

Technical Regulations 2008

Version 12-Feb-2007

The Technical Regulations presented in this document were drawn up to 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.

1. General

The rules stipulated herein apply to the Frisian Solar Challenge, hereinafter referred to as the "race".

The rules apply to the race to be held in 2008.

All participants in the race are expected to have read and agreed to the Technical Rules. The organization will penalize all participants and teams that ignore or violate the Technical Rules. Penalization could be meted out in the form of warnings or disqualification and elimination from further participation.

All questions concerning the interpretation of the Technical Rules must be submitted to the organization in writing. The rules will be published on the website and are binding for all participants.

2. Technical specifications

All participants are at all times responsible for the technical condition and safety of their vessels during the course of the race. Approval of the design and approval during the inspection will under no circumstances exempt the participant of due responsibility.

2.1 Definitions

System voltage: The maximum voltage, measured in Volts, which is measured with a volt meter set between the earthing connection of the electrical system and any other point in the electrical system.

Source voltage: The nominal value of the voltage of the battery.

Dead man's switch: A device that is designed to cut the power supply to the engine as soon as the skipper loses control of the boat or when the skipper leaves the vessel, whether voluntarily or involuntarily.

Battery: The device that is used to store the electrical energy. The following types of batteries are distinguished in the framework of the Frisian Solar Challenge: Lead-acid, Lead-gel, Nickel-Cadmium, Nickel-metal hydride, Nickel-Zinc, Silver-zinc, Nickel-Iron Lithium-ion en Lithium-polymer.

Fully loaded: The condition of the vessel in which all systems have been mounted, all systems have been installed and all systems are operational, all the necessary ballast has been installed and the crew member(s) on board have been issued with the prescribed safety devices.

Freeboard: distance between the waterline and an imaginary line above which openings (like the edge of the deck, drain holes, open end of a pipe, cable feed through) have been made, in fully loaded condition.

2.2 Categories

The race is open to three boat categories:

Class A: Vessels with a single crew member

Class B: Vessels with two crew members

Class C (Open): Vessels in the open class.

Exactly two crew members must be on board two-person vessels during the race.

The following are the maximum dimensions and masses per class:

Category	A (1-person)	B (2-person)	C (open class)
Length ¹	6.0 m	8.0 m	8.0 m
Width	2.4 m	2.6 m	2.6 m
Height above waterline ²	0.7 m	0.7 m	0.7 m

Draught	*	*	*
Mass **	***	***	***

* No maximum draught 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 depth may vary from one month to the next; so, please keep in mind that the draught may vary as well. The propellers may be changed at all times and in all classes during the course of the race.

** Mass without crew members and solar panels, but including batteries and fastening constructions for the panels.

*** No maximum mass is prescribed for the vessels. Participants must however keep in mind that the boats need to be lugged across dry land in two locations in the course of the race. A maximum of 4/5 members of the team will be allowed to lug the boat (also see point 22 in Chapter 2.3 "The Vessel"). The vessel's mass will be determined during the technical inspection, as the mass will be used in the stability test.

¹ 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 disqualification.

² The height above the waterline must be limited to the specified height or it must be possible to reduce it to the specified height during sailing. Any mechanism used to adjust variable height must be either manually or electrically operated from the main battery. It is not allowed to install a secondary power source for that purpose.

2.3 The Vessel

- All vessels must be fitted with solar panels, which will serve as the sole source of energy. The use of wind energy and / or energy derived from manpower or animals will not be permitted.
- No prescriptions apply to the use of materials with the exception of the following limitations:
 - The use of flexible materials that might serve as sails is not allowed.
 - The use of materials that may pollute the water is not allowed.
- The use of energy storage systems, other than batteries, is allowed (e.g. flywheels). The latter types of energy storage may not be started prior to the actual official start of the race. In the case of the use of capacitors for energy storage purposes, the participant(s) must also provide a system whereby the capacitors can be 'emptied' immediately prior to the start of the race. The maximum allowed capacity in this case is 30 Farad.
- The skipper must have a clear field of view at all times.
- The stability of the vessels must be such that: a mass of 10% of the total mass of the vessel without the crew members in a position on the outer edge of the vessel, and with the crew member(s) in their normal position, will not result in lean over exceeding 15 degrees. In that case none of the openings in the hull, such as the outlet opening of the bilge -pump(s) and the deckedge may be submerged below the waterline.
- As the headroom and width of many of the bridges along the planned route are below the maximum allowed heights and widths, it is allowed to adjust the height and width of the vessels when passing under bridges. During those periods the vessels are not required to comply with the stability requirements. The boat's height and width can be adjusted manually or with the use of electrical energy. In the case of the use of electrical energy, the power must be supplied by the solar panels or the main battery. It is not allowed to use an extra energy source for this purpose. It is also allowed to detach the solar panels from the boat when passing under bridges and over/under other types of obstacles. Where participants opt for the latter action, the fastening system of the solar panels must be designed to ensure due safety during this operation.

