

## Codes and Compliance Requirements

The Solar Decathlon Rules and Regulations Committee will review the teams' drawings and submittals to ensure compliance with all applicable codes and Solar Decathlon Regulations. This document highlights some of the code and regulation requirements that are of particular importance, either because of the unique nature of this public event or because of critical safety issues. Although these requirements are being given particular emphasis in this document, the reviewers will evaluate the teams' drawings and submittals for compliance with all applicable codes and regulations.

### CC1. Building Planning and Construction

The building is intended to be representative of a single-family dwelling constructed in accordance with the provisions contained in the International Residential Code (IRC). Because portions of the building will be open to viewing by the general public, specific provisions of the International Building Code (IBC) also apply.

#### *CC1.1 Interior Finishes*

Interior finishes must comply with IBC, Sec. 803, and IBC, Table 803.5, Group R-3.

#### *CC1.2 Glazing*

The following hazardous locations are subject to human impact and require safety glazing:

- Glazing in doors
- Glazing in doors, surrounds, and walls enclosing bathtubs or showers
- Glazing in windows within a 24-in. (61.0 cm) arc of either vertical edge of a door and less than 60 in. (152.4 cm) above the floor
- Glazing within 36 in. (91 cm) of stairways and/or within 60 in. (152.4 cm) of the bottom edge of stair treads when the bottom edge of the glazing is less than 60 in. (152.4 cm) above a walking surface
- Glazing in panels located with all the following conditions present:
  - Pane of glazing is greater than 9 ft<sup>2</sup> (0.836 m<sup>2</sup>)
  - Bottom edge of glazing is less than 18 in. (45.7 cm) above the floor
  - Top edge of glazing is greater than 36 in. (91.4 cm) above the floor
  - Walking surface located within 36 in. (91.4 cm) of the glazing (IRC, Sec. 308.4)

### ***CC1.3 Roofing***

Provide details on the proposed roofing system. All roofing materials shall comply with IRC Chapter 9.

### ***CC1.4 Foam Plastic***

Foam plastics used for above-deck thermal insulation shall only be permitted if the foam plastic is isolated from the interior of the building with 0.5-in. (1.27 cm) thick gypsum board. Provide documentation to demonstrate compliance. (IRC, Sec. R314)

### ***CC1.5 Means of Egress***

Means of egress systems accessible to the public shall comply with IRC Chapter 10.

#### ***CC1.5.1. Stairs***

Stair treads shall be 11-in. (27.9 cm) deep minimum with risers 7-in. (17.8 cm) maximum for any portion of the stairs accessible to the public. Neither treads nor risers shall deviate more than 0.375 in. (0.95 cm) over the entire run of the stairs. "Demonstration stairs" may use 10-in. (25.4 cm) minimum treads and 7.75-in. (19.7 cm) maximum risers. "Demonstrator" spiral stairs shall comply with the IRC. Ladders or stairs with steeper geometries may be provided as "demonstrators" but the design team should be aware that United States building codes typically do not permit their use. (IBC, Sec. 1009.3 and IRC, Sec. R311.5)

#### ***CC1.5.2. Handrails***

Handrails shall be provided on both sides of stairs or ramps used by the public during the display. All handrails shall be designed in accordance with the Solar Decathlon Accessibility Requirements and Guidelines document and IBC Chapter 10. (IBC, 1009.11)

### ***CC1.6 Exterior Envelope***

Provide section detail of proposed wall assembly showing framing, sheathing, weather resistive barrier, flashing, and exterior cladding as applicable. (IRC, Sec. R703)

### ***CC1.7 Ceiling Height***

Ceiling height shall provide a minimum of 7 ft (213 cm) of headroom. (IRC, Sec. R305)

## **CC1.8**     *Skylights*

IRC Section R308.6 regulates skylight glazing. Glazing is limited to certain types, and screening under the glazing may be required. Indicate which glazing products are to be used and provide sufficient details in the submitted plans to ensure compliance. (IRC, Sec. 308.6)

## **CC1.9**     *Fire Protection and Prevention*

### *CC1.9.1. Fire Protection Plan*

Provide a fire protection plan. This plan should indicate the location of fire extinguishers, how egress will be made from the unit, and who will be responsible for life-safety (the team's "Fire-Watch Captain") during the Event. Include a written operations plan for the fire-watch personnel.

