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"Proud Protectors of Life, the Environment, and Property"

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All Interested Parties

RESIDENTIAL ESS INSTALLATIONS – CODE CLARIFICATIONS

ITEM #1: Residential ESS "Unit"- Based Provisions

The Los Angeles County Fire Department (LACoFD) enforces the 2023 Los Angeles County Fire Code (2023 LACFC; LACC Title 32), which is a locally amended version of the 2022 California Fire Code (2022 CFC; CCR Title 24, Part 9). The Fire Code requires that:

> "Individual [energy storage system] units shall be separated from each other by at least 3 feet (914 mm) of spacing" (§1207.11.2.1).

When this provision was written, the term "unit" identified an assembly of battery cells and other essential components for composing a single functional energy storage system (ESS), where said assembly was listed to UL 9540 as a single functional ESS "unit".

As technology advanced, battery manufacturers began making smaller individual ESS units, with the intent of scaling installations of units to the demand of the applicable use. However, the Fire Code did not allow by default for closer groupings of such smaller units.

Therefore, it is clear to see why a discrepancy exists between the battery industry, solar installation companies, and the fire- and life-safety regulatory agencies as to what is the appropriate use of the term "unit". After meeting with industry professionals on February 26, 2024, and listening to the issues associated with the ESS "unit" definition, LACoFD issues the following interim interpretation of the term "unit" to meet the intent of the 2023 LACFC.

Interim Code Interpretation:

In lieu of a clear definition of a **residential ESS "unit"**, and in accordance with the intent as it pertains to the individual amassment of ESS representing a single grouping of fire and/or hazardous-materials load, exclusively for the purposes of **Sections 1207.11.2.1 and 1207.11.4 of the 2023 LACFC**, the following shall serve to clarify:

1. An ESS "unit" shall mean a single grouping of *one or more complete* UL-9540-listed residential ESS units, not to exceed an aggregate *nominal* capacity of 20 kWh in that grouping.

   A "unit"/grouping may consist of more than one ESS unit only where the units are expressly allowed, by the manufacturer's NRTL-approved installation instructions, to be separated by less than 3 feet. See Figure 1.

