ISR 19

19th International Submarine Races

Contestant Manual | Version 1.2

June 20–25, 2027

David Taylor Model Basin | NSWC Carderock | Bethesda, Maryland

Build Smart. Dive Smart.

Sponsored by the Foundation for Underwater Research and Education (FURE)

The Foundation for Underwater Research and Education (FURE) is a 501(c)(3) nonprofit organization dedicated to advancing marine technology and ocean engineering by investing in today's youth pursuing marine-related scientific and engineering research and educational opportunities.

Version	Date Released	Change
1.2	May 20, 2026	First Public Release of ISR 19 Contestant Manual

Major Changes

Several participant requirements have been updated since ISR 18 to maintain our strong safety record. Teams familiar with previous races should pay particular attention to the sections below, which highlight key changes and other items of note. This is not an exhaustive list — all teams are expected to read the manual in its entirety.

Section(s)	Change Topic	Change Summary
3.2	**Team Entry Payment**	U.S. teams may submit entry payments via Zelle in addition to existing payment methods.
4.5	**Host Hotel**	Host hotel is currently TBD but will be updated in the following manual release. The hotel region will remain in the Rockville, MD vicinity.
6.5	**Emergency Pop-up Buoy**	Buoy now optional, whereas it was previously required. Teams may elect to omit buoy subsystem entirely based on improved course visibility and other redundant monitoring. Teams that choose to include the buoy must still meet all existing specs and design requirements as outlined in Section 6.5.
7.1	**Diver Requirements**	Teams are strongly encouraged to dive early and often in the year leading up to the event to ensure all members comfortably meet the minimum requirements: A minimum number of dive sessions and hours per the constraints in Section 7.1 must be completed prior to the event. Dive staff will verify compliance before any in-water activity, including the wet check. Wet checks will be conducted one time only per individual — divers must successfully demonstrate all skills outlined in Section 7.1 at that time to qualify as in-water participants for the race week.
9.1	**Race Theme**	**Build Smart. Dive Smart.** For ISR 19 and beyond, we are hosting the race event with a themed motto to go by. The chosen theme for ISR 19 reflects the dual emphasis on engineering excellence and dive preparedness, echoing the updated dive hour requirements and single-attempt wet check policy. A new themed award will recognize the team that best exemplifies these areas across both design and dive performance.

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SECTION 1 — About FURE & ISR

1.1 Document Overview

Congratulations on considering building and racing a human-powered submarine! This manual has been prepared for those interested in participating in the 19th running of the International Submarine Races (ISR 19), to be held 20 – 25 June 2027 at the David Taylor Model Basin, Naval Surface Warfare Center, Carderock Division (NSWCCD), in West Bethesda, Maryland.

This manual serves as a guideline for participating in ISR 19 and addresses submarine design, race participation, registration, schedules, rules, operations, and related subjects. It has been written and edited by members of the Foundation for Underwater Research and Education (FURE) and its ISR Committee. As a working document, this manual is subject to change and updated versions will be posted on FURE's website at www.internationalsubmarineraces.org as they are released.

1.2 FURE Mission

FURE is a 501(c)(3) nonprofit organization dedicated to advancing marine technology and ocean engineering by investing in today's youth who are pursuing marine-related scientific and engineering research and educational opportunities. FURE partners with technology and engineering students, the general public, government leaders and agencies, educators, industry, scientists, and journalists to reach its goals. FURE has organized marine science educational and outreach activities throughout its history and has sponsored the ISR since 1994. The International Submarine Races are FURE's premier biennial event that contributes to the accomplishment of its mission.

1.3 ISR Purpose

The skills developed in team-based, system-level engineering projects of this complexity are vital to humanity’s collective future. While outer space presents the farthest-reaching frontiers, the undersea domain demands the same or higher levels of engineering skill to safely explore and harness the ocean's resources. FURE recognizes a continuing need to grow both the number and proficiency of engineering students engaging with underwater technology advancement across disciplines. The ISR provides an educational opportunity for these students that translates theoretical knowledge into reality and fosters advancements in subsea vehicle hydrodynamics, propulsion, and life support systems. Enduring lessons will continue to be learned through the process of designing, building, and operating an optimized design. The rules of the competition restrict the vehicle's power solely to that of human power, thus focusing attention on optimizing vehicle performance and life support systems.

1.4 The ISR 19 Challenge

The ISR 19 challenge is to design, build, test, and race a one- or two-person, human-powered submarine across a 100-meter underwater course at the David Taylor Model Basin, NSWC Carderock. Hot on the heels of a record-breaking ISR 18, the bar has never been higher. ISR 19 calls on a new generation of engineers to rise to that challenge, push the boundaries of human-powered underwater vehicle design, and prove that the most powerful force in the water is a smart one.

Build Smart. Dive Smart.

1.5 FURE & ISR Leadership

FURE organizes the overall ISR event and manages volunteers from its ISR committee who have dedicated their personal talents and abilities to maintaining the continuity of this unique technology competition. The current FURE leadership and ISR committee for ISR 19 are as follows, with contact information for various topics mentioned throughout this manual:

Point of Contact	Role(s)	Email Address
Vin Malkoski	FURE President, *Acting* Chairman of the Board	fure.president@internationalsubmarineraces.org
Sarena Padilla	FURE Vice President, *Acting* Contestant Liaison	fure.vicepresident@internationalsubmarineraces.org
Pam Corry	FURE Treasurer	fure.treasurer@internationalsubmarineraces.org
Jane Louie	ISR Head Judge	head.judge@internationalsubmarineraces.org
Kim Malkoski	ISR Dive Supervisor	dive.supervisor@internationalsubmarineraces.org
Dan Dozier	ISR Registrar	registrar@internationalsubmarineraces.org

The ISR Committee operates under the financial and administrative oversight of FURE. FURE solicits support from corporate sponsors, academic officials, and individual donors to fund the races, educational events, and scholarships that advance its mission. The ISR Committee is not affiliated with any other human-powered submarine race.

To remain current with the activities of the ISR and FURE, please regularly access our website at www.internationalsubmarineraces.org or follow us on LinkedIn, Facebook, or Instagram @fure_isr.

1.6 Safety & Liability Overview

Safety is of utmost importance to all involved in the races, and every effort is made to conduct this event as safely as possible. Emergency medical personnel will be on site and prepared, alongside highly qualified safety divers ready to intervene in the event of a mishap. Given the inherent risks of diving and submarine racing, every participating contestant must complete and sign all applicable ISR forms discussed later in this document. Each team assumes full responsibility for any loss of, or damage to, their equipment and submarine, as well as any injury to personnel.

SECTION 2 — Critical Deadlines

2.1 Administrative Timeline

Date	Item
Fri 12 Feb 2027	Team entry & payment due
Fri 19 Feb 2027	Last full refund deadline
Fri 26 Feb 2027	Late fee assessment begins
Wed 31 Mar 2027	Last day to register (including late fee)
TBD May 2027	Individual registrations due
Fri 16 Apr 2027	Copyright forms provided to teams
Tue 01 Jun 2027	Earliest submarine arrival at Carderock
Wed 02 Jun 2027	Copyright forms due back to Head Judge
Fri 19 Jun 2027	Registration & badging opens at host hotel
TBD	Hotel reservations open
TBD	Hotel cancellation deadline

2.2 Technical Deliverables Timeline

Date	Item
Fri 05 Mar 2027	Electrical drive train report due to Head Judge
Wed 31 Mar 2027	Submarine Specification Sheet template sent to teams
Fri 09 Apr 2027	Submarine Specification Sheet due back to Contestant Liaison
Thu 07 May 2027	Presentation sign-up sheet sent to teams
Wed 02 Jun 2027	Design report due to Head Judge
Mon 07 Jun 2027	Presentation file due to Head Judge
Wed 17 Jun 2027	Presentation schedule issued to teams

SECTION 3 — Registration & Fees

All registration forms and supporting information are available on the ISR website at www.internationalsubmarineraces.org. Teams are strongly encouraged to register early — refer to the Administrative Timeline in Section 2 for all important deadlines.

3.1 How to Register Your Team & Individuals

The entry fee of $1,100.00 is assessed for each participating submarine and is due with the Team Entry Form no later than the date listed in the Administrative Timeline.

Important Note: This event is NOT open to the public. Visitors are welcome only if they are associated with a racing team or as a guest of FURE/ISR and it has been coordinated prior to race week, following the same Individual Registration process below to gain access to the facility.

Registration is a two-step process:

- **Step 1 — Team Entry:**
  The Team Leads must complete the Team Entry Form,
  available at https://internationalsubmarineraces.org/contestant-info/, for each prospective submarine and submit it to the ISR Contestant Liaison via email along with full payment via methods listed in 3.2, by the dates listed in the Administrative Timeline. Upon receipt of your Team Entry Form, you will be responded to by the ISR Contestant Liaison for further coordination.
- **Step 2 — Individual Registration (for all Contestants *and* Volunteers):**
  Team Leads must ensure that each team member and all team-associated visitors complete the Individual Registration process described on the ISR website by the date listed in the Administrative Timeline in the race year. Typically, we release the procedure for Individual Registration (defined by the U.S. Navy) early in the month prior to the races, with a due date that shortly follows. Late individual registrations may result in delays in entry to the U.S. Navy facility. Team members who will be supporting the team in the water as a pilot, co-pilot, support diver, or support swimmer will also be required to submit responses to the medical and dive questionnaires in this timeframe as well.