7. 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.
8. If the vessel is designed with a closed cabin, the cabin must be fitted with an air supply/flow system that will ensure that the crew member will at all times have access to fresh air during the course of the race; all subject to the discretion of the technical committee.
9. If the vessel is loaded with ballast, it must be fitted into a separate ballast container. The container must be designed to ensure that the ballast will be expelled from the container in the case of capsizing (90 degrees heel or more) or such that the container will generate sufficient buoyancy to carry both the ballast and its own weight.
10. It is mandatory for all vessels to be fitted with one or more electrical and automatic bilge pumps. The pumps must be designed to empty all compartments that house passengers or electrical components. The system must be designed to ensure that each of the above - mentioned compartments can be pumped empty automatically and independently. The pump may be powered by an extra battery. The pump must have a minimum flow rate of 1,500 litres per hour. The pipe(s) that are connected to the pump must have a minimum internal diameter that is no smaller than the pump's outlet. The pipes 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 l/h.
11. 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. 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.
12. 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. The latter characteristic 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.
13. The use of safety belts is not allowed on board the vessels.
14. The cabin will be inspected for potential hazards.
15. 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.
16. All vessels must be designed with a minimum freeboard 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. Fully closed hulls are exempted from the minimum freeboard of 25 cm over the first 2 m measured from the front end of the vessel.
17. 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 reserve capacity of 20%. The latter capacity must be demonstrated by means of a calculation and a weighing. In addition, the vessel must also be designed such as to ensure that it is incapable of sinking the moment it fills up with water. In the case of the occurrence of the latter situation, it may be assumed that the crew members will not be on board any more. This characteristic must also be demonstrated by means of a calculation and a weighing.

18. All vessels must be fitted with a fastening point for a towline. The fastening point must be capable of holding a minimum load of at least the vessel's own weight. The minimum internal diameter of the fastening point must be 15 mm. All vessels must be provided with a floating towline of a minimum length of 10 m and a minimum diameter of 8 mm. Multi-hull vessels must be fitted with a towline attached to each of the hulls. Towlines may not be manufactured with steel wire or any other type of material that is hard to cut in the case of an emergency situation. The towline(s) must be attached to the front of the hull(s), such that the line will be pulled out when tugged at and such as to remain attached at one side to the hull.
19. All vessels must be fitted with two types of signalling systems; namely an orange warning flag and an audible warning system, such as a ship's horn.
20. All vessels must be fitted with a marker buoy.
21. All vessels must be fitted with at least one paddle with a minimum length of 60 cm, a minimum blade length of 20 cm and a minimum blade width of 13 cm. The paddle must be fastened and sealed in an easily-accessible location on board the vessel. The paddle may exclusively be used in emergency situations or with the permission of the organization. Following the use of the paddle, it must be refastened in the allocated location and resealed.
22. During lugging from waterway to waterway, Class A and C vessels may be lugged by no more than 4 people. It is allowed to use auxiliary systems to lug the boat across obstacles provided those systems are carried on board and are included in the boat's official overall weight. Class B vessels may be lugged by 5 people. It is not allowed to change the lugging team during any given lugging procedure.
23. All vessels must be fitted with an approved fire extinguisher with a minimum capacity of 1 kg of extinguishing material suitable for extinguishing fires, including electrical fires (category E). Due to the fact that it is hard, if not impossible to find category E extinguishers, participants are also allowed to use category A (solid materials) fire extinguishers.
24. 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. 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 of batteries will result in the issuing of a time penalty of one minute per remaining stage for each percentage point of the allowed maximum battery mass. Stages that have already been started will be counted as complete stages (e.g.: installing a new lead-acid battery of 10 kg during the second stage will yield a time penalty of $10 \text{ kg} / 25 \text{ kg} \times 100\% \times 5 \text{ stages} \times 1 \text{ minute} = 200 \text{ minutes}$).
25. All vessels must be fitted with four lifting hook eyes. The hook eyes must be positioned such as to make it possible to lift the vessel, with the installed solar panels, in and out of the water. In the latter situation the vessel must remain horizontal to the greatest extent possible. A maximum deviation of 10 degrees from the horizontal position is allowed. The structural integrity of the vessel must not be compromised during hoisting.
26. The average speed of the vessel must be at least 8 km/h. The latter characteristic will be tested during the prologue to the race.