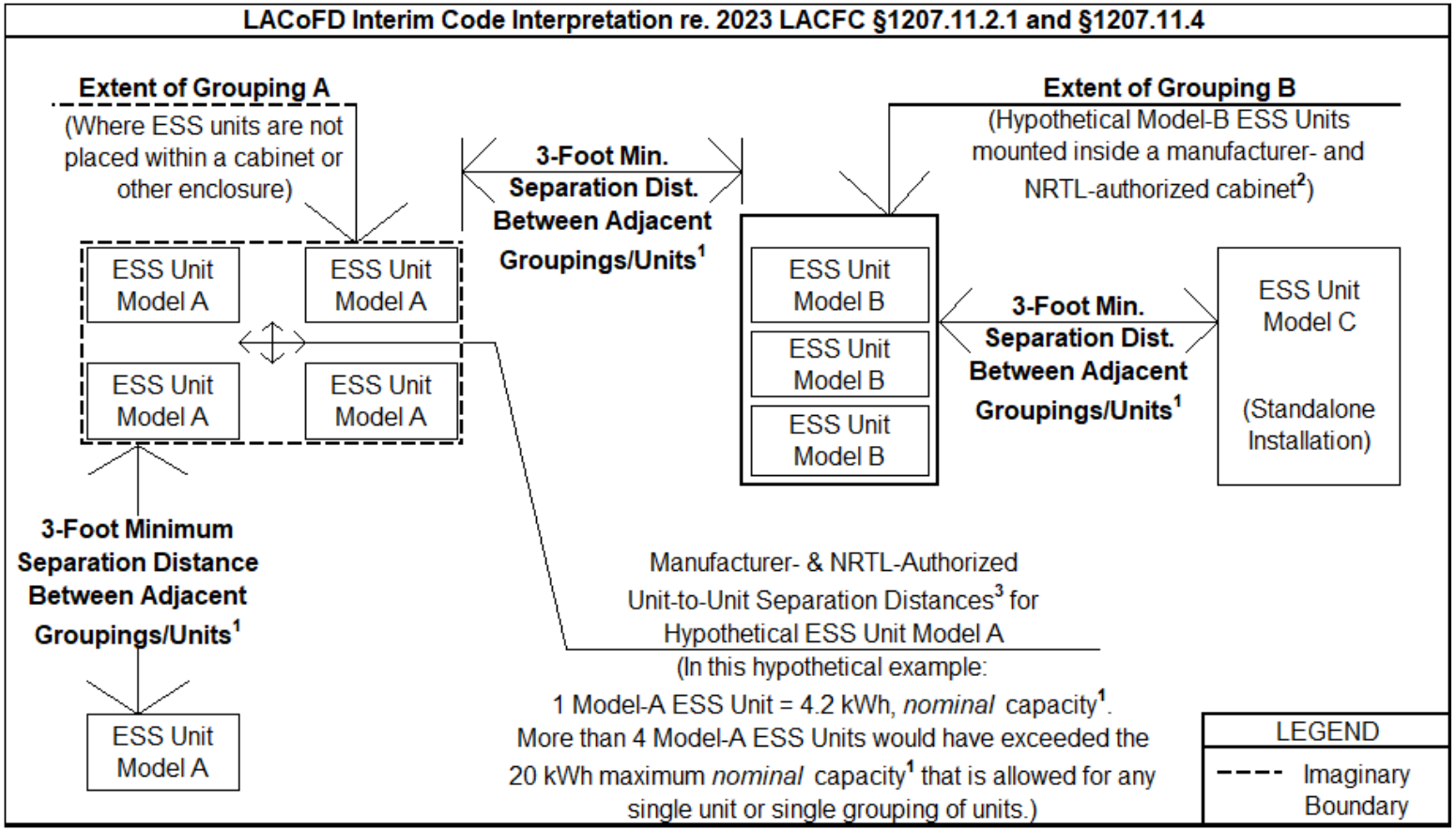
2. If multiple UL-9540-listed ESS units are installed within a cabinet*, the cabinet shall be purpose-manufactured, approved by the manufacturer(s) for the specific UL-9540-listed ESS units being placed within, and minimize the amount of void space within [after the installation of the ESS unit(s) within] in which flammable/explosive gases can accumulate during a failure event.

   *2022 CFC / 2023 LACFC Definition:
   ENERGY STORAGE SYSTEM CABINET. A cabinet containing components of the energy storage system that is included in the UL 9540 listing for the system. Personnel are not able to enter the enclosure other than reaching in to access components for maintenance purposes.

3. In no case shall a reduction be allowed to the minimum requirements, nor separation distances, specified in the manufacturer's installation instructions, specifically those instructions that were approved by the nationally recognized testing laboratory (NRTL) that granted the UL-9540 listing to that make and model of ESS unit.

   a. This rule shall also pertain to the manufacturer's installation requirements regarding the placement of an ESS unit in relation to other units, etc.

   b. A grouping shall not consist of a mixture of different makes and/or models of UL-9540-listed residential ESS units unless specifically authorized by the aforementioned manufacturer's installation instructions.



1. No individual grouping/unit shall exceed 20 kWh *nominal* capacity. Footnote "a" of Table 1207.1.1 (2022 CFC / 2023 LACFC):
   "a. Energy capacity is the total energy capable of being stored (nameplate rating), not the usable energy rating. For units rated in amp-hours, kWh shall equal rated voltage times amp-hour rating divided by 1,000."
2. Where a cabinet is used, the cabinet shall be purpose-manufactured, included and specified in the UL-9540 listing for the specific UL-9540-listed ESS units being placed within, and minimize the amount of void space within the cabinet [after the installation of the ESS unit(s) within] in which flammable/explosive gases can accumulate during a failure event.
3. In no case shall a reduction be allowed to the minimum requirements, nor separation distances, specified in the manufacturer's installation instructions. A grouping shall *not* consist of a mixture of different makes and/or models of UL-9540-listed residential ESS units unless specifically authorized by the aforementioned NRTL-approved manufacturer's installation instructions.