Additional registration and payment information:

- Payments may be made by check or electronic wire transfer — see below for instructions.
- A late fee of $250 will be assessed for any team whose full payment is not received by the late fee deadline as listed in the Administrative Timeline.
- No new applications will be accepted after the final registration deadline as listed in the Administrative Timeline.
- Each submarine must be registered by submarine name. Teams entering more than one submarine must submit a separate Team Entry Form and full registration payment for each, with each submarine carrying a unique name.
- All team members and associated visitors must complete the Individual Registration process referencing their submarine name.
- **International teams are responsible for ensuring the full required U.S. dollar amount is received by FURE, inclusive of all applicable fees. Teams are strongly encouraged to work with their institution's business or finance office prior to initiating a wire transfer to account for currency conversion and any applicable exchange rate markup.**

Refunds & Withdrawals

FURE will issue a full refund for teams withdrawing from ISR 19 prior to the full refund deadline listed in the Administrative Timeline. Teams withdrawing after that date will receive a full refund minus a $250 penalty. The

ISR reserves the right to curtail registrations if the number of registered submarines with full payments exceeds the capacity of the race facility.

3.2 Fees & Payment Instructions

Summary Fee Schedule

Item	Amount	Notes
Entry/Registration Cost	$1,100 per submarine	**See Administrative Timeline for any relevant dates of fees being assessed. For all payment related questions, contact the ISR Contestant Liaison.**
Late Registration	$250 per submarine with late entry	
Late Cancellation	$250 per submarine with late cancellation	

Payment via Zelle

If interested in paying via Zelle, more details to follow in next release of the manual later in 2026.

Payment by Check

Checks must be in U.S. dollars, made payable to: **Foundation for Underwater Research and Education**

Please submit Team Entry Form via email to the ISR Contestant Liaison. Also, mail a copy of the Team Entry Form **along with payment** to:

F.U.R.E.
P.O. Box 40156
Arlington, Virginia 22204
USA

Payment by Wire Transfer

If paying by wire transfer, you must also mail the completed Team Entry Form to the mailing address above.

Field	Details
Bank Name	Wells Fargo Bank, NA
City / State	San Francisco, CA
Routing (Domestic)	121000248
Routing (International)	WFBIUS6S
Account #	6130610493
Account Name	Foundation for Underwater Research and Education

3.3 International Participants (Visas & Letters of Invitation)

Citizens of certain foreign countries must obtain a U.S. visa to attend the races. For country-specific visa requirements, visit http://travel.state.gov/visa/.

Important: Participants who require a U.S. visa are strongly encouraged to begin the application process as early as possible. Processing times vary significantly by country and embassy — some visas require several months to process.

Letters of Invitation

If your country requires a Letter of Invitation from FURE, submit a request by email to the ISR Contestant Liaison and include the following:

- Full name as listed on passport – indicate FAMILY NAME in all caps
- School or company name
- Complete mailing address including country
- Email address
- Phone/fax
- Travel dates to/from the U.S.

Requests will be acknowledged within 72 hours responding with an invitation letter.

SECTION 4 — Facility & Logistics

4.1 The David Taylor Model Basin (DTMB)

The David Taylor Model Basin is a large, in-ground, freshwater basin approximately 3,000 feet long, 51 feet wide, and 22 feet deep. The water is filtered and kept very clear; however, due to the extremely large volume of water in the basin, the filtration cycle is very long, and suspended sediment will cloud the water all day if stirred up. To maximize visibility, all divers are required to minimize disruption of the water near the basin floor.

Separate bathroom and showering facilities are available for men and women. A cafeteria is available on site and open to all event participants. The water in the basin is untreated for biologics. Divers are strongly encouraged to shower with hot water and use ear drops at the end of each diving day.

Some of the model basin's main equipment consists of large platforms mounted on wheeled carriages that move up and down the model basin on rails placed along the basin walls. These rails are extremely sensitive, even when covered. Do not walk near or place anything on the rails. Divers shall not cross the rails, and extreme care must be taken when passing any equipment over them. No one shall be permitted to stand on, lean on, or sit on the walls that support the carriage rails. Refer to the site briefing for reminders on all safety protocol that must be obeyed throughout the event. **All attendees are guests of the David Taylor Model Basin and are not permitted access to areas outside the ISR event area.**

The Race Week Schedule will be posted on the ISR website at www.internationalsubmarineraces.org and includes basin opening and closure times. It is important to arrive early to allow sufficient time to pass through security. Vehicles and their occupants may be searched while entering or leaving the facility at the discretion of base security personnel. All personnel must be prepared to vacate the facility by the published departure time. Teams should begin breakdown and cleanup in advance to ensure timely departure.

If competing within a time constraint during race week, teams may elect to attend only long enough to complete a satisfactory run. Contestants should notify the Race Director of any time constraints so that appropriate arrangements can be made. However, all teams are encouraged to attend the races for as long as possible, given that submarines and their teams will be judged in categories other than speed.

The generous support of NSWC Carderock personnel makes this event possible. All attendees are expected to treat NSWC Carderock personnel with the utmost respect, follow their directions, and honor their workplace.

4.2 Facility Access & Security

FURE, ISR volunteers, guests, and contestants are graciously permitted use of the facilities at NSWCCD, a major U.S. Navy research center. All attendees are considered official visitors of the facility's Commanding Officer and are required to follow all entry and access procedures prescribed by the U.S. Navy.

All persons must be properly cleared by the U.S. Navy to access the facility. Each participant is required to complete the appropriate forms and submit them by the date listed in the Administrative Timeline. Contestants and visitors may be denied entry based on adverse law enforcement records. Upon receiving visitor clearance, contestants and visitors will be issued an event badge that must be always worn while at the facility, except when in the water. Vehicles entering the base are subject to search before entry is granted. Due to limited parking availability, teams must limit the number of vehicles entering the facility.

Cameras, including cameras on mobile phones, are permitted on facility grounds only with a camera pass obtained from base authorities. Photos may only be taken in the model basin race area and only for the purpose of documenting race activities. Concealed cameras are strictly prohibited. All persons entering with a cell phone, internet access device, camera, and/or laptop computer must complete a camera and laptop form for each device, available on the ISR website. Once approved by government security personnel, a camera/laptop pass will be issued and must always be carried in plain sight with the device.

4.3 Rules of Conduct at NSWCCD

During normal facility operations, NSWCCD personnel conduct industrial-type activities in and around the race area. All personnel must wear appropriate clothing for their role in the races. Flip-flops and open-toe shoes are prohibited on and around the model basin's elevator and dive station area.

Contestants are required to always stay within the designated race area. Anyone found outside of the ISR 19 event area or in restricted areas may be escorted off the facility and asked to surrender their event badge. Unless participating in an official tour with NSWCCD personnel, visiting the cafeteria, or accompanied by authorized personnel, please remain in the designated event area.

Each team and all ISR personnel are solely responsible for the loss, damage, or theft of their equipment. When equipment is left unattended, make every attempt to lock or secure it. Teams are strongly encouraged to support one another through the loaning of tools and equipment. Any loaned equipment, particularly dive gear, must be intact and safe before being offered. All loaned gear should be clearly marked to ensure its return. For any unmet equipment needs, please contact race officials for assistance.

The possession or use of alcohol or illegal drugs, including any form of cannabis, anywhere on facility grounds is absolutely prohibited. As NSWCCD is a federal facility, U.S. federal laws apply.

4.4 Parking & Vehicle Access

The ISR website will contain the latest directions and maps to the facility. Racing will be held in Building 4. Parking is not permitted at the east end of Building 4 or along its sides.

Limited parking is available at NSWCCD, including space for large vehicles. Overnight stays in motor homes or any other vehicles on facility grounds are not permitted. All personnel must vacate the facility by the departure times listed in the Race Week Schedule. Teams are encouraged to bring as few vehicles as possible to minimize traffic flow on the facility grounds.

Parking in reserved spaces is strictly prohibited. All drivers must observe facility speed limits and traffic controls. U.S. Navy Police may issue citations for traffic violations.

4.5 Host Hotel

The host hotel for ISR 19 has not yet been finalized as of v1.1 release of this manual. Details including hotel name, address, room rates, reservation instructions, and cancellation deadlines will be posted on the ISR website and distributed to registered teams once confirmed. When booking, teams should identify themselves as part of the **ISR 19 Room Block** to receive the negotiated group rate.

Note: *Breakfast arrangements, if included in the room rate, are available to hotel guests only and are not provided to all race participants. Breakfast hours and availability will be confirmed alongside hotel details.*

All hotel-related deadlines, including the reservation cutoff and cancellation deadline, will be listed in the Administrative Timeline once confirmed.

4.6 Shipping & Customs

Shipping Address:

Naval Surface Warfare Center, Carderock Division (NSWCCD)
Receiving Code 3341
Building 143
9500 MacArthur Blvd
West Bethesda, MD 20817-5700
USA

NSWCCD Receiving Contact:

Melissa Thompson
Email: **melissa.a.thompson114.ctr@us.navy.mil**

Containers must be marked **INTERNATIONAL SUBMARINE RACES** in large letters. Team affiliation or submarine name must also be marked on the exterior of the container. Teams should allow sufficient transport time to ensure equipment arrives before the start of race week. Submarines should not arrive at Carderock before the date listed in the Administrative Timeline.

Teams must call and email the designated Carderock receiving contact one week prior to the expected shipping date to confirm arrival. Providing crate dimensions and weight in advance will help the facility determine forklift requirements. NSWCCD does not provide recommended shipping companies or assist with customs. Teams must verify with their shipping company that arrangements have been made for customs processing and final delivery to NSWCCD in time to support their participation. NSWCCD should only be contacted for final delivery confirmation and signature.

Non-U.S. Citizen Drivers

Non-U.S. citizen truck drivers are not permitted on NSWCCD property. Trucking companies that do not comply will have their drivers denied entry to the facility, which may result in delays and increased shipping costs.

Delivery Hours and Requirements

Deliveries must be made Monday through Friday between 0630 and 1400. Teams must ensure their trucking company is aware of facility hours and access requirements. **Shipping companies must arrive before 1400 with only U.S. citizen drivers and helpers or they will be denied entry to the property.** Teams should call one hour prior to arrival to minimize unloading delays, as forklift assistance is almost always necessary.

