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V2.2

# Solar Decathlon China

## BUILDING CODE

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ORGANIZING COMMITTEE OF SOLAR DECATHLON CHINA

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## Section 1. General Rules

- 1.1.1 The Building Code was formulated to protect the health and safety of the public entering the buildings constructed by the teams participating in the Solar Decathlon (SD) (2018) (hereafter referred to as “participating buildings”). The Building Code was designed to provide reference in the design phase for the participating teams, in order to avoid great contradiction between the design proposal for the participating building and Chinese building codes.
- 1.1.2 The Building Code is applicable to the buildings participating in SD China 2018.
- 1.1.3 The Chinese National Standard (GB) as well as the National Standard for Building Industry (JGJ) has been adopted as reference.
- 1.1.4 According to Chinese laws and regulations related to building construction, the final design documents for construction must be produced in coordination with or reproduced by Chinese design institutes and approved by authorized auditing centers. SDC organizing committee can provide assistance in finding cooperating design institutes for finalizing the documents if teams request for it. All the auditing and approval processes will be arranged by SDC organizing committee with required materials submitted by the teams.
- 1.1.5 As specified by the regulations, the participating buildings shall have a building area restricted to the range of 120~200 m<sup>2</sup> and are to be designed for a service life of 50 years. This specification is designed to facilitate these requirements.
- 1.1.6 The building is the demonstration of single-family dwelling, but it will be open to the general public. Therefore, the building design shall meet the design requirements for residential and public buildings at the same time. The building shall be divided into the two areas below according to the opening conditions:
  - a. Public area – an area that visitors can enter.
  - b. Restricted area – an area that only the participators and the judging panel can enter.
- 1.1.7 The selection of structural systems and building materials shall follow the principles of recyclability and shall be comprehensively determined according to factors such as geographic environment, functionality, load characteristics, material supply, construction conditions, etc.
- 1.1.8 The building field data required for design, including soil bearing capacity, wind speed and exposure, design snow and seismic loading, is offered separately by the organizing committee.
- 1.1.9 International system of units shall be used in all design submissions, including but not limited to drawings, project manuals, and other related documents. Other systems of units are optional for reference purpose.

## Section 2. Adopted Code

2.1.1 The Chinese Division of the Solar Decathlon Building Code governs the standards for safety and health. The Chinese building codes adopted as reference include:

1. *Code for Design of Civil Buildings* (GB50352-2005)
2. *Code of Design on Building Fire Protection and Prevention* (GB50016-2014)
3. *Code for Fire Prevention in Design of Interior Decoration of Buildings* (GB50222-95, Revised Edition, 2001)
4. *Residential Building Code* (GB50368-2005)
5. *Design Code for Residential Buildings* (GB50096-2011)
6. *Codes for Accessibility Design* (GB50763-2012)
7. *Assessment Standard for Green Building* (GB/T50378-2014)
8. *Code for Green Design of Civil Buildings* (JGJ/T229-2010)
9. *Design Standard for Energy Efficiency of Public Buildings* (GB50189-2015)
10. *Code for Design of Masonry Structures* (GB50003-2011)
11. *Load Code for the Design of Building Structures* (GB50009-2012)
12. *Code for Design of Concrete Structures* (GB50010-2010)
13. *Code for Seismic Design of Building* (GB50011-2010)
14. *Standard for Classification of Seismic Protection* (GB50223-2008)
15. *Code for Design of Steel Structures* (GB50017-2003)
16. *Code for Welding of Steel Structures* (GB50661-2011)
17. *Code for Design of Timber Structures* (GB50005-2003, 2005)
18. *Code for Design of Building Foundation* (GB50007-2011)
19. *Technical Specification for Lightweight Residential Buildings of Steel Structure* (JGJ209-2010)
20. *Technical Specification for Low-rise Cold-formed Thin-walled Steel Buildings* (JGJ227-2011)
21. *Technical Specification for Application of Autoclaved Aerated Concrete* (JGJ/T17-2008)
22. *Thermal Design Code for Civil Building* (GB50176-93)
23. *Code for Design of Building Water Supply and Drainage* (GB50015-2003, 2009 Edition)
24. *Technical Code for Solar Water Heating System of Civil Buildings* (GB50364-2005)
25. *Code of Design for Building Reclaimed Water System* (GB50336-2002)
26. *Engineering Technical Code for Rain Utilization in Building and Sub-district* (GB50400-2006)
27. *Code for Design of Wastewater Reclamation and Reuse* (GB50335-2002)
28. *Standard for Water Saving Design in Civil Building* (GB50555-2010)
29. *Code for Design of Extinguisher Distribution in Buildings* (GB50140-2005)
30. *Code for Acceptance of Construction Quality of Water Supply Drainage and Heating Works* (GB50242-2002)
31. *Code for Acceptance for Construction Quality of Ventilation and Air Conditioning Works* (GB50243-2002)
32. *Code for Design of Outdoor Water Supply Engineering* (GB50013-2006)
33. *Code for Design of Outdoor Wastewater Engineering* (GB50014-2006, 2014 Edition)
34. *Design Code for Heating Ventilation and Air Conditioning of Civil Buildings* (GB50736-2012)
35. *Technical Code for Fire Protection Water Supply and Hydrant Systems* (GB50974-2014)
36. *Code for Design of Power Supply and Distribution Systems* (GB50052-2009)
37. *Code for Design of Low Voltage Power Distribution* (GB50054-2011)
38. *Code for Design of Power Distribution of General-Purpose Utilization Equipment* (GB50055-2011)
39. *Code for Electrical Design of Civil Buildings* (JGJ16-2008)
40. *Code for Design Protection of Structures Against Lightning* (GB50057-2010)
41. *Standard for Lighting Design of Buildings* (GB50034-2013)
42. *Technical Code for Protection of Building Electronic Information System against Lightning* (GB50343-

2012)

- 43. *Code for Design of Cables of Electric Engineering* (GB50217-2007)
- 44. *Code for Design of Electrical Measuring Device of Power System* (GB/T50063-2008)
- 45. *Code for Electrical Design of Residential Buildings* (JGJ242-2011)
- 46. *Technical Code for Application of Solar Photovoltaic System of Civil Buildings* (JGJ203-2010)
- 47. *Code for Classification for Burning Behavior of Building Materials and Products* (GB8624-2012)
- 48. *Unified Standard for Reliability Design of Engineering structures* (GB50153-2008)

#### 2.1.2 Alternate Materials and Methods of Construction.

The requirements of the Chinese Building Codes listed herein are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by these codes provided that such alternates are approved by SD China. An alternative material or method of construction may only be approved when the proposed alternative complies with the intent of the provisions of this code. The proposed alternate shall be fully documented by the team with justification as to how the alternate is at least the equivalent of that prescribed.

## Section 3. Terms

### 3.1.1 Guard Rail

Defined as a structure used for perimeter enclosure of a building or its attached user occupied elements as a protective measure for preventing people from falling in the normal use of buildings. It is generally used in the positions of elevated balconies, decks, stairs or occupied roof parapets.

### 3.1.2 Rain Awning

Defined as a horizontal member at the entrance of a building and at the upper part of a roof balcony for shedding rain and protecting an exterior door from rain erosion.

