

Gran Canaria Invitational

Contestant's Handbook and Rules

February 2024

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Revision History

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Introduction

The Gran Canaria Invitational (GCI) is an open-water human-powered submarine racing event which takes place annually in the Bahía de Arinaga, off the town of the same name on the east coast of Isla Gran Canaria, in Spain's Canary Islands archipelago. The event is hosted by the Rhine Waal University of Applied Sciences (HSRW) in collaboration with the Submarine Racing Series (SRS), an Irish startup company, and is the first event of what will be a multi-venue international league of submarine racing.

The GCI is open to teams of university students or dedicated community groups. It pits the teams and their self-made, flooded, pedal-powered submarines against each other in a head-to-head format over a 400m course in 5-7m of water. The open-ocean event is complementary to, but compatible with, existing human-powered submarine races in the USA and UK, which take place in enclosed testing tanks.

The race event is a central element of a science communication strategy intended to "bring the ocean into people's living rooms". The concept is to make use of the excitement of underwater racing to familiarise the sports-enthused public with the aquatic environment and to highlight the challenges facing the coastal ocean in areas of conservation concern in the EU and around the world.

Story so far

The first proof of concept (PoC1) of the race event took place in Sept 2023 and featured two biomimetic submarines, *Rivershark* and *Chelonia*. The former was originally designed and built in 2007 by a team of students from the University of Bath, in the UK, and was raced in PoC1 by a Dutch-German community team of experienced submarine racing alumni. The newcomer was a brand-new machine designed, built and raced by a team of current students from HSRW in Cleves, Germany. Teething troubles plagued the *Chelonia* throughout the race week, but the veteran *Rivershark* was undaunted by the open-ocean conditions and was able to secure victory.

The second proof of concept (PoC2) of the GCI is scheduled for Sept 2024. There are six places available on the starting line. Both original teams are back, though *Rivershark* has retired, so *Chelonia* will be the veteran vessel. Who will join them in their underwater challenge?

Draft Rules

The rules laid out in this document are still in development and subject to change as details become more apparent. Updates will be published to the GCI moodle site as the changes are agreed by the race organisers and the judges. Participants are encouraged to keep track of the changes, and indeed to provide feedback as the rules are developed. A forum for this purpose has been set up on the moodle site. Once the rules have been finalised, the watermark will be removed, the version number will roll over to 1.0, and the final document will be uploaded to the public-facing GCI website.

Race Committee and Officials

The GCI PoC 2 is overseen by a committee consisting of:

- Operations Director
- Logistics Director
- Head Judge
- Communications Director
- Safety Director
- Finance Director

The racing is managed by the following officials:

- Dive Control
- Surface Manager
- Ramp Manager
- Shoreside Manager
- Race Queue Manager
- Divemaster
- Racecourse Judge
- Shoreside Judge
- Race Marshals (at the surface and underwater)
- Safety Divers

Affiliations

The GCI PoC 2 has no affiliation to the European International Submarine Race (eISR) hosted by QinetiQ and the IMarEST, not to the International Submarine Races (ISR) hosted by the Foundation for Underwater Research and Education (FURE).