Return Shipping

All submarines must be shipped out of NSWCCD within two weeks of the conclusion of the races. Submarines not removed within this period will become property of FURE. Return shipping arrangements must be made prior to the end of race week and communicated to the designated Carderock receiving contact. Submarines not being shipped must be physically removed from NSWCCD by the conclusion of the awards ceremony on the final day of race week.

International Shipments

All international teams are responsible for shipping their submarines and equipment to and from the race location and must ensure all required import and export customs declarations are completed. This can be a significant time and financial effort, and teams should build this process into their plans early. If requested, FURE will provide contacts from teams who have successfully navigated these challenges in the past. Neither FURE nor NSWC Carderock can act as the importer of any team's equipment.

4.7 Media & Publicity

Media representatives interested in attending ISR 19 must contact the FURE President in advance. All media entering NSWCCD must obtain prior clearance and be escorted by the base Public Affairs Office at all times. Names of foreign media representatives must be submitted by the date listed in the Administrative Timeline. FURE will coordinate all media requests with the NSWCCD Public Affairs Office for final approval prior to credentialing.

SECTION 5 — Race Week Operations

5.1 ISR 19 Event Schedule

SATURDAY, 19 JUN 2027

Time	Event
0900 – 1700	ISR Contestant and Volunteer Registration at **Hotel Location TBD**
1800 – 2100	FURE Volunteer Briefing at **Hotel Location TBD**

NOTE: NO ENTRY for contestants at NSWCCD / David Taylor Model Basin (DTMB) on Saturday 19 June 2027

SUNDAY, 20 JUN 2027

Time	Event
0630	Breakfast opens for hotel guests — **Hotel Location TBD**
0730	NSWCCD Gates Open
0730 – 2100	Contestant and Volunteer Registration, **Hotel Location TBD**
0800 – 0900	Race Operations Volunteer Briefing, DTMB East End
0800 – 1530	Contestant Staging & Parking Assignments at DTMB
0900 – 1600	Course Set-Up at DTMB
0900 – 1530	Contestant Compliance — Dry Safety Inspections at DTMB
1600	Depart NSWCCD Property
1700	*First Group* Contestant Briefing, **Hotel Location TBD**
1700 – 2100	Contestant Diving Paperwork Review and Approval, **Hotel Location TBD**
1900	*Second Group* Contestant Briefing, **Hotel Location TBD**

MONDAY, 21 JUN 2027

Time	Event
0545	Breakfast opens for hotel guests — **Hotel Location TBD**
0730	NSWCCD Gates Open
0730 – 1600	Contestant Registration, DTMB East End Entrance Tables
0800 – 0815	Contestant Briefing at DTMB East End — followed by Racing
0830 – 1600	Compliance and In-Water Safety Inspections at DTMB, as permitted by Dive Staff
1700	Racing Stop
1800	Depart NSWCCD Property

TUESDAY, 22 JUN 2027

Time	Event
0545	Breakfast opens for hotel guests — **Hotel Location TBD**
0730	NSWCCD Gates Open
0800 – 0815	Contestant Briefing at DTMB East End — followed by Racing
0830 – 1600	Compliance and In-Water Safety Inspections at DTMB, as permitted by Dive Staff
1700	Racing Stop — ISR Staff Briefing at DTMB East End
1800	Depart NSWCCD Property

WEDNESDAY, 23 JUN 2027

Time	Event
0545	Breakfast opens for hotel guests — **Hotel Location TBD**
0730	NSWCCD Gates Open
0800 – 0815	Contestant Briefing at DTMB East End — followed by Racing
0830 – 1500	Compliance and In-Water Safety Inspections at DTMB, as permitted by Dive Staff
1600	Racing Stop
1800	Depart NSWCCD Property

THURSDAY, 24 JUN 2027

Time	Event
0545	Breakfast opens for hotel guests — **Hotel Location TBD**
0730	NSWCCD Gates Open
0745	Group Photo — All Boats, East End Parking Area
0800 – 0815	Contestant Briefing at DTMB East End — followed by Racing
0830 – 1600	Compliance and In-Water Safety Inspections at DTMB, as permitted by Dive Staff
1300 – 1600	VIP Tours, begin at DTMB East End
1500 – 1700	VIP Reception, DTMB East End — Sponsor TBD
1700	Racing Stop
1800	Depart NSWCCD Property

FRIDAY, 25 JUN 2027

Time	Event
0545	Breakfast opens for hotel guests — **Hotel Location TBD**
0730	NSWCCD Gates Open
0800 – 0815	Contestant Briefing at DTMB East End — followed by Racing, including possibility of Side-by-Side Racing

1200	**RACING STOP — END OF ISR 19 RACING**
1200 – 1430	Breakdown, Stow, and Clean DTMB
1210 – 1345	Closing Picnic for all volunteers and contestants, outside DTMB East End — Sponsor TBD
1400 – 1600	Awards Ceremony, NSWCCD Auditorium, Building 40
1700	**DEPART NSWCCD PROPERTY — END OF ISR 19 EVENT**

SATURDAY, 26 JUN 2027

Time	Event
0800	NSWCCD Gates Open — ISR Staff Only

Schedule Notes:

- **Sunday 20 June 2027**
  Teams are permitted entry to NSWC Carderock after receiving their badges at the host hotel. Dry safety inspections may begin at noon for submarine teams that are on site and prepared. Given the substantial resources gathered for this event and the number of teams participating, teams are strongly encouraged to maximize their time in the water.
- **Monday 21 June – Thursday 24 June 2027**
  On Monday, teams should prepare for in-water inspections as soon as their submarine passes dry inspection and team divers are cleared to dive. Racing will commence when the racecourse and timing and video systems are confirmed ready and at least one submarine is approved to race.

  Continuous racing will take place throughout the week. Racing hours will normally run from 0800 to 1530 each day. Other scheduled events may reduce available racing time on any given day.
- **Friday 25 June 2027**
  - Racing concludes no later than 1200 ET
  - All teams must break down their site, return any borrowed equipment, and prepare submarines and related gear for shipping
  - ISR staff will conduct ISR gear breakdown and removal — all ISR rental gear should be organized in a central location for pickup
  - Closing picnic then Awards Ceremony to follow — see race week schedule for times

5.2 Submarine Preparation

Upon arrival, each team will be assigned an outdoor staging area in the parking lots and grass adjacent to the working end of the basin (DTMB East End). The exact size of each area will be determined by the total number of submarines to be accommodated. The space must be sufficient to contain a storage vehicle, the submarine, dive gear, tools, tables, and adequate working space.

Power availability is limited both inside and outside the building — particularly in the outdoor staging area. Teams are strongly encouraged to bring their own generators. Per NSWCCD environmental regulations, gasoline for generators must be stored in a secondary containment system such as a hard plastic containment pan or equivalent to prevent ground spillage.

Summer months in the vicinity of Washington, D.C. can be extremely hot. Shade cover, sunscreen, and constant hydration are strongly recommended. Teams are encouraged to bring a van or large truck to store non-essential gear and provide additional workspace.

The use of power tools, epoxies, paint, and similar materials is permitted. Teams are responsible for cleaning up all debris and stains resulting from their work. Any chemical considered hazardous to health or the environment, must be accompanied by a Material Safety Data Sheet (MSDS). Teams are expected to be considerate of fellow competitors and NSWCCD facility personnel. The disposal of any epoxy, paint, solvent, or petroleum-based product is expressly forbidden unless supervised by NSWCCD personnel.

When submarine assembly is complete and the crew is ready for inspection, a team representative should notify the Surface Operations Director. The ISR Committee will dispatch judges to the team's staging area to conduct the dry safety inspection. The Surface Operations Director coordinates all submarine entry into the building. Space inside the building is limited and priority will be given to teams in their final stages of preparation or already in the inspection queue. Once cleared, teams will join the queue awaiting entry into the basin. Teams that are prepared and ready early are likely to benefit from additional racing opportunities. Teams are strongly encouraged to arrive as early and remain as long as possible to maximize their time on the water.

5.3 Launching, Underwater Staging, Recovery, & Submarine Removal

Launching

Teams are strongly encouraged to have a wheeled cradle or cart for transporting their submarine around the facility and for launching. If the submarine is launched using a cradle or cart, it must be negatively buoyant or secured to the basin elevator to prevent floating during launch and recovery. See Section 6.6 for cradle specifications.

The working end of the basin has a platform with an in-water elevator. Submarines will be moved into position on the elevator under the direction of Dive Staff. The elevator will be lowered and the submarine eased into the water by the crew and support divers. Team members with Personal Floatation Devices (PFDs) must remove the cradle from the elevator and the building immediately after the submarine is launched.

Underwater Staging

Beyond the basin elevator, designated areas known as the beaches serve as underwater staging areas. Once the Dive Supervisor has cleared a team to launch, they will be directed to one of these staging areas. This provides the crew time to ballast and trim the submarine and verify all systems prior to racing. The submarine will receive a visual safety inspection from Dive Staff on every launch.

The submarine diver support team should consist of sufficient qualified divers to move the submarine from the staging areas to the starting position, assist in loading the submarine crew, and positioning the submarine in the Team’s preferred starting location ready for launch. In general, this should consist of at least three divers.

When the team is prepared to race, a support diver will surface and notify the Race Starter. In the event of a significant delay, crews are encouraged to exit the water and warm up between runs. Teams must be ready to race immediately upon being called.