### 3.1.3 Fire Resistance Rating

Defined as the period of time a building member, accessory or structure is designed for exposure to fire until it loses its stability, integrity or heat insulation under standard test conditions for fire resistance in accordance with the *Code for Classification for Burning Behavior of Building Materials and Products* GB8624-2012.

**Exception:** Such fire resistance rating may be determined by testing in accordance with other test standards approved by the SD China.

### 3.1.4 Non-Combustible Component

Defined as a building member made of non-combustible materials. Non-Combustibility material denotes a kind of material that does not ignite, weakly burns or carbonizes when it is exposed to fire or subjects to high temperature in air, such as metallic material and natural or artificial inorganic mineral material used in buildings.

### 3.1.5 Difficult-combustible Component

Defined as a building member made of difficult-combustible material or a building member made of combustible material but having non-combustible material protective coating. Difficult-combustible material denotes a kind of material that is not readily igniting, weak burning or carbonizing when it is exposed to fire or subjects to high temperature in air, and its burning or slightly burning will immediately stop when fire source is removed. Such as asphalt concrete, wood treated with fire protection, organic material filled concrete and cement shaving board.

### 3.1.6 Combustible Component

Defined as a building member made of combustible material. Combustible material denotes a kind of material that can immediately burn or weakly burn when it is exposed to flame or subjects to high temperature in air, and support combustion or weak combustion when fire source is removed, such as wood product, etc.

## Section 4. Building Planning and Construction

### 4.1 Fire Safety

- 4.1.1 The design of building fire protection, fire-suppression equipment and interior finishes in the final design proposal adopted by the participating team, must have received fire prevention approval by the fire security organization and obtained the approval documents for the fire protection of building works issued by the local fire security organization. Refer to 1.0.4 for the approach to meeting these requirements.
- 4.1.2 Fire Resistance Rating and Fireproof Structure of Building Components
- The fire resistance rating for the building shall be in accordance with Table 1 for the combustibility and duration of fire resistance for building components. For timber structure buildings, the fire resistance of building components shall be in accordance with Table 2.

**Table 1** Combustibility and duration of fire resistance (h) for building components

Building Element	Component Flammability / Fire Resistance Duration in Hours
Firewall	Non-combustible component / 3.00
Bearing wall	Difficult-combustible component / 0.50
Exterior non-bearing wall	Difficult-combustible component / 0.75
Stair hall wall/elevator shaft wall	Difficult-combustible component / 1.00
Partitions on both sides of evacuating corridor	Non-combustible component / 0.75
Room partition	Difficult-combustible component / 0.25
Heal post	Difficult-combustible component / 1.00
Beam	Difficult-combustible component / 1.00
Floor slab	Difficult-combustible component / 0.50
Bearing components of roof	Difficult-combustible component / 0.25
Evacuating stairs	Difficult-combustible component / 0.50
Ceiling (including ceiling joists)	Difficult-combustible component / 0.15

Note: The table is cited from the *Code of Design on Building Fire Protection and Prevention* (GB50016-2014) and *Residential Building Code* (GB50368-2005).

**Table 2** Combustibility and duration of fire resistance (h) for timber structure building components

Building Element	Component Flammability / Fire Resistance Duration in Hours
Firewall	Non-combustible component / 3.00
Bearing wall, stair hall wall	Difficult-combustible component / 1.00
Exterior non-bearing wall	Difficult-combustible component / 0.75
Elevator shaft wall	Non-combustible component / 1.00
Partitions on both sides of evacuating corridor	Difficult-combustible component / 0.75
Room partition	Difficult-combustible component / 0.50
Heal post	Combustible component / 1.00
Beam	Combustible component / 1.00
Floor slab	Difficult-combustible component / 0.75
Bearing components of roof	Combustible component / 0.50
Evacuating stairs	Difficult-combustible component / 0.50
Ceiling (including ceiling joists)	Difficult-combustible component / 0.15

Note: The table is cited from the *Code of Design on Building Fire Protection and Prevention* (GB50016-2014).

- When a timber structure building has roofs with various heights, combustible components shall not

be used for the bearing components of the lower roof. When difficult-combustible bearing components are used, the fire resistance duration shall not be less than 0.75h.

- (ii) For the roof of a light timber structure building, except the waterproof layer, the thermal insulation layer, and the roof sheathing, all other parts shall be regarded as bearing components, for which combustible components shall not be used, and the fire resistance duration shall not be less than 0.50h.

- b. See Table 3 for the combustibility and fire resistance rating for typical walls.

**Table 3** Combustibility and duration of fire resistance (h) for typical walls

Name of Structure		Thickness of Structure (mm)	Combustibility and Duration of Fire Resistance (h)
Bearing wall	Solid wall made of silicate brick, concrete and reinforced concrete	120	Non-combustible component, 2.50
		180	Non-combustible component, 3.50
		240	Non-combustible component, 5.50
		370	Non-combustible component, 10.50
	Block wall made of aerated concrete	100	Non-combustible component, 2.00
	Block wall made of lightweight concrete, Wall made of natural stone	120	Non-combustible component, 1.50
		240	Non-combustible component, 3.50
		370	Non-combustible component, 5.50
Non-bearing wall	Block wall made of lightweight concrete, (not plastered and painted)	75	Non-combustible component, 2.50
		100	Non-combustible component, 3.75
		150	Non-combustible component, 5.75
		250	Non-combustible component, 8.00
Non-bearing wall	Block wall made of aerated concrete	150	Non-combustible component, 2.92
	Block wall made of ceramsite concrete	240	Non-combustible component, 4.00
		290	Non-combustible component, 7.00
	Block wall made of light aggregate concrete	100	Non-combustible component, 1.50
		150	Non-combustible component, 2.00
		200	Non-combustible component, 2.25
		250	Non-combustible component, 3.00
	Block wall made of portland fly-ash cement	200	Non-combustible component, 4.00
	Vertical wallboard made of reinforced aerated concrete	150	Non-combustible component, 3.00
	Partition wall made of aerated concrete	75	Non-combustible component, 2.00
	Hollow wall made of gypsum perlite concrete	60	Non-combustible component, 1.20~1.50
		2 layers (60+60), hollow 50	Non-combustible component, 3.75
	Gypsum board, steel joist	2 layers (12+12), hollow 80	Non-combustible component, 0.33
		2 layers (2×12+3×12), hollow 70	Non-combustible component, 1.25
		2 layers (2×12+2×12), hollow 70 packed with mineral wool	Non-combustible component, 1.20
	Common gypsum board (mixed with paper fibers) steel joist	2 layers (2×12+2×12), hollow 75	Non-combustible component, 1.10
	Fireproof gypsum board (mixed with glass fibers) steel joist	2 layers (2×12+2×12), hollow 75	Non-combustible component, 1.35
		2 layers (2×12+2×12), hollow 75	Non-combustible component, 1.60



		packed with 40 rock wool	
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- c. The setting of shafts shall comply with the following requirements:
  - (i). The cable shaft, piping shaft, smoke vent shaft, exhaust duct shaft, etc. shall be set separate, and enclosed by incombustible components whose fire-resistance rating is not less than 1.00h.
  - (ii). The cable shaft and the piping shaft shall be sealed with incombustible materials whose fire resistance rating is not less than that of the floor slab or fireproof sealing materials in the position of each floor slab; the gaps of the holes communicating the cable shaft and the piping shaft with rooms and corridors shall be blocked with fireproof sealing materials.
  - (iii). Grade C fire doors shall be used for the access doors of the cable shaft and the piping shaft.