### *CC1.9.2. Required Equipment*

Each house will be required to have smoke detectors per IRC requirements and a fire extinguisher with a minimum Underwriters Laboratory (UL) rating of 2A-10BC. All battery system rooms or rooms containing a battery system enclosure must have a smoke detector that is either audible from outside the room or has a remote indicator that shall be monitored by the team. Smoke alarms shall be connected to the AC voltage side of the inverter and provided with independent (with the alarm) battery backup. All alarms shall be interconnected and all shall sound when one is activated. (IRC, Sec. R313)

## **CC2. Structural**

The structural drawings and calculations included in the construction drawings and submittals set must be stamped by a licensed professional engineer (PE). Obtaining the PE stamp is the responsibility of the teams, not the Organizers. The Organizers will submit stamped structural drawings and calculations to the National Park Service for final approval. It is strongly recommended that teams involve a licensed structural engineer throughout the design process, because he or she could require structural design changes that could affect other aspects of the house. In addition to meeting applicable IRC requirements, special attention must be given to the structural design challenges unique to the Solar Decathlon. These challenges include, but are not limited to, the following:

- Increased live loads because of public access to houses
- Necessity for tie-downs because of the lack of a permanent foundation (tie-downs must not penetrate more than 18 in. (45.7 cm) into the National Mall topsoil)

- Use of low-impact footings to protect the National Mall grass
- Unique wind loading conditions because of roof-mounted solar systems
- Increased dead loads because of unusual mechanical and electrical equipment, such as batteries and water storage.

The following minimum loads must be used in the structural design:

- Wind: 90 mph (40.2 m/s) (3-second gust), exposure category C (if tie-downs are not used, you must show that there is no overturning or uplifting with a safety factor of 2)
- Railings: 200 lb (890 N) concentrated load applied in any direction at any point at the top of the rail
- Interior Floor, Decks, Ramps: 50 psf (2.39 kPa) live load
- Roof: 20 psf (0.958 kPa) live load
- Soil: 1000 psf (4.79 kPa) load-bearing pressure on top of the soil
- Additional structural design requirements at the post-Event house location (to be determined by the engineer of record).

### ***CC2.1 Prescriptive Requirements***

Structural systems shall be designed in accordance with the appropriate prescriptive provisions of the IRC. See alternate materials provisions in CC2.6. For structural framing, a one-line structural plan view drawing is required at a minimum. Successive plan sheets shall be provided and shall include foundation footings, floor framing, wall locations, and roof framing. All structural components shall be listed including sizes, species and grade, and repetitive spacing (on-center distances). Include details on connections between joists and beams, floor systems and foundations, walls and floors, rafters and beams, etc. Specify proprietary hangers or other mechanical connections. (IRC, Sec.R301.1)

### ***CC2.2 Design Loads***

Structural plans shall indicate the design loads [e.g., 50 psf (2.39 kPa) floors, 100 psf (4.78 kPa) means of egress components, 20 psf (0.958 kPa) snow roof live load] and the location, size, and weight of special loads such as liquid storage tanks, mass or trombe walls, and battery storage racks. (IRC, Sec. R310.2 and Rules and Regulations, Regulation 10.3.3)

### ***CC2.3 Exterior Construction***

Structural plans shall include design details for any exterior appurtenances such as decks, stairs, ramps, awnings, canopies, and roof projections. (IRC, Sec. R301.1)

### ***CC2.4 Specific Point Loads***

Provide wind-analysis calculations for point-load connections demonstrating the components' abilities to withstand 90-mph (40.2-m/s), exposure category C, wind conditions. Provide point-load connection details for all solar panel connections to demonstrate that the connections will resist uplift. (IRC, Sec. R301.1)

### ***CC2.5 Foundation Details***

Provide a foundation plan for temporary set up on the National Mall. Plans shall include location and size of all pad footings and required tie-down anchors (e.g., type, number, and installation configuration) to prevent wind uplift or over-turning. (IRC, Sec. R401.1 and R401.2)

