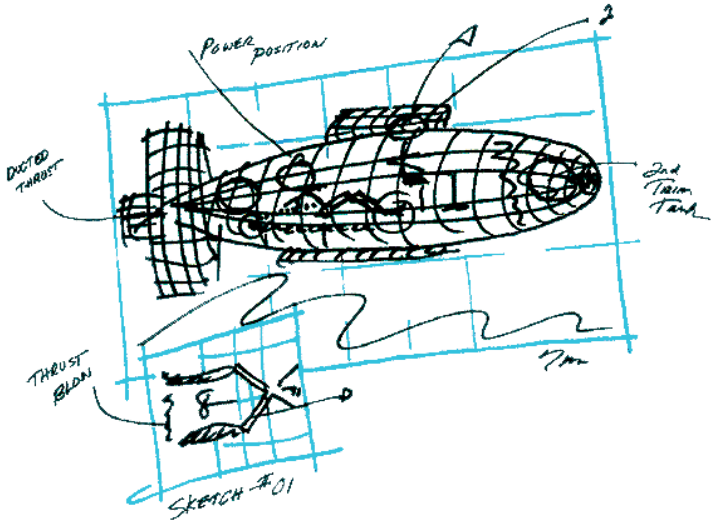

ISR™ 14
International Submarine Races
Contestants' Manual
Version 1.04
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Produced by the
International Submarine Races (ISR™)
and the
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1. ISR™ 14 CONTESTANTS' MANUAL CHANGE HISTORY

Version	Date	Change
1.0		First Release
1.01	5/12/2016	Updated Head Judge & Contestant Liaison contact info
1.02	9/13/2016	Updated wire transfer fees in Section 10
1.03	9/13/2016	Updated e-mail addresses with internationalsubmarineraces.org
1.04	5/10/2017	Updated SCUBA and diving requirements (paragraphs 5.4, 7.1, and 7.3) and ISR13 speed records (paragraph 6.8)

2. INTRODUCTION

2.1. Background Information

Congratulations on considering building and racing a human powered submarine. This manual has been prepared for those who are interested in participating in the 14th running of the International Submarine Races (ISR™ 14), to be held at the David Taylor Model Basin located at Carderock Division of the U.S. Naval Surface Warfare Center (NSWC) at Bethesda, Maryland June 25th to June 30th, 2017. The David Taylor Model basin is one of the largest fresh water hydrodynamic test facilities in the world.

The manual is intended to be a guideline for the ISR™ 14 submarine design, race participation, registration, schedules, rules, operations, and related subjects. It has been written and edited by the ISR™ leadership team. As a working document, this manual is subject to change and any updated versions will be placed on the ISR™ website. Please refer to the calendar section for pertinent dates.

2.2. ISR™ Challenge

The ISR™ 14 challenge is to design, build and race a one- or two-person, human-powered submarine on an underwater course.

2.3. ISR™ Rationale

There is a continuing need to increase the competency and number of engineering students and improve the efficiency of hydrodynamics, propulsion and life support systems for small, subsea vehicles. Profound lessons may be learned through the

process of designing, building and operating an "optimized design". The rules of this competition restrict the vehicle's power to human power, thus focusing attention on maximizing the vehicle's design and life support system.

2.4. ISR™ Mission

The mission of the ISR™ is to:

- To inspire students of the various engineering disciplines to delve into broad areas of underwater technology advancement and to provide them an educational experience that translates their theoretical knowledge into reality.

- To foster advances in subsea vehicle hydrodynamic, propulsion and life support systems.

- To increase public awareness of the challenges people face in working in and exploring the ocean depths.

2.5. Organization of ISR™

The Foundation for Underwater Research and Education (FURE) is a not-for-profit, educational, operating foundation established in 1987. FURE's purpose is to increase awareness of and encourage educational programs about marine science, technology and engineering among students, the general public, government leaders, educators, other scientists, and journalists. FURE has organized marine science educational and outreach activities and has managed the International Submarine Races since 1994. FURE is the race organizer for the 14th ISR™. The race is managed by a group of volunteers who have dedicated their personal talents and abilities to maintaining the continuity of this unique technology competition.