#### 4.1.3 Combustibility of Interior Finishing Materials

- a. The combustibility of finishing materials shall be classified into four grades in accordance with *Classification for Burning Behavior of Building Materials and Products* (GB8624-2012) and shall comply with the provisions in Table 4.

**Table 4** Combustibility grades of finishing materials

Grade	Combustibility of Finishing Materials
A	Incombustible
B1	Mildly combustible
B2	Combustible
B3	Easily combustible

Note: The table is cited from the *Code for Fire Prevention in Design of Interior Decoration of Buildings* (GB50222-95, revised edition, 2001).

- b. The combustibility grades of the finishing materials in each position inside the residential building shall not be lower than those provided in Table 5.

**Table 5** Combustibility grades of finishing materials for residential buildings

Ceiling	Wall	Floor	Partition	Fitment	Decorative Fabric		Other Finishing Materials
					Curtain	Bedspreed	
B1	B1	B1	B1	B2	B2	B2	B2

Note: The table is cited from the *Code for Fire Prevention in Design of Interior Decoration of Buildings* (GB50222-95, revised edition, 2001).

- c. The distribution box inside the building shall not be directly installed on the finishing materials with a grade lower than B1.
- d. When the high-temperature luminaries are in close proximity to non-Grade A finishing materials, protective measures for fire prevention shall be taken such as heat insulation, heat radiation, etc. The combustibility grade of the materials used for light fixture shall not be lower than Grade B1.
- e. Hangings, sculptures, models and specimens made of finishing materials of Grade B3 shall not be arranged in public buildings. When necessary, keep away from fire or heat source.
- f. For kitchens in the building, the ceiling, walls and floor shall be all made of finishing materials of Grade A.

#### 4.1.4 Combustibility of Exterior Finishing Materials

- a. The thermal insulating materials outside the exterior wall and those in the building wall cavity shall be of Combustibility Grade A;
- b. Fireproof structure of building lighting (glazed) roof
  - (i). The window-sill walls and the walls between windows shall be packed with non-combustible material. When the external wall is made of non-combustible components with the duration of fire resistance of no less than 1.00h, fire-resistant materials shall be packed in the walls;
  - (ii). Fireproof partition shall be designed for the gaps between lighting roof and fireproof partitioning components, the gaps between the lighting roof and solid wall or the edge of roof opening, etc.

#### 4.1.5 Measures for Safe Evacuation and Escape

- a. The number of evacuees in public spaces shall be determined by calculating it based on the assumption of 0.5 person/m<sup>2</sup> for their corresponding building areas.
- b. The respective overall width of evacuating corridors, fire exits, evacuating stairs, room evacuating doors in the building shall be determined by calculation. The clear widths of the fire exits and room evacuating doors shall be no less than 0.9m, whereas the clear widths of the evacuating corridor shall be no less than 1.1m. If provided, the clear widths of outward two-side evacuating doors on the first floor shall be no less than 1.4m.
- c. Exterior fire escape stairs are prohibited.
- d. The stair hall for evacuation shall comply with the following provisions:
  - (i). The stair hall shall have access to natural lighting and natural ventilation;
  - (ii). No protrusions or other barrier affecting evacuation shall exist in the stair hall.

## 4.2 Routine Safety – Preventive Measures for Falling

- 4.2.1 Protective measures shall be taken at the free-falling positions of balconies, lanais, decks, occupied roofs, exterior windows, open stairs, etc., and the specific requirements for arrangement are as follows:
  - a. The balcony rails (boards) shall be no less than 1.05m.
  - b. The stair railings shall be no lower than 0.90m. When the stair railings at the horizontal segment are longer than 0.50m, the railings shall be no lower than 1.05m. When the stair hall shaft (the shaft between two stair treads) is wider than 0.11m, the measures for preventing children from climbing and sliding must be taken.
  - c. In order to prevent children from climbing, the railings shall be formed from vertical components with the clear distance of the components of no more than 0.11m.
  - d. The railings shall be made of firm and durable materials and shall be able to bear the horizontal load specified in the load code (the horizontal load at the top of the residential railings is required to be higher than or equal to 0.5kN/m).
  - e. Protective facilities shall be provided when the step height exceeds 0.70m and any of the sides are free.
  - f. Gaps between the bottom guard rail and the floor or roof shall not exceed a height of 0.10m. (Note: The railing height shall be calculated by the vertical height from the floor or roof to the top surface of the railing handrail; if a position for stepping on, which is wider than or equal to 0.22m and lower than or equal to 0.45m, is available at the bottom, it shall be calculated from the top surface of the position for stepping on.)
- 4.2.2 The construction of the following parts of the glass building materials must be made of safety glass:
  - a. Window glass with the area of  $\geq 1.5\text{m}^2$  or French windows whose distance from the bottom edge of the glass to the final finishing surface is  $< 0.50\text{m}$ ;
  - b. Curtain wall;
  - c. Non-vertically assembled windows, various overhead glazing installations (including skylight and lighting roof) and suspended ceilings;
  - d. Indoor partition, and partitions in the showering positions and bathtub;
  - e. Breast boards of stairways, balconies and platform corridors, and breast boards in courtyard;
  - f. Floor used for pedestrians to walk on;
  - g. Public entrances/exits, hall, etc.
- 4.2.3 Safety glass should be rationally used, according to the specific use of the glass parts
  - a. The safety glass shall be tempered glass and sandwich glass conforming to the current national standards, as well as other glass products formed by the combined processing of tempered glass or sandwich glass meeting the standard of *Technical Code for Application of Building Glass* (JGJ113-2009), such as safety hollow glass. Monolithic semi-tempered glass and monolithic wired glass considered acceptable safety glass materials.
  - b. The maximum permitted area of safety glass shall comply with the provisions in Table 6.
  - c. Glass for movable doors, fixed doors and French windows shall be selected in accordance with the following provisions:
    - (i). Safety glass conforming to the provisions in Table 6 shall be used for framed glass;

- (ii). Tempered glass with the nominal thickness of no less than 12mm shall be used for frameless glass.
- d. The indoor partitions shall adopt safety glass, and the maximum area in use shall comply with the provisions in Table 6.

**Table 6** Maximum Permitted Area of Safety Glass

Type of Glass	Nominal Thickness (mm)	Maximum Permitted Area (m <sup>2</sup> )
Tempered Glass (single layer)	4	2.00
	5	2.00
	6	3.00
	8	4.00
	10	5.00
	12	6.00
Sandwich Glass (a film is sandwiched between two layers)	6.38, 6.67, 7.52	3.00
	8.38, 8.67, 9.52	5.00
	8.38, 8.67, 9.52	7.00
	12.38, 12.67, 13.52	8.00

Note: The table is cited from the Technical Code for Application of Building Glass (JGJ113-2009).

