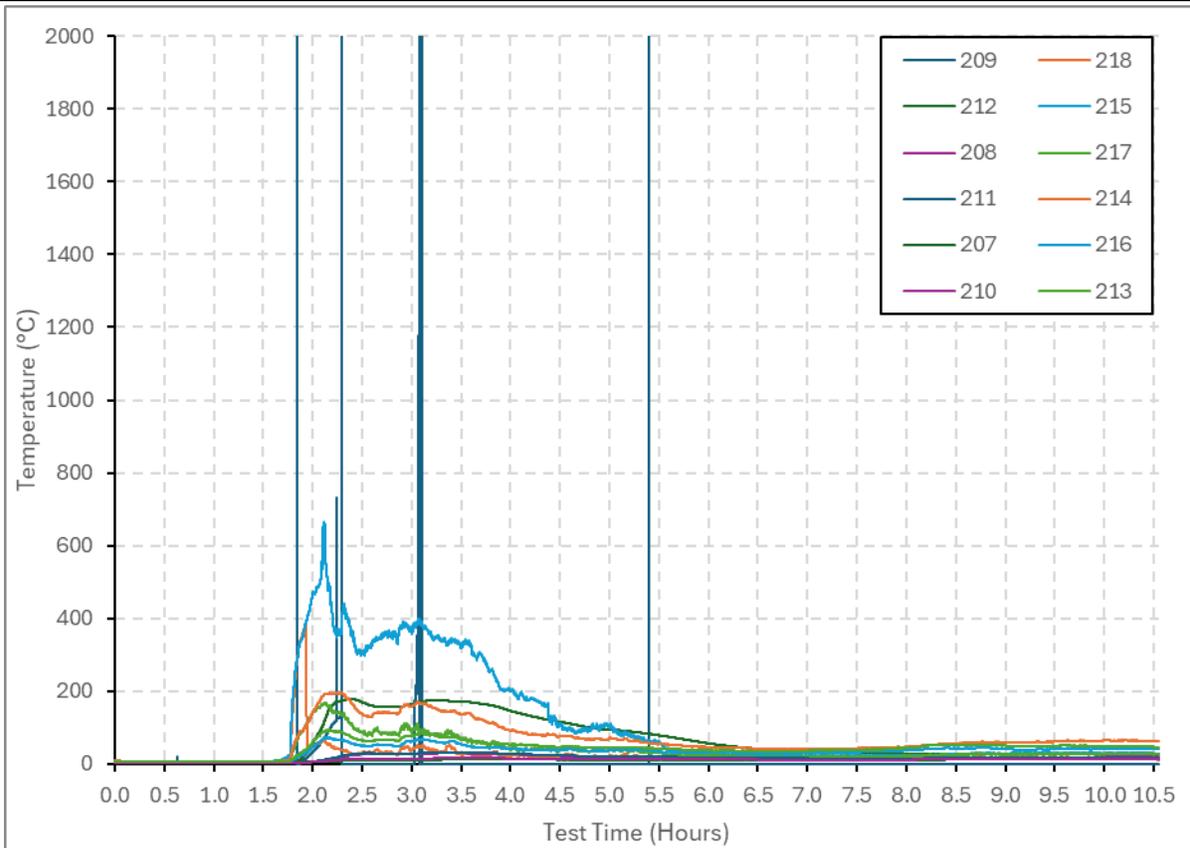


Figure 4.26: Rear Target Unit M-LINK 2 Rear Wall Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
209	Target Unit Rear-M-LINK 2 Interior Rear Left Side, behind Pack #14 (209)	2156.2*	211	Target Unit Rear-M-LINK 2 Interior Rear Right Side, behind Pack #8 (211)	32.0
218	Target Unit Rear-M-LINK 2 Exterior Rear Right Side, 2886 mm from ground (218)	384.1	214	Target Unit Rear-M-LINK 2 Exterior Rear Left Side, 1968 mm from ground (214)	199.0
212	Target Unit Rear-M-LINK 2 Interior Rear Right Side, behind Pack #14 (212)	178.4	207	Target Unit Rear-M-LINK 2 Interior Rear Left Side, behind Pack #2 (207)	13.0
215	Target Unit Rear-M-LINK 2 Exterior Rear Left Side, 2886 mm from ground (215)	663.9	216	Target Unit Rear-M-LINK 2 Exterior Rear Right Side, 1050 mm from ground (216)	73.5
208	Target Unit Rear-M-LINK 2 Interior Rear Left Side, behind Pack #8 (208)	30.2	210	Target Unit Rear-M-LINK 2 Interior Rear Right Side, behind Pack #2 (210)	16.2
217	Target Unit Rear-M-LINK 2 Exterior Rear Right Side, 1968 mm from ground (217)	168.7	213	Target Unit Rear-M-LINK 2 Exterior Rear Left Side, 1050 mm from ground (213)	93.7

**\*Note: Thermocouple potentially compromised**

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### Attachment 4 – Temperature graph during testing

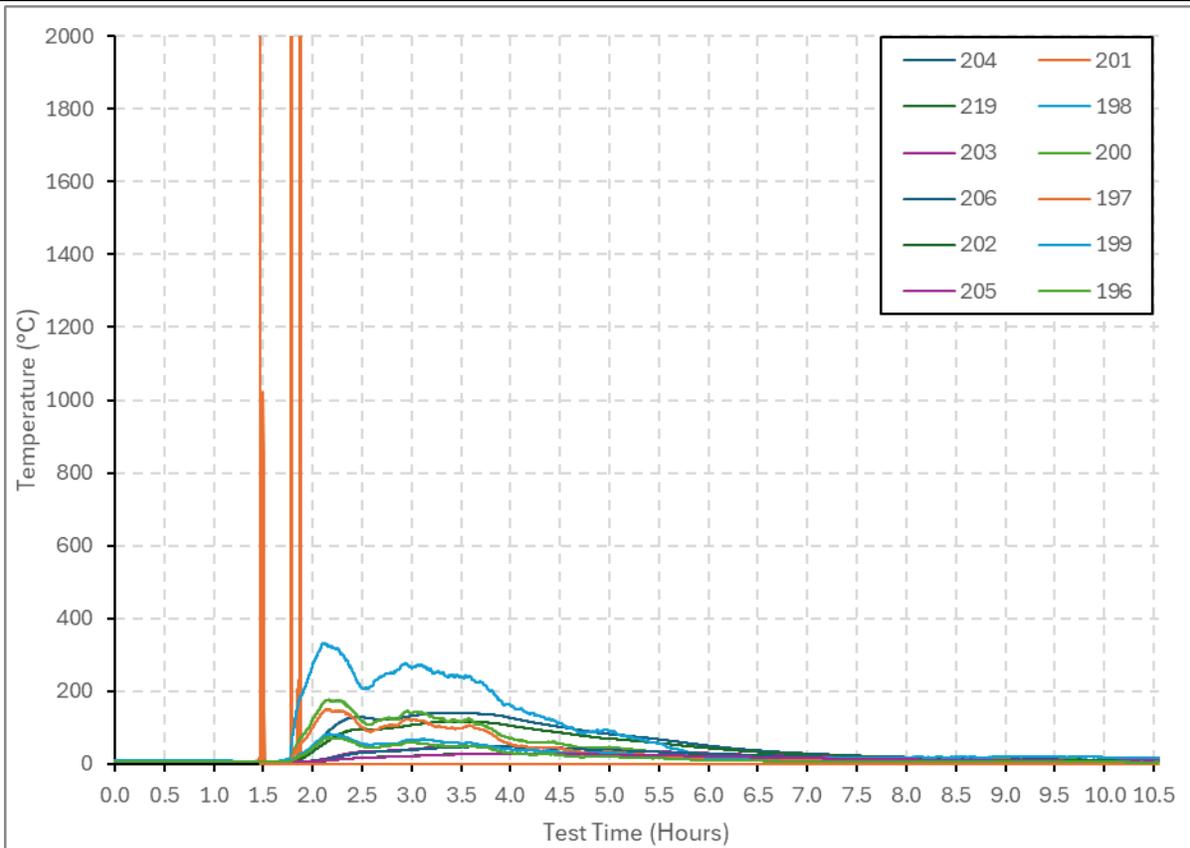


Figure 4.27: Rear Target Unit M-LINK 3 Rear Wall Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
204	Target Unit Rear-M-LINK 3 Interior Rear Left Side, behind Pack #14 (204)	140.9	206	Target Unit Rear-M-LINK 3 Interior Rear Right Side, behind Pack #8 (206)	48.4
201	Target Unit Rear-M-LINK 3 Exterior Rear Right Side, 2886 mm from ground (201)	2159*	197	Target Unit Rear-M-LINK 3 Exterior Rear Left Side, 1968 mm from ground (197)	150.5
219	Target Unit Rear-M-LINK 3 Interior Rear Right Side, behind Pack #14 (219)	115.7	202	Target Unit Rear-M-LINK 3 Interior Rear Left Side, behind Pack #2 (202)	29.6
198	Target Unit Rear-M-LINK 3 Exterior Rear Left Side, 2886 mm from ground (198)	333	199	Target Unit Rear-M-LINK 3 Exterior Rear Right Side, 1050 mm from ground (199)	82.8
203	Target Unit Rear-M-LINK 3 Interior Rear Left Side, behind Pack #8 (203)	49.5	205	Target Unit Rear-M-LINK 3 Interior Rear Right Side, behind Pack #2 (205)	28.5
200	Target Unit Rear-M-LINK 3 Exterior Rear Right Side, 1968 mm from ground (200)	176.7	196	Target Unit Rear-M-LINK 3 Exterior Rear Left Side, 1050 mm from ground (196)	73.4

**\*Note: Thermocouple potentially compromised**

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### Attachment 4 – Temperature graph during testing

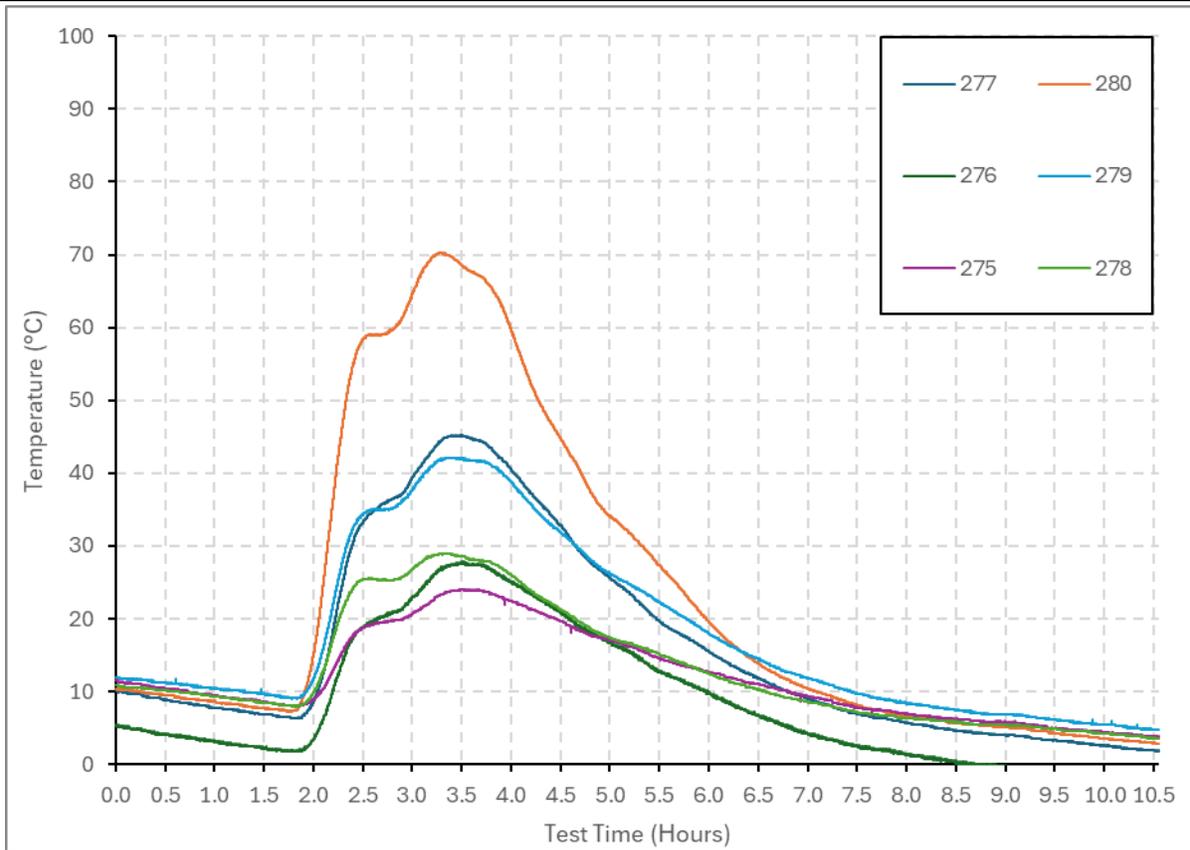


Figure 4.28: Rear Target Unit Dummy E-PANEL Door Temperatures

TC	Location	Max (°C)
277	Target Unit Rear E-Panel Left Door Interior, 2886 mm from ground (277)	45.3
280	Target Unit Rear E-Panel Right Door Interior, 2886 mm from ground (280)	70.3
276	Target Unit Rear E-Panel Left Door Interior, 1968 mm from ground (276)	27.8
279	Target Unit Rear E-Panel Right Door Interior, 1968 mm from ground (279)	42.0
275	Target Unit Rear E-Panel Left Door Interior, 1050 mm from ground (275)	24.1
278	Target Unit Rear E-Panel Right Door Interior, 1050 mm from ground (278)	29.0

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**Attachment 4 – Temperature graph during testing**

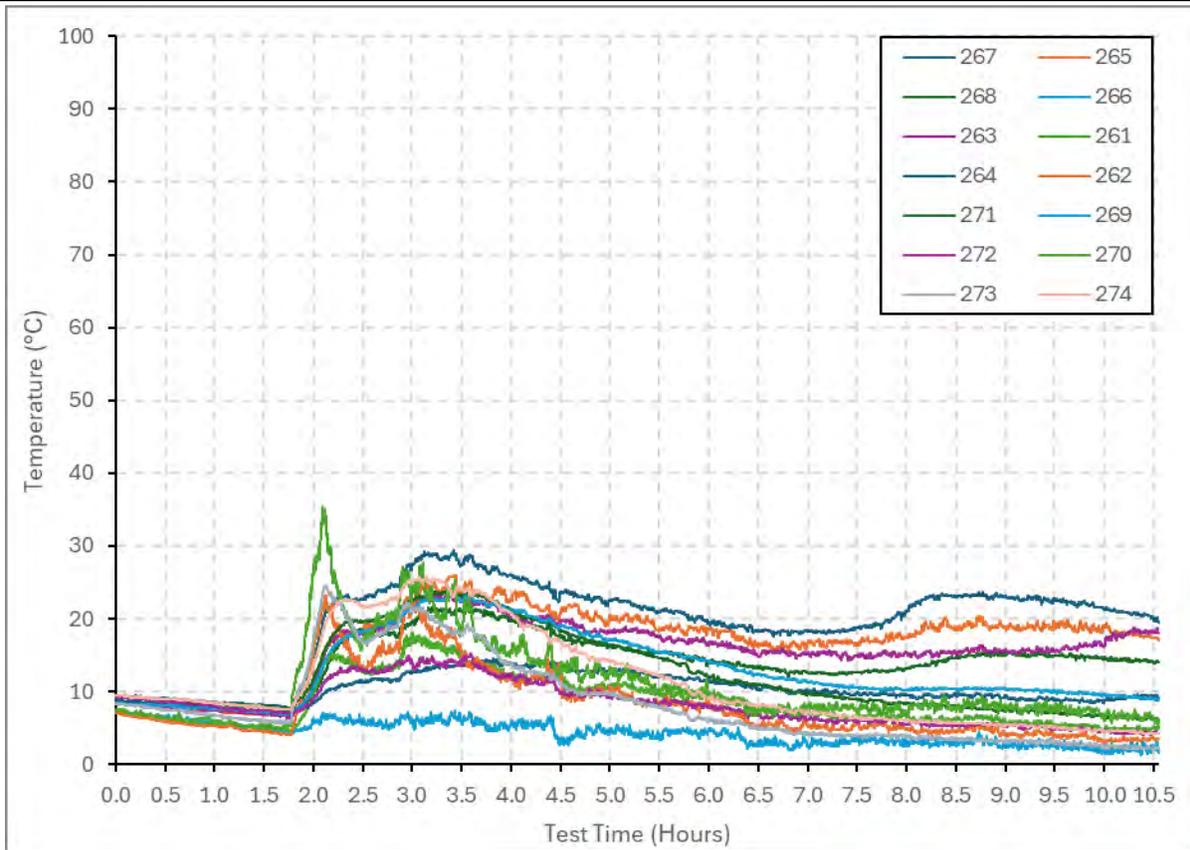


Figure 4.29: Rear Target Unit SKID Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
267	Target Unit Rear SKID Exterior, M-LINK 2 Left Side (267)	29.4	262	Target Unit Rear SKID Interior, M-LINK 1 Right Side (262)	23.1
265	Target Unit Rear SKID Exterior, M-LINK 2 Right Side (265)	26.0	271	Target Unit Rear SKID Exterior, M-LINK 3 Left Side (271)	23.7
268	Target Unit Rear SKID Interior, M-LINK 2 Left Side (268)	22.0	269	Target Unit Rear SKID Exterior, M-LINK 3 Right Side (269)	23.8
266	Target Unit Rear SKID Interior, M-LINK 2 Right Side (266)	7.4.0	272	Target Unit Rear SKID Interior, M-LINK 3 Left Side (272)	15.2
263	Target Unit Rear SKID Exterior, M-LINK 1 Left Side (263)	23.5	270	Target Unit Rear SKID Interior, M-LINK 3 Right Side (270)	35.4
261	Target Unit Rear SKID Exterior, M-LINK 1 Right Side (261)	18.1	273	Target Unit Rear SKID Exterior, E-Panel (273)	24.6
264	Target Unit Rear SKID Interior, M-LINK 1 Left Side (264)	14.5	274	Target Unit Rear SKID Interior, E-Panel (274)	25.8

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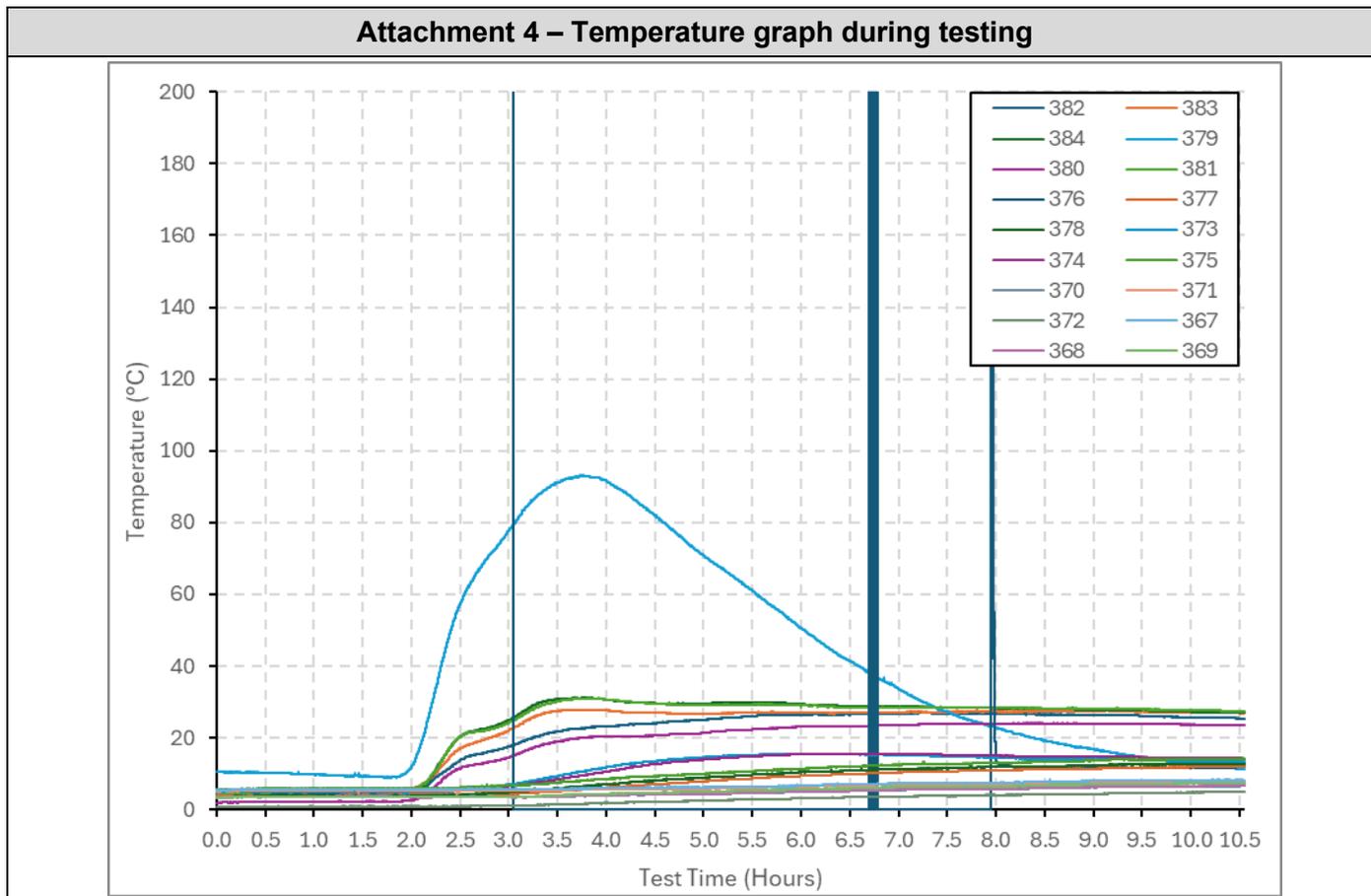


Figure 4.30: Rear Target Unit Module Temperatures

**\*Note: Thermocouple potentially compromised**

TC	Location	Max (°C)	TC	Location	Max (°C)
382	Target Unit Rear - Pack #14 Left CMA#1 Interior Ambient (382)	27.0	373	Target Unit Rear - Pack #11 Right CMA#1 Interior Ambient (373)	15.6
383	Target Unit Rear - Pack #14 Left CMA#2 Interior Ambient (383)	28.2	374	Target Unit Rear - Pack #11 Right CMA#2 Interior Ambient (374)	15.6
384	Target Unit Rear - Pack #14 Left CMA#3 Interior Ambient (384)	31.1	375	Target Unit Rear - Pack #11 Right CMA#3 Interior Ambient (375)	14.3
379	Target Unit Rear - Pack #14 Right CMA#1 Interior Ambient (379)	215.9*	370	Target Unit Rear - Pack #7 Left CMA#1 Interior Ambient (370)	6.8
380	Target Unit Rear - Pack #14 Right CMA#2 Interior Ambient (380)	24.1	371	Target Unit Rear - Pack #7 Left CMA#2 Interior Ambient (371)	8.0
381	Target Unit Rear - Pack #14 Right CMA#3 Interior Ambient (381)	31.1	372	Target Unit Rear - Pack #7 Left CMA#3 Interior Ambient (372)	5.0
376	Target Unit Rear - Pack #11 Left CMA#1 Interior Ambient (376)	11.9	367	Target Unit Rear - Pack #7 Right CMA#1 Interior Ambient (367)	8.3
377	Target Unit Rear - Pack #11 Left CMA#2 Interior Ambient (377)	12.9	368	Target Unit Rear - Pack #7 Right CMA#2 Interior Ambient (368)	6.7
378	Target Unit Rear - Pack #11 Left CMA#3 Interior Ambient (378)	12.9	369	Target Unit Rear - Pack #7 Right CMA#3 Interior Ambient (369)	7.5