The leadership team for the 14th ISR™ is as follows:

Kurt Yankaskas – ISR Executive Director
Jerry Rovner - Race Director
Peter Hanway – Assistant Race Director
Dave Peterson - Surface Operations Director
Vin Malkoski - Diving Supervisor
Michael Ales Head Judge
Susan Rovner – Contestant Liaison
Charlie Behrle - President and Chairman of the Board, Foundation for Underwater Research and Education
Nancy R. Hussey – Board of Directors (Emeritus), Foundation for Underwater Research and Education

The ISR™ operates on a virtual basis, with support from corporate sponsors, government and academic officials, and a host of private individuals.

Funding and administrative support for the ISR™ is provided through the Foundation for Underwater Research and Education (FURE), a 501(c)(3) not-for-profit organization established in 1987 by Nancy R. Hussey. FURE is dedicated to supporting educational programs in marine technology and engineering, working with other not-for–profits, research organizations, government leaders, educators and students.

To remain current with the activities of the ISR™ and FURE, access the website at *www.Internationalsubmarineraces.org*

The detailed history of the races can be found in Appendix 1.

2.6. Sanctions and Affiliations

The International Submarine Races are not affiliated to any other group or human-powered submarine race.

2.7. Safety and Liability

Every effort is being made to conduct this event as safely as possible. There will be emergency medical personnel on hand, and many highly qualified safety divers prepared to intervene in the case of mishap. Because of the potentially dangerous nature of submarine racing, every participating contestant must fill out and sign a number of forms discussed later in this document and are available on the ISR™ website. *(www.InternationalSubmarineRaces.org.)* Each team shall assume full responsibility for the loss or damage of their equipment and any damage to the submarine or injury to personnel.

3. FACILITY SECURITY AND RULES

ISR 14 is hosted by NSWC Carderock, a major US Navy research facility. NSWC Carderock is an industrial site for research of a sensitive nature. All persons must be properly cleared to be allowed access to the facility. Every participant will need to fill out the appropriate forms and send them in well before ISR 14 for processing, according to the deadlines posted on the website. All contestants and participants will be issued a special badge that must be worn at all times while in the facility (except when in the water). While there is plenty of parking space available, contestants should attempt to limit the number of vehicles coming into the facility. This should help with the traffic control workload of the security guards.

Cameras (including cameras on mobile phones) are allowed into the facility, but can only be used in the model basin itself, and only for the purpose of filming the race proceedings. Do not

attempt to use a concealed camera. NSWC Carderock will require that everyone fill out a camera and laptop form, available from the ISR™ website at a future date. After the camera/laptop form has been approved by government security personnel, a camera/laptop pass will be issued and must be carried with the camera/laptop at all times in plain sight.

Contestants are required to stay within the race area. Anyone found outside around the ISR™ 14 event area or going into restricted areas could be escorted out of the facility and asked to surrender his/her badge. Unless you are taking a tour with NSWC Carderock personnel, visiting the cafeteria, or are with authorized personnel, please remain in the event area.

Each team, as well as all ISR™ personnel, is solely responsible for the loss, damage or theft of their equipment. When it is unattended, make every attempt to lock or secure it. The help and support of one another through the loaning of tools and equipment is strongly encouraged; but mark loaned gear so that it will return to its owner, and make sure that anything you offer, particularly dive gear, is intact and safe. If you need something, please ask.

The possession or use of alcohol or illegal drugs is absolutely prohibited by NSWC Carderock and the ISR™ anywhere on the facility grounds. As this is an industrial setting, flip-flops and other open toe shoes are prohibited on and around the basin's elevator.

