

Solar Challenge

Technical Regulations

Version 4 April 2017

The Technical Regulations presented in this document serve as directives for the race. Situations that are not covered by the Rules will be decisively resolved at the sole discretion of the jury.

The most important changes with respect to the 2014 Technical Regulations have been highlighted in blue

Changes with respect to the May 2015 version have been indicated in yellow

Changes with respect to the 2016 version have been indicated in red

1. General

- The rules stipulated herein apply to the Solar Challenge 2017, hereinafter referred to as the "race" and the Young Solar Challenge.
- The rules apply to the race to be held in 2017.
- All participants in the race are expected to have read, understood and agreed to the Technical Regulations. The organization will penalize all participants and teams that ignore or violate the Technical Regulations. Penalties could be given in the form of warnings up to and including disqualification and elimination from further participation.
- All questions concerning the interpretation of the Technical Regulations must be submitted to the organization in writing. The rules will be published on the website and are binding for all participants. If deemed necessary by the organization, she has the right to amend these regulations.

2. Technical condition and safety

All participants are at all times responsible for the technical condition and safety of their vessels during the course of the race. The design must be made such that the vessel can safely participate in the race taking into account all aspects of the race (sailing, storage in the paddock, etc.). Approval of the design and approval during the inspection will under no circumstances exempt the participants of their responsibility.

3. Definitions

The definitions used, can be found in the Notice of Race.

4. Categories

4.1 The race is open to the following boat categories:

- A. Challenge class vessels with one single crew member (one person challenge class)
- B. Challenge class vessels with two or more crew members (multi person challenge class) where all crew members must be on board of the vessel during the race.
- C. Top class vessels.
- D. V20 class vessels.
- E. Young Solar class vessels.

4.2 The following are the maximum dimensions per class:

Category	A	B	T (top class)
Length	6.0 m	8.0 m	8.0 m
Width	2.4 m	2.4 m	2.4 m

The dimensions of the V20 and Young Solar class vessels are standard to their particular class.

- 4.3 The length is the overall length from the front end of the vessel up to and including the rear end of the vessel, and including the propulsion system. Exceeding the maximum length by more than 0.5% of the allowed length will result in a penalty issued by the jury.
- 4.4 No maximum draught or height is prescribed for the vessels. Participants must however take into account the fact that the depth of the water is limited in certain sections of the route. The actual water depth and height clearance may vary from time to time.

5 The Vessel

- 5.1 All vessels must be fitted with solar panels, which will serve as the sole source of energy.
- 5.2 No prescriptions apply to the use of materials with the exception of the following limitations:
- The use of (flexible) materials and constructions that might serve as sails is not allowed.
 - The use of materials that may directly pollute the environment when in contact with water is not allowed.
- 5.3 The use of energy storage systems, other than batteries for storing electrical energy, is allowed (e.g. flywheels, super capacitors, etc.). The total onboard energy storage capacity is limited to 1.5 kWh (=5.4 MJ). This capacity includes the storage capacity of batteries for storing electrical energy. Young Solar class vessels make use of dedicated batteries prescribed for their class.
- 5.4 The skipper must have a clear field of view and have unobstructed hearing at all times. The vessel may not have a closed cabin.
- 5.5 All vessels must be designed to ensure that all crew members will be able to evacuate the vessel within 5 seconds without any form of outside assistance.
- This must be demonstrated by means of an evacuation test.
 - The dead man's switch must also be activated simultaneously during the evacuation without having a delaying effect of any nature whatsoever on the evacuation.
 - Hatches that need to be opened before a crew member can evacuate the vessel are not allowed
 - The minimum width of the cabin is 50 cm.
 - When two crew members are sitting next to each other the minimum width is 100 cm.
 - The cabin must have a suitable seat for each crew member.
- 5.6 The use of safety belts is not allowed on board the vessels.
- 5.7 The cabin may not have any potential hazards for the crew members.