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Project / Network: <b>80236098</b>	Description: <b>LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system</b>	

**Attachment 4 – Temperature graph during testing**

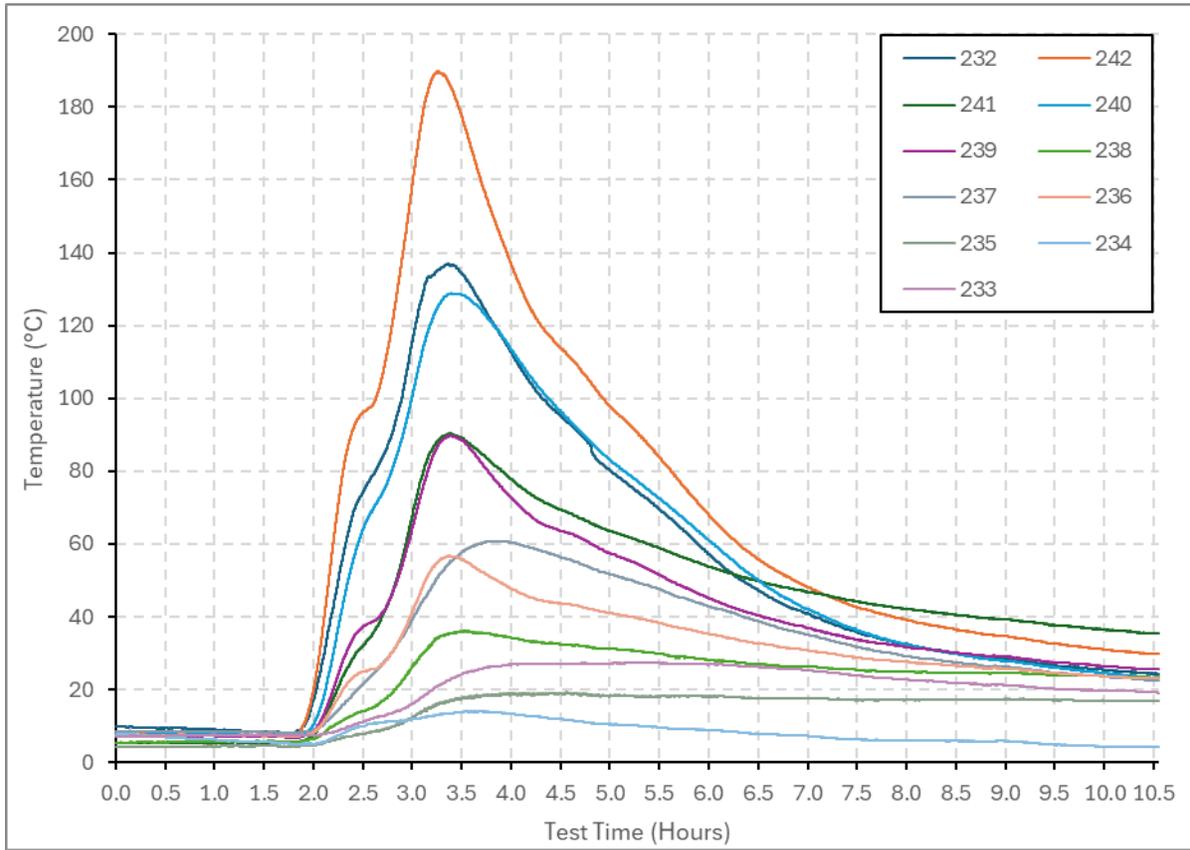


Figure 4.31: Target Unit Side Rack & Module Surface Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
232	Target Unit Side - M-LINK interior ambient (232)	136.9	237	Target Unit Side - Center Rack Surface near Pack #11 (237)	60.7
242	Target Unit Side - Left rack beside Pack #14 (242)	189.8	236	Target Unit Side - Left rack beside Pack #8 (236)	56.7
241	Target Unit Side - Pack #14 surface (241)	90.4	235	Target Unit Side - Pack #7 surface (235)	19.2
240	Target Unit Side - Center Rack Surface near Pack #14 (240)	128.9	234	Target Unit Side - Center rack beside Pack #8 (234)	14.0
239	Target Unit Side - Left rack beside Pack #11 (239)	89.7	233	Target Unit Side - Left rack beside Pack #2 (233)	27.4
238	Target Unit Side - Pack #11 surface (238)	36.0			

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Project / Network: <b>80236098</b>	Description: <b>LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system</b>	

### Attachment 4 – Temperature graph during testing

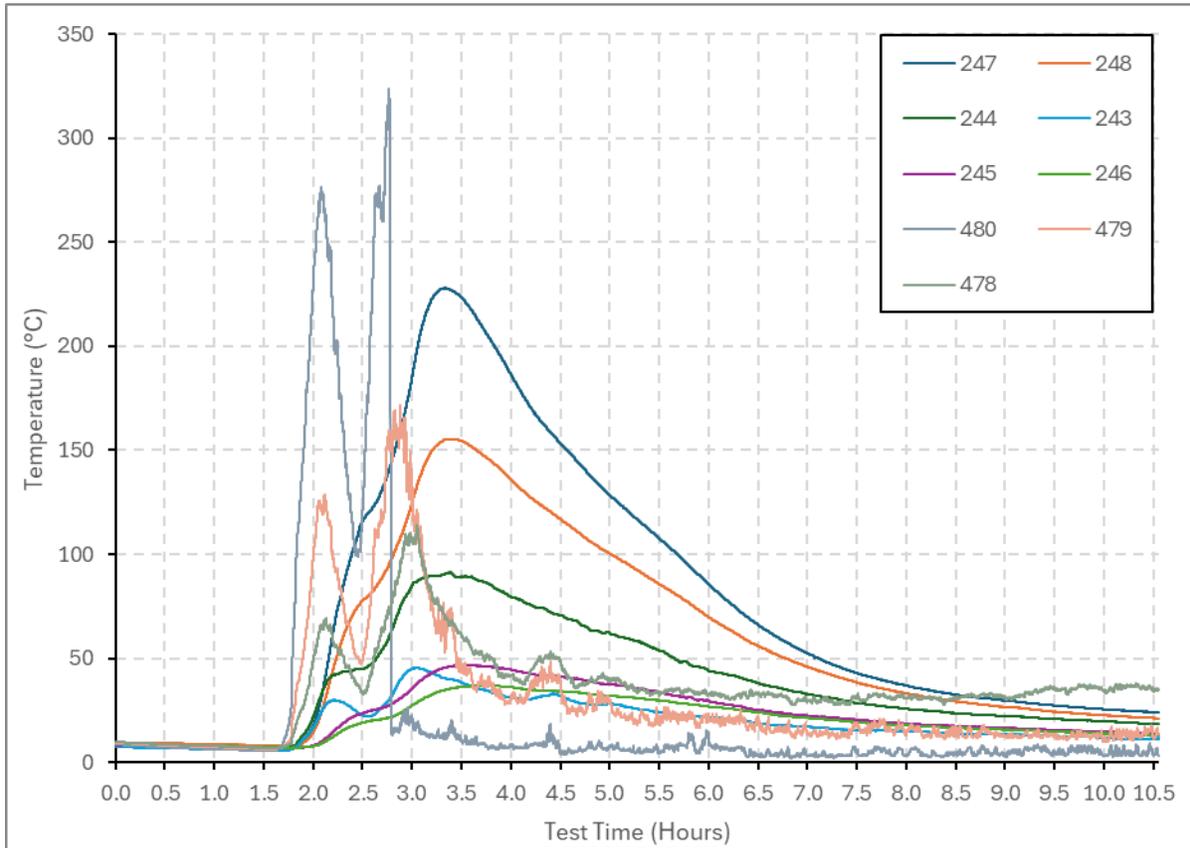


Figure 4.32: Side Target Unit Door and Side Temperatures

TC	Location	Max (°C)
247	Target Unit Side - M-LINK left ventilation panel strut (247)	227.9
248	Target Unit Side - M-LINK right ventilation panel strut (248)	155.3
244	Target Unit Side - Inside of M-LINK Door, on HVAC (244)	91.1
243	Target Unit Side - Inside of M-LINK Door, on Chiller (243)	45.3
245	Target Unit Side - Inside of M-LINK Door, upper intake fan (245)	46.9
246	Target Unit Side - Inside of M-LINK Door, lower intake fan (246)	36.9
480	Target Unit Side - Exterior Side, 2886 mm from ground (480)	323.5
479	Target Unit Side - Exterior Side, 1968 mm from ground (479)	171.9
478	Target Unit Side - Exterior Side, 1050 mm from ground (478)	114.1

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Master Contract: N/A	Model: JF2 DC LINK 5.1	Page number 73 of 82
Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Attachment 4 – Temperature graph during testing**

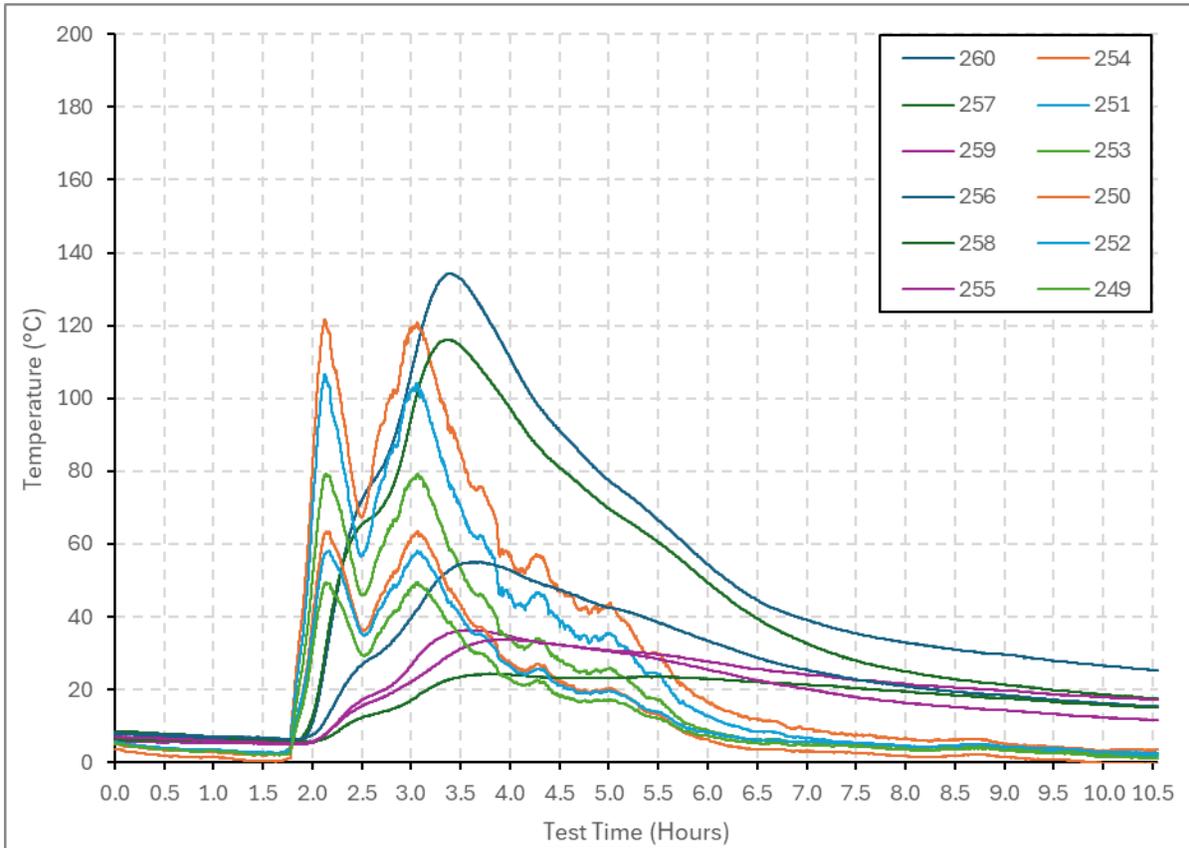


Figure 4.33: Side Target Unit Rear Wall Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
260	Target Unit Side - Interior Rear Left Side, behind Pack #14 (260)	134.3	256	Target Unit Side - Interior Rear Right Side, behind Pack #8 (256)	54.9
254	Target Unit Side - Exterior Rear Right Side, 2886 mm from ground (254)	121.8	250	Target Unit Side - Exterior Rear Left Side, 1968 mm from ground (250)	63.4
257	Target Unit Side - Interior Rear Right Side, behind Pack #14 (257)	116.1	258	Target Unit Side - Interior Rear Left Side, behind Pack #2 (258)	24.4
251	Target Unit Side - Exterior Rear Left Side, 2886 mm from ground (251)	106.7	252	Target Unit Side - Exterior Rear Right Side, 1050 mm from ground (252)	58.1
259	Target Unit Side - Interior Rear Left Side, behind Pack #8 (259)	36.4	255	Target Unit Side - Interior Rear Right Side, behind Pack #2 (255)	33.9
253	Target Unit Side - Exterior Rear Right Side, 1968 mm from ground (253)	79.4	249	Target Unit Side - Exterior Rear Left Side, 1050 mm from ground (249)	49.6

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Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

### Attachment 4 – Temperature graph during testing

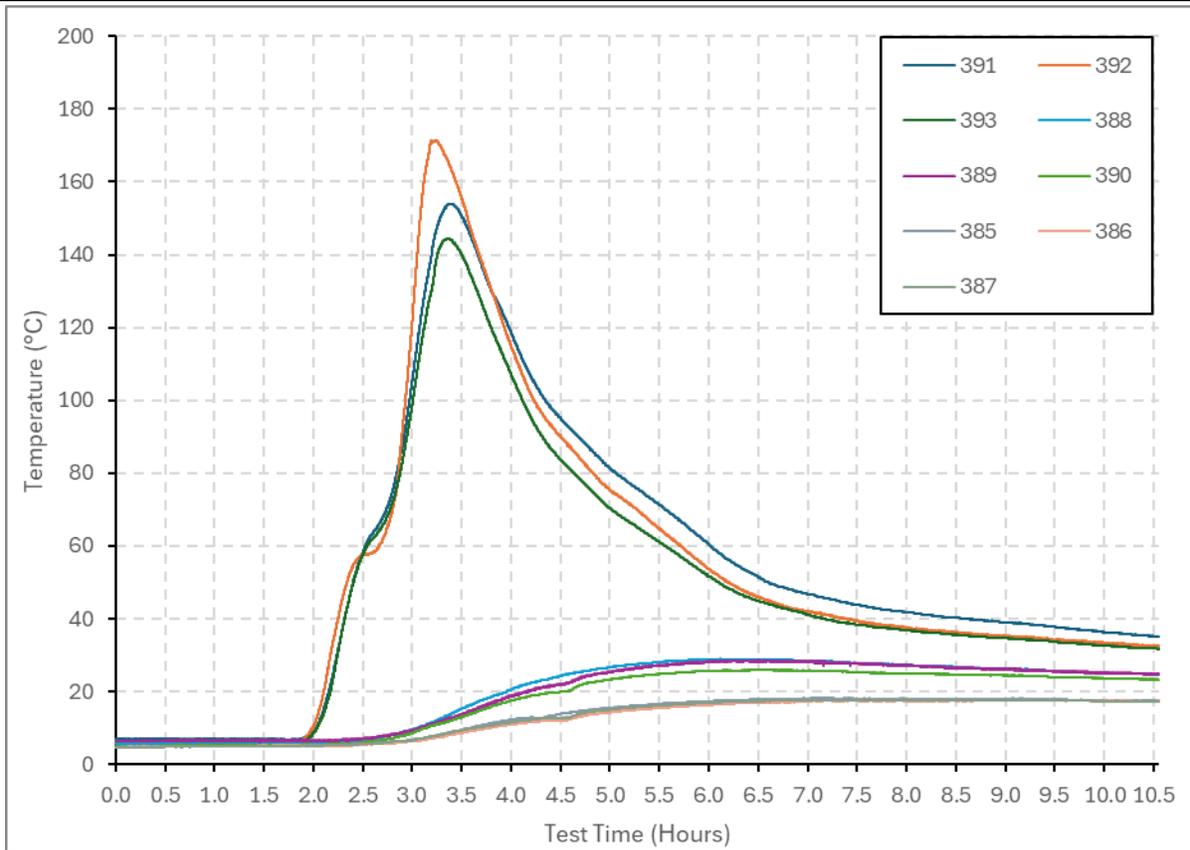


Figure 4.34: Side Target Unit Module Temperatures

TC	Location	Max (°C)
391	Target Unit Side - Pack #14 Left CMA#1 Interior Ambient (391)	153.9
392	Target Unit Side - Pack #14 Left CMA#2 Interior Ambient (392)	171.4
393	Target Unit Side - Pack #14 Left CMA#3 Interior Ambient (393)	144.5
388	Target Unit Side - Pack #11 Left CMA#1 Interior Ambient (388)	29.0
389	Target Unit Side - Pack #11 Left CMA#2 Interior Ambient (389)	28.7
390	Target Unit Side - Pack #11 Left CMA#3 Interior Ambient (390)	26.0
385	Target Unit Side - Pack #7 Left CMA#1 Interior Ambient (385)	18.1
386	Target Unit Side - Pack #7 Left CMA#2 Interior Ambient (386)	17.6
387	Target Unit Side - Pack #7 Left CMA#3 Interior Ambient (387)	17.7

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Project / Network: <b>80236098</b>	Description: <b>LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system</b>	

**Attachment 4 – Temperature graph during testing**

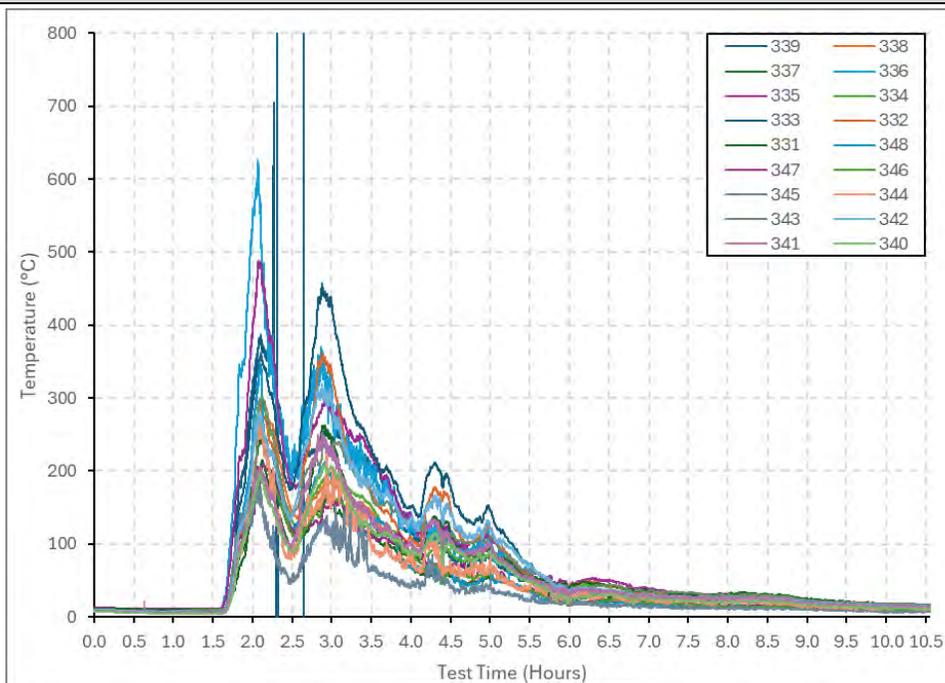


Figure 4.35: Front Aisle and Wall Temperatures

TC	Location	Max (°C)	TC	Location	Max (°C)
339	Initiating Unit Front Aisle - TC Tree 4 5' In front of M-LINK 1, 2886 mm from ground (339)	2155.8*	348	Front Target Wall - TC Array 3 Centered on M-LINK 1, 2886 mm from ground (348)	347.5
338	Initiating Unit Front Aisle - TC Tree 4 5' In front of M-LINK 1, 1968 mm from ground (338)	296.5	347	Front Target Wall - TC Array 3 Centered on M-LINK 1, 1968 mm from ground (347)	207.5
337	Initiating Unit Front Aisle - TC Tree 4 5' In front of M-LINK 1, 1050 mm from ground (337)	243.5	346	Front Target Wall - TC Array 3 Centered on M-LINK 1, 1050 mm from ground (346)	194.8
336	Initiating Unit Front Aisle - TC Tree 5 5' In front of M-LINK 2, 2886 mm from ground (336)	625.7	345	Front Target Wall - TC Array 2 Centered on M-LINK 2, 2886 mm from ground (345)	179.1
335	Initiating Unit Front Aisle - TC Tree 5 5' In front of M-LINK 2, 1968 mm from ground (335)	488.5	344	Front Target Wall - TC Array 2 Centered on M-LINK 2, 1968 mm from ground (344)	278.6
334	Initiating Unit Front Aisle - TC Tree 5 5' In front of M-LINK 2, 1050 mm from ground (334)	297.5	343	Front Target Wall - TC Array 2 Centered on M-LINK 2, 1050 mm from ground (343)	301
333	Initiating Unit Front Aisle - TC Tree 6 5' In front of M-LINK 3, 2886 mm from ground (333)	457.5	342	Front Target Wall - TC Array 1 Centered on M-LINK 3, 2886 mm from ground (342)	319.3
332	Initiating Unit Front Aisle - TC Tree 6 5' In front of M-LINK 3, 1968 mm from ground (332)	361.9	341	Front Target Wall - TC Array 1 Front Wall Centered on M-LINK 3, 1968 mm from ground (341)	252.7
331	Initiating Unit Front Aisle - TC Tree 6 5' In front of M-LINK 3, 1050 mm from ground (331)	261.8	340	Front Target Wall - TC Array 1 Front Wall Centered on M-LINK 3, 1050 mm from ground (340)	208.0

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Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