4. OVERVIEW OF FORMS, FEES, AND DATES

Below is a summary of the forms, fees and key dates. Additional details appear later in this document.

4.1. ISR™ #14 Team Registration

All teams need to submit the following registration form from the ISR™ website:

5.1 Team Entry Form

Where does this form get mailed?

Form 5.1 is due no later than 3 November, 2016 with the $300.00 non-refundable portion of the entry fee to:

F.U.R.E.
PO Box 543
Haymarket, VA 20168
chip3483@gmail.com

A copy of this entry form must be sent to:

International Submarine Races
c/o Susan Rovner - Contestant Liaison
746 Savannah Drive
Pawleys Island, SC 29585
contestant.liaison@internationalsubmarineraces.org

(843) 235-0463

4.2. ISR™ 14 Registration for Individual Contestants, Visitors, Volunteers and Spectators

The registration process for individual contestants, visitors, volunteers and spectators for ISR™ 14 is currently under development and the details will be available at a later date on the website. The due date of all individual registrations will be May 1, 2016.

4.3. Submarine Specification Sheet for Race Program

These forms will be issued Monday, 1 April 2016 and must be returned to the Contestant Liaison no later than Monday, 1 May 2016.

4.4. Visas

Visas may be required for foreign citizens. See details later in this document.

4.5. Registration Fees

3 November 2016 $300 - Nonrefundable; Mailed with Team Entry Form
2 February 2017 $950 – Final Registration Fee

Late payments may disqualify your team and void registration or incur a late payment fee of $250. Additional details appear later in this document.

4.6. Critical Due Dates

3 November 2016	Initial Team Registration
2 February 2017	Final Team Registration
2 April 2017	Final Design Report Draft Outline
4 May 2017	Final Design Report – 2 CDs
15 April 2017	20-minute Presentation: Sign-up Sheet
4 May 2017	20-minute Presentation: Schedule Issued
1 May 2017	All Individual Registrations Complete
26- 30 June 2017	20-minute Presentations during race week (2 CDs with

presentation(s) are required.) (Presentations to be scheduled with Head Judge)

5. SUBMARINE DESIGN GUIDELINES

5.1. Definition

For the purpose of this event, a submarine shall be defined as a free flooding (liquid-filled) vehicle that **fully encapsulates the occupant**(s), and operates entirely beneath the surface of the water. (The submarine must fully encapsulate the occupants for the entire race. (E.g. failure of a hatch is reason for disqualifying a run.)) Entrants designed to propel themselves by crawling on the bottom are not submarines but tractors and are prohibited. The vehicle may carry one or two persons.

5.2. Propulsion Systems

5.2.1. Propeller system

A propeller system is defined as a water-coupled device with radiating blades that create thrust when spinning.

5.2.2. Non-Propeller system

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

Submarine propulsion systems shall be directly coupled to a human being and shall not employ any energy devices. All power trains shall be direct-drive without the use of any de-coupling devices.

SCUBA exhaust air from the crew may be eliminated by any method at the discretion of the team, but may not be used to produce a propulsive force. You are encouraged to give this considerable thought; any exhaust air trapped in the hull will cause major changes in trim and buoyancy.

In the case of a two-person submarine, BOTH of the crew may elect to provide propulsion. In this case, however, both crew members must be directly coupled to the drive train; i.e. pilots may not have a system where they could stop providing power by de-coupling. The pilot must retain the capability to provide navigational, safety, and steering functions.

5.3. Design Categories

All submarines participating in this event shall fall into one of the following categories:

One-person submarine, propeller driven --
Colleges and Universities; High Schools and Independents

One-person submarine, non-propeller driven --
Colleges and Universities; High Schools and Independents

Two-person submarine, propeller driven --
Colleges and Universities; High Schools and Independents

Two-person submarine, non-propeller driven --
Colleges and Universities; High Schools and Independents

5.4. Life-support Systems

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

5.4.1. Aluminum Cylinders Made from Alloy 6351-T6

The use of aluminum cylinders manufactured from Alloy #6351-T6 (Luxfer, Walter Kidde, and others) during the period January 1972 through approximately December 1988 will not be allowed. The cylinders have an unacceptable risk of failure due to neck cracks.