- 5.8 The stability of the vessels must be such that a prescribed rolling moment of 150 Nm applied to the vessel with the vessel loaded with a load of 70 kg (60 kg for Young Solar class vessels) at the location of seat of the skipper, will not result in lean over exceeding 12.5 degrees averaged over a measurement period of 5 seconds.
- In that case none of the openings in the hull, such as the outlet opening of the bilge-pump(s) or the edge of the deck or any of the solar panels may be submerged below the waterline.
 - In case (additional) floats are being used, the floats on either side must have an additional volume of at least 50 dm³.
 - It is allowed to use more than one (additional) float on either side of the vessel. In that case the total displacement of the combined floats on either side must be 50 dm³ or more.
 - A vessel having floats or multiple hulls must be designed such that the highest floater touches the water surface before reaching a roll-angle of 5 degrees.
- 5.9 All vessels must be fitted with a commercially available and approved dead man's switch that will remain fully functional at all times while the skipper and/or other crew members are on board.
- This will be tested during the evacuation test,
 - The functionality must be such that when removed the motor stops running and that when replaced it requires at least one more additional action to have the motor start running again.
- 5.10 If the vessel is loaded with ballast, it must be properly fixed to the vessel. The ballast required to make up for a deficiency in a skipper's or sailor's mass must be placed in or near their seat. It must be easy accessible for inspection.
- 5.11 It is mandatory for all vessels to be fitted with one or more electrical and automatic bilge-pumps.
- The pump(s) must be designed to empty all compartments that house passengers or electrical components.
 - The pump(s) must be placed such that they can empty the hull both in static and in sailing condition. This includes accelerating and decelerating manoeuvres.
 - The system must be designed to ensure that each of the above-mentioned compartments can be pumped empty automatically and independently.
 - The pump(s) must have a minimum combined flow rate of 1500 litres per hour.
 - The pipe(s) and/or hoses that are connected to the pump(s) must have a minimum internal diameter that is not smaller than the pump's outlet.
 - The pipes and/or hoses must be installed such that all bilge water is pumped overboard.

- If the vessel is a multi-hull design, the pump capacity may be distributed; in other words, a catamaran may be fitted with two pumps, one in each hull, and each with a capacity of 750 litres per hour.
- If floats are fully watertight it is not compulsory to install an electrically driven bilge pump in the floats.

5.12 All rotating components in or on the vessel must be adequately shielded to prevent unintentional contact.

- This applies both on the water and on land.
- Propeller(s) used for propulsion are exempted from this rule
- In the case of the use of a flywheel for power storage purposes, it must be fitted into a protective housing that is capable of containing all released components in the case of disintegration of the system.
- The latter characteristic must be demonstrated by means of a suitable test or calculation.

5.13 All fastening systems used on board the vessel must be mechanically secured.

- All connections that may rotate during operation must be secured with the use of a cotter pin.
- The use of securing means, such as "loctite" is not allowed, except with the special permission of the organization.
- Permission will only be granted based on a prior written application to the organization with due motivation.
- The application must also include a design description and a description of the need for the use of this type of securing means.
- In a bolt and nut connection the thread of the bolt must stick out of the nut with a minimum of two full turns.
- The same holds for threaded rods.
- When using self locking nuts the thread must stick out of the plastic locking ring with a minimum of two full turns.
- The use of locking washers is advised. The use of washers in bolted connections is compulsory.
- The use of Velcro is allowed under the condition that this has been clearly indicated in the design and approved by the technical committee prior to the technical inspection.
- The technical committee may ask additional connections to be installed at all times, especially when it concerns the solar panels or items that influence the safety of the crew members or the operation.

5.14 All vessels must be designed with a minimum freeboard (for the definition of freeboard see the Notice of Race) of 25 cm over the first 2 m measured from the front end of the vessel and a freeboard of at least 20 cm over the rest of the vessel.

- Both freeboards must be determined in fully loaded condition,
- The connection between the hull and the deck must be watertight.

- 5.15 All vessels must be designed to be capable of generating sufficient buoyancy under full load.
- In this context 'sufficient' is defined as the capacity required to carry the complete construction with the crew member(s) with a minimum reserve capacity of 100%. In other words: the watertight volume above the waterline has to be equal or larger than the displacement of the hull.
 - The latter capacity must be demonstrated by means of a calculation and a weighing.
 - In addition, the vessel must also be designed and built such as to ensure that it remains floating the moment it fills up with water and that there is no contact possible of the water with critical parts of the electrical system like the battery. In this case it may be assumed that there are no crewmembers on board.
- 5.16 All vessels must be fitted with a fastening point for a towline in front of the hull (catamarans must have a fastening point on each hull).
- The fastening point(s) and its supporting structure must be capable of holding a minimum load of at least twice the vessel's own weight.
 - The minimum internal diameter of the fastening point(s) must be 20 mm.
 - All vessels must be provided with a floating towline with a length of 5 m and a minimum diameter of 8 mm, this line must be easy to cut in case of emergency.
 - Catamarans must be fitted with two floating towlines, with a length of 5 m and a minimum diameter of 8 mm, one attached to each of the two hulls. These lines must be easy to cut in case of emergency.
 - The towline(s) must be stored such that they can be accessed easily when needed.
- 5.17 All vessels must be fitted with a minimum of two types of signaling systems
- An uniformly coloured orange or red warning flag with a minimum size of 30 x 30 cm attached to a stick or similar structure with a minimum length of 100 cm.
 - The warning flag may not be combined with the required boat hook.
 - An audible warning system, such as a ship's horn audible at reasonable distance, e.g.
 - An orally operated horn
 - A horn operated by a compressed air bottle
 - An electrically operated horn
- 5.18 All vessels must be fitted with a clearly visible yellow or orange marker buoy with a diameter of at least 12 cm. that is permanently connected to the vessel by a buoyant rope with a minimum length of 5 m.