2.4 Solar panels

1. All participants in Class A and B are bound to fit their vessels with the solar panels provided by the organization, namely the solar panels loaned by the sponsors, Sharp and The Sun Factory. Participants in Class A are provided with five panels each with peak capacities of 175 W, and participants in Class B are provided with six panels on loan. The technical specifications for the panels are available on the Frisian Solar Challenge website.
2. No prescriptions apply with respect to the installed power of the solar panels used in the open class; however, the maximum surface area of the solar panels is limited to 8 m^2 . The surface

area of the solar panel is determined by the total combined active area of the solar cells. If the solar cells overlap one another, the covered areas are not counted in the overall determination of the allowed surface area. Participants are required to submit a drawing and calculation of the solar panel during Step 3 of the design process to enable the technical committee to unambiguously determine the total surface area of the solar panel.

3. The solar panels must be placed horizontally on all vessels. The maximum deviation from the horizontal position is 10 degrees. The use of adjustable systems is allowed provided they are exclusively operated on electrical energy deriving from the solar panels or the main battery.
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 -resistant in all directions, including, turbulence and gusts.

2.5 Electronics

The type and mass of the battery pack will be evaluated during the technical qualification.

1. The vessels may be fitted with a battery pack with a maximum nominal capacity of 1 kWh. All further references to the battery pack will refer to the 'main battery'. The nominal capacity is based on a discharge time of 20 hours. To be able to properly judge this requirement, the figures in the list below are used to evaluate the different types of batteries. The battery pack will be weighed during the technical inspection in order to determine whether the battery capacity exceeds the maximum allowed values.

Lead-acid and lead-gel batteries	25.0 kg	(40 Wh/kg)
Nickel-Cadmium	20.0 kg	(50 Wh/kg)
Nickel-metal hydride	14.3 kg	(70 Wh/kg)
Silver-Zinc	8.0 kg	(125 Wh/kg)
Nickel-Zinc	15.2 kg	(66 Wh/kg)
Nickel-Iron	20.0 kg	(50 Wh/kg)
Standard Lithium-Ion	7.1 kg	(140 Wh/kg)
Lithium-Polymer	6.0 kg	(167 Wh/kg)

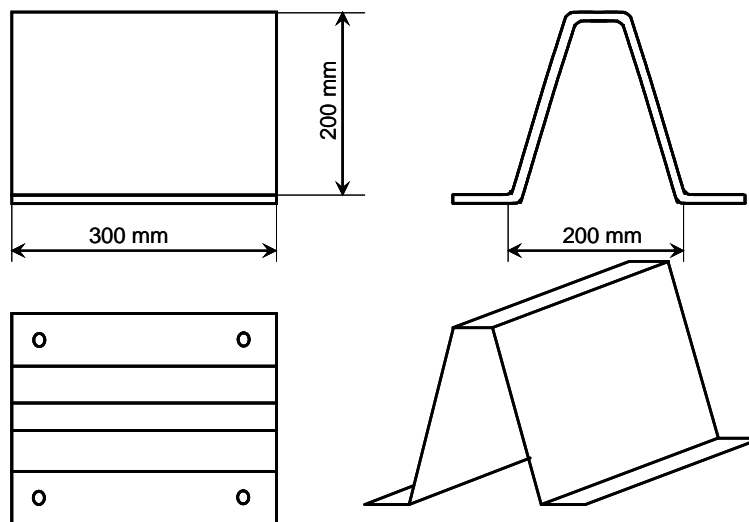
2. Participants found to have installed battery power in excess of the maximum allowed levels will be issued a time penalty. The time penalty consists of 1 minute per stage per percentage point of the excess amount of allowed maximum battery mass. The same penalty will apply in the case of the replacement of (part of) the battery pack.
3. A properly functioning Battery Monitoring System is mandatory for all batteries other than lead-acid and lead-gel batteries. The system must monitor both the battery's voltage and temperature, and must also be capable of shutting the system down when necessary. The Battery Monitoring System must be designed to monitor all individual battery panels. The mass of the Battery Monitoring 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.
4. The maximum allowed system voltage is 52 V DC or AC RMS.
5. The maximum allowed voltage of the (composed) main battery is 48 VDC.
6. 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. All solar energy available during the race may be used for purposes of propulsion and /or to recharge the main battery. 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 generate electricity to charge the batteries. 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 batteries. It is