### Attachment 4 – Temperature graph during testing

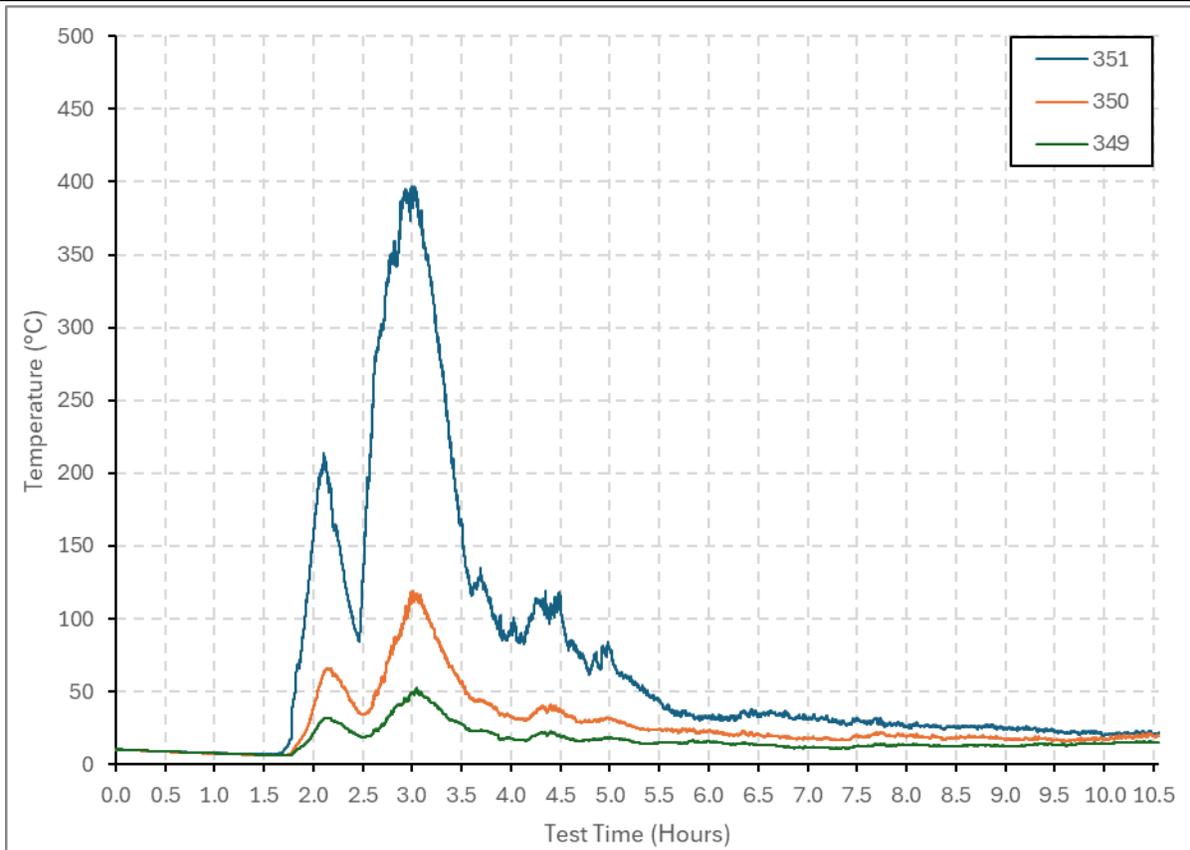


Figure 4.36: Side Target Unit Aisle Temperatures

TC	Location	Max (°C)
351	Side Target Unit Aisle - TC Tree 8 200 mm from M-LINK 3, 2886 mm from ground (351)	397.1
350	Side Target Unit Aisle - TC Tree 8 200 mm from M-LINK 3, 1968 mm from ground (350)	119.6
349	Side Target Unit Aisle - TC Tree 8 200 mm from M-LINK 3, 1050 mm from ground (349)	52.3

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Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

### Attachment 4 – Temperature graph during testing

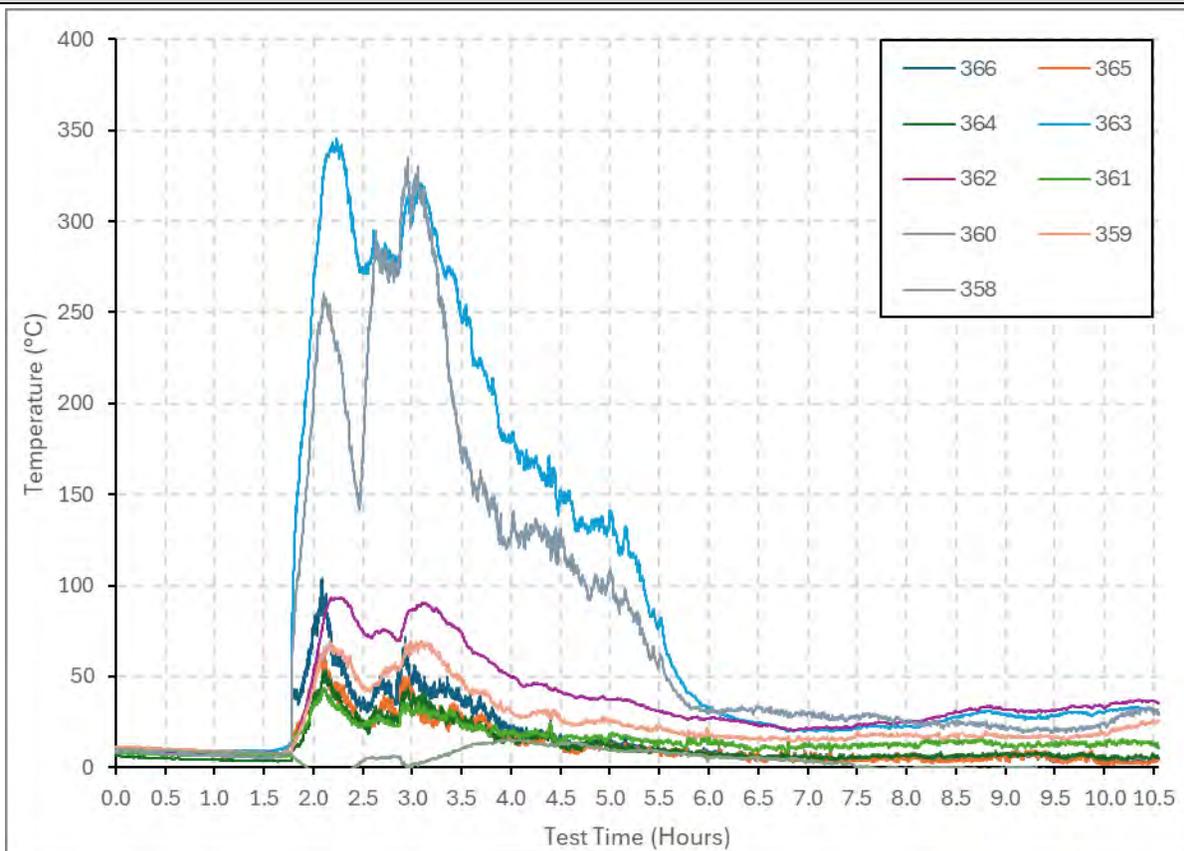


Figure 4.37: Rear Target Unit Aisle Temperatures

TC	Location	Max (°C)
366	Rear Target Unit Aisle - TC Tree 1 200 mm from M-LINK 1, 2886 mm from ground (366)	104.2
365	Rear Target Unit Aisle - TC Tree 1 200 mm from M-LINK 1, 1968 mm from ground (365)	63.2
364	Rear Target Unit Aisle - TC Tree 1 200 mm from M-LINK 1, 1050 mm from ground (364)	53.4
363	Rear Target Unit Aisle - TC Tree 2 200 mm from M-LINK 2, 2886 mm from ground (363)	345.5
362	Rear Target Unit Aisle - TC Tree 2 200 mm from M-LINK 2, 1968 mm from ground (362)	93.6
361	Rear Target Unit Aisle - TC Tree 2 200 mm from M-LINK 2, 1050 mm from ground (361)	43.9
360	Rear Target Unit Aisle - TC Tree 3 200 mm from M-LINK 3, 2886 mm from ground (360)	335.4
359	Rear Target Unit Aisle - TC Tree 3 200 mm from M-LINK 3, 1968 mm from ground (359)	69.6
358	Rear Target Unit Aisle - TC Tree 3 200 mm from M-LINK 3, 1050 mm from ground (358)	15.4

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Project / Network: 80236098	Description: LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Attachment 4 – Temperature graph during testing**

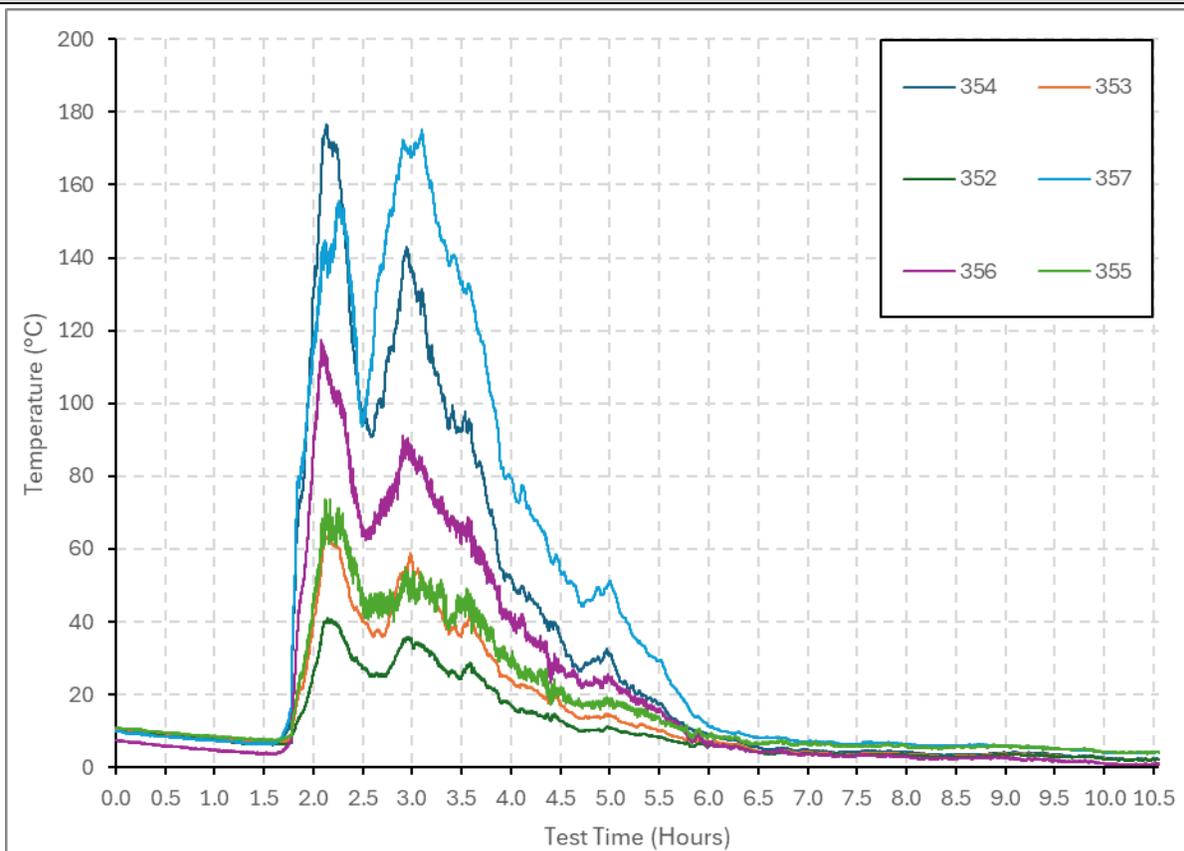


Figure 4.38: Initiating Unit Left Aisle and Wall Temperatures

TC	Location	Max (°C)
354	Initiating Unit Left Aisle - TC Tree 7 2.5' from E-Panel, 2886 mm from ground (354)	176.7
353	Initiating Unit Left Aisle - TC Tree 7 2.5' from E-Panel, 1968 mm from ground (353)	63.3
352	Initiating Unit Left Aisle - TC Tree 7 2.5' from E-Panel, 1050 mm from ground (352)	41.0
357	Left Target Wall - TC Array 4 Centered on E-Panel, 2886 mm from ground (357)	175.2
356	Left Target Wall - TC Array 4 Centered on E-Panel, 1968 mm from ground (356)	117.3
355	Left Target Wall - TC Array 4 Centered on E-Panel, 1050 mm from ground (355)	73.6

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**Attachment 5 – Weather station graph**

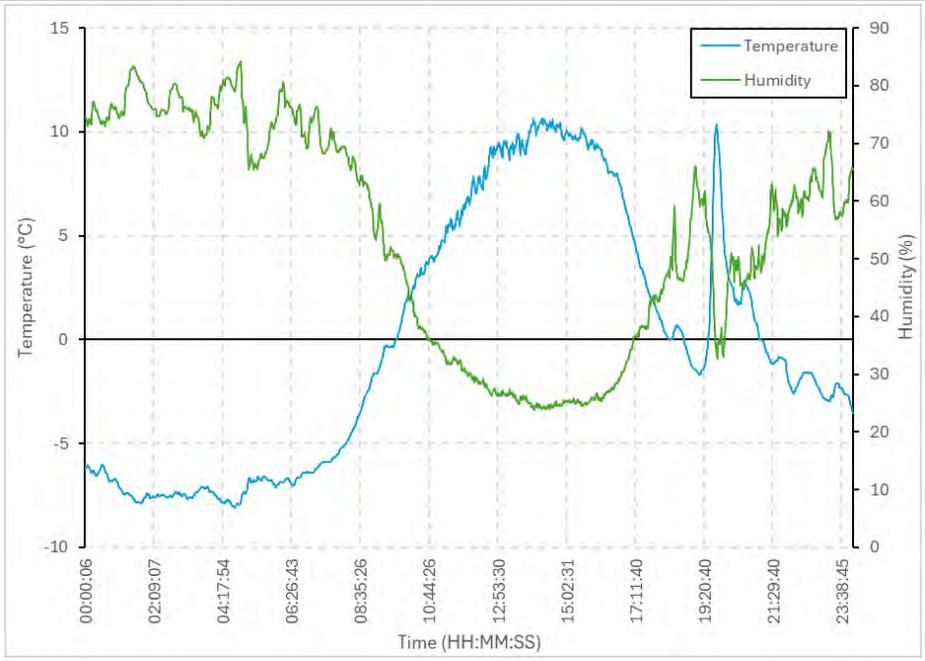


Figure 5.1: Ambient Temperature and Relative Humidity during Test

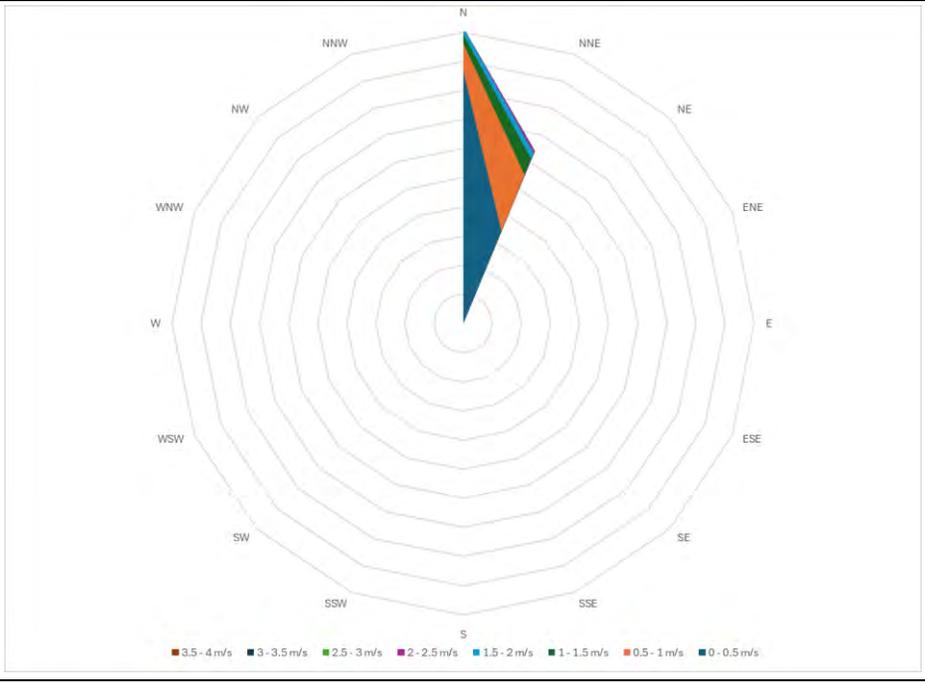


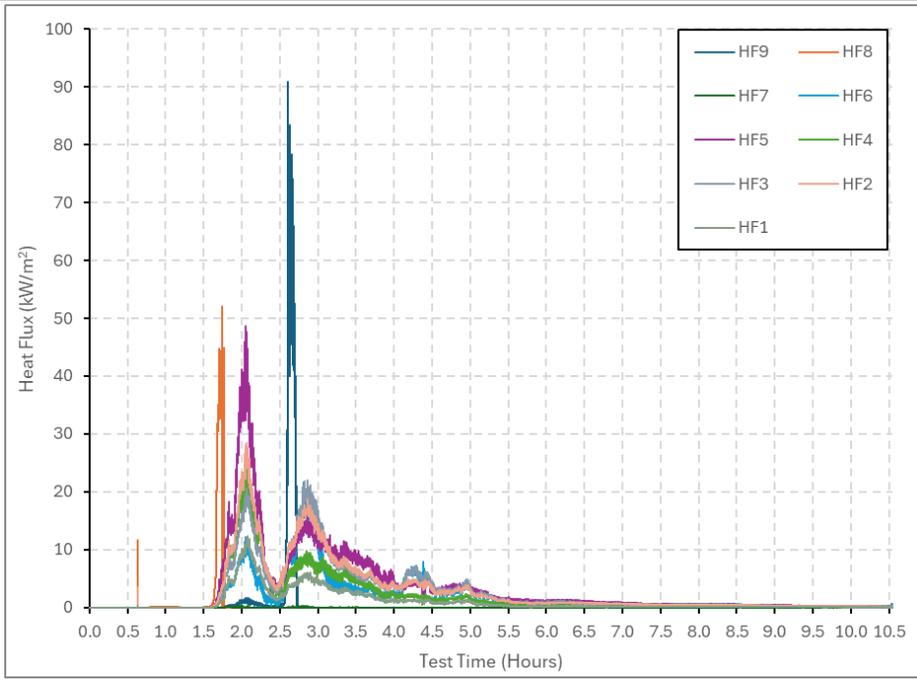
Figure 5.2 Wind Speed and Direction during Test

*The results relate only to the items tested.*

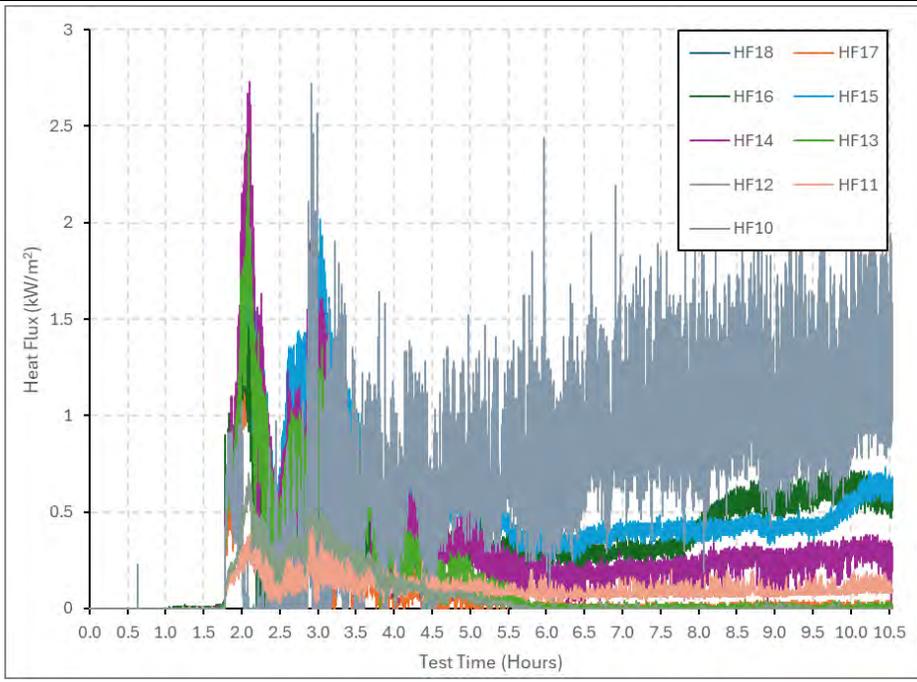
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### Attachment 6 – Heat flux graph



**Figure 6.1: Initiating Unit Front Aisle Heat Flux**



**Figure 6.2: Rear Target Unit Aisle Heat Flux**

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**Attachment 6 – Heat flux graph**

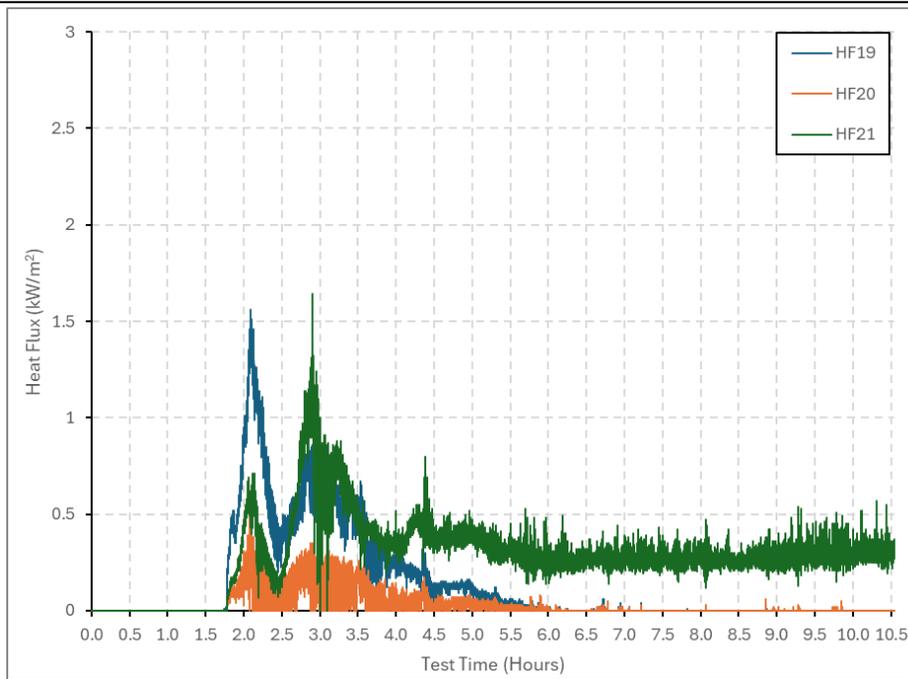


Figure 6.3: Initiating Unit Left Aisle Heat Flux

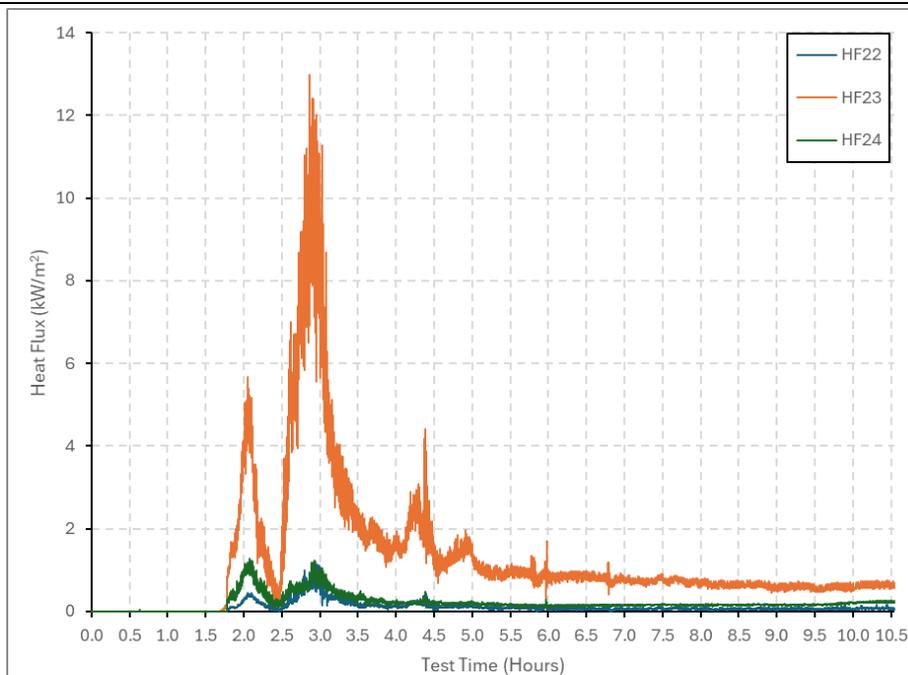


Figure 6.4: Side Target Unit Aisle Heat Flux



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Project / Network:	80236098	Description:	LG JF2 DC LINK 5.1 5.1MWh multi-part battery energy storage system	