- The connection and storage of this buoy must be such that when the vessel disappears under the water surface the buoy starts floating on the water surface and thereby indicates the position of the vessel.

5.19 All vessels must be fitted with at least one paddle per crew member.

- The paddle must be functional such that it is possible for the skipper/sailor(s) to paddle the vessel from the normal seating position in the cockpit
- The paddle(s) must have a minimum overall length of 60 cm, a minimum blade length of 30 cm and a minimum blade width of 13 cm
- The paddle(s) must be fastened in an easily-accessible location on board the vessel.
- The paddle may not be used as a means of propulsion during the race.

5.20 All vessels must be fitted with an approved fire extinguisher with a minimum capacity of 1 kg of extinguishing material suitable for extinguishing fires on board, preferably with a foam based means of extinguishing

- Only fire extinguishers showing a valid approval are allowed
- The fire extinguisher must be mounted in a position such that it can be reached easily by all crew members (including challenge B-class) from the normal seating position in the cockpit and cannot drop into the water after taking it out of its attachment.
- In addition to the manually operated fire extinguisher an automated means of fire extinguishing may be installed.

5.21 All vessels must be equipped with a boat hook with a minimum length of 1 m and a non-metallic hook.

5.22 Every person on board the vessel must be wearing a life jacket. The capacity of the life jacket must be 150 Newton classed or equivalent. The life jacket must be designed such that it keeps the head of the one wearing it above water.

5.23 In the case of the occurrence of a (technical) failure on board, the participants are entitled to repair and/or replace the failed or flawed components with identical ones.

- Wherever possible this must be done under the supervision of the organization.
- In the case of major repairs/replacements, e.g. in the case of the replacement of a battery, the organization will determine the need for a time penalty.
- All repairs to the vessels' electrical systems must be reported to the organization in advance.
- Repairs to other parts of the vessels must be reported subsequently.

- Replacement or recharging of batteries will result in the issuing of a time penalty of five hours for the next stage. Stages that have already been started will be counted as complete stages (e.g.: installing a new battery or recharging an already installed battery during or after the second stage will yield a time penalty of five hours for the third stage). An equivalent rule applies for non-battery energy storage devices.
- When a battery is changed or recharged during the last stage the time penalty will be given for the last stage. An equivalent rule applies for non-battery energy storage devices.
- Modifications to the vessel are not allowed anymore after the vessel has been technically approved by the technical committee.
- Modifications demanded by the organisation however must be incorporated before the given deadline.
- A change and/or update of the software in any component of the vessel is considered a modification.
- While performing a modification, participation in the race is suspended until the modification has been inspected and approved

5.24 The average speed of the vessels in the challenge classes and the V20 class must be at least 8 km/h. The average speed of the vessels in the top class must be at least 12 km/h. This will be tested during the prologue to the race. During the prologue a distance of 10 km will have to be sailed. **Rule 5.24 does not apply to Young Solar class vessels.**

5.25 All sharp edges of the vessel must be adequately protected.

5.26 The steering gear of the vessel must be

- sized for adequate controllability
- must operate smoothly
- be free of play both in loaded and unloaded condition.

