December 12, 2023

Mr. Jake West
Tesla Inc.
3500 Deer Park Road
Palo Alto, CA 94304
Phone – (650) 391-7144

Reference: File E491360 Volume 1 Project 4791096347

Subject: Code Compliance Research Report for Tesla “Solar Roof” Photovoltaic Roofing System.

Dear Mr. West;

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. Any information and documentation involving UL Mark services are provided on behalf of Underwriters Laboratories Inc. (UL) or any authorized licensee of UL.

This letter report serves as our deliverable for the Code Compliance Research phase of this project - the evaluation and certification of the revised Tesla “Solar Roof” BIPV Roofing Tile, Model SR72T3R and the associated non-functional Roofing Tiles. Model SRMTT3R (metal) and SRNFT3R (glass), for UL Listing to the Outline of Investigation for Photovoltaic Roof Coverings, UL 7103.

The attached Report provides a summary of the testing conducted by UL of the Solar Roof System products and our evaluation of the potential compliance of the system to relevant Code Requirements as cited by Tesla.

It should be remembered that the approval of building products and/or materials can only be granted by a building official having legal authority in the specific jurisdiction where approval is sought.

Should you have any questions or comments concerning the above, please feel free to contact the undersigned.

Sincerely,

Ruben Zabalza
Engineering Associate Lead
Solar Energy Group
UL Solutions

Reviewed by:

Paul DePominville
Engineering Associate Lead
Solar Energy Group
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Report Subject:
Tesla “Solar Roof System” Photovoltaic Roofing Tiles, Model SR72T3R and the non-function counterpart tiles, Models SRMTT3R (metal) and SRNFT3R (glass).

1.0 Scope of Evaluation

1.1 This Research Report addresses compliance with the following Codes:

- 2021, 2018 and 2015 International Building Code® (IBC)
- 2021, 2018 and 2015 International Residential Code® (IRC)
- 2020 Florida Building Code (See Section 9)
- 2022 California Building Code® (CBC) (See Section 9)

Note: This report references the most recent Code sections. Section numbers in earlier versions may differ.

1.2 The Tesla Solar Roof System has been evaluated for the following properties, as required under UL 7103 – Outline of Investigation for Photovoltaic Roof Coverings (See Table 1):

- Fire Resistance Classification
- Wind Resistance
- Wind-Driven Rain
- Impact Resistance

1.3 The Tesla Solar Roof System, consisting of BIPV Tiles, Model SR72T3R and the non-functional tiles, Models SRMTT3R & SRNFT3R, have been evaluated for the following use ratings (See Table 1):

- Class A (including B or C) Fire Classified Roof Covering
- Class F wind resistant roof covering.

2.0 Statement of Compliance

The Tesla Solar Roof System complies with the Codes listed in Section 1.1, for the properties stated Section 1.2 and uses stated in Section 1.3, when installed as described in this report, including the Conditions of Use as stated in Section 6.

3.0 Description

3.1 The Tesla Solar Roof System: Building-integrated Photovoltaic Roofing Tiles, Model SR72T3R and the non-energy producing tiles, Model SRMTT3R & SRNFT3R.

3.2 Model SR72T3R: Energy-producing BIPV roofing tiles that serve as both a roof covering and a . Photovoltaic module. The major components include an “FR-4” fiberglass substrate, film layers for attachment and sealing, silicon solar cells, wiring, and molded polymeric mounting components. Each SR72T3R tile is 1140 mm by 430 mm by 5 mm thick. The total height, including bottom mounting items is 34.5 mm. The Model SR72T3R is Listed by UL LLC under Category QHZK – Building-integrated Photovoltaic Modules and comply to UL Outline UL 7103 - Outline of Investigation for Photovoltaic Roof Coverings, which includes all relevant requirements of UL 61730-1 and 61730-2 (Photovoltaic Module Safety Qualification). This standard supersedes UL 1703 – Flat-Plate Photovoltaic Modules and Panels, as required in the IBC, Section 1507.17.6.

3.3 Model SRMTT3R: These Tesla Solar Roof metal tiles are used in non-energy producing areas of the roof. These tiles are made from Galvanized sheet steel with a black powder-coated surface, which is textured to appear identical to the BIPV Solar Roof Tiles. These tiles include integrated mounting components. The dimensions of the full Metal Tile is 1140 mm by 398 mm. These tiles may be cut to lengths that accommodate roof edges or other obstructions. The total height of the Metal Tile is 34.5 mm.