**Attachment 6 – Heat flux graph**

**Maximum Heat flux measurement**

Location	Measured maximum heat flux (kW/m <sup>2</sup> )
HF1- Initiating Unit Front Wall - M-LINK 3, 10 ft In front of Unit, 1.2 m from ground	12.41
HF2- Initiating Unit Front Wall - M-LINK 2, 10 ft In front of Unit, 1.2 m from ground	28.38
HF3- Initiating Unit Front Wall - M-LINK 1, 10 ft In front of Unit, 1.2 m from ground	22.07
HF4- Initiating Unit Front Aisle - M-LINK 3, 5 ft In front of Unit, 1.2 m from ground	24.21
HF5- Initiating Unit Front Aisle - M-LINK 2, 5 ft In front of Unit, 1.2 m from ground	48.70
HF6- Initiating Unit Front Aisle - M-LINK 1, 5 ft In front of Unit, 1.2 m from ground	21.71
HF7- Initiating Unit Front Door - M-LINK 3, Directly in front of Unit Door, 1.2 m from ground	0.66
HF8- Initiating Unit Front Door - M-LINK 2, Directly in front of Unit Door, 1.2 m from ground	52.02
HF9- Initiating Unit Front Door - M-LINK 1, Directly in front of Unit Door, 1.2 m from ground	90.92
HF10- Initiating Unit Rear Side - M-LINK 3, Directly behind Unit, 1.2 m from ground	0.7
HF11- Initiating Unit Rear Side - M-LINK 2, Directly behind Unit, 1.2 m from ground	0.46
HF12- Initiating Unit Rear Side - M-LINK 1, Directly behind Unit, 1.2 m from ground	2.72
HF13- Rear Target Unit Aisle - M-LINK 3, 8 inch behind Unit, 1.2 m from ground	2.43
HF14- Rear Target Unit Aisle - M-LINK 2, 8 inch behind Unit, 1.2 m from ground	2.73
HF15- Rear Target Unit Aisle - M-LINK 1, 8 inch behind Unit, 1.2 m from ground	2.37
HF16- Rear Target Unit Aisle - M-LINK 3, 18 inch behind Unit, 1.2 m from ground	1.8
HF17- Rear Target Unit Aisle - M-LINK 2, 18 inch behind Unit, 1.2 m from ground	1.69
HF18- Rear Target Unit Aisle - M-LINK 1, 18 inch behind Unit, 1.2 m from ground	2.13
HF19- Initiating Unit Left Aisle – 5 ft left of E-PANEL, 1.2 m from ground	1.56
HF20- Initiating Unit Left Aisle - 2.5 ft left of Wall, 1.2 m from ground	0.48
HF21- Initiating Unit Left Aisle - Directly left of Wall Surface, 1.2 m from ground	1.64
HF22- Side Target Unit Aisle - M-LINK 3, Directly right of Wall Surface, 1.2 m from ground	1.13
HF23- Side Target Unit Aisle - M-LINK 3, 2.5 ft right of Wall, 1.2 m from ground	12.97
HF24- Side Target Unit Aisle - M-LINK 3, 5 ft right of Wall at Target Unit, 1.2 m from ground	1.27

End of Report...

# **APPENDIX 3.9-D: EXPLOSION PREVENTION SYSTEM DESIGN REPORT**

EXPLOSION PREVENTION SYSTEM DESIGN REPORT

# LG ENERGY SOLUTION BATTERY ENERGY STORAGE SYSTEM

*Engineering Support*

## PREPARED FOR

LG Energy Solution (LGES)  
Sohn, Juno  
junosohn@lgensol.com  
+82 1043842400

Proposal #: 1MDT24007  
Date: May 14, 2025

## PREPARED BY

Michael Townsend  
10 S Wacker Drive, Suite 1300  
Chicago, IL 60606, USA

mtownsend@jensenhughes.com  
+1 920-629-6108



**JENSEN HUGHES**

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*Preparer:* Manuel Daza, PhD

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*Reviewer*

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*Approver*

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### *Revision Record Summary*

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<i>Revision</i>	<i>Revision Summary</i>	<i>Date</i>
0	Initial use	May 14, 2025
1	Incorporated updated sequence of operations and removed previously included Cases 7 and 8	May 26, 2025

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## Executive Summary

LG Energy Solution (LGES) is developing a battery energy storage system (BESS) for which an explosion hazard mitigation strategy is required. The BESS, LGES Model “JF2 AC&DC LINK 5.1 0.25CP/0.50CP Battery Container”, is intended for outdoor installation. A site-independent hazard mitigation strategy for explosion prevention by means of reduction of combustible concentration was developed for this BESS. A solution was developed according to the combustible concentration reduction method of NFPA 69, using UL 9540A test data as the basis for hazard definition, in accordance with NFPA 855. This report focuses on documenting the technical basis, operating principle, and design parameters for the explosion prevention system. The system design, including equipment specifications and drawings, is a separate work product.

The battery cells, modules, and racks that will be used in the subject BESS are manufactured by LGES. It is important to note that, in this context, the terms “module” and “pack” are used interchangeably; however, the term “module” has been used consistently throughout this report for clarity and consistency. Thermal runaway propagation testing of the battery cells was conducted by UL LLC (UL), and the properties of the gases that vented from cells were determined. Module-level and unit-level tests were also conducted, and these results were used to develop a gas release rate profile. This combined dataset was used as the basis to determine exhaust rates required to maintain a global concentration of combustible vent gas below 25% of the lower flammability limit (LFL) of the gas, per the NFPA 69 requirement.

The explosion hazard was defined based on the release of flammable “venting gas” from a failing battery module. This gas was assumed to have been generated by the venting of failing cells within the module. The composition of this battery gas was assumed to be equal to that measured in the cell-level UL 9540A test by volume: 59.3% hydrogen, 10.0% carbon monoxide, 22.4% carbon dioxide, and 8.3% total hydrocarbons. The lower flammability limit of the battery gas was measured to be 7.4% by volume. Based on a review of module- and unit-level UL 9540A test data, it was determined that upon the occurrence of thermal runaway and venting of initiating and adjacent cells, propagation to adjacent cells occurred in a module. According to the observation of thermal runaway in the module- and unit-level test reports by the operator, a total of 979.4 g of battery gas at approximately 209.6°C would be released over 750 seconds, at an average rate of 1.3 g/s.

An automated exhaust ventilation system composed of two (2) roof exhaust vents and two (2) intake fans, was designed to maintain the global concentration of battery gas in the compartment below 25% of the LFL, based on the explosion hazard present. The hazard scenario was defined as the event involving the longest reasonable delay time between the detection of battery vent gas and the activation of the ventilation system. This hazard scenario was simulated in FDS, and it was demonstrated that under the normal operation conditions and abnormal operating conditions, the global concentrations of battery gas would not exceed the performance criterion of 25% of the LFL, which is 1.85%.

The explosion prevention solution presented here is applicable only to the explosion hazard present as defined based on UL 9540A test data, in accordance with NFPA 855. Additional scenarios that may create a fire or explosion hazard shall be analyzed separately.

## 1.0 Introduction

LG Energy Solution (LGES) is developing a battery energy storage system (BESS) that incorporates lithium-ion phosphate (LFP) battery modules in rack storage within a steel enclosure. The subject BESS, LGES Model “JF2 AC&DC LINK 5.1 0.25CP/0.50CP Battery Container”, is intended for outdoor installation, and the installation site is unspecified. This report solely addresses the general requirements for explosion control in a BESS, per NFPA 855 Section N9.6.5.6 [1]. A site-specific report may be required on a case-by-case basis.

The explosion hazard under consideration for this BESS is caused by the release of flammable gases from venting LFP batteries. The approach adopted here for the design of an explosion prevention system applicable to this hazard was developed in accordance with NFPA 69 Chapter 8 [2], “deflagration prevention by combustible concentration reduction.” The design basis for such a system is that the combustible concentration of flammable gases must be maintained at or below 25 percent of the LFL of those gases (in air). This was achieved by activating an exhaust system in response to the detection of flammable gases in the BESS.

This report presents a generalized explosion prevention system designed to mitigate the aforementioned hazard by means of control of combustible concentration. Site-specific details were not considered in this design. Therefore, additional site-level hazard analyses will be required prior to the installation of this product to ensure that the explosion prevention approach is suitable. It is possible that additional or alternative mitigation strategies may be required to comply with local regulations.

## 2.0 Background

### 2.1 DETAILS OF THE SUBJECT BESS

The JF2 AC&DC LINK 5.1 0.25CP/0.50CP consists of 3 M-LINKs and 1 E-PANEL. In this analysis, M-LINK is the subject BESS, which is a rectangular, single-enclosure structure that accommodates two (2) battery racks, as shown in Figure 1 and Figure 2. The battery enclosure's interior footprint was measured to be nominally 2.10 m wide by 2.57 m deep by 2.746 m tall, and the enclosure volume to be 14.8 m<sup>3</sup>.

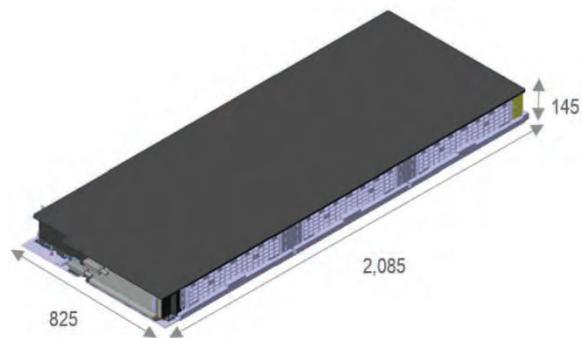


**Figure 1: Computer rendering of the M-LINK**

The battery system in the M-LINK comprises two (2) battery racks in parallel. Each battery rack has a total capacity of 852 kWh and contains 14 modules (JF2 module) connected in series (75 ~ 109.5 V each). Each module contains 120 battery cells in a 30S4P configuration, so each M-LINK battery system contains 3360 battery cells. A typical module and cell are shown in Figure 3 through Figure 5. It is important to note that a module comprises three cell module assemblies (CMAs), each containing a total of 40 cells. To mitigate the risk of thermal runaway propagation, each CMA is equipped with three aerogel pads, and a Mica sheet is placed between each CMA for added safety (see Figure 12).



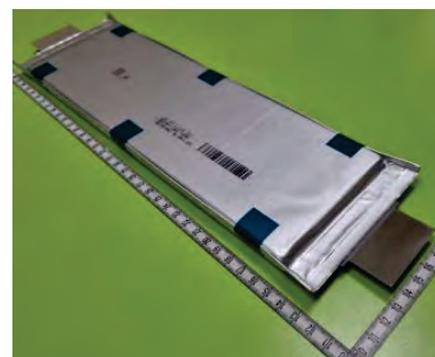
**Figure 2: Battery racks and modules in the M-LINK.**



**Figure 3: A battery module**



**Figure 4: Battery cell distribution in a module**



**Figure 5: A battery cell.**

## 2.2 HAZARD DEFINITION

The explosion hazard present in the subject M-LINK is defined as the release of flammable “venting gas” from a failing battery module. It is assumed that the origin of this failure will be an initiating cell within a module that is somehow driven to vent battery gas and develop into a thermal runaway. At this point, involvement of adjacent

cells may occur. The propensity for this “propagation” of thermal runaway and venting of cell gas is assessed via UL 9540A testing or equivalent, as stipulated in NFPA 855 Section A.9.1.5.1 [1]:

*A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of gases generated at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire and explosion protection required for an ESS installation.*

UL carried out UL9540A testing for the LGES batteries used in the subject BESS; the cell-level [3], module-level [4], and unit-level [5] UL test reports were provided to Jensen Hughes by LGES to support the present analysis.

**2.2.1 Battery Gas Composition and LFL**

UL 9540A cell-level testing [3] was conducted on the LGES lithium-ion phosphate battery cell, Model JF2. In this testing, a cell was placed inside an 82 L pressure vessel and driven into thermal runaway using flexible film heaters on both faces of the cell. Heating was applied at a rate of 4°C/min to 7°C/min. The cell vented at a surface temperature of 128.9°C and transitioned to thermal runaway at a surface temperature of 209.6°C. The total volume of gas vented from the cell was 64 L (at NTP). The composition of the battery vent gas was measured to be 59.3% hydrogen, 10.0% carbon monoxide, 22.4% carbon dioxide, and 8.3% total hydrocarbons (by volume). The density of the gas at NTP was calculated to be 0.728 g/L (kg/m<sup>3</sup>) using Equation 1 and the lower flammability limit of battery gas was measured to be 7.4% [3]. Table 1 shows the chemical properties of the battery gas mixture. Note that the total hydrocarbon component (C<sub>x</sub>H<sub>y</sub>) of the battery gas mixture was assumed to be equivalent to propane (C<sub>3</sub>H<sub>8</sub>) in the present analysis.

$$\rho_{bg} = \sum_{i=1}^i \rho_i \vartheta_i \quad (1)$$

Where,  $\rho_{bg}$  is the battery gas density,  $\rho_i$  is the density of component  $i$ , and  $\vartheta_i$  is the volume fraction of component  $i$  in the mixture.

*Table 1: Battery Gas Composition from JF1 LFP Cell Based on UL9540A Test Data.*

<i>Component</i>	<i>Volume Fraction (<math>\vartheta_i</math>)</i>	<i>Mass Fraction</i>	<i>Molar Mass</i>	<i>Density (<math>\rho_i</math>) (at NTP)</i>	<i>25% LFL</i>
	<i>(%vol)</i>	<i>(%wt)</i>	<i>(g/mol)</i>	<i>(kg/m<sup>3</sup>)</i>	<i>(%)</i>
H <sub>2</sub>	59.3	6.8	2.0	0.08	-
C <sub>3</sub> H <sub>8</sub>	8.3	18.4	44.1	1.83	-
CO	10.0	16.0	28.0	1.16	-

<i>Component</i>	<i>Volume Fraction (<math>\vartheta_i</math>)</i>	<i>Mass Fraction</i>	<i>Molar Mass</i>	<i>Density (<math>\rho_i</math>) (at NTP)</i>	<i>25% LFL</i>
	<i>(%vol)</i>	<i>(%wt)</i>	<i>(g/mol)</i>	<i>(kg/m<sup>3</sup>)</i>	<i>(%)</i>
CO <sub>2</sub>	22.4	58.8	44.0	1.83	-
Mixture	100.0	100.0	17.5	0.728	1.85

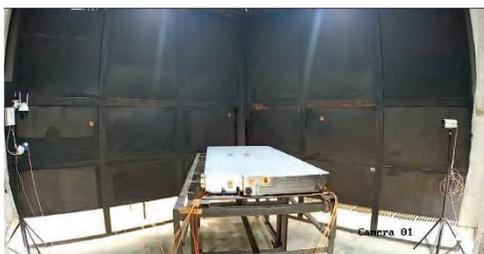
It is assumed that the battery vent gas that will be released into the M-LINK enclosure per the hazard scenario has equivalent composition and LFL to that measured in the cell-level UL 9540A test. This assumption is conservative because these tests are conducted in a vessel within which the atmosphere contains less than 1% oxygen by volume. As a result, the flammable components of the battery gas do not burn off as they are released, resulting in elevated levels of H<sub>2</sub> and total hydrocarbon component (taken as C<sub>3</sub>H<sub>8</sub>) compared to what might be expected in the atmosphere of the hazard scenario (dry air containing 20.95% oxygen by volume).

**2.2.2 Propagation of Thermal Runaway and Battery Gas Release Rate**

This section presents results from UL 9540A testing that were used to evaluate the propensity for the propagation of thermal runaway and conservatively define the explosion hazard associated with a battery venting event.

**2.2.2.1 Module-Level Testing**

In the module-level test [4], a single cell was driven to venting and thermal runaway (Figure 6 through Figure 8) via a flexible film heater. The initiating cell (Cell 11 as identified in the test scheme) started to vent at a temperature of 133°C and underwent thermal runaway at a temperature of 154°C. Following the thermal runaway, venting smoke was observed (Figure 7 through Figure 10). The condition of the module post-test is shown in Figure 11. Based on these module test results, it can be concluded that the thermal runaway occurred in cells inside the module and the module enclosure was not damaged.



**Figure 6: Initiating Cell 11 venting at 00:24:45.**



**Figure 7: First smoke observed at 00:25:54.**



**Figure 8: Initiating Cell 11 undergoing thermal runaway at 00:27:14.**



**Figure 9: Thermal runaway propagation at 00:37:43.**



**Figure 10: Maximum Smoke Release Rate at 00:44:04.**



**Figure 11: Test termination at 02:45:00.**

Figure 12 shows a schematic of the initiating and adjacent cells, while the corresponding temperatures on those cells measured during the module-level test are presented in Figure 13. The cells with a maximum temperature higher than the thermal runaway temperature (concluded in the cell-level report (209.6°C) [3]) are the initiating Cell 11, Cell 8, Cell 4, and Cell 1 located at the end of the CMA #2 (see Figure 12). It indicates that those cells underwent thermal runaway during the module-level test.

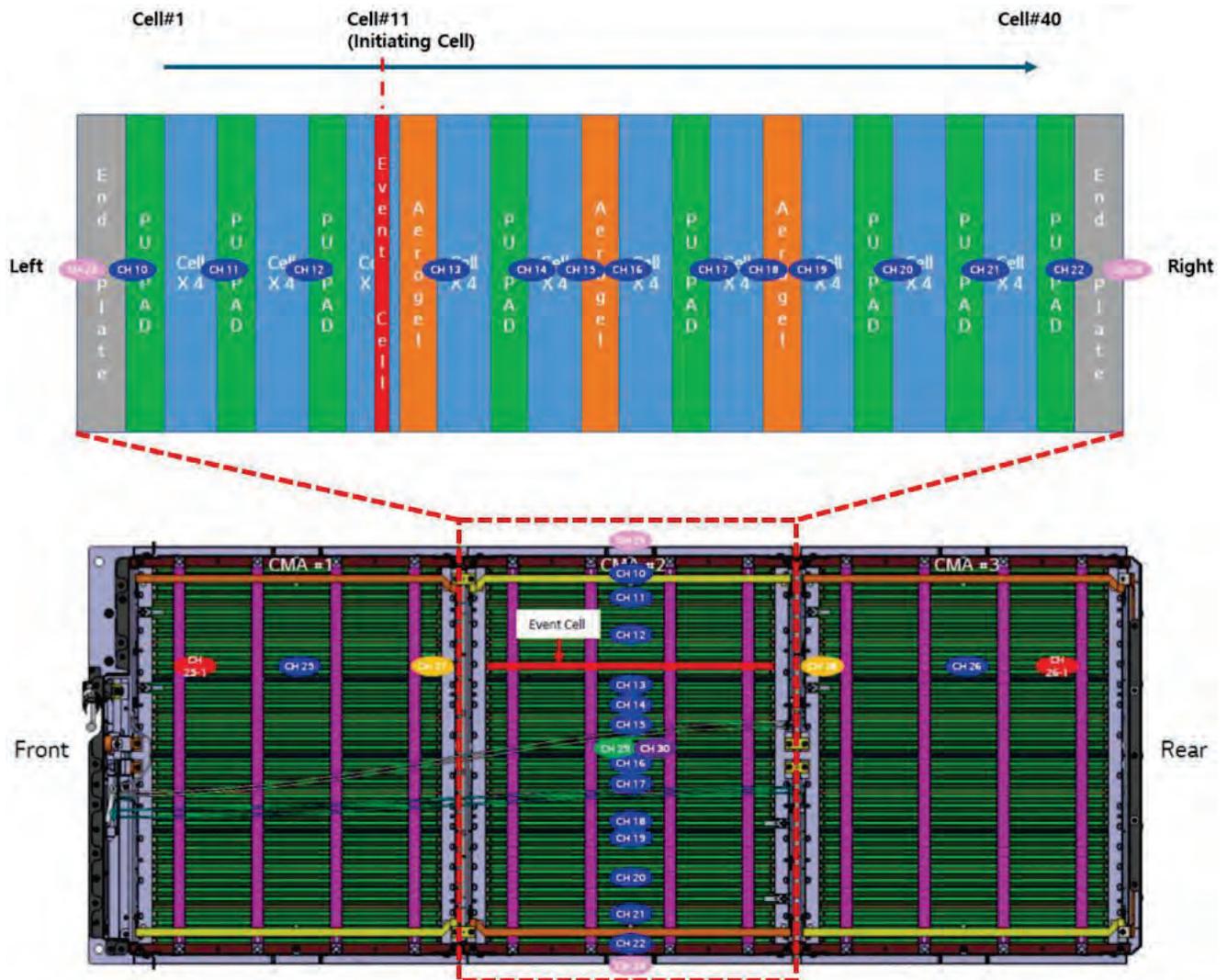
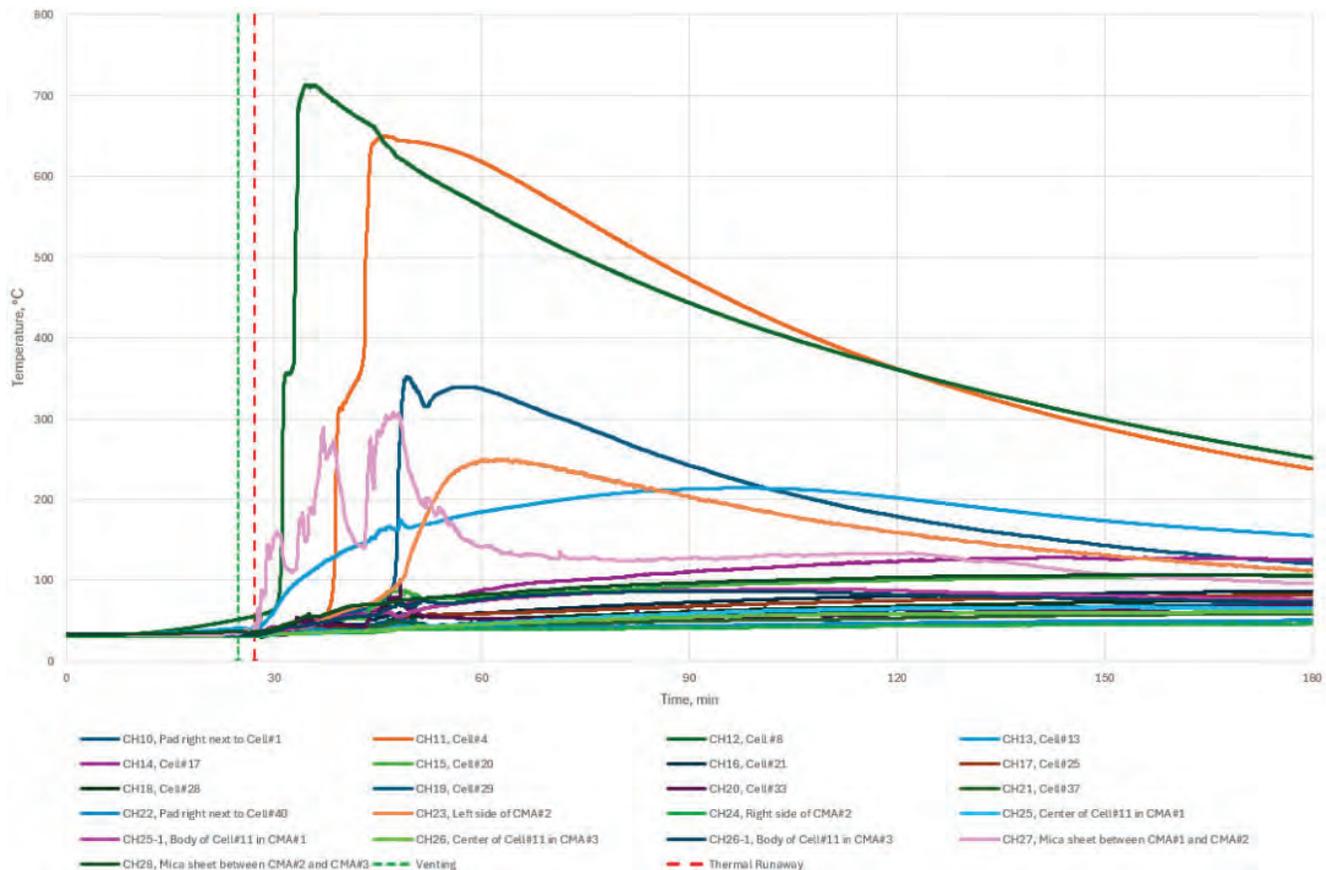