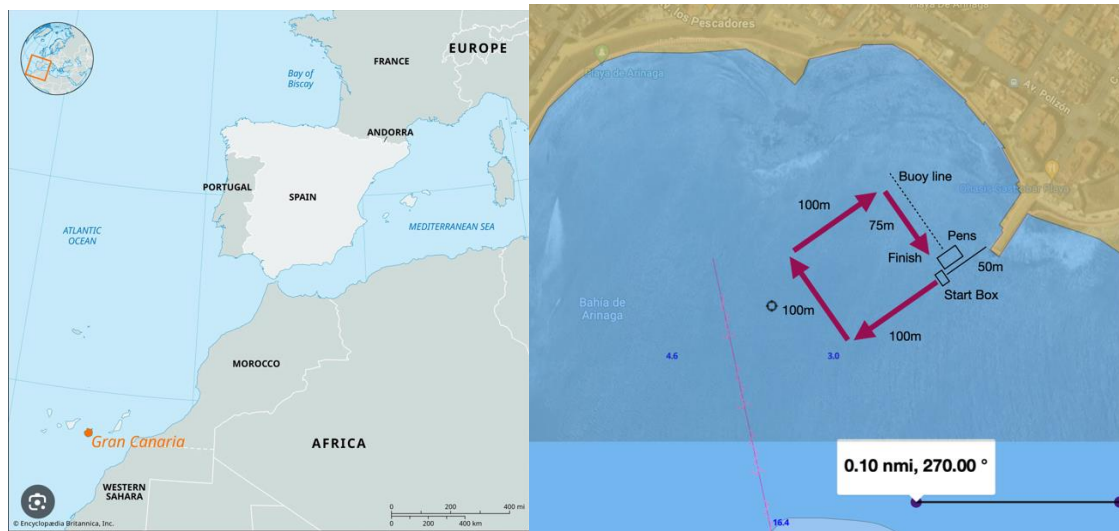
Liability

Submarine racing is, like any other sport, an activity which encompasses a certain amount of personal risk. Every effort is taken to ensure a safe environment. Rescue divers are always present, and medical help is on hand. However, the onus is on the participants to ensure their own safety and that of those around them, whether underwater, at the surface, or ashore. The Rhine Waal University of Applied Sciences, Submarine Racing Series and the GCI Race Committee assume no liability for injury to participants, nor for damage to or loss of their equipment. Participants are made aware of these risks and are required to acknowledge this awareness by signing a liability waiver during the registration process.

It is the responsibility of every individual and team to secure and look after their own equipment. The Rhine Waal University of Applied Sciences, Submarine Racing Series and the GCI Race Committee accept no liability for loss, damage or theft. Although help and support amongst teams is encouraged, it is a team's responsibility to ensure their equipment is clearly identifiable and they know where it is located.

Location

The 2024 GCI PoC 2 takes place in the Bahía de Arinaga, a sheltered bay on the east coast of Isla Gran Canaria, Spain. The race itself is held in 5-7m of water, with a starting line approximately 100m off the tip of the Muelle de Arinaga, a historical pier providing shelter from the north wind and east swell. The shoreside activities take place in the town of Playa de Arinaga.



Definitions

Design Rules

1. Submarines must be designed to be operated by a single pilot.

Hull

1. Overall length may not exceed 5.5m.
2. Maximum width, excluding appendages, may not exceed 1.5m.
3. The submarine must have a free flood hole or drain hatch opening sited on the underside of the vessel, close to the longitudinal centre of gravity position, with minimum dimension 117cm² (18in²).
4. Drag reducing coatings on the hull are permitted, so long as they do not slough off the submarine into the environment.
5. The hull must be painted or wrapped such that it is bright when viewed from above and dark when viewed from below.

Hatches

1. All internal and external handles and release mechanisms used to exit the submarine must be marked with a high visibility orange patch of minimum area 10cm² and be marked with the word "Rescue" in black on the orange patch.
2. External handles and release mechanisms must be readily available from inside and outside the submarine.
3. All hatches must be secured to the hull by means of hinges, straps, or other similar mechanisms.

4. The mechanism permanently securing the main hatch to the hull must not restrict in any way the pilot's ability to exit the submarine.

Cockpit

1. All pilot restraints within the submarine (eg toe clips or shoulder straps) must have the release mechanisms clearly identified with high visibility orange material.
2. Hatch release mechanisms must be highlighted with orange paint and immediately clear instructions (e.g. Pull to Release) must be printed in black on an orange painted square of minimum 10cm x 10cm size.
3. The pilot's face must be visible from outside the submarine when the pilot is in the submarine in the racing position, with the main hatch closed.
4. The pilot must be able to see unimpeded in a 180° arc in the horizontal plane and from 90° vertically downward to 10° above horizontal in the sagittal plane.
5. Provision must be made in the design of the cockpit layout for the display of two A5-sized waterproof checklists in the pilot's field of view. The checklists will be provided by the judges and race organisers each day of the event.