- e. Glass in bathrooms shall comply with the following provisions:
  - (i). Glass for shower partitions and bathtub partitions shall be safety glass conforming to the provisions in Table 6.
  - (ii). Frameless glass in the bathroom shall be tempered glass conforming to the provisions in Table 6 and with a nominal thickness of no less than 12mm.
- f. Glass for indoor breast boards shall comply with the following provisions:
  - (i). Breast board glass not bearing horizontal load shall be tempered glass conforming to the provisions in Table 6 and with a nominal thickness of no less than 5mm, or sandwich glass with a nominal thickness of no less than 6.38mm.
  - (ii). Breast board glass bearing horizontal load shall be tempered glass conforming to the provisions in Table 6 and with a nominal thickness of no less than 12mm, or sandwich glass with a nominal thickness of no less than 16.76mm. When the lowest point of the breast board glass is at the height of 3m and above or 5m and below from the floor, tempered sandwich glass with a nominal thickness of no less than 16.76mm shall be used. When the lowest point of the breast board glass is at the height of 5m and above, breast board glass bearing horizontal load shall not be used.
- g. The design for resisting wind pressure is required for outdoor glass breast boards in addition to conformance to the provisions in Table 6. For areas requiring anti-seismic design, the combined effect of seismic action shall be taken into consideration.
- h. According to the specific positions of easily impacted building glass, provide notable markers in the line of sight or provide guardrails as an anti-collision measure. Reliable guardrails shall be provided in positions where people or glass may fall after a collision.
- i. The roof glass shall comply with the provisions in Table 6. The following considerations also apply: when the peak of the roof glass is at a height of  $\leq 3\text{m}$  from the ground, homogeneous tempered glass or sandwich glass shall be used; when the peak of the roof glass is at a height of  $\geq 3\text{m}$ , sandwich glass with the film thickness of  $\geq 0.76$  must be used.
- j. No pedestrian path or parking space shall be arranged under glass curtain walls. Rain awnings should be provided at the entrances/exits for people. Rain awnings should extend 1.2m from the curtain wall.

### 4.3 Routine Safety – Preventive Measures for Slipping and Falling

- 4.3.1 The anti-skid factor of floor is a key indicator for the anti-skid and anti-falling performances of floor. When selecting floor materials, the anti-skid factor for the surface of the floor materials shall be fully considered according to the different uses of the floor.
- 4.3.2 The anti-skid performance of floor shall be classified into three grades according to the anti-skid factor of

floor materials (see Table 7).

**Table 7** Grade for Anti-Skid Performance of Floor

Anti-skid Grade	Unsafe	Safe	Very Safe
Anti-skid Factor	< 0.5	0.5 ~ 0.79	≥ 0.8
Anti-skid factor: Refers to the ratio of the tangential force to the vertical force when skid exactly occurs for an object to overcome the maximum static friction.			

Note: The table is cited from the Classification and Test Method of Slip Resistance for Ground Stones (JC/T1050-2007)

- 4.3.3 The anti-skid factor for the surface of the floor materials shall be  $\geq 0.50$ . At entrances, hallways and corridors with heavy pedestrian traffic, the safe anti-skid factor shall be 0.6 and above for horizontal floors and 0.8 and above for ramps.
- 4.3.4 Anti-skid measures shall be taken for stairways. The non-skid strips should be depressed or raised no more than 3mm from the surface of the stairs. Local lighting shall be provided at the origin and terminal ends of the stairways.
- 4.3.5 Stair treads shall be at the same height for each flight of stairs. Total riser deviation in any single run of stairs shall not exceed 10mm.
- 4.3.6 For the treads and risers of indoor stairways, the depth shall be no less than 0.26m, and the height shall be no more than 0.175m. For the treads and risers of outdoor stairways, the depth shall be no less than 0.30m, and the height shall be no more than 0.15m but no less than 0.10m; moreover, all risers shall be anti-skid. Indoor stairways shall have two risers at a minimum; if the elevation difference is less than two risers, ramps should be used instead of stairways.
- 4.3.7 Ramps shall comply with the following provisions:
- The slope of an indoor ramp not for wheelchairs shall not exceed 1:8, whereas the slope of an outdoor ramp shall not exceed 1:10;
  - If the projected horizontal length of the indoor ramp not for wheelchairs exceeds 15m, a landing is required, and the width of the landing shall be determined in accordance with the function and the cushion space necessary for the equipment dimensions;
  - The ramp for wheelchairs shall have the width of no less than 1m and the slope of no more than 1:12; a landing of 1.5m long is required if the horizontal projected length of the ramp exceeds 12m;
  - Anti-skid measures with an anti-skid factor of  $\geq 0.8$  shall be taken for ramps.
  - Ramps with a slope exceeding 1:20 and a change in elevation greater than 0.15m shall be provided with handrails on each side of the ramp. Such handrails shall be provided with 0.90m minimum clearance and shall have their upper surface placed between 0.86m and 0.97m above the walking surface.
- 4.3.8 Barrier-free areas should be accessible to wheelchairs, and a wheelchair ramp should be made wherever there is a height difference. Walkway in the competition site should be smooth, skid-proof and solid.

### 5.1 General Provisions

- 5.1.1 Refer to 1.0.4 for the approach to meeting all requirements for structural design.
- 5.1.2 The participating buildings shall be of any structural type complying with available current Chinese national (or industrial) standards. Structural types addressed in the standards include, reinforced concrete structure, steel structure, masonry structure, wood structure, cold-bending hollow steel section, autoclaved aerated concrete, etc.
- Exception:** Structural configurations not prescribed by the adopted standards may be used when properly documented and approved by SD China in accordance with the provisions of Section 2.0.2.
- 5.1.3 The structure shall have sufficient reliability within the design service life, and both the ultimate limit states design and the checking of serviceability limit states shall be carried out by using the design method for limit states based on probability theory.
- 5.1.4 Lateral Forces
- a. The structural design shall meet the requirements for wind resistance and earthquake resistance as provided by Sections 5.2.3 and 5.2.4. Earthquake-resistant design shall meet all the requirements of *Code for Seismic Design of Building*, Chapter 5 (GB50011-2010).
- Exception:** Alternative seismic and wind lateral design methodology may be used when approved by SD China. Such design methods shall be part of an approved national or international standard. Such design must accommodate for the full seismic and wind forces prescribed by SD China.
- b. The bearing capability of the foundation and base shall be calculated, and the analysis and calculation of earthquake effect and wind load for the structure, component and their joint nodes shall be provided. The possible overturning, sliding, uplift, etc. of buildings and structures shall be calculated. Priority should be given to the rational design of the structure itself, while applying appropriate structural measures to prevent overturning, sliding and wind that may lead to the structural or component damage.
- 5.1.5 The project shall have the design service life of 50 years, safety level of Grade 2, earthquake-resistant fortification of Type C and the factor of structural importance of 1.0 in accordance with *Unified standard for reliability design of building structures* GB50068-2001.
- 5.1.6 The structural system shall comply with the following provisions:
- a. A geometrically stable system shall be employed;
- b. Reliable connectors and necessary anchoring and support are required among all components, in order to ensure the structural rigidity and integrity;
- c. Direct and reasonable paths for force transmission are required.
- 5.1.7 Any ancillary facility and equipment attached to the building, such as solar panels, shall be reliably connected with the major structure. The designer shall perform the analysis and calculations of earthquake action and wind load for all joint nodes for connecting the ancillary facility and equipment with the major structure, and shall provide the structural details of the joint nodes as well.
- 5.1.8 The structural design shall include the detailed design of all the exterior accessory buildings, such as decks, stairs, ramps, awnings, canopies, protective devices for roof, etc., as well as the details regarding the structures connected to the major structure.