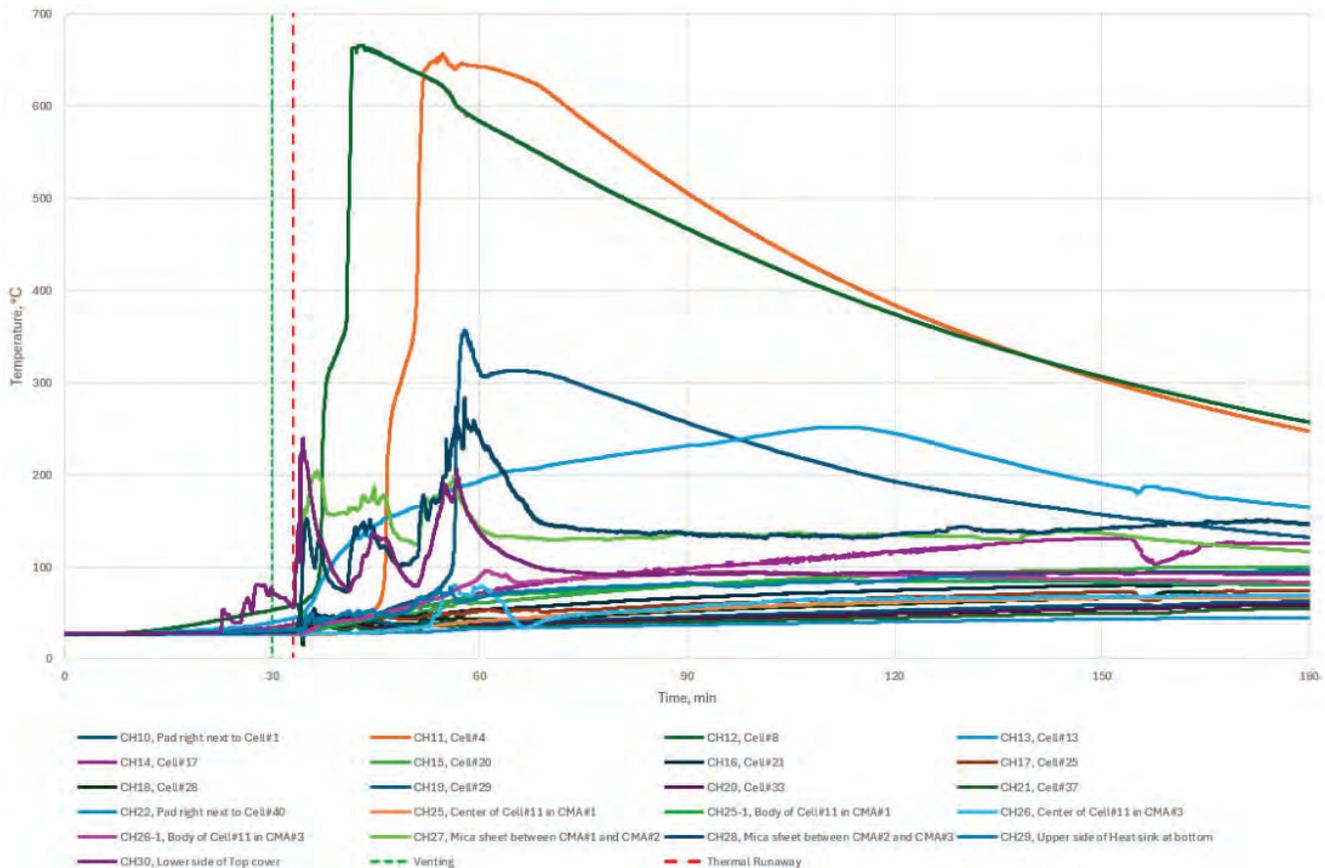
Figure 12: Schematic of the initiating (Event) and adjacent cells in a module.



**Figure 13: Cell involvement during module-level testing.**

### 2.2.2.2 Unit-Level Testing

In the unit-level test [5], one cell in an initiating module was driven to thermal runaway in a manner identical to that of the module-level test. According to the temperature profiles in the unit-level test report, four cells in total underwent thermal runaway during the test, including the initiating cell (Cell 11), which was in contact with the flexible film heater, Cell 8, Cell 4, and the end cell of CMA #2, Cell 1. This conclusion is consistent with that from the module-level report. The maximum surface temperature of the initiating cell is slightly higher than 800°C, while Cells 8, 4, and 1 experienced maximum surface temperatures of 670°C, 650°C, and 360°C, respectively (see Figure 14). In contrast, the maximum surface temperatures of the remainder cells in the unit are much lower than the thermal runaway threshold temperature. Furthermore, there was no module-to-module and unit-to-unit thermal runaway propagation, and no flaming occurred during the unit-level test.



**Figure 14: Cell involvement during unit-level testing.**

### 2.2.3 Battery Gas Release Rate Model

To support the design of an explosion prevention system by means of reduction in combustible concentration, the amount (rate of release into the enclosure over time) of combustible species (battery vent gas) must be estimated. A gas release rate model was developed using UL 9540A test data, including cell-, module-, and unit-level test reports, as the design basis.

The gas composition was obtained from the cell-level test. The composition measured was 59.3% hydrogen, 10.0% carbon monoxide, 22.4% carbon dioxide, and 8.3% total hydrocarbons. As previously noted, the density of the battery gas at NTP was calculated to be 0.728 g/L.

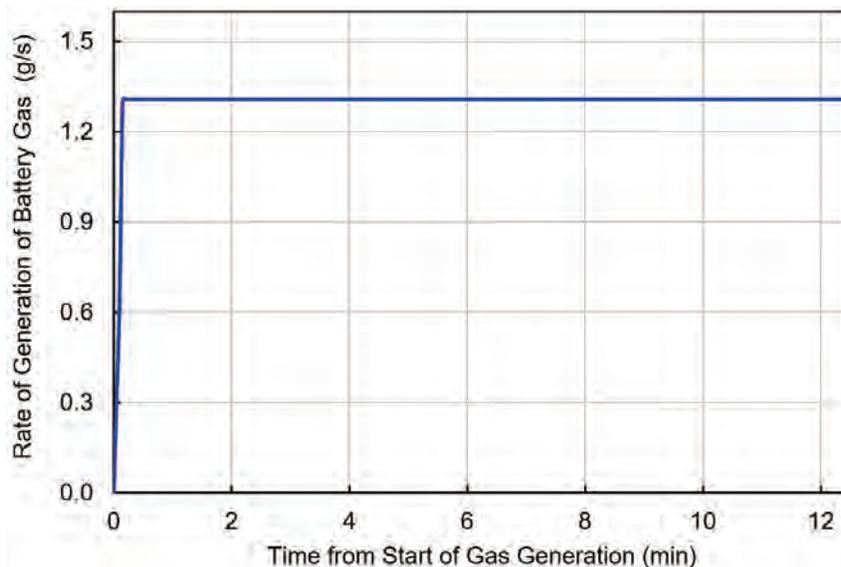
Through module-level testing, it was determined that cell-to-cell propagation occurred within an initiating module during a failure event. According to the temperature threshold for initiating thermal runaway, the process first propagated from the initiating cell (Cell 11) to Cell 8. From there, it spread to Cell 4 and then to Cell 1 before ceasing propagation within the module. Notably, there are two (2) cells separating the initiating Cell 11 from Cell 8, three cells between Cell 8 and Cell 4, and two (2) cells between Cell 4 and Cell 1. It can be inferred that the intermediate cells also experienced thermal runaway during this failure event. Additionally, the cell adjacent to the initiating cell, Cell 12, is also presumed to have undergone thermal runaway. However, thermal runaway did not extend to Cell 13 and beyond due to the aerogel pad installed between Cell 12 and Cell 13.

It is essential to note that each module comprises three (3) CMAs, with a total of 40 cells in each. To mitigate the risk of thermal runaway propagation, each CMA is equipped with three aerogel pads, and a Mica sheet is placed between each CMA for added safety. Consequently, it was concluded that a total of 12 cells experienced thermal runaway, leading to an estimated release of 979.4 g of gas from these cells. This estimation was derived from the total volume of battery gas presented in Table 8 on page 13 of the UL 9540A module-level test report [4].

According to the observation of thermal runaway in the unit-level test report by the operator and the associated temperature profiles in Figure 14, the shortest propagation time of thermal runaway between two cells was noted to be 180 seconds. This time frame was recorded from the initiating cell (Cell 11) to Cell 8, with Cells 10 and 9 positioned in between. As a result, a conservative average propagation time from one cell to another is estimated to be around 60 seconds.

For the gas source term scenario, the total time required for thermal runaway to affect all 12 cells in CMA #2 was determined to be 720 seconds. Based on reference [6], the gas release from each cell was assumed to occur over approximately 30 seconds (refer to Appendix A for details of the assumed release timing per cell). Therefore, the total duration for thermal runaway propagation and gas venting was estimated to be 750 seconds.

A constant average gas release rate was assumed over this period. This assumption is supported by the battery module's physical configuration—specifically, the presence of a plastic cover that temporarily confines gas released from individual cells before it disperses into the enclosure. This containment effect promotes a more uniform release into the interior space. Accordingly, the mass release rate was calculated to be 1.3 g/s over 750 seconds (12.5 minutes), as shown in Figure 15. This corresponds to a volumetric gas release rate of 107 L/min, as presented in Equation 2. This mass release rate was used in the CFD modeling to evaluate the effectiveness of the explosion prevention system.



**Figure 15: Model for Sequential Venting of 12 Cells within a Module**

$$\dot{V} = \frac{\dot{m}}{\rho_{bg}} = \frac{1.3 \text{ g/s}}{0.728 \text{ g/L}} = 1.79 \frac{\text{L}}{\text{s}} \cong 107 \text{ LPM} \quad (2)$$

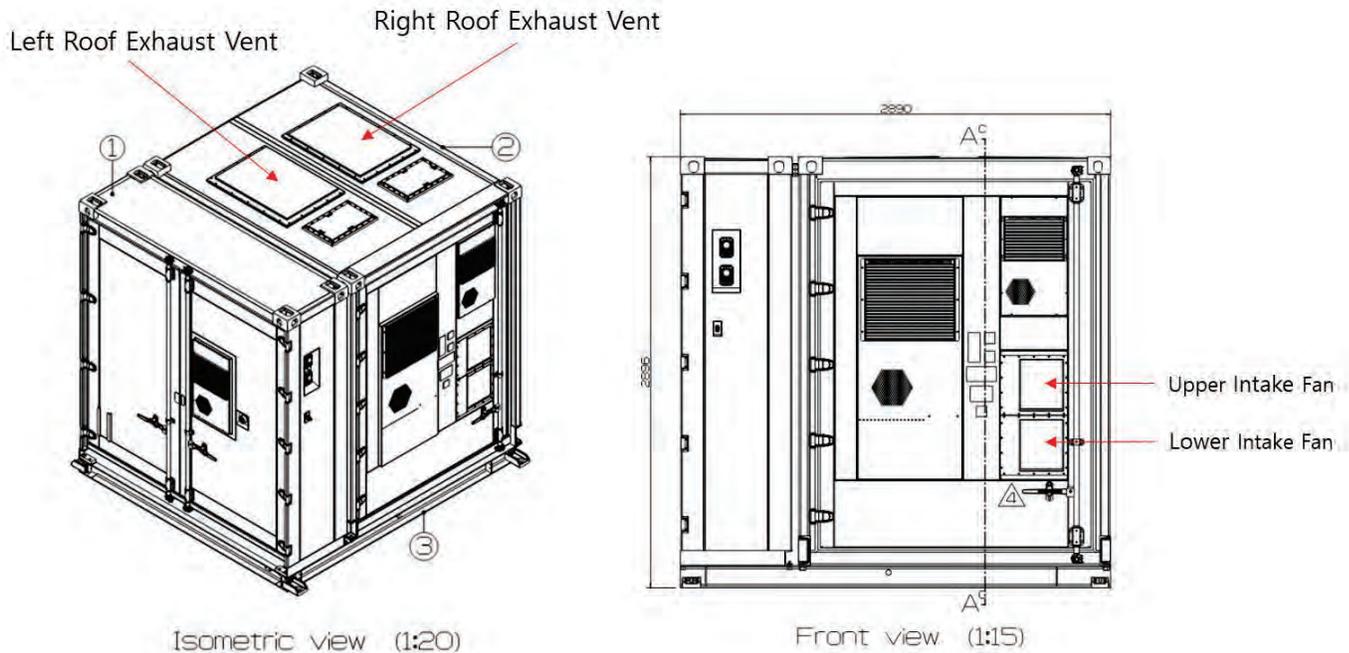
Where,  $\dot{V}$  is the battery gas volumetric release rate and  $\dot{m}$  is the battery gas mass release rate.

### 3.0 Hazard Mitigation Strategy

A hazard mitigation strategy was developed to address the explosion hazard, as defined in Section 2.2. The general approach was to design a system capable of maintaining the global concentration of flammable gas below 25% of the LFL of that gas (in air), in accordance with the performance criterion of NFPA 69 [2]. To this end, a system incorporating multiple forms of detection and automated activation of exhaust was designed. Upon detection of battery gas, the system will trigger the activation of mechanical exhaust for battery ventilation. Exhaust flow and placement requirements were determined via computational fluid dynamics (CFD) modeling; this methodology also permits flow visualization, ensuring the effective performance of the exhaust system. The explosion prevention system must also interact with the fire and communication systems and the control level, as detailed below.

#### 3.1 EXPLOSION PREVENTION SYSTEM

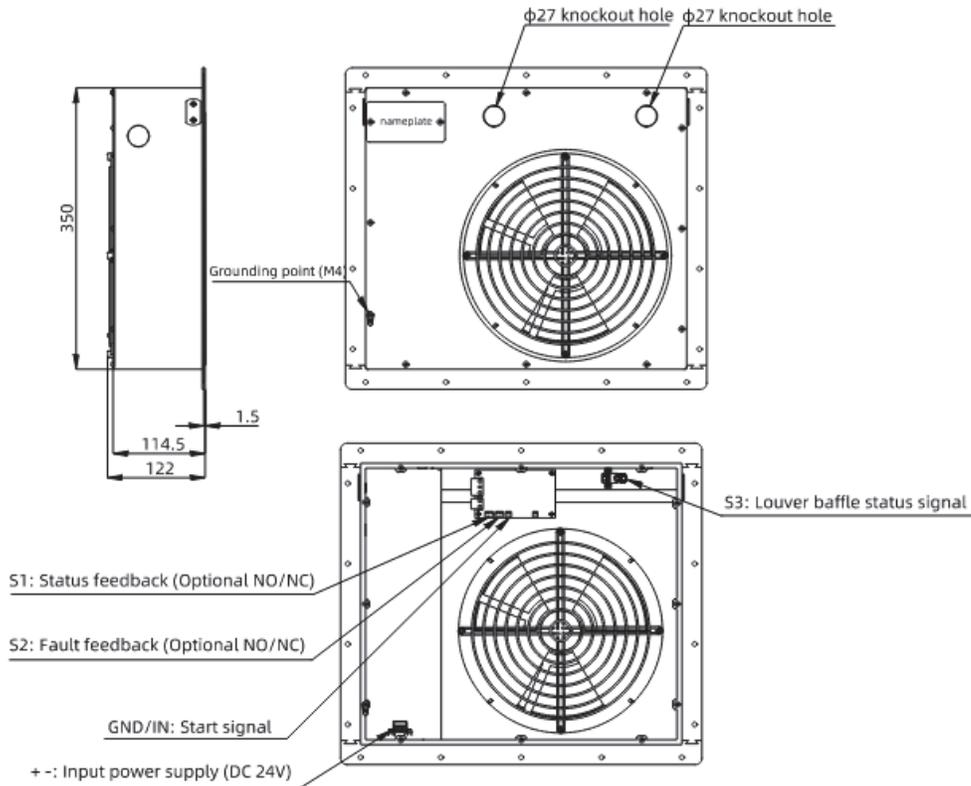
The BESS is outfitted with one (1) H<sub>2</sub> gas detector and one (1) smoke detector. The activation threshold for the H<sub>2</sub> detector and the smoke detector is 10% LEL and a light obscuration sensitivity of 1.5% per meter, respectively. Those detectors are installed at the ceiling level near the center. Two (2) roof exhaust vents were prescribed on the roof of the battery enclosure; two (2) intake fans were mounted on the front of the battery enclosure, as shown in Figure 16. The dimensions of the roof exhaust vents (right and left) are each 0.4384 m<sup>2</sup> and the intake fan openings (lower and upper) are each 0.037 m<sup>2</sup>. This results in a total exhaust area of 0.8768 m<sup>2</sup> and total make-up air area of 0.075 m<sup>2</sup>. The intake fans are modeled based on the performance curve, which is illustrated in Figure 18.



**Figure 16: Roof ventilation and intake fan locations.**

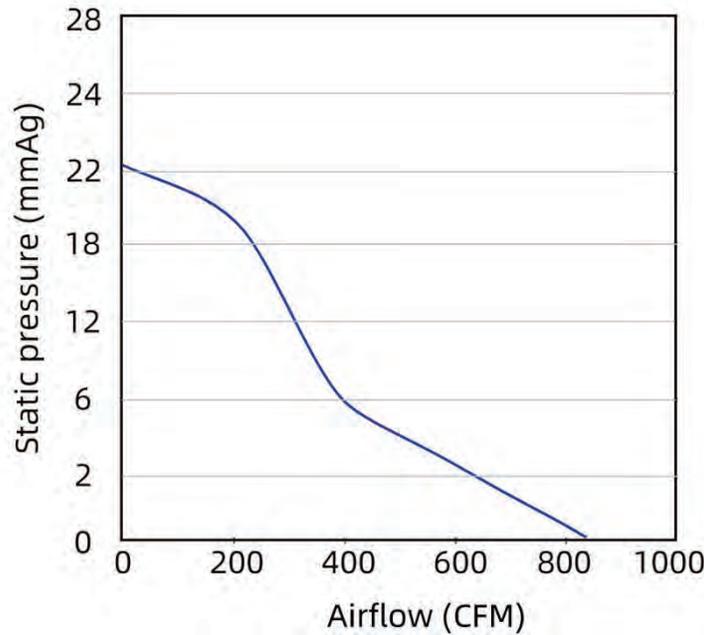
### 3.1.1 Intake Fan Performance

The intake fans in the BESS are Model EF17-850-00210, manufactured by Nanjing Heben M&E Equipment Technology Co., LTD [7]. The schematic of the intake fan is illustrated in Figure 17. The airflow rate of the fan was modeled according to the fan performance curve provided by the manufacturer [7], as well as assuming a fixed supply flowrate of 75 CFH per fan. When the fan performance curve was used in the simulations, to adopt a conservative approach, 85% of the fan airflow illustrated in Figure 18 was utilized.



Unit: mm

**Figure 17: Intake fan schematic.**

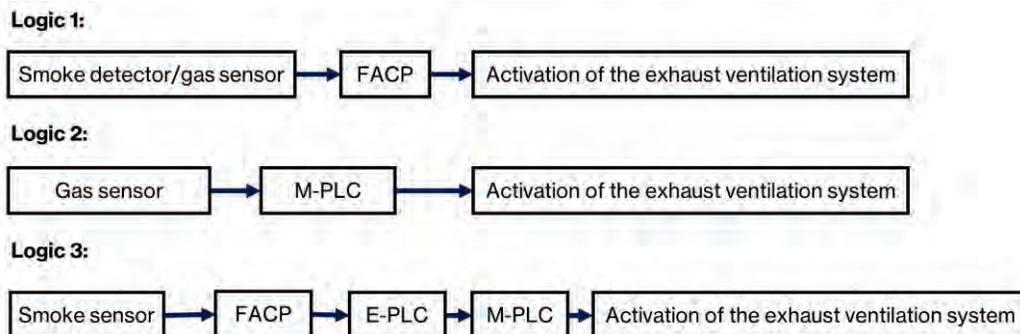


**Figure 18: Fan Performance Curve.**

### 3.2 SEQUENCE OF OPERATIONS

For the automated exhaust ventilation system, a sequence of operations detailing the fire alarm inputs and operations/actions is provided in the JF2 AC&DC LINK 5.1 Fire Safety Logic [8]. A high-level overview is provided here to describe the detection and actions associated with the explosion prevention system.

Three methods exist for activating the exhaust ventilation system. The first method involves the Fire Alarm Control Panel (FACP). The control logic is as follows: Upon detection of smoke or gas, the smoke or gas sensor sends a signal to the FACP, which activates the exhaust ventilation system. The second method involves the M-PLC. The control logic is as follows: Upon gas detection, the gas sensor sends a signal to the M-PLC, which activates the exhaust ventilation system. The third method involves FACP, E-PLC, M-PLC. The control logic is as follows; Upon smoke detection, the smoke sensor sends a signal in following sequence, FACP, E-PLC, M-PLC, which activate the exhaust ventilation system. These three methods are also illustrated in the Figure 19.