### ***CC2.6 Alternate Materials***

Alternate materials are permitted as follows:

- Engineered Lumber (e.g., TJI's, LPI's, and BCI's) pursuant to specific manufacturer's design data. The product selected must carry a current International Code Council (ICC) Evaluation Services report.
- Structurally insulated panel systems (SIPS) pursuant to specific manufacturer's design data. The product selected must carry a current ICC Evaluation Services report. Also be advised that foam plastics must be thermally isolated from the interior of the dwelling (see CC1.3 for more details).
- Engineered trusses (floor or roof) must be designed in accordance with IRC Sections R502.11 or R802.10 as appropriate. Individual truss reports shall be provided for review and shall bear the seal of a registered design professional. (IRC, R104.11)

### ***CC2.7 Structural Steel***

Provide structural details for load-carrying structural steel assemblies. Include welded or bolted connections within the assembly and where attached to other structures. (IRC, R301.1.3)

## **CC3. Electrical (non-PV)**

### ***CC3.1 Drawing Requirements***

The following requirements are in addition to the requirements listed in the "Drawings and Submittals (Contest 3 Details)" document under the "Electrical" bullet:

- Electrical plan(s) must include layouts of proposed receptacles, switches, light fixtures, smoke alarms, ceiling fans, etc.
- Provide a key for electrical symbols used in the electrical plans. (IRC, Sec. R106.1.1)

### ***CC3.2 Outdoor Receptacles***

Any receptacles used on the exterior of the building must be ground-fault circuit-interrupter (GFCI) protected. Enclosures provided must be suitable for damp locations. (IRC, Sec. E3802.3)

### ***CC3.3 Arc-Fault Circuit Protection***

Any AC circuit providing power to bedrooms shall be protected with arc-fault circuit protection. (IRC, Sec. E3802.11)

### ***CC3.4 Ground-Fault Circuit Protection***

Any AC receptacles located in kitchens or bathrooms shall be GFCI protected. (IRC, Sec. 3802.1 and 3802.6)

## **CC4. Electrical (PV)**

All houses must meet all applicable electrical requirements stated in the 2002 National Electric Code (NEC2002). Particular attention should be paid to Articles 690, 480, 445, 250, 310, 400, and 240, which refer to photovoltaic system design, storage batteries, generators, grounding, conductors for general wiring, flexible cords and cables, and over-current protection devices, respectively. Teams are also encouraged to read the following publication: Wiles, John C. (2001). *Photovoltaic Power Systems and the National Electric Code: Suggested Practices*, Sandia Report SAND2001-0674.

### ***CC4.1 Drawing Requirements***

Provide details on the proposed PV system along with a key for symbols used in the drawings. Such details shall include information on the photovoltaic panels, distribution (e.g., wiring, inverters, switch gear, and over-current protection), and storage equipment. (IRC, Sec. R106.1.1)

### ***CC4.2 Equipment Listings***

All equipment shall carry an approved testing agency's listing. Provide manufacturer's listing information for the PV equipment selected. (IRC, Sec. E3303.3)

## **CC5. Mechanical (non-solar)**

### ***CC5.1 Drawing Requirements***

Provide a key for symbols used in the drawings. (IRC, Sec. R106.1.1)

### ***CC5.2 Return Air***

Return air shall not be taken from a bathroom, kitchen, mechanical or furnace room. Return air shall not be taken where there is a presence of flammable vapors (e.g. battery storage room). (IRC, Sec. M1602.2, Items 2 and 4)

### ***CC5.3 Outside Air***

#### ***CC5.3.1. Intake Location***

Outside air shall not be taken closer than 10 ft (304.8 cm) from an appliance or plumbing vent, or discharge outlet of an exhaust fan [unless the intake is located at least 3 ft (91.4 cm) below the vent or fan discharge]. (IRC, Sec. M1602.2, Item 1)