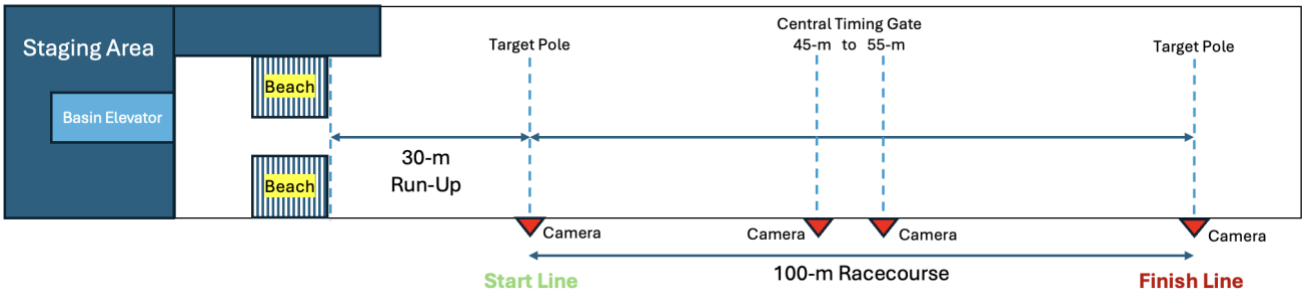
Submarine Recovery & Removal

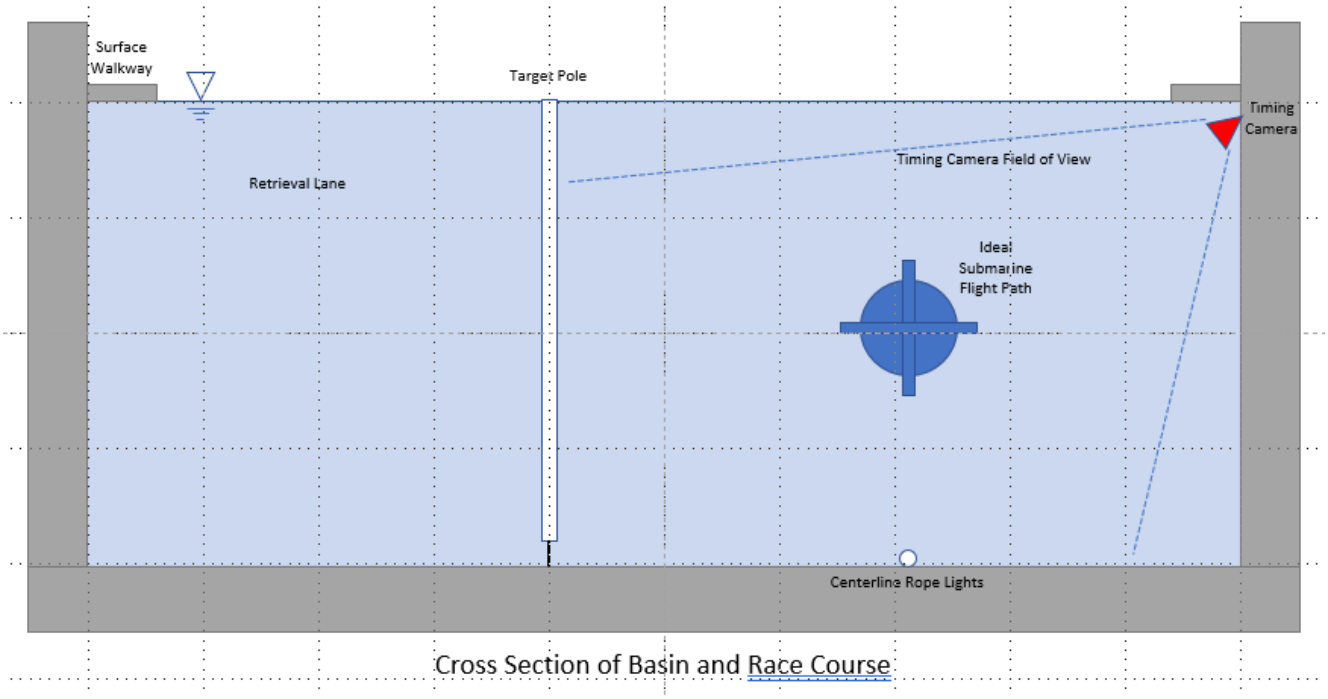
When the submarine is ready to be removed from the water, the team must request permission from the Dive Supervisor, who will coordinate with the Surface Operations Director. Cradles must not be brought into the basin

area until permission is granted. Recovery follows the reverse of the launch procedure. Team members with PFDs must move the cradle onto the elevator and secure it. Once the submarine has fully drained, the crew may move the submarine and cradle off the basin elevator. Teams must remove the submarine from the building immediately following recovery. Teams should return any borrowed equipment and begin preparing their submarine for the next run or for shipping as applicable.

5.4 Course Layout & Timing System

The racecourse runs along the approximate centerline of the basin. A course diagram illustrating the full layout is provided below and will be posted on the ISR website.





Cross Section of Basin and Race Course

The centerline of the course is marked along its entire length by underwater rope lights weighted to remain on the basin floor. A 30-meter acceleration zone precedes the start line. **Teams wishing to utilize the acceleration zone must obtain advance permission from the Dive Supervisor or designated dive staff prior to doing so.** Timing target gates are located at the start line and at the finish line 100 meters downrange. An additional timing gate is centralized within the 45- to 55-meter region of the racecourse to capture maximum submarine speed during

peak acceleration. Each timing gate spans approximately 8 meters across the basin and is constructed of white PVC tubing. Gates are rigid enough to support their equipment, flexible enough to withstand a major collision, and can be quickly and precisely relocated following any impact.

The course cross-section diagram illustrates the layout of the start and finish line timing poles and cameras. Submarines navigating low and right or high and left may fall outside the timing camera field of view, resulting in a successful run without a recorded speed measurement. In these cases, the Race Director has sole discretion to designate a run as successful.

The start line is illuminated with a distinct color to differentiate it from the finish line. Submarine speed will be recorded across the entire 100-meter racecourse. A successful run requires the submarine to pass through the timing gate at the start line and through the timing gate at the finish line.

Underwater video cameras continuously record each submarine as it passes through each timing gate. Cameras are positioned on the timing gates with a wide-angle view to capture submarines at most depths. White incandescent lights illuminate each timing gate area to ensure clear camera visibility. Every effort will be made to clear accumulated silt from the basin floor prior to racing. Sediment stirred from the basin floor significantly reduces visibility for both submarine crews and timing cameras. All divers are prohibited from swimming near the basin floor within the racecourse boundaries and the adjacent approach and recovery areas, except in emergency situations.

The 100-meter finish line is marked with red lights. Safety divers and Navy support divers will be stationed beyond the finish line. Submarines must cease all propulsion upon reaching the finish line. Beyond the finish line the basin is largely unlit and surface support is not available. A cargo net is positioned beyond the finish line to prevent submarines from traveling too far downrange.

Teams shall not strike the timing gates. Damaged gates will require course closure for repairs, causing delays for all competitors. Teams must not strike manned or unmanned, mobile or fixed cameras located throughout the course. These cameras feed non-timing-related video to the surface.

Timing System

The timing system uses four fixed underwater video cameras positioned to look across the course at target poles on the opposite side. Four different camera and target pairs are located at the start line (0 meters), a central timing gate that is 10 meters long for top speed estimates (placed at 45 to 55-meters), and at the finish line (100-meters). Video from all cameras is combined into a four-part split-screen signal and recorded with television time code. The time code generator counts each 1/30-second television frame as well as seconds, minutes, and hours. A time resolution of 1/60 second is achievable through interpolation of the submarine's position change between adjacent frames.

After each run, the recorded video is reviewed to identify the exact frame in which an identifiable marking or component of the submarine passes through each of the four targets. The time elapsed between targets is calculated from the difference in time code and frame number. A spreadsheet program then calculates the submarine's average speed over the 10-meter and 100-meter timing gates of the course. Timing officials will generate and authenticate a speed form for every run.

FURE continuously updates the timing and video system and reserves the right to modify the system described herein. Teams will be notified of any changes prior to race week.

Timing Results

Submarine speeds will be displayed on monitors and posted on a status board as soon as they are available. A dedicated section of the status board will show the highest recorded speed in each category. As records are broken, the new top speed will replace the previous maximum. When races occur in rapid succession, speed determination may be delayed but will be posted as soon as available.

Teams must not request speed data from timing officials during active racing. **Note: access to the center aisle (righthand side of the racecourse) is restricted to ISR race officials and authorized volunteers at all times.**

5.5 Racing Procedures

When called to race, teams should move their submarine into the course starting area. Support diving crews should be kept small to minimize congestion in the starting area. If another submarine is already positioned to launch, teams must wait and allow it to launch unhindered before moving into the start position. **Prior to repositioning a submarine around the staging area whatsoever, teams are required to make known their movements to the Dive Supervisor.**

From this point, teams have a maximum of ten minutes for final pre-launch preparation. Teams that exceed this time limit without launching will be moved to the back of the queue if other submarines are ready.

A 30-meter acceleration zone separates the beach staging area from the start line. **Only with express permission from Dive Staff, teams may begin their run within this acceleration zone** and are encouraged to experiment with their starting position across multiple runs. The crew may begin a run at any depth from 6 feet below the surface to the basin floor.

By definition, a submarine must travel completely submerged. Any run in which any part of the submarine breaches the surface will be ruled a Did Not Finish (DNF). The same ruling applies if the submarine fails to pass between the vertical markers at each gate. Minor course deviation is permitted during a run, but the submarine must pass through all four gates properly. Striking gate uprights or disturbing cameras or targets will result in the run being declared as DNF.

Start Procedure

When the submarine is straight, level, properly aligned with the course, and sufficiently clear of the basin floor, the support diver must verify that the course is clear both fore and aft. The support diver will then surface and notify the Race Starter that the submarine is ready to race. The Race Starter will grant permission to race via underwater loudspeaker. The support diver will signal the crew to begin propulsion using the universal start signal — rotating one arm in a cranking motion — alerting all nearby divers to clear the area. The Race Starter will then notify all subsea personnel via underwater loudspeaker that the submarine is underway.

Topside support crew will walk along the concrete aisle on the left side of the racecourse to assist with submarine retrieval at the far end. All team members providing surface support within the basin walls must wear PFDs or wet suits provided by each team.