3.4 Model SRNFT3R: These Tesla Solar Roof glass tiles are used in non-energy producing areas of the roof. These tiles are made from tempered glass with a black powder-coated surface, which is textured to appear identical to the BIPV Solar Roof Tiles. These tiles include polymeric mounting components. The dimensions of the full glass Tile is 1140 mm by 421 mm by 5 mm. The total height of the Glass Tile is 34.5 mm.

4.0 Performance Characteristics

The performance characteristics listed are for the Tesla Solar Roof System which have been installed in accordance with the manufacturer's installation instructions as reviewed by UL 7103 listing and per this Code report.

4.1 Fire Resistance: Class A (which includes Class B and Class C) fire resistance Classification as a roof covering, as evaluated to the requirements of UL 790, as required within UL 7103.

4.2 Wind Resistance: Class F (110) as a photovoltaic tile roof covering, as evaluated in accordance with ASTM D-3161, as required within UL 7103, and was also evaluated to the requirements of Florida Testing Application Standard, TAS 100.

4.3 Wind-Driven Rain: The Tesla Solar Roof System complied with the requirements for wind-driven rain resistance as evaluated in accordance with UL 7103, Section 26 and was also evaluated to the requirements of TAS 100.

4.4 Impact Resistance: The Tesla SR72T3R Solar Roof Tiles and the SRMTT3R non-functional metal tiles are rated "Class 4" in accordance with the requirements of UL 2218, as required within UL 7103. This information is provided for information only. There are no requirements in the IBC, IRC or FBC for hail impact when the structure is designed for HVHZ loads and the minimum roof decks are present.

4.5 Impact Resistance: The Tesla SRNFT3R Solar Roof non-functional glass tile is rated "Class 4" in accordance with the requirements of FM 4473. This information is provided for information only. There are no requirements in the IBC, IRC or FBC for hail impact when the structure is designed for HVHZ loads and the minimum roof decks are present.

5.0 Installation

5.1 General

The Tesla Solar Roof System must be installed in accordance with the manufacturer's published installation instruction, the applicable Codes, and this Research Report. A copy of the manufacturer's instructions must be available on the jobsite during installation.

The roof covering system must be protected at the edges and penetrations at Eave, rake and other flashing conditions per methods described in the Tesla installation instructions.

5.2 Application

The Tesla Solar Roof System is for steep-slope roof applications at a minimum roof slope of 2:12, installed over a minimum 15/32-inch-thick plywood or minimum 7/16-inch-thick OSB, complying with the applicable requirements of the Code.

For Class A fire classification, the deck must be covered with one of the following:

a. Two layers Firestone Clad-Gard SA-FR underlayment,
b. One layer of FT Synthetics Cobalt FR Self-Adhered,
c. One layer of Tesla Solar Roof Self-Adhered Roofing Underlayment, Model SR-SAUL-1 or SR-SAUL-4 or SR-SAUL-3.

For Class C fire classification, the deck must be covered with one layer of Tesla Solar Roof Self-Adhered Roofing Underlayment, Model SR-SAUL-2.

Underlayment must be installed in accordance with IBC Section 1507.1.1 or IRC Section R905.1.1.

The tiles are attached by mechanical engagement to polymeric mounting components that are mechanically fastened to the prepared roof deck. The mounting components are fastened with two 1-1/2” ring-shank roofing nails, with 3/8” heads and 1/8” shanks.

The Tesla Solar Roof System is permitted for use with wind speeds designated for ASTM D3161, Class F, in accordance with IBC table 1504.1.1 and IRC table R904.2.4.1.

6.0 Conditions of Use

6.1 Installation must comply with this Research Report, the manufacturer’s published installation instructions, and the applicable Codes. In the event of a conflict, this report governs.

6.2 The Tesla Solar Roof System tiles and components are manufactured under a quality control program with quarterly inspections conducted by UL LLC Field Services inspection personnel.

7.0 Supporting Evidence

7.1 Reports of tests in accordance with TAS 100 (1995), as witnessed by UL LLC Engineering personnel for inclusion in this Report.

7.2 Data for ASTM D3161 (2016), TAS107 (2020), UL 790 (2014), UL 2218 (2010) and UL 61730-2 (2016), as required for this Roofing type within UL 7103, are included in the Test Record of the UL LLC Listing Report for the Tesla Solar Roof BIPV roofing tile SR72T3R, file E491360, Vol.1, Sec. 4, dated 2022-10-12, and may be obtained with consent from Tesla, itself.

7.3 UL Certificate of Compliance UL-US-L491360-113-80119102-5, Report Reference E491360-20191108, dated October 7, 2022, indicating compliance to ANSI/UL 61730-1 and 61730-2

(which supersedes Standard UL 1703 – Flat-Plate Photovoltaic Modules and Panels), as required for this Roofing type within UL 7103.