5.27 **Adding removable parts to the vessel in Young Solar class vessels is not allowed. Adding removable parts to the vessel in all other classes is allowed.** These additional parts have to meet all necessary requirements of these technical regulations

- The removable parts must either be installed or carried in the boat during the complete race.
- During step 3 of the design process it must be clearly indicated that you want to apply this rule and this has to be approved
- The boat will have to pass the technical inspection both with and without the removable parts installed
- Marking parts as removable parts after having passed step 3 in the design process is not allowed
- Propellers are considered removable parts but do not need to be specifically mentioned
- Certain parts will not be allowed to be classified as removable parts. They include at least:
 - parts necessary for achieving the required stability, for example floats

- solar panels
- Physical removal/installation of removable may be done manually. In the case of removal this means taking them off and storing them in the hull of the boat before travelling further. The first bullet of this rule applies. Inside the hull it must be clearly marked where the removed parts will be stored such that they don't go "missing".
- Using a system that makes it possible to take components (hydrofoils, etc.) in and out of the water without removing them from the boat will have to be a system that is operated electrically from the main battery. This may be done in both a direct (e.g. an electrically operated actuator) and indirect way (e.g. the system requires forward speed of the boat to operate and the required forward speed is achieved via the propulsion system that is powered electrically). Rule 5.28 applies.
- Trimming the setting of components (e.g. small adjustments of the pitch angle of the blades of a hydrofoil) whilst being installed and submerged in the water may be done both electrically and manually. Manual operation may be direct (manual operation of a control) or indirect (e.g. using a hydraulic or pneumatic system that is powered manually). The condition for manual operation is that there may be no significant propulsive force being generated from the manual operation of the system.

5.28 The configuration of the vessel is not prescribed and may be adjusted throughout the race. However, any means to adjust the configuration must be electrically operated from the main battery. It is not allowed to install a secondary power source for that purpose. The adjustment of the solar panels may only be done electrically, see rule 6.3. Furthermore, the vessel must meet all requirements of these regulations in all possible configurations. Rule 5.28 does not apply to Young Solar class vessels.

6 Solar panels

6.1 All participants in challenge classes are required to fit their vessels with the standard solar panels provided by the organization, namely the solar panels loaned by the sponsors. Participants in the challenge class A are provided with 4 panels with an overall peak capacity of approximately 1040 Wp, and participants in the challenge class B are provided with 5 panels on loan with an overall peak capacity of approximately 1300 Wp. The technical specifications for the panels will be made available on the website of the race. Solar panels for the Young Solar Class have an overall peak capacity of 480 Wp.

The solar panels of the V20 and Young Solar class vessels are standard to their particular class.

- 6.2 No prescriptions apply with respect to the area of the solar panels used in the top class as long as they do not exceed the maximum size of the vessel given in section 4 of these regulations.
- The maximum power output of the solar panels is limited to 1750 Wp.

- Participants are required to submit a drawing and calculation of the power of the solar panel during Step 3 of the design process to enable the technical committee to unambiguously determine the total power output of the solar panel.
- This calculation must be based on the technical data sheet of the solar cells used as supplied by the manufacturer (no supplier brochure) where the power output is reported.
- The data supplied by the manufacturer must be in accordance with IEC 61215, terrestrial application in standard test condition (STC) for Silicon solar cells.
- For other than terrestrial Silicon solar cells the power output has to be reported on the basis of the outcome of a measurement performed in accordance with IEC 1829. During the technical inspections a check on the total power output may be performed.
- A measurement of the power output of the solar panels will be part of the technical inspection. The inaccuracy of the measurement will be 2%. Therefore, the acceptable measured upper limit for the power output will be $1750 \text{ Wp} + 2\% = 1785 \text{ Wp}$. Any value measured above 1785 Wp will be considered non-compliant with the regulations and will therefore not be accepted.

6.3 The solar panels must be placed horizontally on all vessels.

- The maximum deviation from the horizontal position is 10 degrees.
- This also holds for the maximum deviation from the horizontal position for curved solar panels.
- The use of adjustable solar panels is allowed provided they are adjusted by using (electrical) energy derived from the solar panels or the main battery.

6.4 Each applied solar panel must be mechanically secured to the vessel, either in a frame or otherwise.

- The design of the fastening system must be such that it will be wind- and water resistant in all directions, including, turbulence, waves and gusts.
- This must be demonstrated during the design phase by means of a calculation in step 3 of the design process
- All parts of the solar panel sticking out of the hull as well as the frames used to attach the solar panels must be provided with protection of sharp edges

7 Electronics

The vessels may be fitted with a battery pack with a maximum capacity of 1.50 kWh. All further references to the battery pack will refer to the 'main battery'. To be able to judge this requirement, all batteries will have to undergo a capacity test. V20 class vessels and Young Solar class vessels are exempted from the capacity test. For lithium based batteries this capacity test will be a constant resistance, full discharge test. The resistance applied during the test is determined by the nominal voltage of the battery and given by the following expression:

$$R_{\text{test}} = V_{\text{nom}}^2 / 1500 (\pm 15\%)$$

Where: R_{test} = resistor value used during the test in Ohm

V_{nom} = nominal voltage of the battery in V

Teams using non-lithium based batteries must indicate this in step 4 of the design procedure. An appropriate means of testing these batteries will be provided.