Subsurface support crew shall not follow the submarine onto the course. Topside support personnel may not follow by boat or by swimming on the surface. This is to minimize traffic on the active racecourse. **Topside personnel for each team must check-in with the Race Starter upon being ready to trace their submarine down the racecourse along the left side concrete aisle.** This will ensure efficiency of submarine runs that will follow the

team currently at the starting line by having the topside personnel positioned correctly for their team's run and submarine retrieval.

Post-Run

Once the submarine has traversed the course or stopped along it, crew members shall not exit the submarine until instructed to do so by Navy divers. Navy divers will tow the submarine to the left side basin wall. The submarine's topside support crew is then responsible for towing the submarine back to the beach staging area, hugging the basin wall to avoid obstructing the racecourse.

Upon returning to the start line area, teams will be directed by the Dive Staff back onto the start line, placed in the queue, or waved back to the underwater staging area depending on racecourse traffic.

Teams must check all crew and support diver air supplies after each run. If any supply is low, teams must immediately request repositioning to the staging area. If the crew is unable to complete additional runs, teams must request repositioning for submarine removal. Submarines must not be moved to the lift, nor carts brought into the building, without first checking with the Dive Supervisor and Surface Operations Director.

Submarines will be permitted to make as many runs as time allows. All teams must be as fully prepared as possible before entering the race queue. Teams experiencing technical issues should allow other teams to pass in the queue to keep racing moving efficiently.

5.6 Braking & Post-Run Procedures

Submarine braking at the end of the course is unlikely to be a major challenge given the basin's considerable length beyond the finish line. However, crews are encouraged to stop their submarines in as short a distance as practical.

Speed brakes and/or flaps are acceptable braking methods. Otherwise, pilots are to stop pedaling once across the finish line to avoid producing additional forward acceleration. Drogue chutes and sea anchors are prohibited due to the risk of snagging on course equipment or other objects. Braking by rapid ascent or breaching is strictly prohibited due to the risk of embolism, which exists even at shallow depths.

The topside support crew shall follow the progress of the submarine along the racecourse and be ready to receive the submarine from the Navy Safety Divers and assist the crew in exiting the submarine and returning it to the staging area. The Surface Operations Director will provide guidance on the return process as needed.

5.7 Safety Protocols During Operations

Indoor Facility Hazards

⚠ **RESTRICTED AREA:** The center-right narrow aisle, on the right-hand side of the racecourse as entered from the basin's working end, is restricted to ISR Staff and authorized ISR volunteers only. The timing and video control station is located in this aisle. Unshielded high-voltage power cables that power the basin's overhead carriages are present in the ceiling of this area. Contact with these cables is potentially fatal. Long poles, pipes, or similar objects must not be handled in this area.

The beach structure is an inclined slotted structure designed to attenuate wave action — it is not solid. Entering or swimming under the beach structure is prohibited. Care must be taken to avoid catching toes or equipment

between the slats. Divers or support staff wearing fins may not climb or walk across the beaches in water shallower than mid-thigh depth.

Slatted steel walkways run along both sides of the basin. All divers must look up before ascending, particularly near the basin walls. A carriage-arresting gear structure hangs over the water at approximately the 60-meter mark. Navy Zodiacs with spinning propellers may also be present on the surface. Always look up before ascending.

Lighting levels vary throughout the basin. Intense summer thunderstorms can cause sudden power failures. The basin can get very dark, very quickly. Dive lights are strongly recommended — both for personal visibility and as signaling devices to others.

PFD requirements within the basin carriage rails are described in Section 7.6.

Submarine Operational Safety

DON'T PANIC. If crew members remain calm, continue breathing from the regulator, and remain with the submarine until Navy divers arrive and provide instruction, almost any situation can be managed.

Air supply can be lost by dropping the regulator, running out of SCUBA air, or equipment malfunction. **KEEP YOUR REGULATOR IN YOUR MOUTH AT ALL TIMES!** If there is an air supply problem, crew members must reach for their alternate air source first, then open the hatch. Crew members should remain inside the submarine until Navy divers arrive to assist.

Support divers control descent prior to the start and are responsible for crew safety throughout. Support divers must actively monitor crew members for ear clearing difficulties or any signs of distress during descent. Visual contact with all crew members must be maintained throughout the entire descent.

Ascent is controlled by the vehicle and may be more rapid than a free diver ascent. Crew members must continue breathing throughout the entire human-powered submarine operation. **NEVER HOLD YOUR BREATH!** The vehicle should always operate near the basin floor unless there is a control problem or emergency.

Some submarines may have buoyant hatches. If a hatch is opened on the surface, loss of buoyancy may cause the submarine to descend. Crew members must have access to SCUBA regulators at all times, and support personnel must avoid positioning themselves beneath the submarine.

BEWARE OF THE PROPELLER AND PROPULSION UNIT DURING OPERATION — STAY CLEAR WHEN ROTATING. Submarines may have sharp edges, bolt heads, hoses, and hatches that can cut or pinch hands and snag SCUBA equipment. All personnel must exercise caution around submarine exterior surfaces.

A moving submarine carries significant inertia. Never position yourself between a moving submarine and the basin walls.

Cold water increases the risk of cramps. All divers should stretch prior to diving, maintain proper nutrition, and stay well hydrated. Crew members are particularly susceptible to cold as they are only physically active during runs and are strongly encouraged to exit the water between runs to warm up. The Dive Supervisor and/or Staff will remove divers who exhibit signs of being chilled or distressed from the water as needed.

Any diver experiencing a diving or equipment problem must stop diving immediately. Continuing to dive while impaired creates risk for all personnel. The Dive Supervisor must be notified whenever a diver exits the water due to a problem.

SECTION 6 — Submarine Design Requirements

6.1 Definition of a Submarine

For this event, a submarine is defined as a free-flooding (liquid-filled) vehicle that **fully encapsulates the occupant(s)** and operates entirely submerged. The submarine may carry one or two persons and must fully encapsulate the occupant(s) for the entire race. Premature release of the hatch is grounds for disqualifying a run. Entrants designed to crawl along the basin floor are classified as tractors, not submarines, and are prohibited.

6.2 Design Categories

All submarines participating in this event must fall into one of the four categories:

One-person submarine, propeller-driven
One-person submarine, non-propeller-driven
Two-person submarine, propeller-driven
Two-person submarine, non-propeller-driven

Teams are classified by their representing organization — college or university, high school, corporate entity, or independent — and will be judged against others within the same classification when considered for awards.

6.3 Propulsion Systems

Propeller System

A propeller system is defined as a water-coupled device with radiating blades that create thrust when spinning. Blades rotating in a vertical plane, driven by a rotating shaft external to the hull and generally aligned with the direction of travel, will be considered a propeller system.

Non-Propeller System

A non-propeller system is defined as any other water-coupled device that creates thrust when operated. A bottom-crawling vehicle is not a water-coupled device.

Permissible Types of Drive Trains

Drive trains that convert human power to activate the thrust-producing system may be any combination of mechanical systems (series of gears and rotating or sliding shafts), fluid systems (pneumatic or hydraulic, provided exhaust fluids do not create any vehicle propulsion), or low-power direct current electrical systems. In all cases, no energy storage device may store energy prior to crossing the start line and release it during the race.

In the case of fluid drive-train systems, no fluid may be released into the basin water that is not already present in the basin.

Teams using direct current electrical drive-train systems must review and comply with the diver-safe electrical limits set forth in IMCA D 045, *Code of Practice for the Safe Use of Electricity Under Water*. The publication defines safe voltages, safe distances, mitigation effects, and application scenarios for the use of electricity underwater. The maximum permitted limits without a trip device are 30V DC or 7.5V AC. Teams using electrical drive-train systems must submit a written compliance report to the ISR Head Judge by the date listed in the Technical Deliverables Timeline. **Teams are encouraged to notify the Head Judge as early as possible once a system design is confirmed, to facilitate timely approval to operate.**

Submarine propulsion systems must be directly coupled to a human being and shall not employ any stored energy devices. All power trains must be direct drive with no de-coupling devices permitted.

Other Considerations

SCUBA exhaust air from the crew may be eliminated by any method at the team's discretion but may not be used to produce a propulsive force. Teams are encouraged to give this considerable thought — any exhaust air trapped in the hull will cause significant changes in trim and buoyancy.

In the case of a two-person submarine, both crew members may elect to provide propulsion. Both must remain directly coupled to the drive train at all times. The pilot must retain the capability to perform navigational, safety, and steering functions.

6.4 Life Support Systems

All diving (submarine crew, team divers, and ISR staff divers) during the ISR will be conducted using air as a breathing gas and open-circuit SCUBA equipment.

Authorized SCUBA Cylinders at ISR

See Section 7.3 for additional information.

Submarine Primary Air Supply

The primary air supply shall be carried onboard the submarine and must provide sufficient capacity for a minimum of one full speed run, plus 150% reserve capacity per crew member. Supporting calculations shall be included in the team's design report.

Primary air supply pressure gauges must be clearly visible to the submarine crew at all times. Crews are required to monitor their air supply continuously and shall not allow pressure to fall below 500 psi (34 bar). ISR Dive Staff may conduct air supply checks at any time.

Submarine Secondary (Reserve) Air Supply

The secondary air supply for each crew member shall be self-contained and either worn securely on the body or fastened with Velcro or a clip in an accessible location in front of the pilot. It must provide sufficient capacity to enable the crew member(s) to exit the submarine and ascend from the basin floor at a safe ascent rate to the surface. If two pilot crew members, in the case of two-person submarines, there must be two independent secondary air supplies present. Once the submarine is on the racecourse or has stopped along the course, crew members shall not exit the submarine until instructed to do so by Navy divers. This supply may also be used during submarine ingress and pre-run preparation. **Teams are responsible for providing their own adapters to permit filling of Spare Air cylinders.**

On-Board Pneumatic Systems

Any pneumatic systems on a submarine must have a dedicated air supply, independent of the crew's primary and secondary air supplies.