### 5.2 Load and Load Effect Combination

#### 5.2.1 General Requirements

The structural design shall pay special attention to reflecting the unique requirements for the structural design of buildings in Solar Decathlon, mainly including the following contents:

- a. Increased live loads due to public access to houses;
- b. Roofs and walls shall meet the specific wind load requirements for installing solar system;
- c. Increased dead loads because of unusual or concentrated mechanical and electrical equipment.

- 5.2.2 The live loads of floor and coefficients of combined value shall be no less than the provisions in Table 8.

**Table 8** Live Loads of Floor and Coefficients of Combined Value

No.	Type	Standard Value (kN/m <sup>2</sup> )	Coefficients of Combined Value
1	Room	2.0	0.7
2	Corridor, Stair, Ramp	3.5	0.7
3	Storeroom	5.0	0.9
4	Kitchen (dining room)	4.0	0.7
5	Accessible Roof	2.0	0.7
6	Roof garden	3.0	0.7

Note:

1. Values indicated in Table 8 are derived from *Load Code for the Design of Building Structures* GB50009-2001, 2006.
2. The value shall be checked according to the actual load;
3. The live load shall be set as 3.5kN/m<sup>2</sup> for other possible crowded areas such as decks, ramps and walkways used for staging the touring public during the exhibition stage of the competition.

### 5.2.3 Wind Load Design

The standard value of wind load and the basic wind pressure shall meet the provisions of the current national standard of *Load Code for the Design of Building Structures* (GB50009-2001), and the ground roughness shall be of Class B. For participating works, the standard value of wind load vertical to the surface of the building shall be calculated according to the following formula:

- a. When the major bearing structure is calculated,

$$w_k = \beta_z \mu_s \mu_z w_0$$

Wherein,

$w_k$  – Standard value of wind load (kN/m<sup>2</sup>);

$\beta_z$  – Wind fluttering factor at altitude z, calculated as specified in Paragraphs 7.4 ~ 7.6 of *Load Code for the Design of Building Structures* (GB50009-2001, 2006);

$\mu_s$  – Type factor of wind load, employed as specified in Paragraph 7.3 of *Load Code for the Design of Building Structures* (GB50009-2001, 2006);

$\mu_z$  – Variation factor of wind pressure altitude, employed in accordance with Table 9;

**Table 9** Variation Factor of Wind Pressure Altitude

Altitude Above the Horizon or Sea Level (m)	Variation Factor of Wind Pressure Altitude $\mu_z$
5	1.00
10	1.00
15	1.14
20	1.25
30	1.42
40	1.56
50	1.67

$w_0$  – Basic wind pressure. The wind load for Dezhou shall be taken as 0.45kN/m<sup>2</sup> which is the basic wind pressure with the recurrence rate of 50 years (at 10m above the ground, 10-minute average annual maximum wind speed is about 26.86m/s)

- b. When the enclosing structure is calculated,

$$w_k = \beta_{gz} \mu_s \mu_z w_0$$

Wherein:

$\beta_{gz}$  – Gustiness factor at altitude z, determined according to Table 10;

**Table 10** Value of Gustiness Factor

Altitude Above the Horizon (m)	Gustiness Factor $\beta_{gz}$
--------------------------------	-------------------------------

5	1.88
10	1.78
15	1.72
20	1.69
20	1.64
40	1.60
50	1.58

$\mu_s$  – Type factor of wind load; when the strength of the enclosing component and the connector is checked, the type factor of local wind pressure shall be employed as specified in Table 7.3.3 of *Load Code for the Design of Building Structures* (GB50009-2001, 2006).

When it is predicted that the wind velocity may exceed 26.86m/s, a notice for forcible withdrawal (evacuation order) will be issued. The design value may be altered after the local authority of Dezhou confirms the final site of the structure according to the requirements of the event organizers.

- 5.2.4 In Dezhou, the earthquake-resistant fortification intensity is 7, and the design basic acceleration is 0.10g. The calculation of the earthquake-resistant action shall meet the requirements of the *Code for Seismic Design of Building*, Chapter 5 (GB50011-2010).

**Exception:** Alternative engineering analysis shall be permitted when approved by SD China. Such analysis shall be conducted in accordance with an approved national or international standard deemed acceptable to the SD China organizers.

- 5.2.5 In Dezhou, the snow load shall be 0.35kN/m<sup>2</sup>, and the coefficient division of quasi-permanent value for snow load shall be II. The calculation of the standard value for snow load shall meet the requirements of the *Load Code for the Design of Building Structures*, Chapter 6 (GB50009-2012).

**Exception:** Alternative engineering analysis shall be permitted when approved by SD China. Such analysis shall be conducted in accordance with an approved national or international standard deemed acceptable to the SD China organizers.

- 5.2.6 Load on the Railing Top

The horizontal load on the railing tops of stairs, stands, balconies, accessible roofs, etc. shall be set as 1.0kN/m<sup>2</sup>. The vertical load shall be set as 1.2kN/m<sup>2</sup>.

- 5.2.7 For various check calculations, the most unfavorable load combination for each shall be taken. The load combination shall meet the requirements of the current national standard of *Load Code for the Design of Building Structures*, Chapter 3 (GB50009-2012). The check calculation of the structural earthquake resistance shall meet the requirements of the *Code for Seismic Design of Building*, Chapter 5 (GB50011-2010).

### 5.3 Materials

- 5.3.1 The variety, specifications, performances, etc. of all the employed raw materials, components and equipment shall meet the design requirements and shall be tested, listed or evaluated as required by the adopted standards. Audit (evaluation) reports of the participating countries shall be attached (for example: the audit report by American ICC-ES, or the audit report by European ETAG) when required by the SD China Building Code.
- 5.3.2 All materials shall not emit any poisonous substance to the indoor or outdoor environment of the building;
- 5.3.3 All local (Chinese) materials shall meet the relevant provisions of the current national standards of China and shall be accompanied by the test report issued by the state authoritative testing organization.
- 5.3.4 If the structural materials adopted for construction are alternate materials due to the nonconformity with the design, it is the responsibility of the applicant to provide adequate proof documenting the alternate as meeting the intent of the prescriptive code requirements as provided by Section 2.02. The organizers reserve the right to deny any alternate for failure to clearly demonstrate code equivalence.
- 5.3.5 All the phase-change materials used for the building components must be marked on the plans. Specifications for the material composition must be provided with fire-performance testing data. Notice that phase-change embedment in gypsum board or interior wall or ceiling finishes may affect the ability of these materials to

pass the required fire tests.