Propulsion

1. Submarine propulsion must be water coupled.
2. Wheels or other bottom propulsion methods are prohibited.
3. Submarine propulsion system(s) must be directly coupled to the pilot (no clutches).
4. Energy storage systems are permitted, only where the energy is stored and dissipated during the race run itself, eg. resonant elastic structures on oscillating biomimetic fins. Flywheels or other energy storage devices that can be loaded before the submarine crosses the start line are prohibited.
5. Hydraulic, pneumatic, or electric power transmission systems are permitted, only if all of the energy used for propulsion is produced by the pilot.
6. Only water-resistant grease may be used to lubricate boxed gearing.
7. Propeller or propulsor tips must be painted high visibility orange.

Control

1. Tips of control surfaces must be painted in high visibility orange.
2. Any electronic control systems must be complemented by purely mechanical systems. The pilot must be able to disengage the electronic control system and engage the mechanical one from inside the vessel, without opening the hatch. The disengage/engage system must itself be purely mechanical so that it will still operate in case of a failure of electrical supply.

Lights

1. Submarines must display all-round white flashing light(s) such that the strobe is visible from 360° in both the horizontal and sagittal planes.
2. The light(s) in the previous rule must be wet-replaceable such that a support diver can swap out a defective or discharged light without bringing the submarine to the surface or removing it from the water.

Instrumentation

TBD

General Systems

1. The use of any fluid other than water within the submarine's hydraulic system(s) is prohibited. The use of oil anywhere within the submarine, including within sealed watertight electronic component containers, is prohibited.

2. Electric systems must not exceed 24VDC.
3. If fitted with batteries, the type of battery, the battery location and how the battery can be isolated must be detailed close to where batteries are fitted.

Safety

Life Support

1. All breathing air must be supplied using open-circuit SCUBA systems and use compressed normal atmospheric air. Special gas mixes, e.g. nitrox, are prohibited.
2. Rebreather systems are prohibited for all divers.
3. A primary air supply for the pilot must be carried aboard the submarine with sufficient capacity to complete a run at speed and not fall below a minimum pressure of 80 bar.
4. The pilot's air pressure gauge must be visible to the pilot when inside the submarine.
5. The pilot must carry a secondary independent air supply with a capacity of no less than 3L and a pressure regulator system of its own.
6. The secondary air supply must not be used for tasks such as loading and preparing for a run, and its pressure must not be allowed to fall below 80 bar.
7. With the pilot in the submarine and all hatches closed, the pilot must be able to communicate the pressure of their primary and backup air supplies to a support diver.
8. It is forbidden to use the pilot's onboard air supply (primary and backup) for any other use than life support.
9. The primary air supply must be rigidly fixed (strapped) into the hull using a standard dive cylinder clamping system as know from BCDs. The release handle of the tank strap must be painted orange.
10. The secondary air supply must be fixed to the pilot and not fixed to the submarine.
11. All support divers must be equipped with a spare second stage regulator (octopus) for safety and support, as required by Spanish law.
12. No diver shall allow the pressure in their cylinder to drop below 80 bar. Repeat remaining pressure offences may result in the diver being excluded from the competition. Air supply pressures will be checked on entry and exit from the water, and the Dive Master has the ultimate authority to decide whether a diver will be allowed to enter the water.
13. Evidence must be provided of qualified servicing of all first and second stage regulators within twelve (12) months prior to the last day of the event.
14. All breathing air cylinders must either be completely black in colour, or their shoulders must be painted in a four-quadrant black and white pattern, as required by Spanish diving law.
15. Serial numbers and manufacturer's information should be stamped into the crown in accordance with European Standard EN 1089-2.
16. All air cylinders must clearly display current hydrostatic test (within the 5 years prior to the last day of the event) and visual inspection (within the 12 months prior to the last day of the event) dates.
17. Certificates attesting to the hydrostatic and visual inspections must be uploaded to the moodle site and accompany the cylinders to the race site.
18. All air cylinders must be CE certified to appropriate EN or BS Standards that are suitable for PPE/breathing apparatus. The current standards are:
 - EN 1964:2000 Transportable gas cylinders – Seamless Steel,

- EN 1975:2000 Transportable gas cylinders – Seamless Aluminium,
- EN 12245:2002 Transportable gas cylinders – Fully wrapped composite,
- EN 12257:2002 Transportable gas cylinders – Seamless hoop-wrapped composite,
- BS 5045-7:2000 Transportable gas containers – Seamless Steel, and
- BS 5045-8:2000 Transportable gas containers – Seamless Aluminium.