Support Diver Air Supply

All support divers must be equipped with an alternate air source — such as an additional second stage, Air II, pony bottle, Spare Air, or similar device — to support submarine crew ingress and egress while submerged. Additional information on diving equipment can be found in Section 7, Diver & Crew Requirements.

6.5 Submarine Safety Requirements

Submarine Coloration

The entire submarine must be painted in high-visibility coloration, using lighter colors such as white, yellow, or orange. **The entire dorsal surface must be a light color to facilitate monitoring while on the racecourse.** A white reflective strip at least 3 inches wide is required along both the port and starboard sides for the full length of the hull. Hull numbers will not be assigned. Teams must display the team or submarine name prominently on the hull for identification purposes. The listing of sponsors, affiliates, or team members is acceptable.

Propeller tips and control surface tips shall be painted or marked in fluorescent green, bright yellow, or bright orange for easy visibility by divers and support personnel. Hull protrusions such as bolts or other sharp-edged items must be covered with a cap or reflective tape if they cannot be cut flush with the hull.

Rescue Egress

All exits designated for emergency egress shall be clearly marked at the handle or release mechanism with a 4-inch square orange patch bearing the word RESCUE. If this is not possible due to space or surface constraints, the handle or release mechanism must be clearly marked with highly visible fluorescent tape. The handle or release mechanism shall be easily accessible from both inside and outside the submarine. Judges, Dive Staff, and Navy divers may require modifications to markings or release mechanisms following inspection.

Submarines with two pilots must have clearly legible markings near the RESCUE markings indicating a two-person crew. Crew egress hatch(es) shall be positively buoyant and either tethered to the hull or hinged to it.

Crew Restraints

Any method of crew attachment to the submarine — such as restraining harnesses or toe-clips — must have its release mechanism clearly marked with orange paint or fluorescent tape. Any shoes that clip into the pedals must be painted orange. Judges will verify compliance with these requirements during both dry and in-water safety inspections. Teams must identify all release points to the wet judge and/or Navy divers during inspection.

Pilots must wear a safety harness to enable safety divers to extract them from the submarine and lift them over the basin wall and out of the water if necessary. If two-person submarine, both pilots must wear a safety harness.

Crew Visibility

Viewports, windows, canopies, and similar structures shall be positioned to provide the crew with the most unrestricted view possible, with particular emphasis on forward and downward visibility for the pilot. The crew's face and head shall be visible to support and safety divers at all times.

Strobe Marking Light

Each submarine shall carry white strobe lights providing 360° visibility in the horizontal plane and when viewed from above or below. In addition, a white strobe visible 360° in the vertical plane must be present on each side of the submarine, visible from any lateral, fore, or aft angle. Multiple strobe lights are acceptable if needed to meet this requirement. Strobe lights shall not be part of any emergency pop-up buoy system. All strobe lights shall be active whenever the submarine is submerged. A non-functioning strobe light is grounds for disqualification. Teams are strongly encouraged to change batteries frequently based on usage and to carry spare light assemblies in the event of failure, including flooding.

Emergency Pop-up Buoy

The use of an emergency pop-up buoy is optional (but NOT required) for ISR 19. Given the significant improvements to course visibility and monitoring infrastructure since prior races, teams may elect at their own discretion whether to incorporate a buoy into their submarine design. Teams that choose to include an emergency buoy are required to follow the guidelines below and will have their buoy system reviewed as part of both dry and in-water safety inspections.

Required Specifications for Optional Emergency Pop-Up Buoy

If incorporated, the buoy should meet the following minimum specifications:

- Color: Bright or fluorescent orange or yellow
- Shape/Size: Rounded, at least 4 inches in smallest dimension
- Buoyancy: Free-floating with continuous positive buoyancy

Required Design Guidelines

If a buoy system is included, each crew member must be able to independently release the float in the event of emergency or disablement. Locking devices on the release mechanism may be employed during staging to prevent inadvertent release, but the mechanism must be unlocked and active whenever the submarine is racing or occupied by crew members.

Teams incorporating a buoy are required to use a 'deadman' switch design that automatically deploys the buoy upon incapacitation of the pilot. Should a buoy be released — intentionally or accidentally — Navy divers will deploy immediately, and the active run will be considered Did Not Finish. All propulsion must cease upon buoy release.

6.6 Other Design Requirements

Submarine Width Limitations

The only method of entry for submarines into the water is via the basin's elevator. The maximum permitted submarine width is 84 inches (2.13 meters). Components may be removed or folded to meet this requirement and reattached once the submarine is in the water.

Submarine Drainage

The submarine must drain freely within three minutes when raised out of the water using the basin's elevator. The submarine must be raiseable and moveable off the elevator without stopping to allow drainage, ensuring quicker water access for all submarines. No submarine will be permitted to leave the lift area while still draining. Drainage apertures must allow water to drain from the lowest point of the hull.

Launch Cradle

The launch cradle must not float off the basin elevator during submarine lowering or recovery. This may be accomplished through negative buoyancy and/or the use of straps to secure the cradle to the elevator. Cradles must have a minimum of 4-inch diameter caster-style wheels for easy movement over the elevator floor grates and must be sturdy enough to withstand travel between the team's work area and the basin's elevator. If possible, the cart should be negative and submersible to permit parking the submarine on the bottom of the basin. This alleviates crowding on the staging beaches.

Land (Dry) Wireless Communications

During the races, the use of cell phone-based systems or Federal Communications Commission (FCC) approved Family Radio Service radios is permitted for land-based team communications. Any other method of land-based wireless communication must be approved by the Race Director to avoid communications interference.

Underwater (Wet) Communications

Wired submarine crew intercommunication systems are allowed but must be fully described in the team's Design Report for review by the judging panel. Wireless underwater communication systems are prohibited due to potential interference with ISR underwater race communication systems.

Sonic and Laser Emissions from Submarines

Sonic Transducers

Teams that plan to use commercially available ultrasonic transducers as part of a navigation or control system, must contact the Head Judge and Diving Supervisor prior to beginning construction. Given the properties of the basin (semi-enclosed concrete tank), the potential for diver injury is increased beyond the risk when this equipment is used in open water. As such, all proposed designs will be reviewed and approved/denied on a case-by-case basis.

Laser Emissions

Laser emissions from submarines are permitted only if the laser emitter complies with ANSI Z136.1 for Class 1 or Class 1M lasers. Teams must submit the make and model of the emitter along with manufacturer's certification of ANSI Z136.1 compliance to the Head Judge at least 30 days prior to ISR 19. Head Judge approval is required before any laser device may be operated during a race.

Automatic Control Systems for Steering, Diving, & Navigation

Use of automatic control systems for steering, diving, and navigation can add significant complexity to submarine systems while potentially reducing pilot workload. Many automatic control systems have been used with varying degrees of success in prior races. Teams must carefully weigh the benefits of automatic control against the inherent complexity and increased failure risk compared to simpler control systems. For any automatic control system, teams must identify the following in their Design Report: key system design factors, sensor hazards to operators and safety divers, electrical shock hazards, dangerous failure modes, and fail-safe operating modes. Pilot-controlled backup control systems must be installed on all submarines incorporating automatic control systems.

Drag Reduction Materials and Submarine Fluids

With the exception of wax applied to the hull and fins, the use of drag-reduction materials on the hull or appendages is prohibited. The submarine shall not release any fluid or material into the basin other than air bubbles. Designs incorporating air injection systems must meet the following criteria:

- The air injection system must have an independent air source, separate from the pilot's primary or secondary air supply.
- The design must include provisions for the safe release of compressed air in the event of mechanical failure without impacting submarine buoyancy. Trapped air can result in a rapid uncontrolled ascent, potentially causing injury to the pilot or nearby divers. This safety system must be described in the Design Report.
- Bubble release — whether operational or emergency — must not obscure the pilot's vision or hinder safe maneuvering, nor may it obstruct the vision of safety and rescue divers.
- The air injection system must pass both the dry and wet safety inspections, including a successful demonstration of the system's uncontrolled ascent prevention, before it may be used during a race run.
- The ISR Race Director may, at their discretion, require the air injection system to be disabled if any safety concerns are identified during inspections or racing.

Reuse of Submarines

Colleges and Universities may only enter ISR 19 with:

1. A brand-new submarine hull, or an older hull that has undergone a major design change — such as a conversion from propeller to non-propeller drive or vice versa, or a major control system change. In this case, the submarine's name shall be its previous name with "Mod 1" appended.

OR

2. A submarine that did not complete a successful racecourse run during any previous ISR event.

Under either condition above, a team's second submarine entry may be from any previous ISR. The reuse prohibition also does not apply to independent, corporate, or high school teams.

SECTION 7 — Diver & Crew Requirements

7.1 Certification Requirements

All submarine team members and in-water support crew who wish to dive at the ISR must hold a valid Open Water certification (Autonomous diver, ISO 24801-2) from an internationally recognized diver certification organization such as NAUI, BSAC, PADI, SDI, SSI, etc., or be able to document equivalent military diving experience (U.S. Navy, U.S. Coast Guard, etc.). The minimum age for certified divers to dive at the races is 15. Divers younger than 15 years old will not be permitted to dive during the ISR. Questions regarding diver status and eligibility must be directed to the Supervisor of Diving no later than three months prior to ISR 19. A copy of certification or training documentation must be submitted to the ISR Dive Staff during event registration. All divers must have their certification cards available for review at the event.

The ISR Dive Staff will review the medical history of all contestants requesting water entry and the Supervisor of Diving has sole discretion to approve or deny entry based on the submitted medical history form, physical condition, and any other information relevant to participant safety. A physician's letter approving a contestant to dive may be considered ***but is not guaranteed to supersede*** the Supervisor of Diving's determination.

Use AAUS med form in addition to UHMS – This will be provided when we post the forms.