## 5.4 Foundation

- 5.4.1 Provide a foundation plan for temporary setup on the competition site. 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 overturning and to provide adequate lateral load transference for design seismic forces.
- a. All houses, decks, and other structures shall be provided with foundations sufficient to safely transmit gravity, lateral, and uplift loads. For purposes of design, the presumptive paved surface bearing capacity shall be 75kN/m<sup>2</sup>.
  - b. Uplift design may employ uplift anchorage, dead-load analysis, or a combination of both. Anchorage embedment in the site will be limited to the 450mm. Teams are encouraged to configure their structures to take advantage of dead loads to resist wind uplift, and seismic and wind generated overturning, and sliding. All designs shall be supported by calculations demonstrating the efficacy of the system.

### 5.4.2 Expanding Materials for Foundation Bed

The foundation shall be able to adapt to the changed field elevation. The bedding for leveling the base elevation shall not rely on imported materials. If the imported bedding material must be used, the material shall be able to transmit all the loads without pollution to local soil; all the bedding materials shall be secured by proper methods to avoid erosion by water and wind; the method of restraint shall be certified.

- 5.4.3 The design of foundation and its bedding shall meet the requirements of the current national standard of *Code for Design of Building Foundation* (GB50007-2011) and the relevant local standards in Dezhou.

**Exception:** Alternative foundation design analysis shall be permitted when approved by SD China. Such analysis shall be conducted in accordance with an approved national or international standard deemed acceptable to the SD China organizers.



## Section 6. Water Supply and Drainage Systems

### 6.1 Fire Protection Facilities

- 6.1.1 Indoor fire hose reels or portable fire hoses are required for the participating buildings.
- 6.1.2 Indoor fire extinguishers are required, and at least 2 fire extinguishers shall be arranged in one computing unit. A single fire extinguisher shall have the configured minimum extinguishing level of 2A and the maximum protected area of  $75\text{m}^2/\text{A}$  for a unit extinguishing level.
- 6.1.3 Fire suppression sprinkler systems are not required. The municipal water distribution system does not provide fire demand on site. Otherwise, the participating buildings have to define their own fire water tanks.

### 6.2 Water Supply and Drainage

- 6.2.1 It is prohibited to directly connect the urban water supply pipeline with the water supply pipeline of the self-prepared water source.
- 6.2.2 It is prohibited to connect the pipelines for non-drinking water such as reclaimed water, recycled rainwater, etc. with the potable water pipeline. Such water sources may only be used for exterior plant irrigation purposes or as otherwise permitted by Section 6.7.
- 6.2.3 The water outlets of the water distribution parts of drinking water pipes for sanitary ware, water equipment and components, etc. shall comply with the following provisions:
  - a. The water outlets shall not be submerged by any liquid or impurity;
  - b. The water outlets shall be higher than the minimum air gap of the overflow edge of the container (plumbing fixture vessel) by at least 2.5 times of the diameter of the water outlets.
- 6.2.4 Vacuum breakers are required for the following water pipelines which are directly introduced from the drinking water pipelines in the building:
  - a. On the water supplementing pipes, when the air gap between the outlet of the water filling or supplementing pipe for the waterscape pool, collecting basin of circulating cooling water, etc. is 2.5 times smaller than the outlet diameter;
  - b. At the origin of the pipeline, if the irrigation nozzle is underground or auto lifting for the chemical-free sprinkler irrigating system of planting beds and greenbelts;
  - c. Fire (hose) reel;
  - d. At the connected joint between the washing nozzles connecting to the outlet and the water supply pipeline.
- 6.2.5 The water quality of the water supply system and hot water system for living, the water quality of the pipeline drinking water system and the water quality of non-drinking water shall all meet the requirements of the corresponding current national standards.
- 6.2.6 When the plumbing fixture without water trap is connected with the drainage pipeline, a water trap with the depth of water seal of no less than 50mm shall be arranged under the outlet. A floor drain with the depth of water seal of no less than 50mm shall be arranged in the position where a shower set and a washing machine are available.
- 6.2.7 The soil stacks for residential kitchen and washroom shall be arranged separately. The drainage pipelines shall not pass through the bedrooms.
- 6.2.8 Water closets shall be fully functional, and shall be connected to the water supply and the sewage disposal systems.

### 6.3 System Selection

- 6.3.1 The water supply system in the building shall directly supply water by using the water pressure of the urban water supply pipe network. When the water pressure and (or) yield of the outdoor water supply pipe network are insufficient, the scheme of water storage adjustment and pressurized water supply shall be selected in accordance with the principles of health, safety, economy and energy conservation.
- 6.3.2 The hydrostatic pressure of water supply after the threshold water meter in the building shall be no less than 0.1MPa, and the water supply pressure of the service pipe shall be no more than 0.35MPa.

## **6.4 Tubing, Accessories and Water Meters**

- 6.4.1 Water meters shall be installed on both the residential service pipes and the water pipes necessary to meter the water yield in the building. Products with favorable water saving performance are required for the sanitary ware and accessories. The pipelines, valves and accessories shall be made of anticorrosive materials.

## **6.5 Hot Water**

- 6.5.1 If the sanitary ware is provided with a mixer of cool and hot water or mixed faucet, the cool and hot water supply systems shall have similar water pressures at the distributing position.
- 6.5.2 The working pressure and working temperature of the tubing and pipe fittings used for the hot water system shall not be higher than the allowable working pressure and working temperature calibrated by the product standards. Corrosion-resistant tubing shall be selected for the hot water pipelines.

## **6.6 Waterscape**

- 6.6.1 The water feature should have sufficient circulation/treatment/measures taken to ensure the water does not become stagnant and a nuisance hazard.

## **6.7 Non-traditional Water Source**

- 6.7.1 Domestic water not in contact with the human body, such as water for landscapes, greening, vehicle washing, road watering, toilet flushing, etc. is recommended to make use of the non-traditional water sources such as urban recycled water, rainwater, building reclaimed water, etc., and shall meet the corresponding standards for water quality. The urban recycled water shall be used in priority if possible.
- 6.7.2 It is forbidden to connect the water supply system of non-traditional water sources with the potable water pipelines, and the following measures for preventing misconnection, misuse and accidental consumption shall be taken:
- The outer wall of the water supply pipeline of non-traditional water sources shall be colored or marked as specified by relevant standards;
  - A locking device is required if a water intake is available;
  - Notable markers of “Reclaimed Water” are required for the pool, water tank, valves, water meter, hydrant, water intake, etc. of the reclaimed water system; Notable markers of “Rainwater” are required for the pool, water tank, valves, water meter, hydrant, water intake, etc. of the rainwater system;
  - The pipes shall be inspected in segments for the acceptance of works so as to prevent misconnection.
- 6.7.3 The following safeguard measures shall be taken for using non-traditional water sources, and shall not produce any adverse impact on human health or surrounding environment:
- The non-traditional water sources of rainwater, reclaimed water, etc. shall have sufficient capabilities of disinfection and sterilization without any pollution to the water quality in the processes of storage, distribution, etc.;
  - The water supply system shall be provided with alternate water source, overflow device and relevant switching facilities, etc.

## ***Section 7. Heating, Ventilation and Air Conditioning***

### **7.1 Drawing Requirements**

- 7.1.1 The definitions of all symbols in the given drawings shall be explicitly stated.