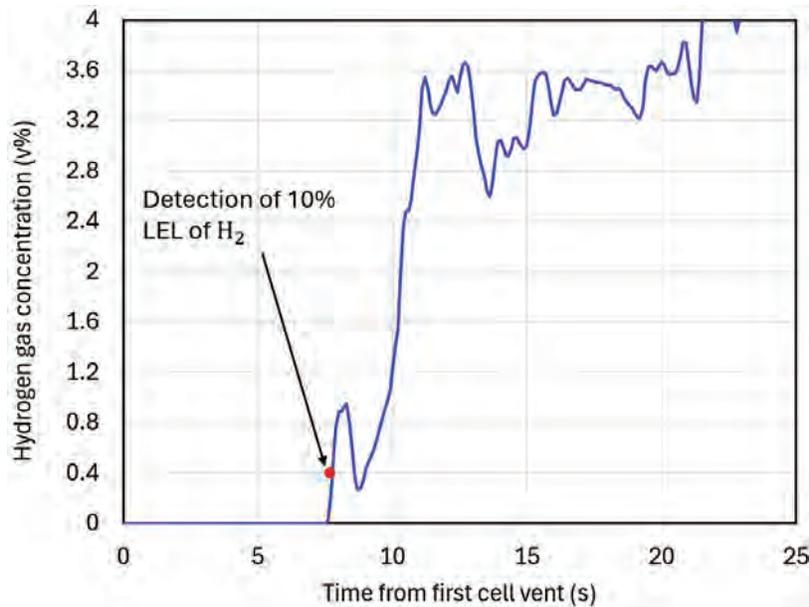


**Figure 19: Fire alarm inputs and operations.**

### 3.3 HAZARD SCENARIO

While the flammable gas hazard was defined in Section 2.2, the “worst-case” scenario was also defined, and the calculation approach tailored to this scenario. The reasonable worst case will occur when the time between the first venting of battery gas and the activation of the automated exhaust ventilation is the longest. In order to evaluate this scenario, a series of assumptions based on delays within the system with conservative assumptions were modeled and evaluated as follows:

Following cell venting, there will be a brief delay of approximately 7.4 seconds for the battery gas to reach the H<sub>2</sub> detector. This duration was determined through CFD simulation for the worst-case scenario, as depicted in Figure 20. The estimated detection time was increased by 20% to account for uncertainties in the CFD model. Additionally, the time delay required for all exhaust vents to open fully is 27 seconds, as provided by the Client. Finally, the exhaust system reaches full capacity after a 20-second linear ramp. This worst-case hazard scenario for which the explosion prevention system was designed is summarized in Table 2.



**Figure 20: Concentration Modeled at Time from First Cell Vent at the H<sub>2</sub> Gas Sensor.**

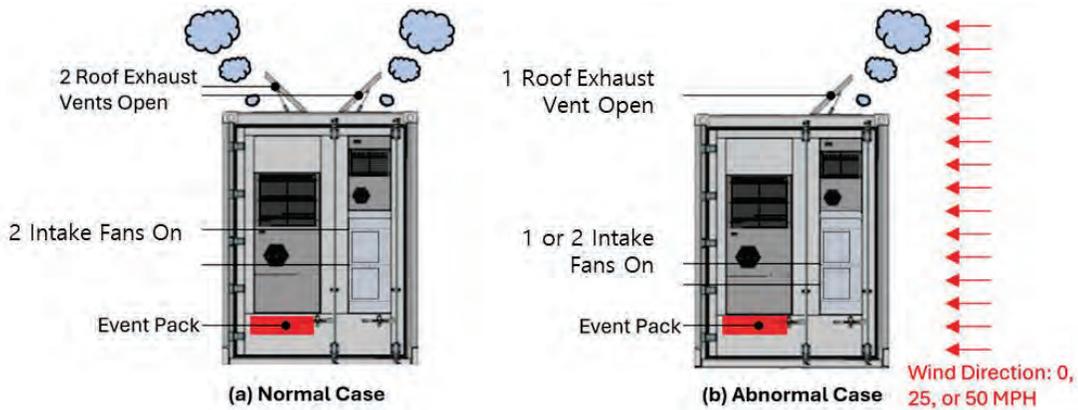
**Table 2: Event timeline for hazard scenario.**

<i>Time (s)</i>	<i>Event</i>
0	Initiating event – cell vent gas released from a module.
7.4	Gas is present at the H <sub>2</sub> detector.
8.9	Gas detection time increased by 20% to account for uncertainties in the CFD model.
35.9	The time delay required for all exhaust vents to open fully is 27 seconds.
55.9	The intake fans reach full capacity after a 20-second linear ramp.

This report evaluates two categories of scenarios related to the operation of the explosion prevention system: normal and abnormal operating conditions. Under normal operating conditions, the system is assumed to activate two roof exhaust vents and operate both intake fans as designed. In contrast, the abnormal scenarios assess degraded system performance, specifically, cases where one intake fan and/or one roof exhaust vent are non-operational.

Figure 21, Table 3, and the Items below outline the six (6) test cases that were evaluated in this analysis. The modeling approach used in each simulated case is identified in Table 3 and described in detail in Section 3.4.

- **Case 1:** Normal operation with both intake fans and roof exhaust vents active.
- **Case 2:** Normal operation under 50 mph wind conditions.
- **Case 3:** Abnormal condition with only the bottom intake fan and right roof exhaust vent operational.
- **Case 4:** Same as Case 3, but with 50 mph wind conditions.
- **Case 5:** Abnormal condition with only the right exhaust vent operational and a fixed supply fan flow rate.
- **Case 6:** Same as Case 5, but under 50 mph wind conditions.



**Figure 21: Explosion prevention system evaluating both (a) Normal and (b) Abnormal conditions.**

**Table 3: Cases considered for testing.**

Case	Intake Fan On	Roof Exhaust Vent	Wind (mph)	Gas Release	Fan Flow Rate	Modelling Approach
1	Lower & upper	Right & left	0	Yes	P-Q Fan curve	1
2	Lower & upper	Right & left	50	Yes	P-Q Fan curve	1
3	Lower	Right	0	Yes	P-Q Fan curve	1
4	Lower	Right	50	Yes	P-Q Fan curve	1

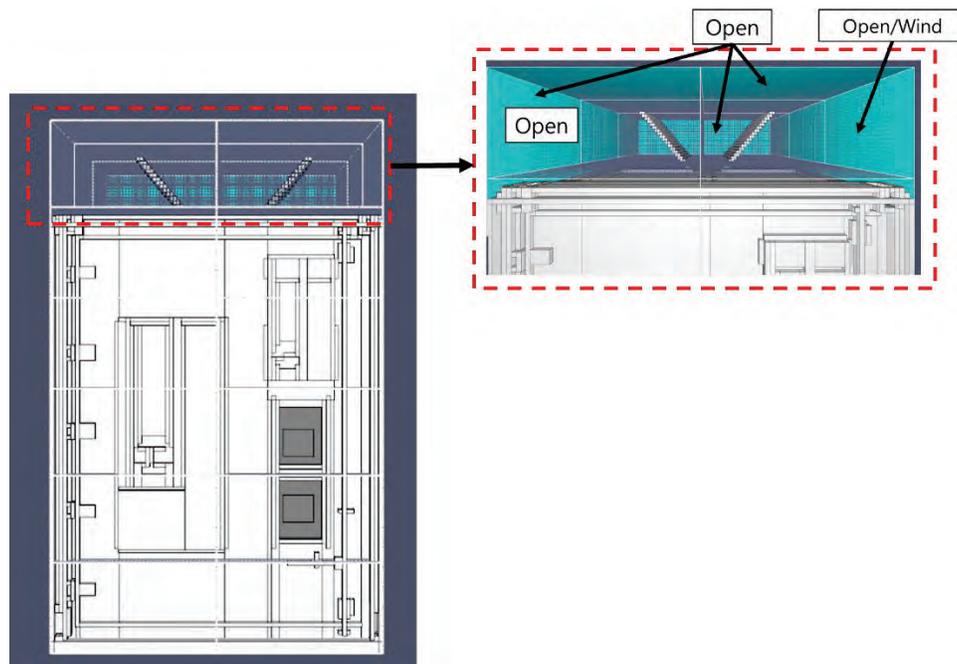
5	Lower & upper	Right	0	Yes	Lower Fan: $44.2 \frac{ft^3}{min}$	2
					Upper Fan: $44.2 \frac{ft^3}{min}$	
6	Lower & upper	Right	50	Yes	Total: $44.2 \frac{ft^3}{min}$	2

### 3.4 CALCULATION APPROACH

The calculation approach adopted in the present analysis was to utilize CFD modeling, and the CFD tool employed was the Fire Dynamics Simulator (FDS). FDS was developed by NIST and primarily used to study fire and dispersion of smoke and gas [9]. FDS version 6.9.1 was used to perform simulations for the current study. The model geometry was established by importing the 3D CAD file provided to Jensen Hughes by LGES using Pyrosim simulation software, a graphical user interface (GUI) front-end to FDS produced by Thunderhead Engineering. Small fixtures (those having dimensions less than 1 cm) were neglected, and cylindrical structures were converted to cubic blocks (FDS is a cartesian-mesh-based flow solver).

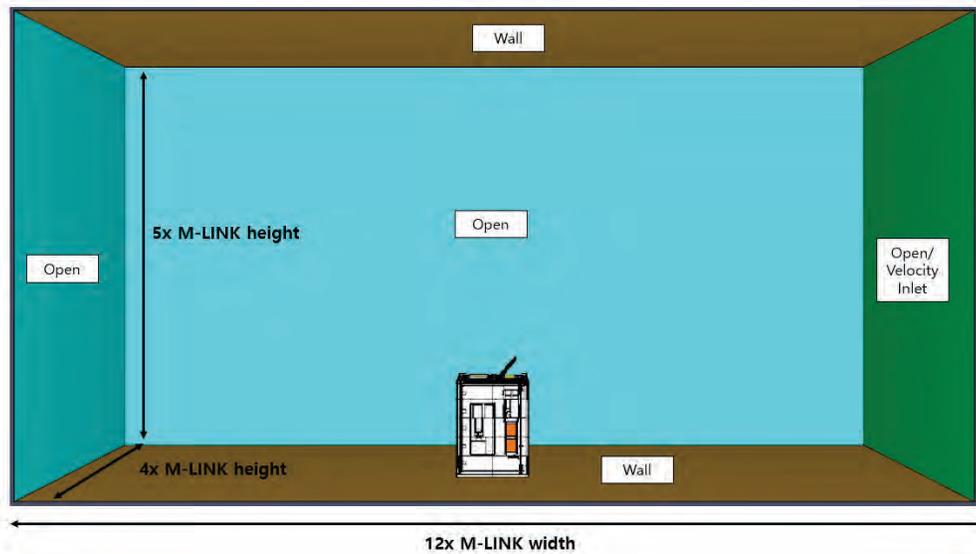
As requested by the client, two modeling approaches were employed in FDS for this analysis: **Approach 1 – “Specified Wind Speed and Direction”** and **Approach 2 – “Wall of Wind”**. The use of both approaches was intended to evaluate whether the simulation results are sensitive to the chosen modeling method and to ensure the robustness of the findings.

In Approach 1, the computational domain boundaries were positioned near the BESS enclosure, as illustrated in in Figure 22. Pressure-outlet boundary conditions with a static pressure of zero were applied at the domain edges to represent ‘open’ boundary conditions. For wind scenarios, the wind velocity magnitude and profile were specified, ensuring that the maximum wind speed was reached near the top of the BESS enclosure, with the wind direction set to enter from the right boundary, following a conservative approach. For further details of this modeling approach, refer to section 16.1 (page 215) of the FDS User Guide [9])



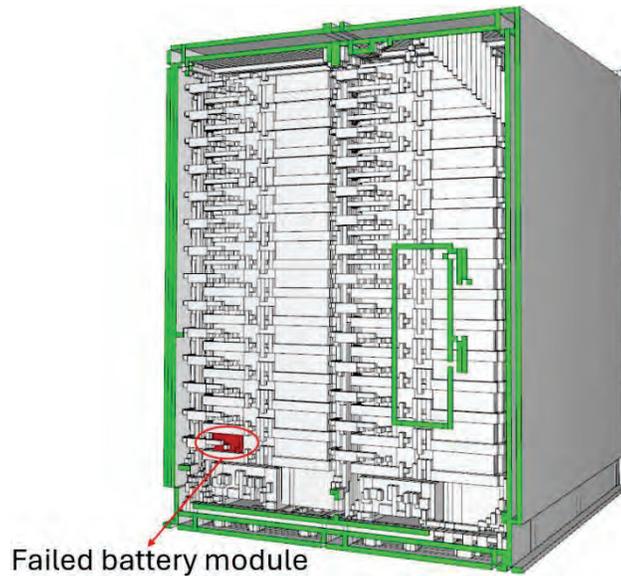
**Figure 22: Modeling Approach 1: Specified Wind Speed and Direction.**

In approach 2, the computational domain boundaries were positioned farther away from the BESS enclosure, as illustrated in Figure 23. Wall boundary conditions were applied at the top and bottom of the domain, while pressure-outlet boundary conditions with a static pressure of zero were assigned to the remaining boundaries to represent open conditions. This setup also allows these boundaries to be treated as symmetric when appropriate. For wind scenarios under this approach, the right boundary was defined as a velocity inlet using a power-law wind profile, ensuring that the desired wind speed was achieved near the top of the BESS enclosure. For further details of this modeling approach, refer to section 16.4 (page 217) of the FDS User Guide [9])



**Figure 23: Modeling Approach 2: the Wall of Wind.**

The mesh resolution covering the BESS enclosure was determined through a grid sensitivity study, which established that a resolution of 2.54 cm was suitably converged for the analysis. All geometrical elements of size less than 2.54 cm were thickened to fit this mesh. Details of the BESS geometry are shown in Figure 24. Additional details on the CFD modeling approach and parameters for each simulation scenario are provided in Appendix B.



**Figure 24: The location of the failed battery module.**

The hydrogen detector was positioned at the center, two inches below the ceiling. Two (2) natural roof exhaust doors and two (2) door intake fans were mounted on the roof and front wall of the battery enclosure, respectively, as shown in Figure 16. Roof exhaust doors were modeled for having a 27-second delay to open fully (provided by the Client). On the other hand, the intake fans were modeled as a 20-second ramp from zero to the target flow rate. Their exhaust capabilities were tested to evaluate the effectiveness of the explosion prevention system.

Battery gas was released from the front left of a module in a rack positioned on the left of the battery compartment, as shown in Figure 24. If the initiating rack were located near the intake fans, then more mixing would occur, resulting in lower local concentrations of battery gas. If the initiating rack were near the exhaust outlets, then the fan would preferentially exhaust battery gas instead of a mixture of battery gas and air, resulting in a lower global concentration of battery gas. The location selected between the intake fans and exhaust is a compromise between these two extremes, to create a conservative analysis where both the resulting global concentration and local concentrations will be high.

## 4.0 Analysis and Results

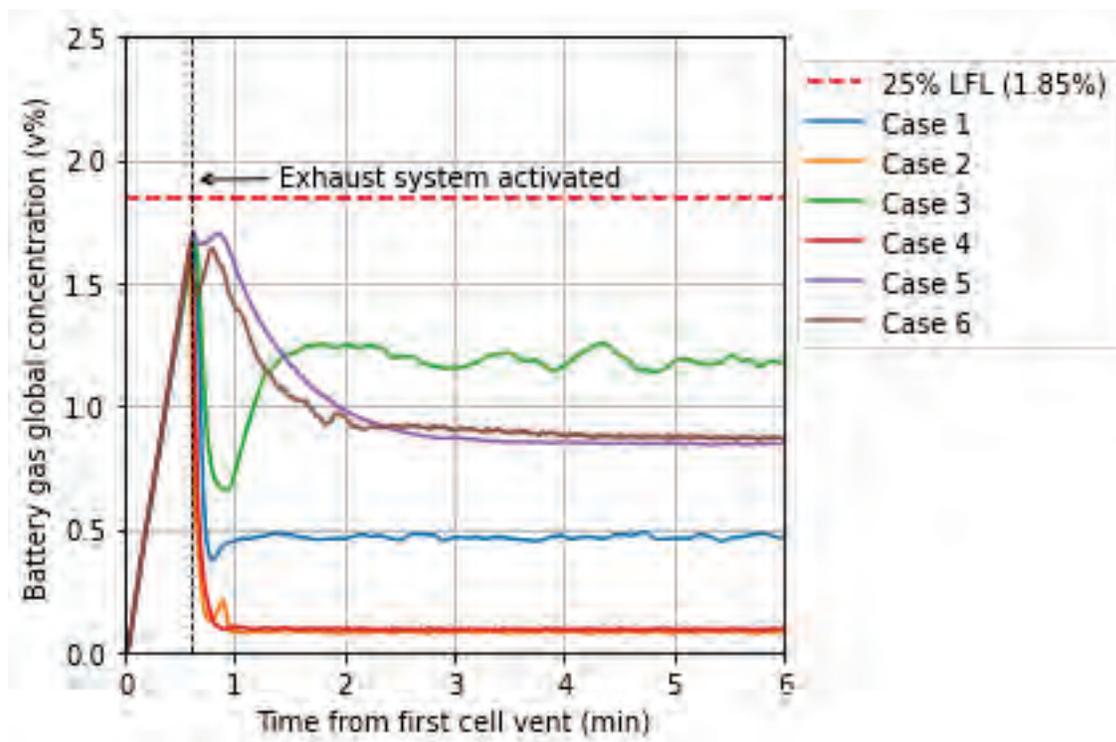
### 4.1 GLOBAL CONCENTRATION OF GAS IN THE ENCLOSURE

Figure 25 shows the temporal evolutions of the global battery gas concentration in the enclosure with different operational conditions simulated. In all cases, the global concentration of the vented battery gas in the enclosure remained below the performance standard of 25% of the LFL of the gas for the entire duration of the vented battery gas release. The performance standard mandated by NFPA 69, which is at 25% of the LFL, is equal to 1.85%. Table 4 outlines the peak global and steady state average gas concentration predicted for the cases simulated with battery gas release.

**Table 4: Peak and average steady-state concentrations for cases with battery gas release.**

Case	Peak Global Concentration (%)	Average Steady State Concentration (%)
1	1.64	0.47
2	1.66	0.08
3	1.67	1.18
4	1.67	0.09
5	1.71	0.84
6	1.67	0.87

In summary, the results indicate that the explosion prevention system, under both normal and abnormal operating conditions simulated in this analysis, effectively mitigates explosion hazards for the scenarios considered. The system's performance aligns with the criteria outlined in NFPA 69. Time-series plots of airflow through the roof exhaust vents for all cases simulated are presented in Appendix C.



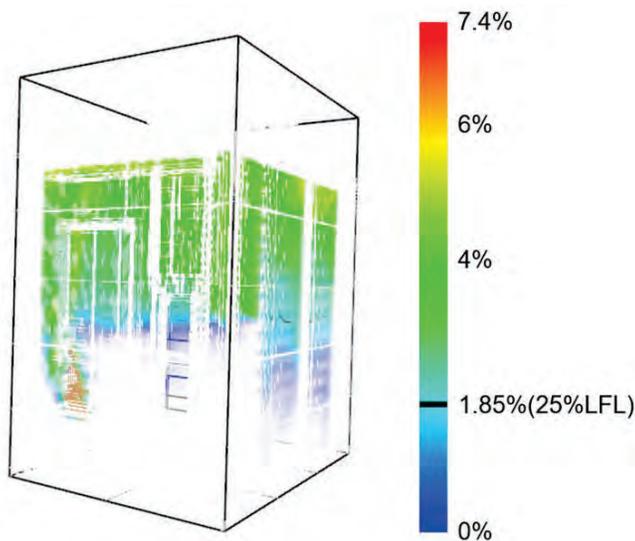
**Figure 25: Global gas concentrations within the BESS for the hazard scenarios considered.**

## 4.2 LOCAL CONCENTRATIONS OF GAS AT SELECT LOCATIONS AND TIMES

This section illustrates local battery gas concentrations with the explosion prevention system for Case 3 (abnormal condition with only the bottom intake fan and right roof exhaust vent operational) by 3D volume rendering over the FDS computational domain at selected times.

### 4.2.1 Gas Concentration Before Activation of the Exhaust (t = 35.9 s)

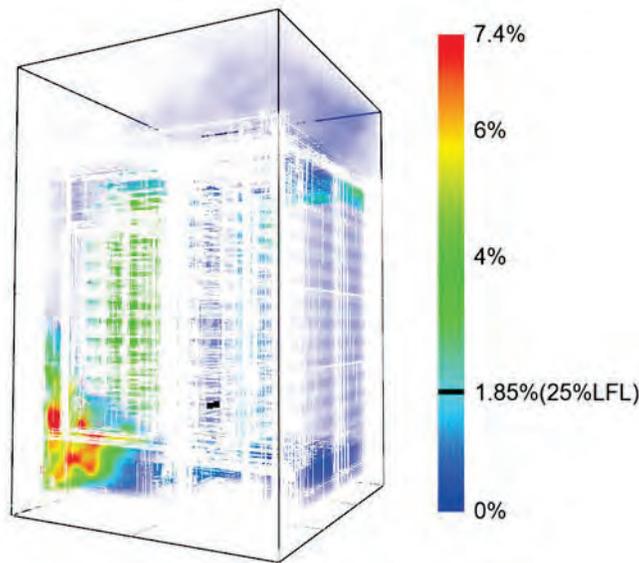
Figure 26 shows the dispersion of battery gas at 35.9 seconds from the start of gas release. By this time, the emitted gas had spread to the upper region of the enclosure. High-concentration regions were localized directly in front of and above the initiating module. At those regions of the enclosure, gas concentrations reached as high as 50% of the LFL. However, the global average gas concentration was lower than the NFPA 69 threshold of 25% of the LFL (see Figure 25).



**Figure 26: Battery gas concentration at 35.9 s (before activation of the exhaust).**

### 4.2.2 Gas Concentrations After One (1) Minute of Exhaust (t = 95.9 s)

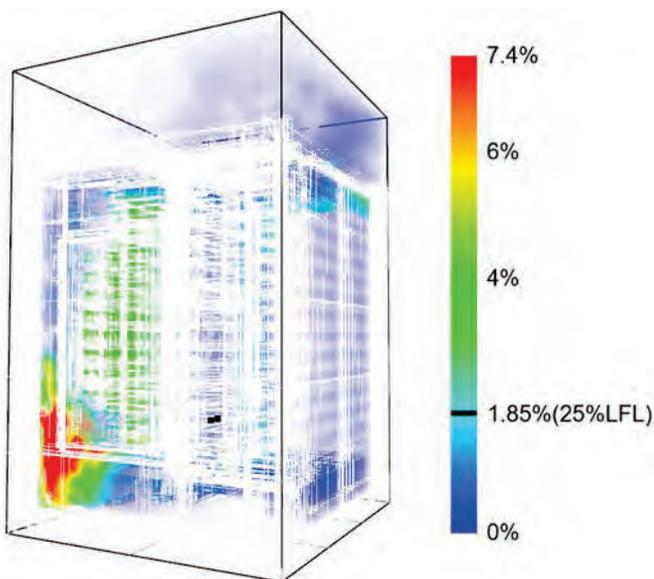
The distribution of battery gas one minute after activation of the exhaust is presented in Figure 27. By this time, high-concentration regions in the upper level of the BESS enclosure had been reduced in size. However, localized pockets of elevated concentration remain in the vicinity of and above the emission source. This is expected due to the proximity to the release point and the buoyant movement of gas toward the exhaust vent.



**Figure 27: Battery gas concentration after 95.9 s (after one (1) minute of exhaust running).**

**4.2.3 Gas Concentrations After Five (5) Minutes of Exhaust Running (t = 335.9 s)**

Figure 28 illustrates the dispersion of battery gas five minutes after the exhaust system was activated. As expected, elevated concentration regions persist near and above the initiating rack, primarily due to the continuous influence of the release source and buoyant gas movement. The overall dispersion pattern is consistent with that observed in Figure 27 and would persist throughout the remainder of the simulation period.