Surface Signalling Buoy

1. The submarine must be equipped with a high visibility pop-up (surface signalling) buoy.
2. The SSB must have a net buoyancy of at least 500g.
3. The SSB must be attached to the submarine by 10m of floating, highly visible line.
4. The SSB line must be stowed such that it cannot be a tangling hazard to the pilot.
5. The SSB line must be threaded through a tube within the hull so that it cannot snag on any fitting when the SSB is released.
6. The SSB must either form part of the hull or be contained in a fully flooded compartment inside the submarine hull.
7. The SSB must be deployed automatically should the pilot become incapacitated (eg it must be operated by a dead man's handle).
8. Override mechanisms on the SSB are permitted while the submarine is attended by support divers behind the starting line.
9. Override mechanisms must not be activated after the submarine has crossed the starting line.

Surface Tracking

1. All submarines must trail a surface marker buoy (SMB) of the type trailed by ocean swimmers, of minimum volume x L and minimum buoyancy x kg.
2. The SMB must be attached to the submarine by a line no longer than 15m in length.

Support Divers

1. At least one support diver is required to load a pilot and start a race.
2. Divers must wear a dive computer or carry set of dive tables and wear a dive watch.
3. Divers must carry a small knife or line cutting device.
4. Divers must carry a whistle attached to their buoyancy control device (vest).

Qualification

Eligibility

Team Eligibility

The GCI PoC 2 is a team event. Each team must be sponsored by an organisation which agrees to take on the public liability for the team's actions. Teams may be sponsored by academic institutions, community groups, or corporate entities.

University Teams

To be eligible as a university team, a group must consist only of currently registered undergraduate or postgraduate students or recent graduates (within the calendar year) at a recognised university. Institutional staff members may be incorporated in the team. The spirit of the University level is one of student-led design and manufacture. Academic staff

are encouraged to provide mentoring roles, but it is not intended that they will "run the show".

Community Teams

Groups of dedicated individuals may form community teams. These must run under the banner of a legal entity which can take on the public liability for the team's actions and provide proof of insurance therefor. Community teams may draw their members from anywhere, subject to the age limit specified below.

Corporate Teams

Groups of employees of a company who are paid (even if on holiday) while they design, build, and/or race their submarine are considered corporate teams. The GCI is not (yet) open to such teams.

Individual Eligibility

The GCI is open to all persons interested in underwater engineering and marine science, regardless of nationality, creed, race, or gender identification. The only restriction is that all team members must be over the age of 18 at the start of the in-water part of the competition.

Diving Qualifications

Divers must be qualified to dive independently, with the minimum dive qualification EN 14153-2 or ISO 24801. It is the diver's responsibility to provide proof of qualification and that the training received is of the necessary standard. Divers must upload copies of their certification cards to divelogs.de well in advance of the event. They must also bring those cards with them and hand them in physically to the organisers for the duration of the event, so that they can be checked at any time by the local police (Guardia Civil).

All divers must provide logbook (in electronic form via divelogs.de) confirmation of at least twenty completed open water dives post qualification. A complete dive is defined as having gone to a depth of at least five metres and consumed half a 10L cylinder of air. Teams must have at least one diver (in addition to the pilot) with experience of having dived at a previous submarine racing event. All pilots must additionally have been pilots at a previous submarine racing event.

Diving Insurance

Every diver must have personal diving insurance which complies with Spanish Diving Laws. If participating divers do not have insurance of their own (eg. DAN), then they can acquire a policy locally from one of the dive shops. Divers requiring insurance will have to provide their information in good time via the moodle system so that a bulk purchase can be made.