The starting point of the test is a fully charged battery.

Fully charged is defined as the point where the individual cells have reached their maximum voltage and the battery pack as a whole is balanced. The maximum cell voltages are:

Lithium-ion: 4.2 V \pm 0.05 V

Lithium-Polymer: 4.2 V \pm 0.05 V

Lithium-Iron-Phosphate: 3.6 V \pm 0.05 V

A lead-based battery is considered fully charged when the voltage is 14.4 V for a 12 V nominal battery voltage and current through the battery has declined to less than 2% of the nominal capacity of the battery in Amp-hours (e.g. 2 Amps for a 100 Ah battery).

The end of the test is when the battery is fully discharged. Fully discharged is defined as the point where the discharge is stopped by the Battery Management System. This must be the point where all individual cells have reached a voltage below the value given:

Lithium-ion: 2.7 V \pm 0.3 V

Lithium-Polymer: 2.7 V \pm 0.3 V

Lithium-Iron-Phosphate: 2.5 V \pm 0.3 V

A lead-based battery with a nominal voltage of 12 V is considered fully discharged when the voltage is 10.5 V. In order not to damage the battery during discharge the discharge will continue until the voltage reaches 11.7 V. At that time a depth of discharge of 70% is considered to have been reached. The full capacity will be calculated on the basis of that.

Discharge tests will be performed after charging and a consecutive rest of at least 8 hrs. Testing will be performed at a room temperature of $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Non-lead based battery packs must be designed such that the individual cell voltages can be measured. This may be done via an electronic interface which then must be supplied during testing.

Only one battery pack per team can be offered for testing. The battery pack offered must be balanced and have been fully cycled for at least 5 times. The organisation does not take responsibility for incorrect functioning Battery Management Systems, unbalanced battery cells, and other kinds of failures of the battery pack that may appear during testing. These will also form no grounds for seeking redress.

Batteries with a too large capacity will result in the issuing of a time penalty. This time penalty will be ten minutes for every stage for each percentage point of the allowed maximum battery capacity. (e.g.: installing a battery with an overcapacity of 6% will yield a time penalty of 6×10 minutes = 60 minutes for each separate stage during the race). An equivalent rule applies for non-battery energy storage devices.

If a participant decides to install a different means of energy storage, which is not a battery, the total storage capacity is limited to 1.50 kWh (=5.4 MJ). For the use of other types of batteries not mentioned in the overview the participant is required to contact the organisation to have determined the maximum allowable mass.

- 7.1 A dedicated, properly functioning Battery Management System is mandatory for all batteries other than lead-acid and lead-gel batteries.
- A solar controller is not allowed as a Battery Management System
 - The system must monitor both the battery's voltage and temperature, and must also be capable of shutting the system down when necessary.
 - For Lithium-based batteries the monitoring of both charge and discharge currents is required. A means of controlling too high currents must be installed.
 - The Battery Management System must be designed to monitor all individual battery cells.
 - The mass of the Battery Management System is not incorporated into the battery mass while determining the battery mass.
 - The participants must make sure that the batteries can be weighed separately. In case the Battery Management System cannot be easily removed an identical battery must be offered for weighing.

7.2 The maximum allowed voltage is 52 V DC or AC RMS. However, a set-up of the solar panels where the open circuit voltage is higher than 52 V is acceptable under the following conditions:

- When the electrical system is switched on (e.g. a maximum power point tracker or solar controller is active) the maximum voltage in the complete electrical system is 52 V or below.
- In case the electrical system is switched off, the maximum voltage measured in the system is also 52 V with the exception of the part of the electrical system between the solar panels and the maximum power point tracker or solar controller.
- In that part of the system and under that specific condition the maximum voltage must be 100 V or less.
- The cabling and connectors used as well as the housing of the MPPTs will have to be of insulation class IP65 or higher. Possible cables can be of the type Ölflex solar XLS with Epic solar 4 connectors.