**Figure 28: Battery gas concentration after 335.9 s (after five (5) minutes of exhaust running).**

## 5.0 Significant Assumptions and Limitations

The BESS enclosure automated exhaust ventilation system evaluation during normal and abnormal operating conditions, which is intended as an explosion prevention system, is based on the assumptions listed below. If these assumptions change, additional analysis will need to be performed.

- + The failure of a single cell leading to thermal runaway propagation is based on the UL 9540A test reports.
- + The BESS container does not have battery gas suppression systems installed.
- + The hydrogen gas sensor activates at a threshold of 10% of the LFL, and the chosen smoke detector is required to have a 1.5% obscuration within its range (and be set to that value if selectable).
- + The HVAC system is assumed to be shut off after gas detection. The analysis does not consider the accumulation of vented battery gas inside the HVAC system, resulting in a potential explosion.
- + No fire or explosion is assumed in this analysis. Also, the analysis does not consider a flaming off-gas thermal runaway event.
- + The battery release rate in the event of a module failure is based on UL 9540A test data.

The BESS enclosure automated exhaust ventilation system, including its activation and monitoring systems based on the proposed hydrogen gas detection and smoke detection, should be tested to verify that the system performs within these assumptions to ensure satisfactory performance of the explosion prevention system. Any deviation from the above assumptions or to the design outlined in this report should be discussed with the explosion prevention evaluation team to verify that any modifications do not impair the performance of the explosion prevention system.

In addition, the following limitations may apply to this proposed ventilation system strategy for the studied failure event:

- + The ventilation system does not prevent local gas concentrations from exceeding the LFL directly near the issuing battery gases or where gases can accumulate. Local spots in the container may have concentrations above the LFL. It is important to note that NFPA 69 states that the global average concentration should remain below 25% of the LFL.
- + Prior to activation of the automated exhaust ventilation system within the BESS enclosure, localized gas concentrations exceeded the Lower Flammability Limit (LFL) at the ceiling level and near the battery gas release point across all evaluated scenarios.

## 6.0 Conclusions

An explosion hazard mitigation strategy is needed to support a M-LINK installation, satisfying the requirements of NFPA 855. To this end, an explosion prevention solution was evaluated to determine if it met the performance requirements of NFPA 69.

The explosion hazard was identified as being the release of flammable gases into the M-LINK as a result of cell failure and gas venting. A gas release model was developed, based on the UL 9540A test data, to define the flammable gas hazard on the basis of rate of release and composition. The hazard scenario assumed a 35.9-second delay between the initial venting of the starting cell and the activation of the automated ventilation system during normal and abnormal operating conditions. In normal operating conditions, the fan achieves its full capacity at 55.9 seconds (20 seconds after the automated ventilation system). In abnormal operation, one intake fan and/or a roof exhaust vent were non-operational. These scenarios represent bounding cases, in which only the H<sub>2</sub> gas sensor was used in the model.

The hazard scenario was simulated in FDS under six different conditions for the exhaust ventilation system, as outlined in Table 3. These conditions included both normal and abnormal scenarios. The results indicated that, under normal and abnormal operational circumstances simulated in this study, the overall concentrations of battery gas would not exceed the performance criterion of 25% of the Lower Flammability Limit (LFL), which is 1.85%. In conclusion, the explosion prevention system has demonstrated its effectiveness in mitigating explosion hazards. The M-LINK exhaust system meets the performance requirements specified in NFPA 69.

## 7.0 References

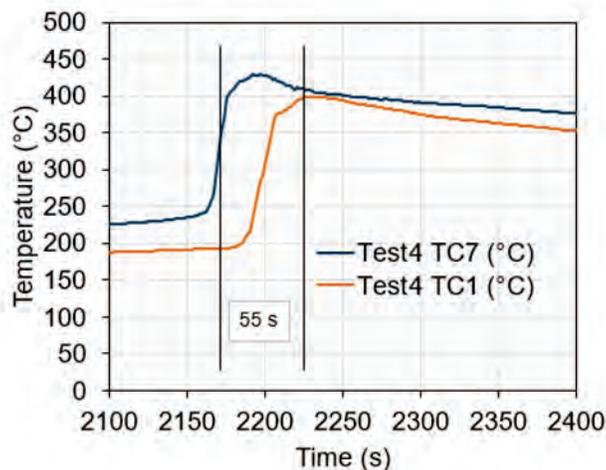
- [1] NFPA, NFPA 855 Standard for the Installation of Stationary Energy Storage Systems, National Fire Protection Association, 2023.
- [2] NFPA, "NFPA 69 Standard on Explosion Prevention Systems," National Fire Protection Association, Quincy, MA, USA, 2024.
- [3] M. Berumen, L. Lee and N. Voss, "UL 9540A: 2019 (Fourth Edition) Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems – Cell Level Test Report – Model JF2," UL Solutions, Northbrook, 2024.
- [4] L. Ali and D. Kim, "UL 9540A: 2019 (Fourth Edition) Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems – Module Level Test Report – Model EP096636PFB1," UL Solutions, Guangzhou, Guangdong, China, 2024.
- [5] L. Ali and D. Kim, "UL 9540A: 2019 (Fourth Edition) Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems – Unit Level Test Report – Model NR27N414L\_P15190NB3," UL Solutions, Guangzhou, Guangdong, China, 2024.
- [6] D. Sturk, L. Rosell, P. Blomqvist and A. A. Tidblad, "Analysis of Li-Ion Battery Gases Vented in an Inert Atmosphere Thermal Test Chamber," *Batteries*, vol. 5, no. 3, p. 61, 2019.
- [7] Nanjing Heben M&E Equipment Technology CO., Ltd, "Exhaust Fan EF17-850-00210".
- [8] LG Energy Solution, "20240612\_JF2-LINK Fire Safety Logic(with Cause&Effect Chart)\_rev.1.0.0-모형".
- [9] K. McGrattan, S. Hostikka, J. Floyd, R. Mcdermott and M. Vanella, Fire Dynamics Simulator User's Guide, National Institute of Standards and Technology, 2019.
- [10] A. W. Golubkov, D. Fuchs, J. Wagner, H. Wilsche, C. Stangl, G. Fauler, G. Voitic, A. Thaler and V. Hacker, "Thermal-runaway experiments on consumer Li-ion batteries with metal-oxide and olivin-type cathodes," *RSC Adv*, 2014.

## 8.0 Appendix A: Supporting Data for Assumed Gas Release Timing per Cell

A gas release duration of 30 seconds per cell was assumed based on reference [6]. Although this value was measured for a different cell type (an NMC battery cell), it remains a reasonable and conservative estimate when compared with the results from the UL 9540A cell-level testing report [3]. Figure 27 presents data from the fourth (4<sup>th</sup>) ambient air UL 9540A cell-level test, where the duration of thermal runaway—corresponding to the period of flammable gas release—was estimated to be 55 seconds. This estimate was derived from an analysis of the cell temperature data, as follows:

- Thermal runaway initiation was identified by the sharp temperature increase in TC7, the heater control thermocouple.
- The end of the thermal runaway was marked by the peak temperature recorded by TC1, located at the edge of the cell near the positive terminal.

The 55-second duration from Test #4 represents the shortest thermal runaway period among the four ambient cell tests, thereby supporting the use of a 30-second duration as a conservative assumption for modeling purposes.



**Figure 29: Selected Temperature Measurements for UL 9540A Cell Test #4.**

It is noteworthy that during UL 9540A cell-level tests, the cells are typically heated using a film resistance heater to initiate thermal runaway. As the temperature increases, chemical reactions within the cell begin to occur, producing flammable gases. At temperatures around 130°C and above, the electrolyte begins to vaporize and decompose, leading to a build-up of internal pressure. This pressure is then relieved through the activation of the cell's safety vent device. This initial gas release event, known as "cell venting," typically involves a relatively small volume of gas and occurs prior to thermal runaway. The onset of thermal runaway generally occurs at higher temperatures, where more energetic exothermic reactions take place, resulting in the release of significantly greater quantities of heat and gas. This behavior is illustrated in Figure 30, where the major gas release associated with thermal runaway is clearly distinguishable from the initial venting event.

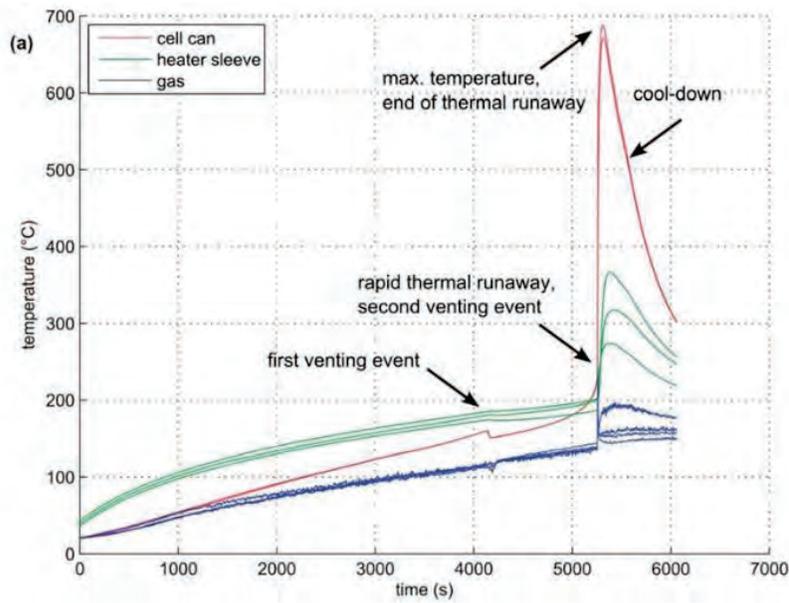


Figure 30: Temperature versus time for stages pre and post thermal runaway [10].

## 9.0 Appendix B: Additional CFD (FDS) Modeling Parameters

**Table 5: Additional CFD Modeling Parameters**

<i>CFD Parameter</i>	<i>Case 1</i>	<i>Case 2</i>	<i>Case 3</i>	<i>Case 4</i>
Maximum allowable pressure iterations per time step	50	50	50	50
Actual maximum pressure iterations per time step	8	50	4	50
Maximum time step (s)	0.04	0.0089	0.04	0.014
Minimum time step (s)	0.00098	0.00024	0.00136	0.00034
Average time step (s)	0.0021	0.00055	0.0022	0.0006
Mesh type	3D Cartesian	3D Cartesian	3D Cartesian	3D Cartesian
Total Number of Grid Cells	1'156,680	1'156,680	1'156,680	1'156,680
Maximum Cell Aspect Ratio	1.0	1.0	1.0	1.0

<i>CFD Parameter</i>	<i>Case 5</i>	<i>Case 6</i>
Maximum allowable pressure iterations per time step	50	50
Actual maximum pressure iterations per time step	5	50
Maximum time step (s)	0.04	0.04
Minimum time step (s)	0.0034	0.00025
Average time step (s)	0.014	0.00064
Mesh type	3D Cartesian	3D Cartesian
Total Number of Grid Cells	1'912,090	1'912,090
Maximum Cell Aspect Ratio	1.0	1.0

### 10.0 Appendix C: Analysis of Airflows through the Roof Exhaust Vents

Figure 31 through **Error! Reference source not found.** shows the airflow through the roof exhaust vents for each simulated case. Positive values represent flow exiting the BESS enclosure (upward direction), while negative values indicate flow entering the enclosure (downward direction).

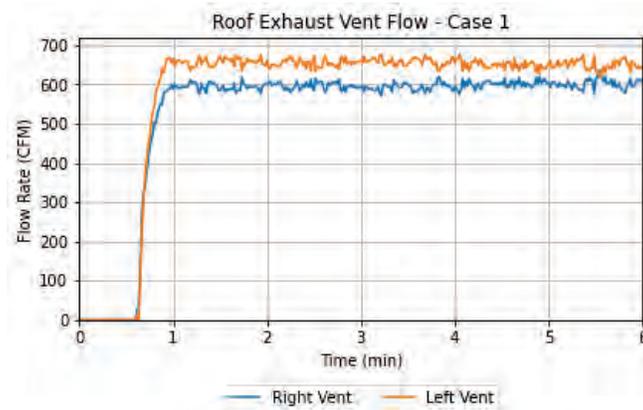


Figure 31: Predicted Roof Exhaust Vent Flows for Case 1

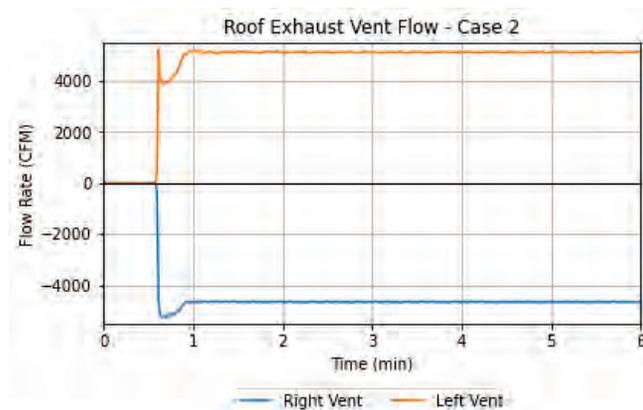


Figure 32: Predicted Roof Exhaust Vent Flows for Case 2

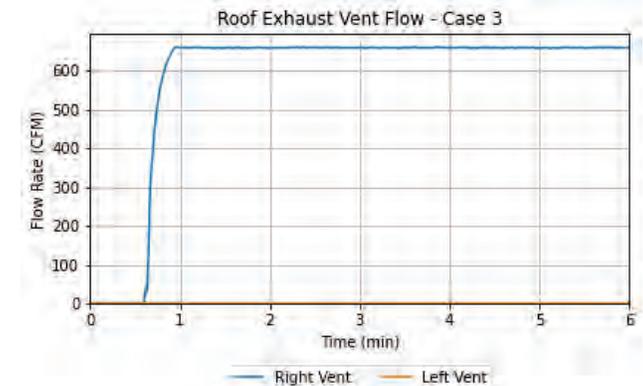


Figure 33: Predicted Roof Exhaust Vent Flows for Case 3

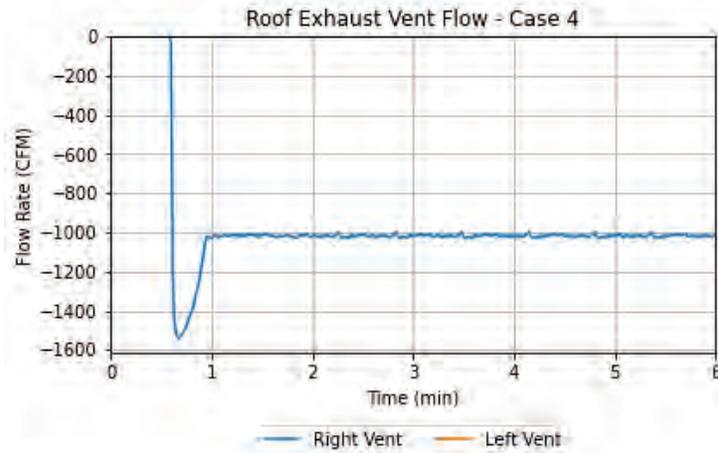


Figure 34: Predicted Roof Exhaust Vent Flows for Case 4

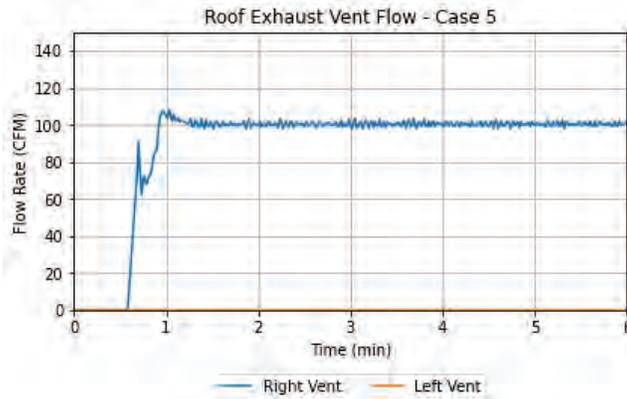


Figure 35: Predicted Roof Exhaust Vent Flows for Case 5

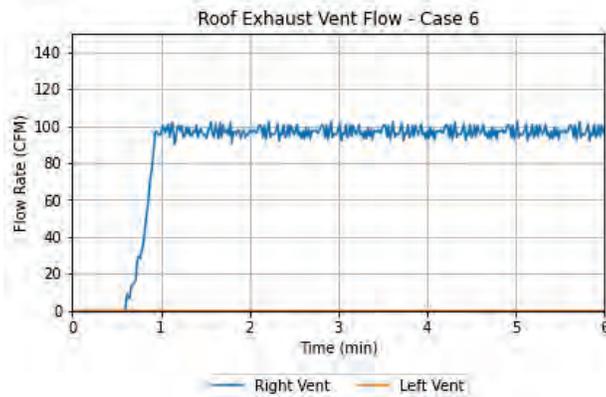


Figure 36: Predicted Roof Exhaust Vent Flows for Case 6

## **APPENDIX 3.9-E: COMMUNICATION BETWEEN APPLICANT AND DIXON FIRE PROTECTION DISTRICT**

**From:** [Ahn, Stephen](#)  
**To:** [Randy Shafer](#); [John Malone](#); [Fire Marshal](#)  
**Cc:** [agreenberg@risksci.com](mailto:agreenberg@risksci.com); [Adams, Josh](#); [Benson, Michael p](#); [adrian.elizondo](#); [Abughali, Ziad](#); [Morley, Ricardo](#); [Syed, Qaim](#); [Omercajic, Nadan](#); [Urry, Doug](#); [Harrison, Joe](#)  
**Subject:** Corby - Update on Technology Change  
**Date:** Wednesday, January 21, 2026 12:16:06 PM

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**CAUTION:** This email originated from an external sender. Verify the source before opening links or attachments.

Dear Chief Shafer and Chief Malone,

I am following up on our earlier discussions regarding the proposed conditions of certification (COCs) for the Corby project related to fire / worker safety to inform you that the project will be switching battery vendors from CATL to LG in order to address supply chain and procurement uncertainties. We have been coordinating with CEC staff to update the CEC application to reflect this change and to utilize technology manufactured in the United States.

At your request, we would be happy to provide you a copy with the supplemental information to be submitted to CEC, which will also be available on the docket. In summary, with this change in battery vendors, the core chemistry (i.e., LFP), safety and thermal stability characteristics, and compliance standards remain the same. LG also incorporates a combination of liquid and air thermal management systems, as well as deflagration panels, in addition to the active ventilation system, to provide redundant layers of protection. The change in technology will also require a larger turning radius for delivery.

The change in battery vendors will not require a change to any of the proposed COCs that we previously discussed and agreed upon, but we wanted to keep you updated in parallel with the submission of the supplemental information to the CEC.

Please do not hesitate to let me know if you have any questions.

**Stephen Ahn** | *Project Director*

**NextEra** Energy Resources

Mobile: [REDACTED]



## **APPENDIX 3.13-A: SOUND STUDY**

January 30, 2026

Qaim Syed  
Senior Project Manager - Development

Subject: Sound Study Update for the Technology Change to Corby Energy Storage

Burns & McDonnell conducted a sound assessment study for Corby Energy Storage, LLC proposed Corby battery energy storage system (BESS) project (Project) in October 2024. The Project is a planned 300-megawatt BESS with a substation located in Solano County, California. Project sound sources include inverters; battery containers equipped with heating, ventilation, and air conditioning (HVAC) equipment; and transformers. The BESS technology vendor proposed for this Project has been changed from CATL to LG. As a result of this change, the sound model was updated to demonstrate continued compliance with the Solano County nighttime sound level limit of 50 dBA  $L_{eq}$ .

### Original Sound Study (October 2024)

The original design of the Project included 544 CATL Ener C+ Battery Containers and 136 Power Electronics GEN3 inverters. Project sound sources were modeled according to the locations provided in the general arrangement drawing provided as Figure A-1 of Attachment A.

Sound levels for each piece of equipment were provided by the manufacturer. Power Electronics provided a noise test, dated October 2021, for the GEN3 inverter with a maximum measured sound pressure level of 73 dBA at 8 meters. CATL provided a noise test of the Ener C+ battery container with a maximum measured sound pressure level of 82 dBA at 1 meter. Specified sound levels were provided by the manufacturers for each substation transformer. Table 1 provides the source sound level for each piece of modeled equipment. Sound level spectrums were provided by the vendor or referenced from equipment of similar size and scope to accurately reflect the frequency characteristics for each source.

**Table 1: Original Study – Modeled Source Sound Level**

Equipment	Number of Sources Modeled	Modeled Sound Power Level (dBA)
Power Electronics GEN3 Inverter	136	102 dBA $L_w$
CATL Ener C+ Battery Container HVAC	544	93 dBA $L_w$
170-MVA Substation Transformer	2	90 dBA $L_w$
85-MVA Substation Transformer	1	87 dBA $L_w$
Auxiliary Transformers	17	79 dBA $L_w$

### Update to Sound Model

As development has progressed in the Project, the original equipment and manufacturers have changed. The new Project sound sources were modeled according to the locations provided in the revised general arrangement drawing provided as Figure A-2 of Attachment A.

Power Electronics provided an updated noise test report, dated August 2024, of the GEN3 inverter with a maximum sound power level of 97 dBA. LG Energy Solutions provided a noise test of the JF2 DC Link 5.1 battery container with a sound power level of 87 dBA. Specified sound levels for each substation transformer are unchanged from the original analysis. Table 2 provides the modeled sound source level assumptions for each piece of modeled equipment for the updated design.

**Table 2: Updated Modeling – Modeled Source Sound Level**

Equipment	Number of Sources Modeled	Modeled Sound Power Level (dBA)
Power Electronics PCSM GEN3 Inverter	114	97 dBA L <sub>w</sub>
JF2 DC Link BESS Container	341	87 dBA L <sub>w</sub>
170-MVA Substation Transformer	2	90 dBA L <sub>w</sub>
85-MVA Substation Transformer	1	87 dBA L <sub>w</sub>
Auxiliary Transformers	9	79 dBA L <sub>w</sub>

**Modeling Results**

Sound modeling was performed using the industry-accepted sound modeling software Computer Aided Noise Abatement (CadnaA), version 2026. The software is a scaled, three-dimensional program, which takes into account air absorption, terrain, ground absorption, and reflections and shielding for each piece of noise-emitting equipment and predicts sound pressure levels. The model calculates sound propagation based on International Organization of Standardization (ISO) 9613-2:2024, General Method of Calculation. ISO 9613-2 assesses the sound level propagation based on the octave band center-frequency range from 31.5 to 8,000 Hertz.

The ISO standard considers sound propagation and directivity. The software calculates sound propagation using omnidirectional, downwind sound propagation and worst-case directivity factors. In other words, the model assumes that each piece of equipment propagates its maximum sound level in all directions at all times. Empirical studies accepted within the industry have demonstrated that modeling may over-predict sound levels in certain directions, and as a result, modeling results generally are considered a conservative representation of the Project’s actual sound level.