Qualification Round

The 2024 GCI PoC 2 is an invitational event. All teams have been offered a place on the starting line based on their recent performance in similar international competitions. In order to be considered for a place, teams are required to upload the documentation

described below to the GCI moodle site. The judges will evaluate the team's application based on the criteria described. Their decision is final.

Specification Sheet

The single page specification sheet must contain the following details:

- a. name of the submarine
- b. length overall
- c. maximum beam
- d. hull weight and contained volume
- e. positions of the Centre of Gravity and the Centre of Buoyancy
- f. type of propulsion
- g. propeller blade length (or equivalent for non-propeller designs)
- h. propulsion rpm/cadence
- i. pedal cadence
- j. type of control of hydroplanes & rudder(s)

The specification is intended to be a starting point for the design of the submarine. If the final design deviates significantly in any of the parameters, the changes must be addressed in the overall design report (in either the design or production sections).

Photographs

For the purposes of qualification, photographs of the following parts of the submarine must be submitted. The photographs must be of the parts that physically "turn up" at the race event. Exceptions to the rule include the paint job and minor changes such as pitch angles. If multiple exchangeable propulsion or control elements are being considered for use in the races, photographs of these must be provided at qualification time.

1. Overall outside views from forward, astern, port, and starboard sides.
2. Close up external views of the control surfaces.
3. Close up external view of the hatch and external hatch release handle.
4. Close up view from outside the submarine of the pilot in racing position inside the vessel.
5. Internal overall view of the cockpit, looking forward.
6. Internal overall view of the hull interior, looking aft.
7. Close up views of the controls.
8. Close up views of the pedals and transmission.
9. Close up views of the control mechanism(s).
10. Close up views of the securing system for the onboard scuba cylinder.
11. Close up views of the signalling buoy system, including the pilot's release mechanism (deadman's mechanism) and demonstrating the function of the buoy itself.

Video

Teams must provide a video of their submarine underway, underwater, and under control. As a minimum the video must show the submarine being propelled by the pilot over a distance of at least three submarine lengths, and it must show that pilot can control the direction of the submarine in both pitch and yaw, all while remaining completely submerged in water clear enough to see all of the activities. Finally, the video must show the team's

loading process and demonstrate the safety features of the submarine, which must include as a minimum the release and surfacing of the signalling buoy and the pilot's exit from the submarine.

Design Report

Detailed instructions to follow soon.

Participation in previous races

To qualify for participation in the GCI PoC 2, teams must have qualified for and taken part in a previous eISR competition or GCI event. All submarine pilots must provide evidence of having piloted a submarine at a recognised race event (ISR, eISR, or GCI) prior to piloting a submarine at the GCI PoC 2. This is to ensure that the submarine and at least some of its crew have gained experience from a set of "sea trials" before attending the GCI PoC 2.

Operations

Ashore

Team operating areas

Teams will be assigned designated parking places in the cul-de-sac of the Calle Alcala Galiano. There they can park their van (see below) and store their equipment. They can also get out of the sun and wind. A professional guard will be posted to ensure security.

Casita workshop

There is a small building at the base of the pier which will be outfitted as a small mechanical workshop. A technician will be available to help teams repair or manufacture small parts.

Freshwater rinse

Dive equipment can be rinsed either in the barrels provided by the casita, or at the shower over by the beach. Directions will be provided on site.

Overnight storage

Submarines and dive gear will be stored overnight in the team's white van. These will be provided by the race organisation for the duration of the event. Vans can be parked in the city of Aguires' secure compound overnight, as parking for large vehicles in Playa de Arinaga is an exercise in frustration.

Ramp

Launch and recovery of submarines takes place on the concrete ramp alongside the lee side of the pier. The ramp extends smoothly into the water at high tide, but at low tide, there is a significant step. The breaking waves can pose some challenges during water entry and exit, so teams will need to devise strategies to overcome the challenge safely.

Launch procedure

To be described

Recovery procedure

To be described

Underwater

Submarine pits

Submarines are moored mid-water on buoys anchored 2m above the sea floor. The pits are designated areas away from the starting line where teams can prepare their submarines without silting up the racecourse itself.