7.3 The maximum nominal allowed voltage of the (composed) main battery is 48 VDC. In order to be able to comply with this rule in combination with rule 7.4 also during charging, the amount of batteries placed in series will be limited. The following limitations must be taken into account:

Type of battery	Nominal voltage used	Maximum charge voltage	Maximum allowed number of batteries in series
Lead-acid and lead-gel batteries	12 V	14.4 V	3
Nickel-Cadmium	1.2 V	1.5 V	34
Nickel-metal hydride	1.2 V	1.6 V	32
Standard Lithium-Ion	3.7 V	4.2 V	12
Lithium-Polymer	3.7 V	4.2 V	12
Lithium-Iron-Phosphate	3.4 V	3.6 V	14

For the use of other types of batteries not mentioned in the overview the participant is required to contact the organisation to have determined the maximum allowed number of batteries in series.

7.4 The main battery may only be charged with the use of the installed solar panels.

- The first stage of the race may be started with a fully charged main battery. It is allowed to tow or trailer the vessel to the starting point of the first stage.
- All solar energy available during the race may be used for purposes of propulsion and /or to recharge the means of energy storage (e.g. battery, fly wheel, super capacitor, hot water, ice, etc.).
- The solar panels may also be used in the mornings before the start of the next stage and in the evenings after the completion of the day's stage to use the available sunlight to charge the means of energy storage.

- From the start of the first stage up to and including the end of the final stage, solar energy is the only energy allowed to recharge the means of energy storage.
- It is also allowed to extract energy from the running engine with the use of short bursts of “regenerative braking” of the vessel.
- The use of other forms of energy to charge the means of energy storage during the course of the race will result in a penalty issued by the jury.

7.5 It is not allowed for a team to install additional batteries.

- Hand held navigation equipment powered by batteries is allowed as long as they are not electrically connected to the electrical system of the vessel.
- The use of (laptop) computers powered by batteries is allowed as long as they are not electrically connected to the electrical system of the vessel.
- All other electrical equipment must be powered from the main battery. This includes all kinds of measurement equipment.

7.6 All energy conducting parts must be fully insulated such as to prevent the occurrence of hazardous situations in the case of contact and exposure to water (for instructions on how to do this, please refer to the NEN/DIN standards for example). Special care has to be taken in case of vessels made out of conducting materials (e.g. aluminium, carbon fibre, etc.).

7.7 The design of the electrical wiring and circuitry must be based on standard colour coding (NEN/DIN standards).

- A plus-cable must be coloured or marked red
- A minus-cable must be coloured or marked black or blue
- All cables must be provided with a suitable strain relief

7.8 Participants are only allowed to use batteries that can be recharged electrically.

- The use of other types of batteries, such as mechanically charged batteries is not allowed. The use of fuel cells is not permitted.
- Every team is responsible for its own batteries.
- All batteries used in the race must be commercially available.
- The batteries may under no circumstances be modified in any way whatsoever.
- The participants must disclose all data related to the batteries no later than during Step 4 of the design process.
- The specified battery data must at least include a detailed description of the type of battery to be used and the so-called “materials safety data sheet” as supplied by the manufacturer thereby providing the organisation with adequate information in case of an emergency.

7.9 The batteries must be mounted in separate housings, such as to eliminate the risk of direct contact between the crew and the batteries and environmental pollution is prohibited.

- The purpose of the battery housing is to simplify the mounting of the battery in the vessel,
- The batteries and the fastening systems must be designed and manufactured such that they will remain fixed in their positions in the case of the vessel capsizing and thereby prohibiting environmental pollution,
- The battery housing may be a separate housing or may be fully integrated in the hull,
- The battery housing must prohibit, in case of damage of the batteries, that electrolyte flows into the hull,
- The battery housing must therefore be manufactured out of materials resistant to the electrolyte of the batteries,
- The battery housing may not be made out of a galvanic conductive material.
- The battery housing must be made out of a fire resistant material,
- The use of Velcro for mounting the battery and/or its housing is not permitted,
- Other suitable means of connection, as for instance used in cars, are allowed,
- The minimum distance between the batteries and the crew is one metre,
- All requirements with respect to mounting the batteries and their housing also apply to all other means of energy storage,
- The housing must be fitted with a forced ventilation system with a minimum capacity of 0.3 m³/minute, Alternatively, the housing may be closed and cooled in another way (e.g. liquid cooling). In that case the cooling must be adequate for all expected circumstances of weather and power consumption. In addition to that, in case of a battery failure gasses may never reach the compartment of the skipper and/or sailor(s). Young Solar class vessels are exempted from this rule
- The ventilation system must be operational at all times from the time the battery is electrically connected to the vessel (= when the mains switch of the electrical system is on),
- Both the inlet and the outlet of the ventilation system must be located at a position behind the crew or in an alternative position that is suitably distant from the crew; all subject to the sole discretion of the technical committee,
- The battery ventilation system must be designed such that upward spray and rainwater will not be able to make direct electrical contact with the battery,
- The battery ventilation system must be powered by the main battery and/or the solar panels.