FIGURE 1: Grouping/Unit-to-Grouping/Unit Separations

ITEM #2: Acceptable Installation Locations at Group R-3/R-4 Occupancies

The 2023 LACFC explicitly states the following regarding the allowable installation locations for these types of ESS installed in association with Group R-3 and R-4 occupancies:

1207.11.3 Location.

ESS shall be installed only in the following locations:

1. Inside detached garages.
2. Inside attached garages when separated from the dwelling unit living space and sleeping units in accordance with Section *R302.6*.
3. Outdoors *or* on the outer side of the exterior building walls in accordance with Section 1207.11.3.1.

ESS shall not be installed inside any of the following locations:

1. Dwelling units, including accessory dwelling units (ADU's).
2. *Sleeping* units.
3. S*paces opening directly into sleeping rooms or units.*
4. C*losets.*
5. Bathrooms.
6. Basements.
7. Accessory structures that are not garages.
8. Vaults.

1207.11.3.1 Outdoors or on outer side of exterior building walls. ESS shall be permitted to be installed outdoors, or on the outer side of exterior building walls, when all of the following conditions are met, in addition to those otherwise required by Section 1207.11:

1. The ESS shall be installed and maintained a minimum of 5 feet (1524 mm) from all of the following:
   1.1. Lot lines.
   1.2. Public ways.
   1.3. Other buildings.
   1.4. Stored combustible materials.
   1.5. Hazardous materials.
2. The ESS shall be installed and maintained a minimum of 10 feet (3048 mm) from vegetation, as specified in Section 1207.5.7.
3. The ESS shall be installed and maintained a minimum of 3 feet (914 mm) from all doors, windows, operable openings, HVAC inlets and other penetrations directly or indirectly into habitable or occupiable spaces, or bathrooms.

Exception: The fire code official shall have the authority to authorize smaller separation distances where such distances are documented and approved to be

adequate for the ESS model(s) in question based on large-scale fire testing, in accordance with Section 1207.1.5.

In summary, ***interior*** installation of ESS units relative to R-3/R-4 occupancies is only allowed within a garage, that being either an attached garage [i.e., a garage physically attached to a residential dwelling unit, with the appropriate safety systems in place, e.g., detection, notification, and code-compliant separations from the dwelling unit(s)]; or a detached garage. It is not allowed within other occupiable or non-occupiable interior areas.

Rationale:

The inherent dangers associated with lithium-ion battery chemistries (including the various sub-categories on the market, such as lithium-iron-phosphate chemistries) have the potential to place homeowners or occupants at significant life-safety risk. Though it is recognized that recent designs and chemistries have perhaps made it more difficult to initiate thermal runaway within a battery cell and/or assembly of cells, once thermal runaway occurs, the flammable and toxic/asphyxiant gases generated remain significantly dangerous and can issue forth from the involved unit in mass without warning to nearby occupants, whether those occupants are sleeping or awake. The gases generated during failure may immediately ignite (creating a fire, blow-torch-like effect, or a fireball), or they may continue to issue forth without ignition. When these gases accumulate within an enclosed space (i.e., room, closet, etc.) they can quickly present an explosion hazard. The heat-generating chemical reaction at the heart of the thermal-runaway process can present the necessary ignition source, or it can be presented by the electrical charges of the system, or by any number of other incidental ignition sources that may be present in/at an occupancy.

No manufacturer of a lithium-ion-based ESS currently on the market has presented to LACoFD the following UL-9540A performance criteria, both of which are required by current State and local codes in order for an ESS to be permitted to be installed within a habitable space:

a) Thermal runaway cannot be induced in the cell; and

b) The cell vent gas does 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.

(UL 9540A, 4th Edition, §7.7.1)

Using the currently most-popular ESS chemistry sub-category, lithium iron phosphate ($LiFePO_4$), as an example, the *flammable* component gases of the vent-gas cocktail that are very quickly produced in relatively large quantities during thermal runaway, include (but are not limited to) hydrogen (H_2) and carbon monoxide (CO). These two gases are consistently the two main flammable gases produced and detected during current minimum testing standards. These flammable gases are colorless, odorless, and

tasteless. Hydrogen gas also produces a non-visible flame component once ignited and has the highest flammability range of any gas known within the scientific community. At this time, despite the existence of UL 9540A and its evaluation of flammability hazards from limited-scale failure of cells within a unit, no true *large*-scale fire test standard or methodology exists by which to accurately characterize maximum-potential failure of an ESS unit, and real-world failures of ESS units continue to occur with results well beyond the degree that the UL-9540A testing demonstrated.