### **7.2 Ventilation Requirements**

- 7.2.1 Mechanical exhaust or independent natural ventilation is required for a bathroom, kitchen, mechanical and electrical equipment room or furnace room.

### **7.3 Air Intake and Exhaust**

#### **7.3.1 Fresh Air Inlet Requirements**

The outdoor fresh air inlet and the air outlet shall be arranged to face different directions.

#### **7.3.2 Protection of Air Inlet and Air Outlet**

Measures for preventing the entry of sundries and rainwater shall be taken for the air inlet and the air outlet via screening or other approved methods.

- 7.3.3 When the air displacement of the exhaust system is more than 300m<sup>3</sup>/h, a comparatively unobstructed air inlet approach or an air-make up system shall be considered.

### **7.4 Bathroom Ventilation**

- 7.4.1 A ventilation measure shall be provided for the bathroom. For the mechanical exhaust system, the air change rate shall be no less than 10 times/hour; for natural ventilation, an external window opening area of no less than 0.14m<sup>2</sup> is required.

### **7.5 Smoke Extraction for Fire Protection**

- 7.5.1 The indoor stairway shall be provided with an external window connected to it.
- 7.5.2 The internal walkway longer than 20m shall be provided with an operable external window. The area of the external window shall be no less than 2% of the floor area of the internal walkway.

## Section 8. Electrical

### 8.1 Power Supply

- 8.1.1 When the electrical load of each house is not more than 12kW, single-phase service power supply shall be used, and each house shall be equipped with at least one single-phase watt-hour meter.
- 8.1.2 There are two ways of electric circuit for the power distribution system. Teams can select either one:
- The three-phase power supply has the voltage of ~220/380V and frequency of 50Hz.
  - The single-phase power supply has the voltage of ~220V and frequency of 50Hz.

The short-circuit current at the inlet is considered as 6kA.

### 8.2 House Electrical Distributor

- 8.2.1 Each house will be provided with at least one house electrical distributor.
- 8.2.2 A main incoming breaker having the isolation function shall be installed in the household distribution box.
- 8.2.3 The circuits for lighting, power supply receptacles, air conditioner receptacles, power supply receptacles of electric cooker and electric water heater, and an independent power supply circuit for fire alarm system and weak current system shall be configured inside the house electrical distributor.

### 8.3 Safety and Protection

- 8.3.1 Each house shall be provided with an electrical self-recovery over/under-voltage protection appliance.
- 8.3.2 Each house shall be provided with a residual current operated protective device at the power incoming line, and the rated value of residual current operation shall not exceed 300mA.
- 8.3.3 The house electrical distributor shall be provided with an electrical power supply incoming breaker appliance for cutting off the phase line and neutral line at the same time, the power supply circuit shall be provided with an electrical short circuit and overload protection appliance, and the power receptacle circuit connected with handheld and mobile household appliances shall be provided with a residual current operated protective device.
- 8.3.4 The power receptacle circuit of the cabinet air conditioner shall be provided with a residual current operated protective device, and the power receptacle circuit of the split-type air conditioner shall be provided with a residual current operated protective device. The residual operating current of the residual current operated protective device shall not be more than 30mA.
- 8.3.5 All power receptacles shall be safety receptacles. Power receptacles of protection level IP54 shall be selected for outdoor locations and for washing machines.
- 8.3.6 For a washroom with shower or bathtub, the bottom edge of the electric water heater power receptacles to the ground should be no less than 2.3m, and the exhaust fan and other power receptacles should not be installed in Zone 0 or 1. See Table 11 for zone division.

Table 11 Zone Division for Washroom

Zone	Description
0	Zones at 0.10m to the floor in bathtub, shower tray or Zone 1 for shower without a tray.
1	Vertical plane around a bathtub or shower tray; or the vertical at 1.20m to the spray header and the horizontal plane at 0.10m to 2.25m above the floor for shower without a tray.

### 8.4 Electrical Lighting

- 8.4.1 Energy saving electric light sources and energy saving accessories shall be selected for residential building lighting, and lighting fitting made of environment-friendly materials shall be selected.
- 8.4.2 The efficiency of interior lighting shall not be less than 70%. For shaded interior lighting, the efficiency shall not be less than 60%. The average luminous efficiency of light sources shall not be less than 60lm/W.
- 8.4.3 Lighting in washroom shall not be installed above or behind the toilet or bathtub and switches shall be set outside the washroom.

## **8.5 Selection of Wire and Wiring**

- 8.5.1 Copper conductors shall be selected for the distribution wire.
- 8.5.2 The service wire shall be no less than 10mm<sup>2</sup>, and the lighting and receptacle circuit branch feeders shall be no less than 2.5mm<sup>2</sup>.
- 8.5.3 Metallic conduits and PVC conduits may be used for distribution circuit wiring in houses. The tube wall thickness of concealed metallic conduits shall be no less than 1.5mm, and the tube wall thickness of concealed PVC conduits shall be no less than 2.0mm.
- 8.5.4 Any wire and cable conduit irrelevant to the bathroom shall not enter or pass through the bathroom. The wire and cable conduit relevant to the bathroom shall not be laid in Zone 0 or 1.

## **8.6 Electrical Equipment**

- 8.6.1 A residential building shall use durable and reliable electrical devices with high efficiency, low energy consumption and advanced performance, and shall give priority to electrical devices made of environmentally-friendly materials.
- 8.6.2 Concealed power receptacles and various information outlets (low voltage communications, video, telephone, etc.) on the same wall in each house shall be at the uniform mounting heights. The distance between high-voltage and low-voltage power receptacles shall not be less than 20cm.
- 8.6.3 The house electrical distributor shall be arranged in the resident corridor or entrance hall for easy access and maintenance.
- 8.6.4 The power receptacles for kitchen and washroom shall not be of the same circuit.

## **8.7 Grounding**

- 8.7.1 The residential power supply shall be provided with multiple grounding at the entry to the building; a ground terminal box shall be installed at the entrance of each house.
- 8.7.2 The bathroom with shower or bathtub shall be provided with local equipotential bonding.
- 8.7.3 Local equipotential bonding shall include metallic water supply and drainage pipes, metallic bathtub, metallic washbasin, metallic heating tube and metallic radiator in the washroom, PE line of washroom power receptacles and reinforcing mesh for buildings.
- 8.7.4 A common ground grid shall be used for the grounding of intense (36V and greater) and weak (less than 36V) current systems in a residential building. The ground resistance value shall be a minimum of 1Ω and shall meet the requirements for the minimum of electrical system therein.
- 8.7.5 All exposed conductive parts of the following electrical devices in the house shall be reliably grounded;
  - a. The metal cases of fixed household appliances as well as handheld and mobile household appliances;
  - b. The metal cases of house electrical distributor, house tele-distributor;
  - c. The metal protection tube, junction box and terminal box for cables;
  - d. The metal case of a Class I lighting lamp.

## **8.8 Equipment List**

- 8.8.1 All the selected electrical equipment shall be summarized in an equipment list.
- 8.8.2 3C Certification Reports are required for all electrical equipment.