5.4.2. Tank Markings

As per U.S. Department of Transportation (DOT) regulations, all scuba cylinders used at the Submarines races must be stamped with "DOT" on the shoulder. Acceptable variations include ICC, DOT, CTC/DOT and TC/DOT. Cylinders brought to the races lacking the DOT stamp cannot be used.

5.4.3. Submarine Primary Air Supply

The primary air supply shall be carried onboard the submarine, and have the calculated capacity to contain the air supply for a minimum of one speed run, plus 150% in reserve capacity for each crew member. Calculations shall be provided as part of the teams' design report.

At all times, all primary submarine air supplies shall have pressure gauges that must be continuously and clearly visible for checking by the internal submarine crew. Submarine crews are required to monitor their own air supply, and shall not allow their air supply to fall below 500 psi. Whenever possible, mount the

internal pressure gauge in a position that can also be viewed from the outside by support divers.

5.4.4. Submarine Secondary (Reserve) air supply

The secondary air supply for each crew member shall be self-contained and worn securely on the body or secured in an accessible location in the submarine, and have sufficient capacity to enable the crew member to exit the submarine with their secondary air supply and ascend from the bottom of the tank at a proper rate to the surface. (Note that once the submarine is on the race course (or has stopped along the course) the crew should not exit the submarine until instructed to do so by Navy divers.) This air supply may be utilized for such duties as getting into the submarine and preparing for a run, but other options such as the use of an octopus (alternate air source) supplied by a support diver should be considered to protect the air supply in the submarine's secondary air supply.
.

5.4.5. Support Diver air supply

All support divers must be equipped with octopus regulators to allow support of submarine crew activities, like getting in and out of the submarine while submerged.

Additional information on diving equipment can be found in Section 7, Diver Information.

5.5. Submarine Safety Requirements

5.5.1. Submarine coloration

It is advised for the purpose of easy location that each entire submarine be painted with high-visibility coloration, using lighter colors like white, yellow, or orange.

In all cases, the length of the top of the submarine (when viewed from above) must be of a light color for monitoring of the submarine while it is on the race course.

Fluorescent or contrasting schemes are advisable to make your submarine distinct. Hull numbers will not be assigned to each submarine. For the purpose

of precise identification it is recommended that the contestants feature the team or submarine name prominently on the hull. The listing of sponsors, affiliates, or team members is acceptable. Propeller tips shall be painted or marked in bright orange for easy visibility for divers.

5.5.2. Rescue egress

Any and all exits that are to be used by a submarine crew for emergency egress shall be clearly marked at the location of the handle or release mechanism by a 4" square orange patch bearing the word "Rescue." If this is not possible, the handle or release mechanism must be clearly marked with at least fluorescent tape. The handle or release mechanism shall be easily accessible from both inside and outside the submarine.

5.5.3. Crew restraint

Any method of attachment of a crew member to the submarine, such as restraining harnesses or toe-clips, must have the release system clearly marked with orange paint or florescent tape. During both the dry and wet safety inspections, the judges will ensure that this requirement is met, and will point out to the rescue divers the specific release points for each submarine.

5.5.4. Crew visibility

Viewports, windows, canopies, etc., shall be located on the submarine so that the crew has as unrestricted a view as possible, especially forward in the case of the navigator. The crew's face and head areas shall also be visible to the support and safety divers at all times.

5.5.5. Strobe marking light

Each submarine shall carry a white strobe light that is visible for 360 degrees in the horizontal plane and visible when viewed from above and below the submarine. Multiple strobe lights are acceptable if needed to meet this requirement. The strobe light shall not be part of the emergency pop-up buoy.