Carbon monoxide also presents a significant toxicity hazard, but the *toxicity* profile of the gases produced during these failures is not well understood because current testing standards for ESS are limited in scope to assess only the flammability and explosivity profile of the gases produced during cell failure.

Neither disconnecting an ESS unit from the circuitry of the associated structure(s)/load(s), nor remotely opening the electrical connections within the unit, will stop the process of a thermal-runaway failure that has already begun within the unit. Likewise, doing so also does not eliminate the electrocution/shock hazard that the "stranded" electricity stored in its cells/modules may present.

Neither the resident nor first responders can stop the process of thermal runaway. Regarding extinguishment, assuming access can be made by which to sufficiently apply water streams to the involved battery cells located beneath the ESS cover, efforts to extinguish a lithium-ion-based ESS fire that is actively consuming the flammable and toxic vent gases being generated by an interior-mounted ESS in thermal runaway complicates the hazard because:

- Extinguishing the fire allows these dangerous gases to now accumulate within the structure.
- When "successful", extinguishment slows down, but does not stop, the thermal-runaway failure, thereby prolonging the event. Stopping the chemical reaction responsible for the event in compromised cells would require disassembling the chemical components within each affected cell.
- Extinguishing the fire turns the remaining, compromised cells of the ESS into what some have described as unexploded ordnance.
- Extinguishing the fire can subject the interior space to costly water damage.
- The introduction of water can cause otherwise unaffected ESS to then become compromised.
- Water runoff presents an unknown toxicity concern.

Regarding efforts to remove the hazard from the structure during or after the initial incident, which is the method fire departments usually use to render a site safe to turn back over to the owner, thereby releasing the fire department personnel back to availability for other emergencies, this is not usually an option, especially when ESS are mounted within the dwelling envelope. As these units are very heavy, they usually require installation whereby they are bolted in place, often to bearing walls. Fire fighters are unable to remove such mounted ESS from the structure because the ESS unit(s) not only

present an electrocution hazard and the possibility of unexpected reignition and ejection of shrapnel, but in many cases fire fighters would need to cut out portions of bearing walls.

Code requires of interior-installed commercial ESS installations utilizing these chemistries that they provide for fire-resistance-rated separations; clearance from combustible materials; ample signage; a listed, third-party monitored, approved commercial automatic smoke-detection system or radiant energy-sensing fire detection system, with occupant notification; explosion control; security against unauthorized access; and periodic inspection.

Causes of ESS failures include mechanical puncture or impact, thermal abuse (e.g., exposure to fire), electrical abuse (e.g., overcharging, over-discharging, water intrusion, short circuiting), failure of the battery management system, manufacturer defect, and degradation over time or use. Los Angeles County contains many earthquake fault lines that could result in failure of these units. Residents may also contribute to mechanical failure, and units are likely to fall into neglect as occupants age and/or cannot afford to maintain, remove, or replace aging/damaged units. Without a fail-safe system approach, the Los Angeles County Fire Code prohibits interior installations at Group R-3/R-4 occupancies, with the exception of the garage space. Fortunately, garages and many exterior- or outdoor-installation options remain, including on the outer side of exterior building walls, on outdoor pads like air-conditioning units, and on exterior “wing” walls.

As the regulatory fire authority for areas within its jurisdiction, LACoFD has determined that the aforementioned hazards inherent in lithium-ion-based ESS are a life-safety risk to homeowners and occupants; and, therefore, these lithium-ion-based ESS are not permitted for installation within interior residential spaces (beyond compliant garages). As new technologies and chemistry types develop and meet the aforementioned performance criteria that allow devices to qualify for other options, ESS may no longer require such oversight for the safety of the public.

CLOSING

LACoFD reserves the right to rescind or clarify any or all of the rulings presented in this document. Should there be any questions related to this document, please contact the LACoFD Fire Prevention Division.

Sincerely,

LOS ANGELES COUNTY FIRE DEPARTMENT OFFICE OF THE FIRE MARSHAL