## **8.9 Weak Systems**

- 8.9.1 A residential building shall be provided with cable TV, telephone, information network, visitor talkback and emergency alarm device for help.
- 8.9.2 Each house shall be provided with a household wiring distribution cabinet.
- 8.9.3 The house lead-in of each low-voltage system shall be distributed and connected in the household wiring distribution cabinet.
- 8.9.4 When the low-voltage cable is fed into the house from the outside, an adaptive signal circuit surge protector

shall be selected, and shall meet the design requirements.

## Section 9. Photovoltaic System

- 9.1.1 The grid-connected PV system shall have corresponding grid-connected protection function, and shall be installed with necessary metering devices.
- 9.1.2 The interface between the PV system and the electricity distribution network shall meet the requirements of voltage deviation, flicker, frequency deviation, phase, harmonic wave, three-phase degree of balance, power factor and other power energy quality indexes, and the requirement of safety of persons and protection of equipment. Except for the particular requirements of Table 12, other characteristics shall comply with the international standard IEC 61727 (Photovoltaic (PV) system – Characteristics of the utility interface).

**Table 12** Characteristic of interface

No.	Name of power	Range of limit
1	Voltage, current and frequency	voltage: 220V (phase-neutral) frequency: 50Hz
2	Normal voltage operating range	Over voltage: 220V+10% Under voltage: 220V-15%
3	Normal frequency operating range	Over frequency: 50Hz+1% Under frequency: 50Hz-1%
4	Over/under voltage and frequency	The PV system shall disconnect from the utility system (grid) whenever voltage or frequency are outside the normal range

- 9.1.3 An isolator shall be arranged between the grid-connected PV system and the public grid. The PV system shall be provided with a special low pressure switch box for grid connection in the position of grid connection, and special marks as well as instructional text and symbols such as "Warning" and "Double Power" are required.
- 9.1.4 The grid-connected PV system shall have the functions of automatic detection and grid-connected tripping protection, and shall comply with the following provisions:
- a. Both the isolating switch and the circuit breaker between the PV system and the public grid shall have the function of breakage of zero line, and the phase line and the neutral line shall be capable of being disengaged and engaged simultaneously;
  - b. When the power quality of the public grid goes beyond the limit, the PV system shall automatically be disconnected from the public grid, and shall not supply power to the grid within 5min after the quality of the public grid returns to normal.
- 9.1.5 The PV system shall be configured and installed with special power metering devices respectively on the power generation side and at the electricity metering points.
- 9.1.6 The participating teams are allowed to consider storing the power energy up to 10kWh. Commercially available direct-current devices are permitted to be connected to the power storage system. The organizing committee will provide the two-way watt-hour meter.
- 9.1.7 The grounding of the PV system shares the same grounding device with the residential electric power system.
- 9.1.8 Product inspection reports issued by the certified third party laboratory or testing organization shall be submitted for both the PV module of the key equipment and the grid-connected inverter in the photovoltaic system.

## Section 10. Solar Thermal System

### 10.1 Product Requirements

#### 10.1.1 Solar Collector

Both the plate and evacuated tube solar collectors shall withstand the working pressure of 0.06MPa in the unpressurized system and shall withstand the working pressure of 0.6MPa in the pressurized system.

#### 10.1.2 Tubing and Pipe Fittings

Metallic tubing and pipe fittings are required for the heat collecting system.

#### 10.1.3 Other Equipment

The corresponding technical and safety performances of the auxiliary heat supplying device matched to the system and the related equipment of circulating water pump, fan, valves, meters, water tank for heat storage, etc. shall all meet the requirements of the relevant national standards.

#### 10.1.4 Thermal solar collectors shall not be installed in direct contact with Photovoltaic panels unless the PV panel manufacturer specifically permits this interface.

### 10.2 Requirements for Working Medium of System

#### 10.2.1 Water conforming to the hygiene requirements shall be used for water in direct contact with users, such as drinking water, bathing water, etc.

#### 10.2.2 Non-toxic and incombustible liquid which will not result in corrosion of corresponding pipelines shall be selected for the working medium for thermal conduction not in direct contact with users.

### 10.3 Installation Requirements

#### 10.3.1 The position of installation and form of connection for the collector shall be determined in accordance with the position of installation and load (including dead load, performance load, wind and snow load, earthquake action, etc.) based on the checking of connecting members and structural safety. The position of installation and form of connection shall meet the requirements for the safety and durability of buildings.

#### 10.3.2 A compensator or other mitigating means is required where thermal induced elongation is sufficient to induce damaging stresses in the piping, valves or the building structure. The type, specification and position of the compensator shall conform to the design requirements.

#### 10.3.3 A slope of $\leq 5\%$ is required for the circulating pipeline connecting the upper and lower collecting pipes of the collector to the hot water tank.

#### 10.3.4 Both the hot water pipeline and the related water storage device shall be insulated. The texture, thickness and outer housing of the material for thermal insulation shall all comply with the design specifications.

#### 10.3.5 Anti-freezing measures in winter shall be taken for the solar collector taking water as the medium.

#### 10.3.6 Other equipment of the system besides the collector shall be installed in accordance with the design specifications.

#### 10.3.7 Other equipment of the system besides the collector shall be installed in accordance with the requirements of relevant national standards corresponding to the products.

### 10.4 Safety Requirements

#### 10.4.1 In order to ensure running safety, a temperature and pressure relief valve, air relief valve, automatic air valve, safety valve, filter, etc. shall be installed in the corresponding positions of the system. Safety valves for temperature and pressure relief shall be installed such that no valves may isolate the thermal collector from the relief valve. The corresponding technical performances shall meet the requirement of the national standard for the products. Bypass pipelines shall be provided for pilot run and replacement as appropriate, and the space for overhaul shall be reserved.

#### 10.4.2 The system pipeline shall not be arranged in the key positions of the building structure. For example, pipes shall not pass through the beam column, embedded column of the anti-seismic wall, end post, etc. If the pipeline passes through the building envelop for the roof, walls, etc., sleeves shall be pre-embedded, and the



measures for water tightness and heat insulation shall be taken.

10.4.3 Reliable anti-freezing measures shall be taken for the outdoor pipelines of the system.

## **10.5 Requirements for Pilot Run of System**

10.5.1 On completion of construction, washing, pressure testing and debugging are required for the system, and the relevant operation shall conform to the design specifications.

10.5.2 The test pressure of the closed system shall be 1.5 times the designed maximum working pressure of the system. The test pressure of open system shall be the designed maximum working pressure of the system.

10.5.3 The maximum noise output and temperature rise of the water pump must conform to the specifications of the equipment descriptions.

## **10.6 Maintenance Requirements**

10.6.1 Enough space shall be reserved for the inspection, maintenance and replacement of the solar collector, controller, exhaust valve, water tank, pump, fan, etc.

10.6.2 The major equipment of the system shall be marked by using the marking methods with permanent applicability; the designer, constructor and running maintainer shall be marked for the system.

10.6.3 The markers of major equipment shall include the name of product manufacturer, product model and main technical performance parameters.

10.6.4 The markers of pipelines shall include materials of tubing and thermal insulation, the main ingredients, functions (supply, return, etc.) and flow direction of the working medium flowing in the pipeline.