The light(s) must carry the markings of either United States Coast Guard (USCG) and/or Safety of Life at Sea (SOLAS) approval and must be removable for judges to examine.

The light shall be operating whenever the submarine is submerged. A non-functioning light is reason for disqualifying the submarine. It is recommended

that batteries be changed frequently, depending on usage and that you have spare(s) light assemblies in case of light failures (e.g. flooding).

5.5.6. Emergency Pop-Up Buoy

All submarines shall carry a high visibility buoy that will release from the hull and float to the surface when an emergency occurs. The float shall be attached to the submarine by thirty feet of strong, highly visible line, at least 1/16" thick. Each crew member shall have a dead-man type of switch that will automatically release the float in the event of disablement. Switch safety mechanisms may be employed during staging to prevent inadvertent release, but the switches MUST be activated whenever the submarine is operating. The release of this buoy will initiate an emergency rescue by the safety divers, whose primary interest will be getting the crew member out of the submarine and to the surface as quickly as possible. If a buoy is accidentally released, the safety divers will react and the run will be considered aborted. All propulsion on the submarine will stop If the emergency buoy is released.

5.6. Other Requirements

5.6.1. Submarine Width Limitations

The only method of entry of submarines into the water is via the basin's elevator. The maximum width permitted of a submarine is 84 inches (2.13 meters) to allow it to be launched via the basin's elevator. It is acceptable to remove parts of the submarine or have folding components to meet this width limitation and then reattach or move such parts once the submarine is in the water.

5.6.2. Submarine Draining

The submarine must drain freely when raised out of the water using the basin's elevator. That is, the water must flow freely out of the submarine such that it can be raised out of the water and moved off the elevator without having to stop the elevator to allow the submarine to drain. (This allows for quicker access to the water for racing for all boats.)

5.6.3. Launch cradle

The launch cradle must not float off the basin elevator during submarine lowering into or recovery from the water. This may be accomplished through it being negatively buoyant and/or the use of straps to secure the cart to the elevator. Cradles must have a minimum of 4" diameter wheels for easy movement over the elevator grates and be sturdy enough to withstand travel between the team's work area and the basin's elevator.

5.6.4. Team Land (Dry) Wireless Communications

At the races, the use of cell phone based systems or US Federal Communications approved Family Radio Service radios is permitted for the teams' land based communications. Any other method of land based wireless communication must be approved by the Race Director to avoid communications interference.

5.6.5. Team Underwater Communications

Wired submarine crew intercommunication systems are allowed but must be fully described in your basic design outline so that they can be reviewed by the Judges' panel.

Wireless team and crew underwater communications systems are prohibited due to potential interference with other race underwater communication systems.

5.6.6. Drag Reduction Materials and Submarine Fluids

Beyond the use of waxes on the submarines hulls and fins, the use of drag-reduction material is prohibited. The submarine shall not release any type of fluid into the basin's waters.

5.6.7. Submission of Basic Design Report

Each submarine team will be required to submit a basic design report to the ISR™ judging panel. This report shall completely document the team's efforts in the conception, design, construction, and testing of its submarine. Entry to the races will not be allowed if this document is not presented by the assigned date. There are three reasons for this requirement. The judges will use the design report to determine if the submarine conforms to the design guidelines and rules set forth in this contestant's manual. In addition, they reserve the right to reject from competition any contestant or team whose design or intentions are not in keeping with the honor and tradition of the races. Deficiency in design from the standpoint of crew safety is also cause for rejection.

The report for each submarine will be compiled and a journal produced to provide educational benefit to those interested in human-powered submarine engineering. An award shall be given to the submarine crew that develops the most complete and informative report for their project. It is part of the scoring.

