# ADDENDUM TO INITIAL EXPRESS TERMS AND RATIONALEFOR PROPOSED BUILDING STANDARDSOF THE OFFICE OF THE **STATE FIRE MARSHAL**REGARDING THE **2022 CALIFORNIA RESIDENTIAL CODE**,

# CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 2.5

# (SFM 03/22)

The State agency shall draft the regulations in plain, straightforward language, avoiding technical terms as much as possible and using a coherent and easily readable style. The agency shall draft the regulation in plain English. A notation shall follow the express terms of each regulation listing the specific statutes authorizing the adoption and listing specific statutes being implemented, interpreted, or made specific (Government Code Section 11346.2(a)(1)).

If using assistive technology, please adjust your settings to recognize underline, strikeout, italic and ellipsis.

## LEGEND for EXPRESS TERMS (Based on model codes - Parts 2, 2.5, 3, 4, 5, 9, 10)

* Model Code language appears upright
* Existing California amendments appear in *italic*
* Amended model code or new California amendments appear *underlined & italic*
* Repealed model code language appears ~~upright and in strikeout~~
* Repealed California amendments appear in *~~italic and strikeout~~*
* Ellipses ( ...) indicate existing text remains unchanged

## ADDENDUM to INITIAL EXPRESS TERMS and RATIONALE

### ITEM 9Chapter 3 BUILDING PLANNING, R328.5, Table R328.5

[The SFM proposal provides the clear intent of the maximum threshold of kWh of ESS for each location on a property.]

**R328.5 Energy ratings.** Individual ESS units shall have a maximum rating of 20 kWh. The ~~aggregate rating~~ *ratings* of the ESS *in each location* shall not exceed *the ratings in Table R328.5.* ~~:~~ *The total aggregate ratings of ESS on the property shall not exceed 600kWh.*

~~1. 40 kWh within utility closets and storage or utility spaces.~~

~~2. 80 kWh in attached or detached garages and detached accessory structures.~~

~~3. 80 kWh on exterior walls.~~

~~4. 80 kWh outdoors on the ground.~~

ESS installations exceeding the permitted individual or aggregate ratings shall be installed in accordance with Section~~1207~~*1207.1 through 1207.9* of the *California Fire Code.*

***TABLE R328.5 MAXIMUM AGGREGATE RATINGS OF ESS***

|  |  |  |
| --- | --- | --- |
| ***LOCATION*** | ***MAXIMUM AGGREGATERATINGS (kWh)*** | ***INSTALLATION REQUIREMENTS*** |
| *Within utility closets, basements, and storage or utility spaces located within dwellings* | *40* |  |
| *In attached garages* | *80* |  |
| *On or within 3 feet of exterior walls of dwellings and attached garages* | *100* |  |
| *On or within 3 feet of exterior walls of dwellings and attached garages* | *200* | *Exterior walls and eaves are constructed with noncombustible surfaces a* |
| *In detached garages and detached accessory structures* | *200* |  |
| *In detached garages and detached accessory structures* | *600* | *Detached garage or detached accessory structure is a minimum10 feet away from property lines and dwellings.* |
| *Outdoors on the ground* | *200* | *ESS is a minimum 3 feet away from property lines and dwellings.* |
| *Outdoors on the ground* | *600* | *ESS is a minimum 10 feet away from property lines and dwellings.* |

*For SI: 1 foot = 304.8 mm*

*a. Noncombustible wall surface shall extend in accordance with all the following:*

*1. A minimum of 5 feet horizontally from the edge of the ESS.*

*2. A minimum of 1 foot vertically below the bottom edge of the ESS.*

*3. A minimum of 8 feet vertically above the ESS, or to a non-combustible eave, whichever is less.*

*The code official is authorized to approve reductions based on large-scale fire testing complying with Section 1207.1.5 of the California Fire Code.*

#### STATEMENT OF SPECIFIC PURPOSE, PROBLEM, RATIONALE and BENEFITS

The proposed changes to the first three sentences of R328.5 clarify the original intent for this section, which was to provide a maximum threshold for each location. It was not the intent to limit installations to one location on the property, or to limit to only 80 kWh for all ESS installed on the property.

Providing the various maximum thresholds in tabular form provides an easier method for the code user to determine the limits for each location.