- also allowed to extract energy from the engine with the use of short bursts of "regenerative braking" of the vessel. The use of other forms of energy to charge the batteries during the course of the race will result in disqualification.
7. It is allowed for a team to install extra batteries for safety reasons where it deems this necessary. This is however subject to the provision that the energy stored in those batteries is not used for propulsion. If a participating team wishes to make use of such extra batteries, it is bound to submit a properly motivated application to that effect to the technical committee by no later than Step 4 of the design process. The technical committee will then decide whether to allow this or not. If the technical committee permits the use of extra batteries, this needs to be specifically mentioned at the technical inspection prior to the race, at which time it will be inspected.
 8. 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).
 9. The design of the electrical wiring and circuitry must be based on standard colour coding (NEN/DIN standards).
 10. Participants are only allowed 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 panels 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 by no later than Step 4 of the design process and at the time of the technical inspection. The specified battery data must at least include a detailed description of the type of battery to be used and the so-called "safety data sheet".
 11. The batteries must be mounted in separate housings, such as to eliminate the risk of direct contact between the crew and the batteries. The minimum distance between the batteries and the crew is one metre. It must be possible to seal the housing, as well as the electrical connections. The housing must be fitted with a forced ventilation system with a minimum capacity of 0.3 m³/minute. 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). 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 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. 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 at all times.
 12. All energy conducting cables must be designed in suitable dimensions to cope with the anticipated voltage and power currents. The system design must provide for a safety margin of 50% above the maximum expected power that will be used.
 13. All vessels must be fitted with an emergency mains switch to cut the power supply to the engine in emergency situations. The switch must be capable of breaking the electrical power supply under full load. The switch must be clearly marked as an engine switch and the 'on' and 'off' positions must be clearly displayed. The lettering must be of a minimum height of 10 mm. It is allowed to use a relay in the switching system. In the case of the use of a relay, it is allowed to use an additional battery to power the relay.
 14. The electrical system 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.
 15. The batteries must be connected to the vessel construction by means of a belt of a minimum width of 3.5 cm or a suitable alternative fastening system. It is not allowed to use Velcro for this purpose.

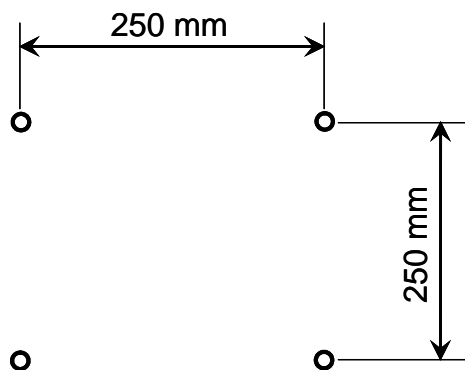
16. Participants are bound to use eye-protecting eye gear at all times when assembling, mounting and / or relocating the batteries and/ or when performing any other types of activities related to the batteries.
17. The batteries must be installed in a suitable battery container. The purpose of the battery container is to simplify the fastening of the battery system to the vessel structure. The battery container must also be designed to prevent electrolytes from flowing into the vessel in the case of damage to the battery. For this reason the battery container must be manufactured from materials that are resistant to the types of electrolytes to be used in the battery. The battery container can be a separate box that is fastened to the vessel structure or a box that forms an integral part of the vessel structure.
18. It must be possible to seal all electrical connections between the solar panels, the propulsion system and the energy storage systems. The organization will apply seals to a number of these systems during the technical inspection. 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.

2.6. Appearance of the vessels

1. All participating vessels must be fitted with a registration panel on the bow. The drawing below represents the rough dimensions of the registration panel. The registration panel will be supplied by the organization. The organization is currently considering the option of fitting the registration panel with a "tracking and tracing" system (GPS and webcam) during the race. If this plan is in fact implemented, the organization will integrate this system in the design of the registration panel. The precise dimensions of the registration panel will be announced in due course.



2. The position of the registration panel will be such as to ensure that the towing eye in the prow will be easily accessible and that the front end of the registration panel will not extend further than 0.50 m beyond the front end of the vessel. For those reasons, participants are required to provide the prow with four protruding, firmly fixed M6 threaded extensions based on the pattern represented below. The prescribed length of the protruding part of the threaded extension is 30 mm. The organization will attach and seal the registration panel.



3. All vessels must be supplied with a registration number, which will be allocated by the organization. Therefore the organization will provide all participants with two stickers. The stickers must be adhered on both sides of the registration panel on the vessel's prow.
4. All participants are also bound to reserve 25% of the front area on both sides of the vessel's hull for the publicity of the organizing authority and its sponsors
5. Participants are allowed to finish the boat design with aesthetic embellishments of their own choice. Participants are also allowed to display their sponsors, under to the provision that such displays are not in conflict with sound moral standards and the interests of the organization; all subject to the sole discretion of the organization.

2.7. Inspections

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.
2. All skippers and crew members are expected to have a minimum weight of 70 kg during the course of the race. To that end, all skippers and crew members will be weighed with their bathing suits and safety vests on. In the case of a skipper or crew member weighing in at less than 70 kg, the weight of the ballast that he or she must carry throughout the race will be determined. The applicable ballast and safety vest will be marked with a unique mark for the applicable skipper or crew member.
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. Vessels that fail to comply with the applicable requirements will be disqualified from participation until the time they do come into compliance and this has been confirmed by means of a re-inspection. All modifications to the vessel, made after the inspection, will be subject to re-inspection. All vessels may be subjected to random additional inspections during the course of the race.
4. 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.
5. 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.