A presentation to the judging panel is required and is part of the scoring. These presentations will last 20 minutes. The format of the presentation will be conveyed to the contestants participating in the 14th ISR™ by the Contestant

Liaison. Because of the importance of this document, it should be as detailed and complete as possible, and it must be easily read and understood.

ISR™ organizers firmly believe that one of the most important aspects of the races is the educational benefit that these reports will offer. The ISR™ Judges will provide a generic format of the report and 20 minutes presentation if requested by a team. Section 3.12 identifies dates of all deliverables. Note that there is also a date listed for final submission of the basic design report. This allows an opportunity to modify the original design. All modifications should be detailed and submitted to the judging panel for review.

All reports are to be copyrighted to the 14th ISR™ and will become the property of the FURE. It is the intention of the FURE to compile the reports into one volume at a later date. Copyright forms will be supplied after the 2 February 2017 date.

5.6.8. Reuse of Boats in ISR™ 14

Colleges and Universities may only enter in ISR™ 14:

1. A brand new submarine hull, or an older hull that has a major design change i.e. converted from propeller to non-propeller, vice-versa or control system change. In this case the submarine's name shall be its old name with the words "Mod 1" added.

OR

2. A submarine that did not make a successful race course run in ISR™ 13 in 2015.

In the case of 1. or 2. above, a team's second submarine entry may be from any previous ISR™ .

6. AWARDS AND RECORDS

The following awards will be given to the contestants at the 14th ISR™ .

6.1. Absolute speed award

Given to the submarine team of the boat from any of the design categories listed in Section 2.3 which sets the highest speed of the race.

6.2. Fastest speed by category

First, second and third place awards to be given to submarine teams in each design category.

A further subcategory of all women crew was initiated for ISR12, however ISR returned to gender neutrality for ISR13 and beyond.

6.3. Innovation

First, second and third place awards to be given to submarine teams in any design category who display the most successful design and construction innovations. The scoring criteria are based on 17 categories with different weights/factors to result in a Figure of Merit Calculation.

6.4. Best use of composites

One award given to the submarine team from any design category which exhibits the best and most successful use of composite materials in the construction of their vessel.

6.5. Best design outline

One award given to the team which submits the best basic design outline of their submarine project.

6.6. Overall Performance

One award given to the submarine team from any design category which displays the best overall performance. This performance will include not only aspects of the above awards, but also team attitude, persistence, and resourcefulness following a scoring criteria based on 17 categories with different weights/factors to result in a Figure of Merit Calculation. A cash prize of $1,000 provided by Booz Allen Hamilton is awarded.

6.7. Best Spirit of the Races

This award is given to the submarine team that displays the best gusto, fortitude, support for the other teams, and overall best spirit. The winner will be selected by the submarine teams themselves, and is awarded in memory of the late ISR™ contestant, Steve Barton of team *Sublime.*

6.8. Current Records

The current record holders from previous ISR^{tm} races are as follows:

Category		Race	Year	Speed	Boat	Organization
One Person	Propeller	ISR13	2015	7.42 kts	WASUB VI	Delft University of Technology
	Propeller – Women[1]	ISR12	2013	5.50 kts	TALON 1	Florida Atlantic University
	Non-Propeller	ISR10	2009	4.92 kts	OMER 6	Ecole de Technologie Superieure
Two Person	Propeller	ISR9	2007	8.03 kts	OMER 5	Ecole de Technologie Superieure
	Propeller – Women[1]	ISR12	2013	3.58 kts	SUB ZERO	Springstead High School
	Non-Propeller	ISR11	2011	6.10 kts	MIGHTY MID	U.S. Naval Academy

1. Subcategory added for ISR12 only

7. DIVER INFORMATION

7.1. Diver Certification

All sub team members and in-water support crew must have a valid *OPEN WATER* certification from a nationally recognized diver certification organization such as NAUI, PADI, YMCA, etc. or be able to document equivalent experience and training (USN, USCG, etc.). The minimum age for certified divers at the races is 15. Anyone not having this certification or experience will not be allowed into the water. A copy of the certification or training must be submitted to the ISR™ committee prior to the event. All divers must have their certification cards with them for review prior at the event and the Diving Supervisor has the authority to require a check-out dive for any diver as a condition of receiving authorization to dive at NSWC Carderock .