The modeled atmospheric conditions were assumed to be calm, and the temperature and relative humidity were left at the program’s default values. Reflections and shielding were considered for sound waves encountering physical structures. Terrain elevations were included in the model to account for surface effects. Ground absorption values can range from 0.0 (fully reflective surface) to 1.0 (fully absorptive surface). Onsite ground absorption was set to 0.3 to account for gravel and offsite ground absorption was set to 0.8 to account for the soft ground cover of the surrounding agricultural land. All sound modeling parameters used are provided in Table 3. The modeled sound level impacts at the nearest impacted residential receptors are provided in Table 4. Sound level contours for the new Project are shown in Figure A-3 and A-4 of Attachment A. The figures show the same proposed 15-foot sound wall used for the 2024 analysis. This sound wall is still included in the updated design.

**Table 3: Sound Modeling Parameters**

Model Input	Parameter Value
Ground Absorption (Onsite)	0.3
Ground Absorption (Offsite)	0.8
Number of Reflections	2
Receptor Height	5 feet above grade
Temperature	50°F
Humidity	70%



**Table 4: Modeled Project Sound Levels at Noise-Sensitive Receivers**

Receiver	Sound Pressure Level (dBA)		
	Modeled Impacts at Residence		Solano County Code Nighttime Guidance
	Old Model (Oct. 2024)	New Model	
Rec01	50	49	50
Rec02	49	48	50
Rec03	44	43	50
Rec04	47	45	50
Rec05	46	45	50
Rec06	43	42	50

The modeled sound level impacts at all six residential receptors are less than those predicted in the October 2024 sound study. As such, the change in equipment vendor does not change any of the previous conclusions of the sound assessment study. The sound model results demonstrate the update to the Project design will still comply with the Solano County nighttime sound level limit of 50 dBA  $L_{eq}$ .

Attachments

Attachment A – Sound Level Contours



## Attachment A – Figures

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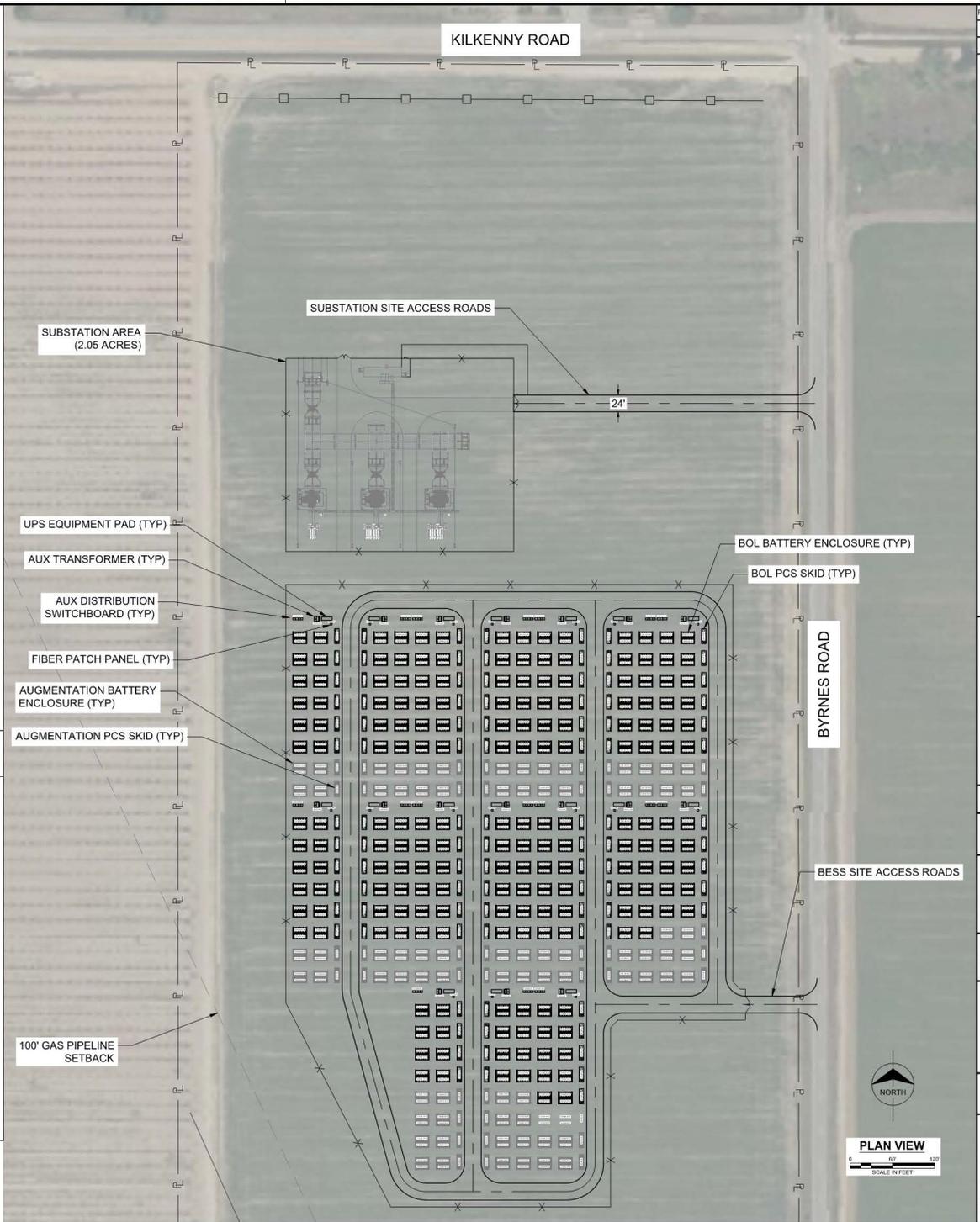
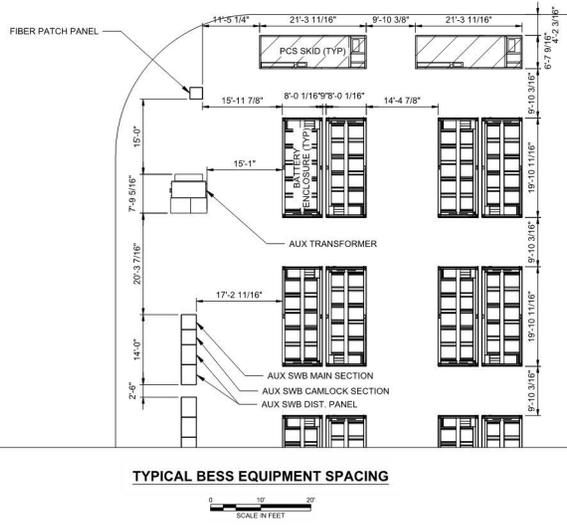
### ENERGY STORAGE SYSTEM DESCRIPTION

FACILITY NAME/PLATE	300 MW / 1200 MWh
BESS EQUIPMENT	BOL: 96 PCS SKIDS, 384 BATTERY ENCLOSURES EOL: 136 PCS SKIDS, 544 BATTERY ENCLOSURES

AREA	ACREAGE (SQ FT)
PARCEL	1,615,704
BUILDABLE AREA (EQUIPMENT AND SUBSTATION)	698,518

- LEGEND:**
- PROPERTY LINE
  - FENCE
  - SETBACK
  - NATURAL GAS PIPELINE EASEMENT
  - ⋈ GATE
- ABBREVIATION LIST**
- AUX - AUXILIARY
  - BESS - BATTERY ENERGY STORAGE SYSTEM
  - BOL - BEGINNING OF LIFE
  - EOL - END OF LIFE
  - PCS - POWER CONVERSION SYSTEM
  - TFM - TRANSFORMER
  - TYP - TYPICAL
  - SWB - SWITCHBOARD

- NOTES:**
- SUBSTATION AREA BASED ON PRELIMINARY DRAWING AND IS SUBJECT TO CHANGE BASED ON FINAL DESIGN. SUBSTATION FOOTPRINT PROVIDED BY SUBSTATION EOR.
  - SITE DRAINAGE REQUIREMENTS TO BE SHOWN ON CIVIL GRADING PLAN.
  - AUGMENTATION EQUIPMENT WILL NOT BE PRESENT DURING INITIAL SITE DEVELOPMENT.



REV	DATE	BY	CHKD	DESCRIPTION
A	12/21/23	JMF	AMH	ISSUED FOR 30% REVIEW
B	05/03/24	JMF	AMH	ISSUED FOR 60% REVIEW

Figure A-1  
2024 Project Layout

**PRELIMINARY - NOT FOR CONSTRUCTION**

**BURNS & McDONNELL**  
 BURNS & McDONNELL WESTERN ENTERPRISES, INC.  
 140 S STATE COLLEGE BLVD., SUITE 100  
 BREA, CA 92821  
 714-256-1595

date: OCTOBER 6, 2023  
 designed: J. FORBES  
 detailed: J. FORBES  
 checked: A. HINERMAN

**CORBY ENERGY STORAGE, LLC**  
 700 UNIVERSE BLVD.  
 JUNO BEACH, FL 33408

**CORBY BESS PROJECT**  
 6885 BYRNES ROAD  
 VACAVILLE, CALIFORNIA 95687

**CORBY BESS ELECTRICAL EQUIPMENT SITE PLAN**

project	163851	contract	-
drawing	BCR-E-200	rev.	B
sheet	of	sheet	
file	BCR-E-200.dwg		

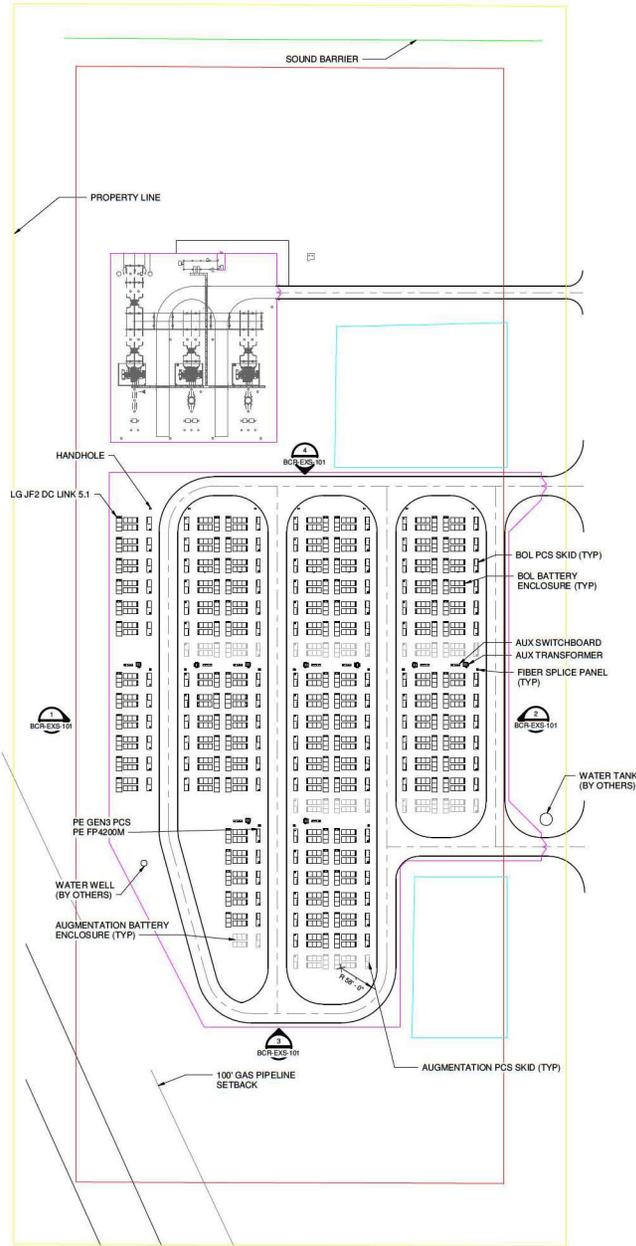
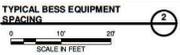
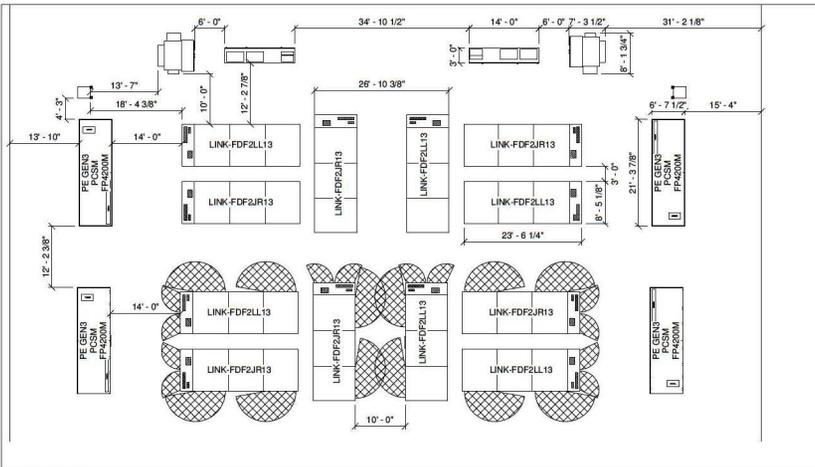
ENERGY STORAGE SYSTEM DESCRIPTION	
FACILITY NAME/PLATE	300 MWh / 1200 MWh

MATERIAL LIST	QTY (EOL)	QTY (EOL)
LG JF2 DC LINK 5.1 (DC LINK: LINK-FDF2JR13, TYPE A)	160	179
LG JF2 DC LINK 5.1 (DC LINK: LINK-FDF2LL13, TYPE C)	143	162
POWER ELECTRONICS POWER CONVERSION SYSTEM (PCSM: FP4200M)	101	114
ABB AUXILIARY TRANSFORMER, 1500KVA, 3-PHASE, 60HZ, 34.5KV/480V	9	9
LAKE SHORE ELECTRIC AUXILIARY SWITCHBOARD 2000A/480V, 3-PH, 60HZ	9	9

AREA	ACREAGE
PARCEL	40.25

PLAN LEGEND	
	FENCE
	GATE
	PROPERTY LINE
	RETENTION POND
	SETBACK

- NOTES:**
- PCS SKID AND BATTERY ENCLOSURE SIZING AND QUANTITIES ARE PROVIDED BY OWNER. THESE QUANTITIES HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE ENGINEER OF RECORD.
  - GRAVED OUT EQUIPMENT IS TO BE INSTALLED AT A LATER DATE AS PART OF AUGMENTATION SCOPE. EQUIPMENT SHOWN IS REPRESENTATIVE ONLY AND ARE NOT INDICATIVE OF FINAL DESIGN.
  - SETBACK OF MORE THAN 100' FROM PROPERTY LINE TO BATTERY ENCLOSURES SHALL BE MAINTAINED THROUGHOUT THE PROJECT PERIMETER.



rev	date	by	chkd	description
A	10/22/25	JRK	JLT	ISSUED FOR 10%
B	12/17/25	SRD	AT	ISSUED FOR 30%

Figure A-2  
Updated Project Layout

This document is being issued for Review under the authority of Joshua A. Tucker, P.E. 21383 on December 17, 2025. It is not to be used for bidding or construction purposes.

**PRELIMINARY - NOT FOR CONSTRUCTION**

**BURNS & MCDONNELL**  
BURNS & MCDONNELL WESTERN ENTERPRISES, INC.  
145 S STATE COLLEGE BLVD, SUITE 600  
BREA, CA 92821

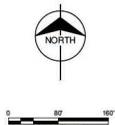
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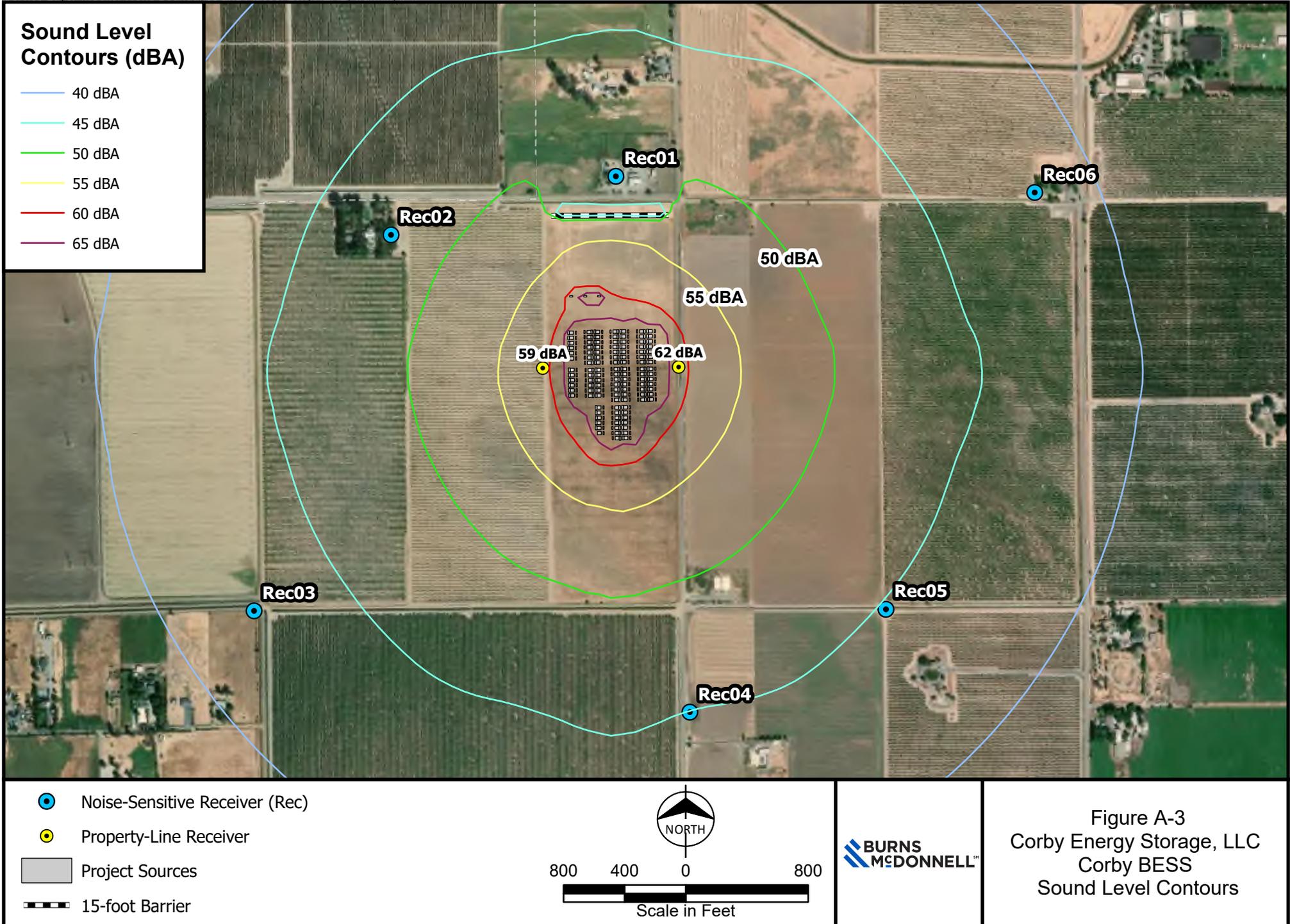
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700 UNIVERSE BLVD.  
JUNO BEACH, FL 33408

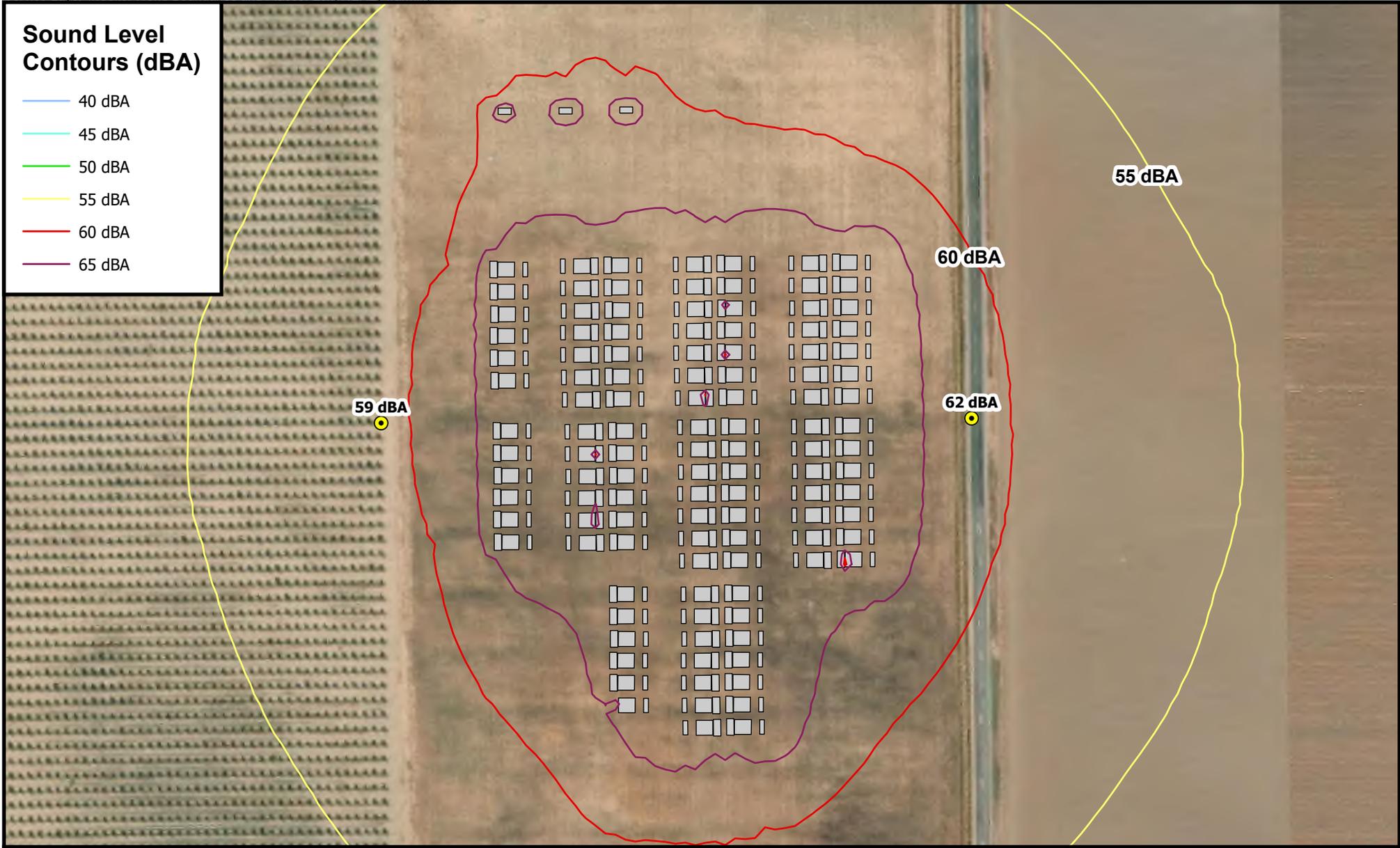
CORBY BESS PROJECT  
6865 BYRNES ROAD  
VACAVILLE, CALIFORNIA 95687

CORBY BESS PROJECT  
EQUIPMENT KEY PLAN

project	contract
163851	
drawing	rev.
BCR-E-200	B
sheet	of sheets
163851	BCR-E-200.dwg







**Sound Level Contours (dBA)**

- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA
- 65 dBA

- Noise-Sensitive Receiver (Rec)
- Property-Line Receiver
- Project Sources

NORTH

200 100 0 200  
Scale in Feet



Figure A-4  
Corby Energy Storage, LLC  
Corby BESS  
Sound Level Contours