7.4 UL Listing Information System entry for UL File E491360 – Category QHZK, under UL 7103, on the UL Product IQ online directory of UL Listed Products.

8.0 Identification

The Tesla Solar Roof BIPV Roofing Tiles are identified on the bottom side of the products with a marking label, containing the Tesla name and logo, Tesla's website address, the product name "Tesla SolarRoof", model number, serial number that identifies the manufacturing location and date, and the UL Listing Mark as indicated below.

NOTE - No additional UL Marking with respect to "Code Compliance" is used. This Report was issued to support the Code compliance and applicable use locations as provided by the data that supports the Listing of the product by UL, as well as the additional client-requested testing to TAS 100, which was witnessed by UL LLC personnel for inclusion into this Report.

9.0 Other Codes

9.1 Florida Building Code:

9.1.1 Scope of Evaluation:

The Tesla Solar Roof BIPV Roofing System was evaluated for compliance with the 2020 Florida Building Code – Building and Florida Building Code – Residential.

9.1.2 Conclusion:

The Tesla Solar Roof System described in Sections 2.0 through 7.0 of this Research Report, comply with the 2020 Florida Building Code – Building and Florida Building Code – Residential, including High-Velocity Hurricane Zones, subject to the following conditions:

- Underlayment must comply with FBC – Building Section 1507.1.1, or FBC – Residential, Section R905.1.1.
- The maximum mean roof height is 33 feet.
- The maximum roof slope is 20:12.
- The Tesla Solar Roof BIPV Roofing System is Classified in accordance with ASTM D3161, Class F (110) and therefore acceptable for use in wind speeds in accordance with the FBC – Building, Section 1507.2.7.1 or the FBC – Residential, Section R905.2.6.1.
- UL is an approved evaluation entity and quality assurance entity pursuant to Florida Statute 553.842 – Product Evaluation and Approval. (ID 0198)

9.2 California Building Code:

9.2.1 Scope of Evaluation:

The Tesla Solar Roof System was evaluated for compliance with the 2022 California Building Code and California Residential Code.

9.2.2 Conclusion:

The Tesla Solar Roof System described in Sections 2.0 through 7.0 of this Research Report, comply with the 2022 California Building Code and California Residential Code, including Wildland-Urban Interface Fire Areas regulated by Chapter 7A, subject to the following conditions:

- When installed on roofs of structures in Wildland-Urban Interface Areas, accessory items (such as trims, gutters, flashing and vents) must comply with CBC Section 705A and 706A or CRC Section R337.5.
- When installed on roofs of structures in Wildland-Urban Interface Areas, the roof covering assembly must be installed as described for Class A in Section 5.2.
- Roofs of structures in Wildland-Urban Interface Areas must comply with CRC Section R337.5.
- Installation of the Tesla Solar Roof BIPV Roofing system must comply with CRC Section 324 provisions for structural roof design, roof access, pathway, setback and electrical.
- Installation of the Tesla Solar Roof BIPV Roofing system must comply with the California Electrical Code.

10.0 Code Compliance Research Report Use

10.1 Approval of building products and/or materials can only be granted by a building official having legal authority in the specific jurisdiction where approval is sought.

10.2 This Code Compliance Research Report shall not be used in any manner that implies an endorsement of the product by UL LLC.

10.3 Reference to the website, https://productiq.ulprospector.com/en/search is recommended to ascertain the current version and status of the UL Listing Certification for these products.

Table 1 – Properties Evaluated

Property	**2021 IBC Section[1]**	**2021 IRC Section[1]**	**2020 Florida Building Code**	**2022 CBC Section[1]**	**2022 CRC Section[1]**
Fire Classification	1505.1	R902.1	1505.1 R902.1	1505.1 705A (WUI)	R902.1 R337.5 (WUI)
Photovoltaic shingles	1507.16	R905.16	1507.17 1518.11 R905.16 R4402	1507.17	R905.16 R324.5 R337.5

1 – Section numbers may be different for earlier versions of the codes

Appendix:
EVALUATION OF BONDING/GROUNDING REQUIREMENTS FOR THE SOLAR ROOF METAL TILE ASSEMBLY

This Appendix represents the result of our evaluation to the partial requirements contained in the following standard:
Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels [UL 2703:2015 Ed.1]

NEC 70: National Electrical Code, 2020 Edition

1. **SUMMARY** - The scope of work was to evaluate the assembly of the Solar Roof BIPV Tile and Metal Tile to the bonding/grounding requirements in the above referenced standards. The Solar Roof BIPV Tiles are frameless modules, which are isolated from the surrounding Metal Tiles via reinforced insulation within the BIPV tile. The Metal Tiles consists of Galvanized sheet steel with a black powder-coated surface, which is textured to appear identical to the BIPV Solar Roof Tiles. These tiles include integrated mounting components.