Important Note: If you have any unusual medical history or special circumstances, including conditions not specifically addressed in the Medical History form, or any questions about your ability to dive at ISR 19, please contact the ISR Dive Supervisor – **with sufficient lead time for doctor's exam and sign-off in advance of ISR 19.**

All ISR divers are expected to be capable of comfortably demonstrating the following basic skills:

- Demonstrate proper weighting (assisted as necessary by ISR Dive Staff)
- Demonstrate ability to equalize ears/sinuses during descents
- Demonstrate ability to ascend at the standard rate of 30 ft/minute (9 m/minute).
  The Carderock Basin is 20' deep, so a proper controlled ascent should take at least 40 seconds.
- Mask clearing
- Mask removal and replacement
- Regulator clearing
- Regulator removal and replacement
- Air sharing underwater using diver supplied equipment
- Air sharing ascent using diver supplied equipment
- Demonstrate ability to achieve and maintain neutral buoyancy underwater
- Communicate underwater using commonly accepted signals
- Demonstrate proper fin technique – scissors kick, frog kick, etc.

All ISR divers must be prepared to successfully demonstrate the skills listed above under the supervision of the ISR Dive Staff. This evaluation will be a condition of authorization to dive during the ISR if required by the Supervisor of Diving.

Prior to ISR 19, divers must have completed at least 15 dives post Open Water certification training. These dives should take place in a Pond/Quarry/Ocean and must be a minimum of 15 feet for 15 minutes. Documentation of these dives will be done using a dive log. Data extractions from digital dive logs or submission of paper dive logs

are acceptable forms of documentation. A sample dive log can be found with the ISR registration materials. Continuing education certifications (Advanced, Rescue, Master Scuba Diver) may be counted against the minimum number at the discretion of the ISR Dive Staff.

Contestants who do not hold the diving credentials listed above but wish to be considered as surface swimmers (only) should submit their registration paperwork as a diver. Skill level will be evaluated by the ISR Dive Staff, and water entry is at the sole discretion of the ISR Dive Staff.

7.2 Diving Equipment

All divers are responsible for the condition, function, and performance of their equipment. The Dive Supervisor has the authority to inspect any diving equipment and prohibit its use if deemed unsafe.

All divers will receive a pre-dive check from a member of the Dive Staff prior to each water entry. It is the responsibility of every diver to ensure their equipment is present and fully functional before entering the dive station area. Divers and teams who are not ready will be directed to resolve equipment issues and will lose their place in the queue.

Regulators and Buoyancy Compensation Devices (BCDs)

- All breathing air must be delivered via an open-circuit SCUBA regulator. Rebreather units are not allowed. All breathing air used by all divers shall be compressed normal atmospheric air. Special air mixes such as nitrox are prohibited.
- The brand of regulators used for primary and secondary air supplies, as well as those used by support divers, is at the discretion of the submarine team. Teams are strongly encouraged to select regulators from established manufacturers with proven reliability.
- Regulators shall be equipped with an alternate air source and pressure gauge. BCD-mounted alternate air sources such as Air II or Air Source, diver-mounted pony bottles, or Spare Air units are acceptable substitutes for a traditional octopus regulator.
- All regulators should be inspected and serviced by a qualified technician prior to the event.
- All BCDs must be in working order and equipped with low-pressure inflators.
- All equipment — including hoses, gauges, and alternate air sources — must be secured to the diver in a streamlined fashion to prevent entanglement or damage.

Weight Systems

- Divers using pellet weight belts or weight pockets must ensure their belts or pockets show no damage that could lead to pellet spillage into the model basin.
- All personal weights must be secured in a quick-release system.
- Divers must be able to open weight belt buckles with one hand. Excess belt material should be trimmed prior to diving.
- Weight harnesses with functioning quick-release pockets are acceptable.
- Weight-integrated BCDs may be used if weights are contained within the quick-release pockets.
- Ankle weights may be used.

Cylinders

- All SCUBA cylinders used at the NSWCCD facility must be stamped with DOT and other appropriate markings as approved by the U.S. Department of Transportation (HMR: 49 CFR Parts 171-180). Tanks stamped with DOT/CTC or DOT/TC (CTC = Canadian Transport Commission; TC = Transport Canada) may also be used due to joint rulemaking with Canada.
- Aluminum cylinders manufactured from Alloy #6351-T6 (Luxfer, Walter Kidde, and others) produced between January 1972 and approximately December 1988 are not permitted. These cylinders present an unacceptable risk of failure due to sustained load cracking (SLC) of the tank neck (HMR: 49 CFR Parts 171-180).
- Per DOT regulations and CGA guidelines, all cylinders must display current hydrostatic test dates stamped on the shoulder and current visual inspection stickers.
- All cylinders will be reviewed by the Dive Staff prior to use at ISR 19. Approved cylinders will receive a sticker authorizing use during the races. No cylinder will be filled by the Navy if the sticker is missing.
- All Spare Air regulators must be in good working order, and cylinders must have current hydrostatic test dates and current visual inspection stickers as recommended by the manufacturer.
- Divers using Spare Air systems must provide their own equipment for filling these cylinders. Navy fill personnel are not responsible for filling Spare Air cylinders and may refuse to do so if the diver does not supply the proper equipment.
- Cylinders will be filled on-site by Navy-supplied personnel and equipment. Empty cylinders should be left at the designated fill station and will be returned to the adjacent tank area once filled. Teams and divers should label their cylinders to identify ownership.

Crew Comfort

- The model basin is not heated — despite being fully enclosed, water temperatures typically range from 60 to 65 degrees F. Crew members and support divers are strongly encouraged to wear dry or wet suits, gloves, hoods, and booties to guard against hypothermia.
- Contestants should exit the water whenever not actively preparing or operating their submarine to limit cold exposure.
- Contestants are encouraged to bring handheld, battery-operated underwater lights to facilitate work on their submarines when submerged.

7.3 Air Supply Monitoring

All divers shall monitor their own air supply at all times and shall not allow it to fall below 500 psi (34 bar). The Dive Supervisor and staff retain sole discretionary authority over water entry, including the authority to deny entry to any diver with less than a full cylinder of air. Divers and submarine crews must carry sufficient air to complete their assigned task — whether racing, providing support, or performing any other in-water activity — and must return to the dive station with a minimum of 500 psi (34 bar) remaining.

7.4 Safety Inspections

Prior to being certified to race for the first time, each submarine shall receive two inspections to ensure crew safety and compliance with submarine design rules — a dry inspection and an in-water inspection. Inspections shall be performed by one or more judges and Dive Supervisor staff, who may be accompanied by members of the Navy dive team to familiarize themselves with the submarine's construction, hatch handles, crew restraint release points, and other critical systems.

Upon completing submarine assembly, teams should notify Surface Operations staff to schedule the dry inspection. After passing the dry inspection, teams must ensure all divers have been approved by the Dive Supervisor's staff and that all dive equipment is ready. Teams should then notify Surface Operations staff to

schedule the in-water inspection. Teams must be on station and ready to dive at their appointed time. Teams that are unprepared will be placed at the end of the inspection queue.

The in-water inspection shall occur with the submarine placed on the basin floor with a full crew aboard. The crew shall perform an emergency egress and, if equipped with an emergency pop-up buoy, demonstrate its operation from all crew positions.

Once each submarine has passed both inspections, an adhesive compliance sticker will be placed on the hull, serving as the team's authorization to request race queue placement.

7.5 Safety Precautions

Safety is everyone's responsibility. Every precaution will be taken to ensure this event is conducted as safely as possible. Qualified rescue divers will be stationed along the course at all times, ensuring one is always in proximity to the racing submarine.

A qualified civilian Dive Supervisor will be on hand at all times to monitor and coordinate underwater activities. Submarine crews and support divers are required to inform the Dive Supervisor when entering and leaving the water. The Dive Supervisor is responsible for participant safety and the smooth operation of the races. All participants must follow instructions given by the Dive Supervisor and their staff at all times.

Qualified emergency response personnel will be on hand at all times, fully equipped to handle injuries and with an emergency vehicle available for transportation. Arrangements have been made for medical evacuation if required. Emergency or urgent care may be advised by an on-site U.S. Navy Corpsman or other uniformed medical staff if warranted, however they will not be able to provide any physical healthcare services. In the case of minor injuries not requiring an ambulance, teams are responsible for providing transportation to a local hospital's emergency room.

All divers will enter and leave the water through the designated dive station. All persons entering the water must check in with Dive Staff and surrender their ID. Upon exiting, all persons must check in with Dive Staff and retrieve their ID before leaving the dive station area.

Each submarine team is responsible for training crew and support divers for emergency egress. Teams should practice this exercise underwater until all involved are thoroughly familiar with the procedure. Teams are also encouraged to act responsibly and safely with regard to other submarine crews and underwater personnel.

Several objects protrude from the basin walls at the surface, such as wave attenuators, and various objects float on the basin surface. All divers should take appropriate precautions when ascending. All divers should remain alert and aware of their surroundings at all times. Carrying an underwater light is strongly recommended for personal visibility and to signal presence to others. Concrete surfaces around the ends and sides of the basin become slippery when wet — non-skid footwear such as dive boots, reef walkers, or boat shoes is recommended. Open-toed shoes and flip-flops are prohibited on and around the model basin's in-water elevator area.

All persons inside the model basin carriage rails must wear a U.S. Coast Guard-approved Type I, II, III, or Type V Personal Flotation Device (PFD) in serviceable condition and appropriately sized for the intended user. A wet suit with sufficient buoyancy to float the wearer is an acceptable substitute if donned and zipped. Teams must ensure sufficient PFDs are available for all support staff retrieving carts or bringing water support items into the basin area.

SECTION 8 — Technical Deliverables

8.1 Submarine Specification Sheet

The ISR Race Program presents overall information about the race, competing teams, and the specifications of each submarine entered. A document template requesting the required information to be printed in the program will be distributed to teams and returned to the Contestant Liaison by the dates listed in the Technical Deliverables Timeline. Accurate and complete information is essential — this form serves as the basis for the printed Race Program and all award letters and plaques.