At the sole discretion of the Diving Supervisor, divers lacking sufficient skill and/or proficiency may be prohibited from performing as a scuba diver during the races.

The ISR™ Diving Supervisor will review the medical history of all contestants requesting entry into the water. The ISR™ Diving Supervisor has the sole discretion to approve any contestant to enter the water based on such review of medical history, physical condition, and any other information intended to manage the risk and the safety of all participants. The ISR™ Diving Supervisor can review a doctor's letter approving a person to dive and either accept it or reject it.

Important Note: If you have any unusual medical history or special circumstances related to diving, please contact the ISR™ Diving Supervisor well in advance at dive.supervisor@internationalsubmarineraces.org

7.2. Checkout Schedule

All of the diver and equipment reviews, tank inspections, and any necessary diver checkouts will be conducted during the first two days of Race Week. As determined by the Diving Supervisor, any diver may be directed to perform a check-out dive with the Dive Staff. After the initial period, additional diver needs will be handled on a case-by-case basis at the discretion of the Diving Supervisor.

7.3. Diving Equipment

All divers are responsible for the condition and functioning of their equipment. However, the Diving Supervisor has the authority to inspect the condition of diving equipment and possibly forbid its use.

All divers will receive a pre-dive check from a member of the Dive Supervisor's staff before being allowed to enter the water on every dive. It is the responsibility of every diver to ensure that their equipment is present and fully functional before entering the dive station area. Divers/teams who are not ready will be sent away to remediate problems and lose their place in the queue.

7.3.1. Regulators and BCs

- All breathing air must be delivered via an open circuit SCUBA regulator. **Re-breather units are not allowed.** All breathing air used by contestants shall be compressed normal atmospheric air. Special air mixes such as Nitrox are prohibited.
- The brand of regulators used for both primary and secondary air supplies, as well as those used by support divers, is left to the discretion of the submarine team, but it is strongly advised that the brand selected be well-known and have a good track record.
- Regulators shall be equipped with an alternate air source (octopus) and pressure gauge. BC–mounted alternate air sources (AIR II, Air Source, etc.), diver-mounted pony bottles or Spare Air units are acceptable substitutes for an octopus.
- Have all regulators checked by a qualified service technician prior to the event.
- All BCs must be in working order and be equipped with low-pressure inflators.

- All equipment - hoses, gauges, alternate air sources, etc. – must be secured to the diver in a streamlined fashion to prevent entanglement or damage.

7.3.2. Weight Systems

- Any divers using pellet weight belts must ensure the belt exhibits no damage that may lead to pellet spillage into the Model Basin.
- All personal weights required for a diver to submerge must be carried in some form of quick-release system.
- Divers must be able to open weight belt buckles with one hand and remove the belt from their body as necessary. Excess belt material should be trimmed prior to diving.
- Weight harnesses with functioning quick-release pockets are acceptable.
- Weight-integrated BCs may be used if the weights are contained within the quick-release pockets.
- Ankle weights may be used.