2. **EVALUATION**

1) **Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels [UL 2703:2015 Ed.1]**

Clause 9.1: Mounting system and clamping/retention device (s) shall have a means for bonding all accessible potentially conductive parts to ground. The grounding means shall comply with the applicable requirements in Grounding and Grounding Devices, Section 8. The grounding means shall be bonded to each conductive part of the rack mounting systems and clamping devices. The grounding means shall be described in detail in the installation manual. See Installation, Assembly and Maintenance/Inspection Instructions, Section 26.
Exception: Accessible conductive components that are not a part of the fault current ground path such as flashings, roof attachments, L-feet, tile hooks, skirts, ballast trays and wind deflectors, and metal roofing panels are not required to be electrically bonded when the following are all true:
a) The installation instructions clearly identify the system's fault current ground path components and their methods of assembly.
b) The accessible conductive component is not likely to be energized other than through direct or indirect contact with other accessible conductive components that are likely to be energized under normal operations or single fault conditions.

In addition, a suitable wire positioning device that complies with the Standard for Positioning Devices, UL 1565, or the Standard for Cable Management Systems – Cable Ties for Electrical Installations, UL 62275, is not required to be electrically bonded.

The Metal Tiles are categorized as metal roofing panels and are not required to be electrically bonded. The installation instructions clearly identify the systems fault current ground path and does not include the Metal Tiles. The PV tiles have no conductive external parts. There are up to 3-layers of additional protection for DC PV conductors under a metal tile: 1) Braided protective sleeve for additional conductor insulation, 2) the Metal tile has a rear insulating layer made from PVDF, and 3) the Metal tile rear includes a plastic

lattice structure and/or flange to further separate conductors away from the metal surfaces. Unsleeved wires are only routed through PV and glass tiles, not through metal tiles. Ground fault paths for Solar Roof systems exist only for the DC circuit conductors as they exit the roof surface into the attic or under an eave or soffit via pass-through assemblies. Circuits exit the pass-through assemblies into conventional junction boxes or conduit couplings, where equipment ground conductors and conduit ground bushings are employed to ensure a continuous EGC path to the solar inverter ground bus in accordance with the National Electrical Code (NEC), ANSI/NFPA 70.
UL 2703 defines 'Likely to be Energized' as 'Any conductive component that may come into contact with a live part under normal operating or single fault conditions. Conductive components of rack mounting systems that enclose electrical circuits or otherwise act as an electrical enclosure, conductive components that are not physically separated from potentially live insulated or non-insulated wires or conductors, conductive components not electrically isolated from other conductive components that are likely to be energized' (Clause 2.22). The Metal Tiles will not come into contact with a live part under normal operating or single fault conditions due to the insulation and separation techniques described above.

2) **NEC 70: National Electrical Code, 2020 Edition - Article 690 Solar Photovoltaic (PV) Systems**

Clause 690.43 Equipment Grounding and Bonding:
Exposed non-current-carrying metal parts of PV module frames, electrical equipment, and conductor enclosures of PV systems shall be connected to an equipment grounding conductor in accordance with 250.134 or 250.136, regardless of voltage. Equipment grounding conductors and devices shall comply with 690.43(A) through (D).

The Tesla Solar Roof BIPV Tile is a separately listed product (UL File Number E491360) and does not have any accessible metallic parts. The Metal Tiles are not categorized as a PV module frame, not part of electrical equipment, and insulated from electrical conductors. They do not mechanically support the Tesla Solar Tile and are used for aesthetic purposes.

3) **Clause 690.43(A) Photovoltaic Module Mounting Systems and Devices:**
Devices and systems used for mounting PV modules that are also used for bonding module frames shall be listed, labelled, and identified for bonding PV modules. Devices that mount adjacent PV modules shall be permitted to bond adjacent PV modules.

The Metal Tiles are not used to mount PV modules and will be electrically isolated from the Tesla Solar Roof BIPV Tiles. They do not mechanically support the Tesla Solar Tile and are used for aesthetic purposes.

4) **690.43(B) Equipment Secured to Grounded Metal Supports:**
Devices listed, labelled, and identified for bonding and grounding the metal parts of PV systems shall be permitted to bond the equipment to grounded metal supports. Metallic support structures shall have identified bonding jumpers connected between separate metallic sections or shall be identified for equipment bonding and shall be connected to the equipment grounding conductor.

The Metal Tile are not used to bond/ground the metal parts of the PV system. They do not mechanically support the Tesla Solar Tile and are used for aesthetic purposes.

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