**Within utility closets, basements and storage or utility spaces:**
The 40-kWh limit is unchanged from the 2022 CRC. That language clarifies that the 40-kWh limit does not apply to spaces or closets located within garages or accessory structures. It only applies to within the dwelling.

**In attached garages:**As the ESS industry has gained more experience with the needs of their customers and the grid, and the building safety community has gained more experience with ESS, it is becoming clear that the arbitrary capacity restrictions in the residential code are a hinderance to the deployment of clean energy technologies and are unneeded for safety. Hundreds of thousands of residential batteries have been installed and constructed to standards leading to greater levels of safety. Taken together these facts support a reasonable increase in kWh capacity to align with other anticipated hazards and fuel loads that may be present in a residential garage.

A modest increase in the allowable aggregate ESS capacity from 80-kWh to 100-kWh does not pose a significant elevated fire risk in the garage.

Manufacturers design ESS to well-established safety standards, have proven track records of operating without igniting in homes, and are built in ways to resist adding fuel to fires from other sources. In the rare event of an ESS fire, a fire from 100-kWh of energy storage does not pose a significantly greater threat to occupant safety and is not significantly more difficult to extinguish than a fire from 80 kWh of energy storage.

The fuel energy density and heat release rate potential presented by a 100-kWh energy storage system are comparable to that of vehicles parked in garages. 100-kWh is a typical capacity of currently available electric vehicles (EVs), which use lithium-ion chemistries as do many stationary ESS. EVs also present significant additional fuel load through materials like upholstered seating and plastic trim. Internal combustion engine (ICE) vehicles have fuel, engine lubricants, and other components with the potential for very significant heat release rates. While the fuel load in a vehicle fueled by a gaseous fuel such as CNG or hydrogen can be less than that of a 100-kWh ESS in total energy output, the dynamics of a designed quick release of a gaseous fuel due to fire exposure in an attached garage can pose a significant concentrated fire exposure, or potentially a deflagration hazard risk to occupants and emergency responders.

This proposal allows homes to add an aggregate of 100-kWh of energy storage to an attached garage, while keeping the content fuel loads at safe levels. While actual fuel loads in garages can vary widely, this can be demonstrated using typical and conservative figures:

A reasonable fuel load for a garage is approximately 22,300 MJ. This assumes the garage is 20’ x 20’ and that a reasonable fuel load density is 600 MJ/m. Parking two gasoline powered cars in the garage makes up approximately 10,600 MJ of fuel load. Other garage items can make up approximately 3,300 MJ of fuel load. The remaining fuel load available to an ESS (22,300 MJ minus 10,600 MJ minus 3,300 MJ) is 8,400 MJ. 8,400 MJ is equivalent to an ESS with an aggregate capacity of 100 kWh, assuming the ESS has a fuel load of 84 MJ/kWh.

**On or within 3 feet (914 mm) of exterior walls of dwellings and attached garages:**ESS on the exterior side of exterior walls pose less of a safety risk than ESS inside attached garages. If an ESS with an aggregate rating of 100-kWh in an attached garage is considered reasonable, then an ESS with an aggregate rating of 100-kWh on the exterior side of exterior walls should also be reasonable.

If an ESS with an aggregate rating of more than 100 kWh catches on fire, the non-combustible surface would protect occupant safety. Batteries that undergo burn tests on non-combustible surfaces, including masonry and cementitious board, perform well. Some tests have been done as part of 9540A.

**In detached garages and detached accessory structures:**This scenario poses minimal risk to occupant safety, considering the distance from the dwelling and testing required of ESS. ESS in detached structures pose less of a safety risk than ESS on the exterior side of the dwelling. If an ESS with an aggregate rating of 200-kWh on the exterior side of the dwelling is considered reasonable, then an ESS with an aggregate rating of 200 kWh should be reasonable for ESS in detached structures.

600-kWh matches Table 1207.5 of the CFC. ESS in structures separated from the dwelling by 10 feet do not pose demonstrable risk to occupants.

**Outdoors on the ground:**This scenario poses minimal risk to occupant safety, considering the distance from the dwelling and the testing required of ESS. Ground mount ESS pose less of a safety risk than ESS on the exterior side of the dwelling. If an ESS with an aggregate rating of 200-kWh on the exterior side of the dwelling is considered reasonable, then an ESS with an aggregate rating of 200 kWh should be reasonable for ESS mounted on the ground.