#### ***CC5.3.2. Screens***

Outside air inlets shall be provided with a screen with openings 0.25 in. (0.64 cm) to 0.5 in. (1.27 cm). (IRC, Sec. M1602.3)

### ***CC5.4 Bathroom Ventilation***

Bathrooms shall be provided with mechanical ventilation systems capable of providing 50 cfm (23.6 L/s) for intermittent ventilation or 20 cfm (9.4 L/s) for continuous ventilation, or provide windows allowing 1.5 ft<sup>2</sup> (0.139 m<sup>2</sup>) opening for natural ventilation. (IRC, Sec. R303.3)

## **CC6. Mechanical (Solar)**

### ***CC6.1 Drawing Requirements***

Provide plan details for any proposed solar mechanical systems. Provide details on collectors, fluid distribution, heat exchangers, etc. along with a key for symbols used in the drawings. (IRC, Sec. 106.1.1)

### ***CC6.2 Cross Connection***

Provide details for the solar hot water system. Provide details indicating if potable water or other heat transfer liquids will be employed. If other than potable water is used, an approved heat exchanger shall be employed to isolate potable water from transfer fluids. (IRC Section R106.1.1)

### ***CC6.3 Access***

Solar collectors, controls, dampers, fans, and pumps shall be accessible for inspection, maintenance, repair, and replacement. (IRC, Sec. M2301.2.1)

### ***CC6.4 Roof Mounted Collectors***

The roof shall be constructed to support all loads imposed by the collectors. If collectors are intended to serve as the roof covering, documentation shall be provided to determine compliance with the roofing provisions in IRC, Chapter 9. If the collectors will be placed over the roof covering, the collectors and supporting structure shall be constructed of non-combustible material or fire-retardant-treated wood equivalent to that required for the roof covering. (IRC, Sec. M2301.2.2)

### ***CC6.5 Pressure and Temperature Relief***

Pressure- and temperature-relief valves shall be provided for components under pressure. Relief devices shall be installed in sections of the system so that a section cannot be valved off or isolated from a relief device. (IRC, Sec. M2301.2.3)

### ***CC6.6 Vacuum Relief***

A vacuum relief valve shall protect system components that might be subjected to pressure drops below atmospheric pressure during operation or shutdown. Indicate if this system is subject to vacuum conditions. (IRC, Sec. M2301.2.4)

### ***CC6.7 Expansion Tanks***

Expansion tanks in solar systems shall be installed in accordance with IRC, Section M2003 in closed-fluid loops that contain heat transfer fluid. (IRC, Sec. M2301.2.6)

### ***CC6.8 Solar Loop Isolation***

Valves shall be installed to allow the solar collectors to be isolated from the remainder of the system. (IRC, Sec. M2301.2.8)

### ***CC6.9 Maximum Temperature Limitation***

Systems shall be equipped with means to limit the maximum water temperature of the system fluid entering or exchanging heat with any pressurized vessel inside the dwelling to 180°F (82°C). This protection is required in addition to required temperature and pressure relief valves in IRC, Section M2301.2.3. (IRC, Sec. M2301.2.9.)

### ***CC6.10 Collector and Thermal Storage Unit Labeling***

Collectors and storage units shall be listed and labeled to show the manufacturer's name, model number, serial number, collector weight, collector maximum allowable temperatures and pressures, and the type of heat transfer fluids that are compatible with the collector and storage units. (IRC, Sec. 2301.3)

### ***CC6.11 Prohibited Heat Transfer Media***

Flammable gasses and liquids shall not be used as heat transfer fluids. (IRC, Sec. M2301.4)

### ***CC6.12 Backflow Prevention***

All connections from the potable water supply to solar systems shall comply with IRC, Section P2902.4.5. (IRC, Sec.M2301.5)

## **CC7. Plumbing**

### ***CC7.1 Drawing Requirements***

The following requirements are in addition to the requirements listed in the “Drawings and Submittals (Contest 3 Details)” document under the “Mechanical and Plumbing” bullet:

- Provide a labeled isometric diagram of the proposed plumbing system for review. Clearly indicate waste lines, vent lines, potable water supply, heat exchange equipment, and the type of any heat exchange fluid other than potable water.
- Provide a key for symbols used in the drawings. (IRC, Sec. 106.1.1)

### ***CC7.2 Water Closet Demonstration***

Water closets (W.C.) are installed for demonstration only and shall not be connected to any portion of the gray water disposal system. The W.C. shall be attached to a PVC or ABS 4-in. (10.2 cm) to 3-in. (7.62 cm) water-closet flange provided with a capped end. The cap shall be located as close as possible to the flange fitting. No structural member shall be cut or otherwise damaged to accommodate the W.C. flange assembly.