7.10 All energy conducting cables must be designed in suitable dimensions to cope with the anticipated voltage and current. Minimum requirements for copper cables in free air, according to the table, under the assumption that a fuse with the correct voltage rating has been selected. The table shows values for slow acting fuses. If the design requires a fast acting fuse values may differ.

Crosssectional area (mm ²)	Allowed current (A)	Required fuse (A) Maximum value allowed
0.75	6	4
1	8	5
1.5	12	10
2.5	17	10
4	22	15
6	29	20
10	40	25
16	54	35
25	71	45
35	87	60
50	105	70
70	135	90
95	165	110
120	190	125
150	220	145

- 7.11 All vessels (except Young Solar Class) must be fitted with an emergency mains switch that can simultaneously interrupt the power supply to the engine and the power between the solar panels and the Maximum Powerpoint Trackers / Solar Controllers in emergency situations.
- 7.12 Young Solar Class vessels must be fitted with an emergency mains switch that can simultaneously interrupt the electrical connection between the battery and the engine, and the electrical connection between the solar panels and the battery.
- 7.13 Thereby it isolates the power sources from the rest of the electrical system. This switch is not the same switch as the dead man's switch
- The switch must be capable of breaking the electrical power supply under full load,
 - The switch must be accessible for emergency personnel from the outside of the cabin. It's position must be marked clearly on the outside of the vessel such that the switch can be easily located.
 - The switch must be clearly marked as an emergency switch,
 - **The 'on' and 'off' positions must be clearly displayed,**
 - The lettering must be of a minimum height of 20 mm,
 - It is allowed to use one or more relays in the switching system,
 - In the case of the use of a relay, this relay must be suited for the application.
 - A system that short circuits the solar panels will be allowed for interrupting the current to the MPPTs /solar controller.
- 7.14 All electrical systems must be provided with a fuse in serial connection with the main battery.

- The fuse may under no circumstances carry more than 200% of the expected power,
- The fuse must be mounted as close as possible to the main battery,
- The rating of the fuse may not be higher than the allowed current in the thinnest wire in the relevant part of the electrical system,
- The following systems must be fused:
 - Solar panel,
 - Motor controller,
 - Battery,
 - Battery Management System.

7.15 Participants are bound to use eye-protecting eye gear at all times when assembling, mounting and / or relocating the batteries and/ or when performing any other types of activities related to the batteries.

7.16 It must be possible to easily seal the energy storage system(s) (battery or any other type of energy storage).

- The participating teams must make sure that the necessary means are made available such that the organisation can apply the seal in a simple and fast way,
- The organization will apply the seal after the vessel has been technically approved,
- If a participant needs to break the seal, he or she is bound to notify the organization as soon as possible,
- The vessel is prohibited from racing from the moment the seal has been broken,
- The vessel may only return to the race once it has been subjected to a technical re-inspection and a new seal has been installed.
- It must be possible to easily seal the housing. This must be done in such a way that it is not possible to (re)charge the battery with any other source than solar energy and that it is not possible to replace the battery without breaking the seal,

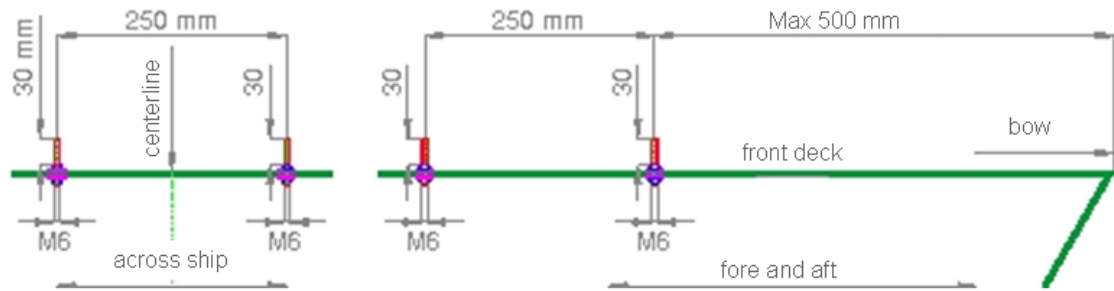
7.17 During the technical inspections the teams are obliged to be able show the electrical circuitry schemes.