Additionally, 200 kWh is equivalent to two typical EVs that can be parked anywhere on the property. 600 kWh matches Table 1207.5 of the CFC. ESS separated from the dwelling by 10 feet do not pose demonstrable risk to occupants.

**Endnotes:**

1. Tesla Model X has a capacity of 100 kWh. Tesla Model S has a capacity of 70-85 kWh. Chevy Bolt has a capacity of 66 kWh. The electric Ford F150 has a capacity of 110-130 kWh or 150-180 kWh with extended range.
**Sources:**
<https://www.forbes.com/wheels/cars/tesla/model-x/>,
<https://www.tesla.com/sites/default/files/tesla-model-s.pdf>,
<https://media.chevrolet.com/media/us/en/chevrolet/vehicles/bolt-ev/2021.tab1.html>,
<https://www.forbes.com/wheels/news/2022-ford-f-150-lightning-ev-pickup-debuts-300-mile-range-priced-at-40k>.
2. Builders’ websites show the typical two-garage is around 20' x 20'. For example, HWS Garages' website states that "The average 2-car garage size is anywhere from 18’ x 20’ to 22′ x 22’.” While some garages are one-car and some are three-car, a poll conducted by Garage Living shows that 61 percent of garages are two-car. Sources: <www.hwsgarage.com/average-garage-sizes/> and [www.garageliving.com/blog/home-garage-stats](http://www.garageliving.com/blog/home-garage-stats).
3. The average fuel load of a living room is 600 MJ/m. 600 MJ/m^2 is also the business standard in NFPA 557. Sources: Alex Bwalya et al., "A Pilot Survey of Fire Loads in Canadian Homes," National Research Council Canada, March 9, 2004; National Fire Protection Association, "NFPA 557: Standard for Determination of Fire Loads for Use in Structural Fire Protection Design," 2020 Edition, Section 6.1.3.
4. 10,577 MJ (rounded to 10,600 MJ) assumes a small car (2,909 MJ) and large car (7,648 MJ). Sources: Mohd Tohir and Michael Spearpoint, "Distribution analysis of the fire severity characteristics of single passenger road vehicles using heat release rate data," Fire Science Reviews, 2013. Also see M.J. Spearpoint, et. al., "Fire load energy densities for risk-based design of car parking buildings," Case Studies in Fire Safety, 29 April 2015.
5. 3,341 MJ (rounded to 3,300 MJ) is equivalent to half the fuel load items in a typical basement living room. Source: Bwalya, A.C., et. al., "Survey Results of Combustible Contents and Floor Areas in Multi-Family Dwellings," National Research Council Canada, 24 October 2008.
6. 84 MJ/kWh is derived from the estimated fuel load of the gases released by an ESS in thermal runaway (44 MJ/kWh) and the estimated fuel load of the burnable contents inside the ESS (40 MJ/kWh). 44 MJ/kWh was derived from reviewing several studies referenced below. 40 MJ/kWh was derived from multiplying 2 kg/kWh (a conservative figure for burnable contents inside the ESS – the weight of internal contents for some ESS is 1.0- 1.5 kg/kWh) by 20 MJ/kg (the typical fuel load of a computer). Sources for fuel load of gases: Frederik Larsson, "Toxic fluoride gas emissions from lithium-ion battery fires," Scientific Reports, 30 August 2017; David Sturk et. al., “Fire Tests on E-vehicle Battery Cells and Packs,” Traffic Injury Prevention, 25 February 2015. Sources for kg/kWh weight of internal burnable contents: Tesla, SimpliPhi, and Solaredge. Source for fuel load of a computer: Alex Bwalya et al., "A Pilot Survey of Fire Loads in Canadian Homes," National Research Council Canada, March 9, 2004.

**Cost Impact:** The code change proposal will not increase or decrease the cost of construction. It clarifies how the maximum thresholds are applied. Allows for more ESS while maintaining a level of safety.

**CAC Recommendation:**

[Enter CAC recommendation(s), if any]

**Agency Response:**

[Enter the agency's response to CAC recommendation(s)]