### ***CC7.3 Plumbing Wall – Structural***

Recommendation: Create a dedicated plumbing wall with thickness sufficient to allow pipe penetrations within the studs not exceeding 60% of the stud width in non-bearing walls. (IRC, Sec. 602.6)

### ***CC7.4 Shower Mixing Valves***

Shower mixing valves shall be pressure balanced, thermostatic mixing, or a combination of the two, with the high limit set at 120°F (48.9°C) to prevent scalding. (IRC, Sec. P2802.3 and P2708.3)

### ***CC7.5 Backflow Prevention***

Backflow prevention is required to isolate the potable water supply from the solar systems. See IRC Section P2902.2 for permissible devices. Because this project uses supply tanks for potable water, the use of a separate and isolated fill system for the solar component may be deemed acceptable backflow prevention. (IRC, Sec. P2902.2)

## **CC8. ADA**

### ***CC8.1 Accessible Route – Interior***

An accessible route shall be provided within the unit to all spaces accessible to the public. Accessible routes shall be designed in accordance with Regulation 10.1 in the Rules and Regulations. Other accessible features may be included in rooms such as kitchens and bathrooms at the discretion of the designers. If any of the features are intended for use by the public, they shall be accessible.

### ***CC8.2 Accessibility – Upper Level Roof Deck and Interior Second Floor/Loft Levels***

This building is intended to demonstrate a single-family dwelling that is not regulated by any federal accessibility standard. However, the building is open to the public for educational purposes and must be accessible in all primary function areas. Therefore, any portion of the building where the public is permitted must be on an accessible route. The Americans with Disabilities Act (ADA) requires an elevator to be installed in buildings (funded pursuant to Title II) where an accessible route is required to stories above the first floor (such as the roof deck, second floor, or loft). The 3000-ft<sup>2</sup> exception located in IBC Section 1104.4 Exc. 1 is superseded by Federal regulation.

Following a discussion with a representative of the ADA Assistance Center, it appears acceptable to “demonstrate” a roof deck, loft, or upper level accessed via a stair, or other means of inaccessible access as long as no member of the public is allowed to access the space during the public display. It is also advisable that students not occupy the area during public viewing. Any provided means of access shall be fully gated or cordoned off to inhibit entry. Adherence to these guidelines should remove any perception that the upper level is being used as a primary function and therefore subject to the accessibility provisions of the ADA.

### ***CC8.3 Accessibility – Ramps***

The following are the most important regulations regarding ramps:

- The slope cannot exceed 1:12
- 60-in. (152.4 cm) landings are required at the top and bottom of the ramp
- Handrails are required if the ramp’s rise exceeds 6 in. (15.2 cm). [American Disabilities Act Accessibility Guidelines (ADAAG), Sec. 4.8]

#### ***CC8.4 Changes In Elevation***

All changes in elevation (including even minor changes in areas such as door thresholds) must be considered along an accessible route. Changes not exceeding 0.25 in. (0.635 cm) are acceptable. Elevation changes between 0.25 in. (0.635 cm) and 0.5 in. (1.27 cm) shall be beveled at a maximum of 1:2. Any higher change in elevation shall be by a ramp with a maximum slope of 1:12. (ADAAG, Sec. 4.5.2)

#### ***CC8.5 Doors and Door Approaches***

All doors shall comply with ADAAG Section 4.13. Doors that can be fixed in an open position may be accepted as part of the accessible route if 32-in. (81.3 cm) minimum clearance is provided through the door opening with the door secured in the fully open position. (ADAAG, Sec. 4.13)