8 Appearance of the vessels

8.1 All participating vessels must show the registration number provided by the organisation.

- Therefore all vessels must mount a registration panel on the front deck. The maximum distance between the most forward threaded rod for mounting the panel and the bow is 500 mm,
- The front deck must have 4 treaded rods, size M6, suitably attached,

- The threaded rods must protrude 30 mm above the deck and be provided with two wide washers and one locking nut each,
- The mounting of the registration panel must be done according to the following drawing,



- The bottom of the registration panel may not be placed lower than the top of the solar panels,
- The registration panel with the registration number will be provided by the organisation,
- The participating team is responsible for the acquiring and mounting the registration panel showing the correct registration number before entering the paddock,
- The registration number must be visible at all times and from all angles,
- The placement of the registration panel may not hinder the accessibility of the towing eye in the prow.

8.2 Participants are allowed to finish the boat design with aesthetic embellishments of their own choice taking into account the rules given in the Notice of Race.

- Participants are also allowed to display their sponsors,
- These displays may not be in conflict with sound moral standards whatsoever,
- All subject to the sole discretion of the organization.

8.3 The registration panel will be fitted with a transponder for tracking and tracing during the race.

8.4 For Young Solar class vessels separate rules which will replace rule 8.1 to 8.3 with respect to appearance will be issued.

9 Inspections

9.1 The organization is entitled to conduct inspections of the vessels at any time of its own choosing.

- The participants are bound to cooperate with such inspections.

9.2 All skippers and crew members are expected to have a minimum mass of 70 kg (60 kg for Young Solar Class skippers) during the course of the race.

- To that end, all skippers and crew members will be weighed
- The weighing will take place with the crew members wearing their bathing suits and life jacket.
- In the case of a skipper or crew member weighing less than 70 kg (60 kg for a Young Solar Class skipper), the mass of the ballast that he or she must carry throughout the race will be determined.
- The applicable ballast will be marked with a unique mark for the applicable skipper or crew member.

9.3 The technical committee will inspect all vessels for full compliance with the requirements prior to the start of the Challenge.

- All participants will be notified in advance of the time and location of the inspections,
- The organization will invite the participants for an inspection,

- During the inspection the participants are required to present their vessel in a race-ready condition,
- Vessels that fail to comply with the applicable requirements will not be allowed to enter the race until the time they do come into full compliance and this has been confirmed by means of a re-inspection,
- All modifications or repairs to the vessel, made after the inspection, will be subject to re-inspection. In order to judge whether a modification or repair is allowed, refer to rule 5.23.

9.4 Participants are at all times responsible for the technical condition and safety of the vessel during the course of the race. Approval during the inspections will under no circumstances exempt participants of their due responsibilities.

9.5 The inspection set-up will be announced to all participants in advance by means of an inspection form that will be used during the inspection. Participants are asked to prepare themselves for the inspection by means of the inspection form, such that this will facilitate a smooth inspection.

9.6 If the vessel is able to sail faster than 20 km/h the skipper(s) must be able to show his or her sailing permit to the organisation.

9.7 Starting from the moment the technical inspection begins the vessels are not allowed to leave the paddock anymore.

- Leaving the paddock without prior permission of the technical committee will lead to a penalty issued by the jury,
- No permission will have to be asked when a vessel is to be sailed to the sailing test, the prologue, the sprint or the starting point of a stage.

10. Sailing test

10.1 The participants are required to demonstrate the sailing performance of their boats. During this demonstration the participants have to sail a prescribed circuit. The vessel and the skipper will be judged on the following aspects:

- Controllability of the vessel,
- Sailing skills of the skipper,
- Stability,
- Freeboard in sailing condition,
- Spray characteristics.

10.2 In case parts have been classified as removable parts under rule 5.27 the sailing test must be passed with and without the removable parts installed.

10.3 Based on the results of the sailing tests the race committee may decide to exclude a participant from one or more stages of the race even if the vessel has been found technically in order. This may be a conditional exclusion based on for instance the expected weather conditions.