For submission, completed templates should be emailed to the ISR Contestant Liaison.

8.2 Design Report

Each submarine team is required to submit a Design Report to the ISR judging panel. This report must comprehensively document the team's efforts in the conception, design, construction, and testing of their submarine. Teams that fail to submit the Design Report by the date listed in the Technical Deliverables Timeline will not be permitted to race.

The Design Report serves three purposes. First, judges will use it to determine whether the submarine conforms to the design guidelines and rules set forth in this manual. Second, the judges reserve the right to reject any team whose design or intentions are not in keeping with the honor and tradition of the races. Third, design deficiencies that compromise crew safety are grounds for rejection.

Reports will be compiled into a journal to benefit those interested in human-powered submarine engineering. FURE considers the Design Report one of the most educationally significant elements of the ISR. See Section 9 for the associated Design Report award.

At a minimum, the Design Report must cover the following topics and be organized according to the outline:

- Executive Summary
- Design Philosophy & Goals
- Design and Fabrication
    - Hull
    - Propulsion System
    - Control Systems
    - Life Support System *(include Primary Air Supply calculations in this section)*
    - Safety Systems
- Submarine Testing
- Crew Training
- Lessons Learned
- Knowledge Transfer
- Budget
- References

The Design Report is limited to 50 pages (excluding the Table of Contents, Figures, Diagrams, Bibliography), single spaced, and Calibri font (size 12). Page counts exceeding 50 pages will incur a 0.5-point per page grade reduction to the report score. Late submission will incur a 2% grade reduction per day. Omission of any required topic will incur an 8% grade reduction per missing topic.

All reports will be copyrighted to and become the property of FURE. FURE intends to make these reports available on the ISR website following the conclusion of the races. Copyright forms will be provided to teams by the date

listed in the Administrative Timeline. Design Reports must be submitted by email to the ISR Head Judge by the date listed in the Technical Deliverables Timeline. If the file is too large to send by email, the team should contact the Head Judge to arrange an alternative submission method such as a shareable cloud link.

8.3 Team Presentations

Each team must deliver a 20-minute presentation to the ISR Judging Committee for each submarine entered.

Presentations must be prepared in Microsoft PowerPoint at a minimum and include the following elements:

- Team Introduction
  - Sponsoring organization
  - Team members
- Overview and Goals
- Design Philosophy
- Design and Fabrication
  - Hull
  - Propulsion System
  - Control Systems
  - Life Support System
  - Safety Systems
- Submarine Testing
- Crew Training
- Lessons Learned
- Knowledge Transfer
- Budget
- Closing

The presentation schedule will be supplied to each team by the Contestant Liaison after team scheduling inputs are received. All relevant dates for this process are listed in the Technical Deliverables Timeline. Presentation materials must be submitted by email to the ISR Head Judge by the date listed in the Technical Deliverables Timeline.

Only judges and the presenting team will be permitted in the judging room during presentations. Team mentors or faculty advisors shall not participate. The next scheduled team will not be allowed to enter until the judges have completed their discussion of the current presentation. Late submission of presentation files will incur a 2% grade reduction per day.

8.4 Copyright & IP

The Final Design Report and the 20-minute team presentation will be copyrighted to and become the property of FURE. The completed Copyright Form — including releases for both the Design Report and the team presentation — is due to the ISR Head Judge by the date listed in the Administrative Timeline.

SECTION 9 — Awards

9.1 Award Categories & Criteria

The following awards will be given to the contestants at ISR 19:

Overall Performance

A trophy and cash award are presented to the submarine team from any design category that displays the best overall performance. Overall Performance is determined by quantifying a weighted, seventeen-parameter Figure of Merit (FOM) for each team and submarine. The FOM incorporates aspects of other award criteria as well as the team's attitude, persistence, and resourcefulness. The runner-up team will receive a plaque and $TBD.

Most Innovative Propulsion System (Non-Propeller Only)

A plaque and cash award are presented to the submarine team from any design category that demonstrates the most innovative non-propeller propulsion system design and resultant performance.

Best Use of Technology

A plaque and cash award are presented to the team in any design category that exhibits the best and most successful use of technology to support their submarine's design, construction, and performance.

Flank Speed Award

A plaque is awarded to the submarine team recording the fastest speed of the race across all design categories. If the speed sets a new overall record, an additional cash award of $TBD will be presented. Previously known as the Absolute Speed Award.

The Blueprint Award

A plaque is awarded to the team that submits the most outstanding Design Report.

Smooth Operator Award

A plaque is awarded in recognition of outstanding efficiency in staging, racing, troubleshooting, and overall run preparation throughout race week. The winner is selected by the Surface Operations Director and ISR Dive Staff.

Build Smart. Dive Smart. Award (Theme of the Races)

Presented to the submarine team that best embodies all components of participating in ISR 19 — demonstrating exceptional engineering judgment in the design and construction of their submarine and translating that ingenuity into outstanding in-water performance. This award recognizes not just speed or innovation in isolation, but the complete package: a team that built smart and dove smart.

The Theme Award is unique to each ISR race cycle and will not be carried forward to future races. ISR 19's theme — Build Smart. Dive Smart. — reflects the race committee's vision for this generation of human-powered submarine engineering.

Spirit of the Races

A plaque is awarded to the submarine team that displays the greatest gusto, fortitude, and support for fellow teams throughout the races. The winner is selected by the competing teams themselves. This award is presented in memory of the late ISR contestant Steve Barton of Team Sublime.

Fastest Speed by Category

Certificates are awarded to the first place and runner-up speed finishers in each design category. If fewer than three submarines compete within a given category, only first place will be recognized.

Participation Plaques with Team Photos

All participating teams will receive a commemorative photo plaque.

9.2 Current Speed Records

Category	Propulsion	Race	Year	Speed	Submarine	Organization
One Person	Propeller	**ISR 18**	2025	**7.68 kts**	**OMER XIII**	École de Technologie Supérieure (ÉTS)
	Non-Propeller	**ISR 10**	2009	**4.92 kts**	**OMER 6**	École de Technologie Supérieure (ÉTS)
Two Person	Propeller	**ISR 9**	2007	**8.03 kts**	**OMER 5**	École de Technologie Supérieure (ÉTS)
	Non-Propeller	**ISR 11**	2011	**6.10 kts**	**MIGHTY MID**	U.S. Naval Academy

APPENDIX A — ISR History & Purpose

The International Submarine Races (ISR) were conceived in 1988 by the H.A. Perry Foundation and Florida Atlantic University's Department of Ocean Engineering. To allow time for new submarine development and fabrication, the event was established as a biennial competition. The first three races were open-water events in Riviera Beach, Florida (1989 and 1991) and Ft. Lauderdale, Florida (1993). In 1994, the Foundation for Underwater Research and Education (FURE) assumed responsibility for conducting the ISR. To address problems in previous open-water races caused by weather and racecourse mechanical issues, FURE officials searched for a protected, freshwater venue for future races. FURE found a willing partner in the U.S. Navy, who offered use of their David Taylor Model Basin at the Naval Surface Warfare Center – Carderock Division in West Bethesda, Maryland. Since the first race inside the David Taylor Model Basin in December 1995, FURE has conducted the biennial International Submarine Races as the capstone Science, Technology, Engineering, and Mathematics (STEM) event for thousands of young men and women. This competition for human-powered underwater vehicles has been continually hosted by the Naval Surface Warfare Center, Carderock Division, and provides valuable educational experiences to the best and brightest engineering and science students from throughout the world. Even during the COVID pandemic in 2021, FURE hosted a virtual ISR (vISR 16) with online professional presentations and remote evaluation of teams' submarine designs, team management, and problem-solving skills.

The International Submarine Races were created to address a potential future shortfall of scientists and engineers in the fields of ocean and marine engineering, and to encourage students to pursue careers in the marine fields. The ISR provides an applied engineering learning opportunity for teams at all educational levels. The challenge remains to design, build, test, and race a one- or two-person, human-powered wet submarine with contestants using SCUBA equipment inside it, operated over a timed course. Each submarine is uniquely designed, built from scratch, and relies upon novel techniques for propulsion and guidance. Every race features creative teams bringing forth ever more innovative designs in materials, propulsion, and navigation and guidance, with resultant speed improvements. A student's participation in the design, construction, testing, and operation of an underwater craft offers real-time application of theoretical knowledge, hands-on problem solving, and team-building skills. The lessons learned during the ISR process provide fundamental building blocks for a successful professional career. The International Submarine Races are also an opportunity for the U.S. Navy, race sponsors, volunteers, and team faculty and parental advisors to invest in the dreams of these young men and women.

FURE is proud to sponsor the ISR where young men and women can take advantage of all professional and personal development learning opportunities, discuss their future, and receive guidance from those who came before them. FURE's hope is that the ISR experience provides a strong foundation from which industrious students can build a future that fulfills their personal and professional interests and contributes meaningfully to the world's scientific and engineering challenges. The International Submarine Races count among their alumni thousands of individuals who have achieved success in the scientific, engineering, and management fields, drawing on the lessons, skills, and connections forged at the races. Former ISR submariner and contestant, and now astronaut, Dr. Megan McArthur Behnken once said, "We dream these amazing dreams. We share these huge goals, and we're going to be successful when we work on them together." Dr. Behnken has also said, "Pursue what you love to do. Don't be afraid to dream. Be curious… and ask the questions."

The late Robert F. Kennedy was a former Attorney General of the United States and brother of the late President John F. Kennedy. About dreaming, he once said, "Some men see things as they are and ask, 'Why?'; I dream of things that never were and ask, 'Why not?'" Dr. Behnken and countless other successful individuals who are graduates of the International Submarine Races are people who, throughout their lives, continuously ask, "Why not?". ***FURE's challenge and advice to ISR contestants — before, during, and after their ISR — is this: don't be discouraged; listen to those who came before; learn from others; don't ever stop dreaming; and do not ever, ever stop pursuing those dreams.***