Starting boxes

The start boxes are marked areas on the sea floor where the submarine racing safety team (SRST) is assembled and the pilot given the command to start. Submarines start at an altitude of approximately 2m above the bottom. The start boxes are staggered by 12m to compensate for the additional length of the outside track.

Racecourse

The GCI racecourse is 400m long, shaped in a square with four 100m sides. The course is marked with a dashed line of flagging tape anchored periodically on the sea floor. The submarines race head-to-head in two lanes spaced two metres apart.

The starting lines are staggered, so the pilot in the inside lane will be catching up to his or her opponent over the full length of the course. The pilots are required to keep to their own lane. In the GCI with its head-to-head format, that means that each pilot is to keep to his or her own side of the centre line. This will be especially important in the corners. Submarines are not allowed to contact each other. The safety divers will work with the judges to determine penalty points for any breach of this rule. Submarines are required to remain submerged for the full duration of the race. Breaches of the surface will result in penalty points. They are also not allowed to disturb any of the course markers or camera installations. Further penalty points will be applied for collisions, in particular if the collisions require repair or delay the races.

Finishing line

At the end of the 400m race the submarines will cross a finish line monitored with an underwater video camera. The winner of a heat should obviously be the first over the line, but a set of rules is still being developed to ensure that penalty points are applied fairly for transgressions of the race rules during the heat. After the boats have crossed the line, they settle to the bottom in the landing area and their pilots are recovered to the surface. The team's support divers recover the submarine to the pits and moor it, so that it can be prepared for the next heat.

Underwater video

TBD.

Prizes

TBD.

Travel & Logistics

Local Community

The town of Arinaga is a small residential town which welcomes a small number of visitors all year round, and has a quiet peaceful feel. The local town council are providing us with many permissions and facilities and it is important therefore that all teams and supporters treat the town, its facilities and marine life, and above all its residents, with respect. We want to leave at the end of the competition with a better reputation than when we arrive.

You are ambassadors for the Universities and entities that you represent, and we trust you will display maturity and empathy towards all the residents, both during the event and after hours in the town.

The event organisers will not hesitate to address any concerns raised to them by the event judges or crew, local officials, residents or visitors to the town. In extreme cases of unacceptable behaviour individuals may be barred from taking any further part in the event, and/or reported to the local police or authorities.

Travel Options

The Canary Islands are located in the Atlantic Ocean off the west coast of Africa. They are an outlying territory of Spain and the EU. Gran Canaria is the largest of the islands, and the largest city in the archipelago, Las Palmas de Gran Canaria, is located on its north coast.

The island's international airport (airport code: LPA) is located on the east coast, about halfway from Las Palmas to Arinaga. There are direct flights there from all over Europe. The easiest overseas connection is via Madrid, but there are other options as well.

The other option is to travel by ferry. There are two ferry companies that operate between Gran Canaria and Huelva in mainland Spain. The trip takes 33 hours one way and 43 hours the other. It's super cheap, but bring a sleeping bag and a good book.

There is excellent public transport in the more developed parts of the island, but in the rural areas like Arinaga, teams will like want to rent a car. There are several rental companies based at Las Palmas airport, and there are lots of deals to be had. Rental contracts will be in Spanish, so be prepared to do some translating.

The town of Arinaga lies about 10 km south of the airport and is split in two. The main part of the town (Cruce de Arinaga) is nestled in the hills above the motorway, where the temperature is somewhat cooler, and the harbour town (Playa de Arinaga) is obviously right on the water. The race takes place at the Muelle (pier), which is at the ocean end of the main street.

Accommodation

The race organisers have booked some AirBnB apartments for you. The intent is to accommodate teams all together in each of the

Shipping

Transport of submarines and diving equipment to and from Gran Canaria will be provided by the Rhine Waal University of Applied Sciences on behalf of the Submarine Racing Series. A 20' shipping container will be made available at the conclusion of the 2024 eISR in Gosport so that submarines and equipment can be shipped first to Germany, where they will spend the summer, and then on to Gran Canaria in time for GCI PoC 2.

Teams are responsible for making their own arrangements for shipping their submarines and equipment to the eISR and home from Germany.

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