7.3.3. Tanks

- **The use of aluminum cylinders manufactured from Alloy #6351-T6 (Luxfer, Walter Kidde, and others) during the period January 1972 through approximately December 1988 will not be allowed. The cylinders have an unacceptable risk of failure due to neck cracks.**
- As per U.S. Department of Transportation (DOT) regulations, all scuba cylinders used at the Submarines races must be stamped with "DOT" on the shoulder. Acceptable variations include ICC, DOT, CTC/DOT and TC/DOT. Cylinders brought to the races lacking the DOT stamp cannot be used.
- As per DOT regulations and CGA guidelines, all tanks must have current hydro test dates stamped on the shoulder and have current visual inspection (VIP) stickers.
- As required, aluminum tanks should display evidence of inspection of the neck threads by eddy current machine (Visual Plus).
- All tanks will be inspected by the Dive Staff prior to use at the ISR™ . Approved tanks will receive a sticker for use during the races. No tank will be filled if the sticker is missing.
- All Spare Air regulators are in good working order and cylinders must have current hydro test dates and current visual inspection (VIP) stickers as recommended by the manufacturer.
- Divers using Spare Air systems are required to have the proper equipment for filling these tanks. The Navy divers filling the tanks are not responsible

for filling Spare Air bottles and may refuse to do so if the diver does not supply the proper equipment.

7.4. Divers Monitoring of Their Air Supply

All support divers are required to monitor their own air supply, and shall not allow their air supply to fall below 500 P.S.I. The Diving Supervisor and staff have complete discretionary authority with regard to allowing divers to enter the water, especially with less than a full cylinder of air. Divers and submarine crews must have sufficient air to complete their task (sub race, support assignment, etc.) safely and return to the dive station with a minimum of 500 P.S.I.

7.5. Submarine Inspections

After completion of the diver reviews, submarine safety checks will be scheduled with the Judges and Dive Staff. Teams will be expected to be on station and ready to dive at their appointed time. Teams that are unprepared will be moved to the end of the line.

8. SAFETY

8.1. Safety Inspections

Prior to entering the water, each submarine shall receive an inspection to ensure maximum crew safety. The inspection shall be performed by one or more judges and/or dive supervisor staff, who may be accompanied by members of the Navy dive team, so that they can familiarize themselves with construction of the submarine and the location of hatch handles, crew restraint releases, etc. A second safety wet inspection shall occur when the submarine has been placed in the underwater staging area on the bottom of the basin. The crew shall be asked to perform an emergency egress and demonstrate the operation of the emergency pop-up buoy (from both positions in the case of two-person subs).

Once each submarine has passed both inspections, an adhesive sticker will be placed on the hull to signify compliance, so that inspections don't have to be repeated every time the submarine is deployed.

8.2. Safety Precautions

Every precaution is being taken to ensure that this event will be run as safely as possible. There will be qualified rescue divers stationed around the course so that one is always near the racing submarine.

A qualified dive supervisor will be on hand at all times to monitor and coordinate underwater activities. The sub crew and support divers are required to inform the dive supervisor when entering and leaving the water so that he can be aware of their

activities. The dive supervisor is responsible for your safety and the smooth operation of the races. Please pay close attention to any instructions given by this individual. A qualified emergency response team shall be on hand at all times to react to any accidents. They will be completely equipped to handle injuries and will have an emergency vehicle for transportation. Arrangements have also been made for medical evacuation if required.

All divers will enter and leave the water through the dive station. All persons entering the water will check in with the dive staff and surrender their ID. Similarly, everyone must check in with the dive staff and retrieve their ID before leaving the boat lift area.

Each sub team shall be responsible for training crew and support divers for emergency egress. They should practice the exercise under water until all involved are thoroughly familiar with the procedure. Teams are also encouraged to act responsibly and safely with regard to other sub crews and underwater personnel. As there are several objects that protrude from the side of the basin at the surface, like the wave attenuators, and several objects that float upon the basin surface, like boats, all divers are advised to take the usual precautions when surfacing. In general, stay alert and be aware of your surroundings when underwater. Carrying a light is advisable for your own use and also to mark your presence for others. The traffic areas around the ends and sides of the basin are concrete and when wet they may become slippery. Non-skid footwear like dive boots, reef walkers or boat shoes are recommended. Open toed shoes and flip flops are prohibited on and around the boat lift area.

DANGER: Access to the center right narrow aisle (on the right hand side of the race course) is limited to ISR™ Operations Staff and ISR™ volunteers only. The timing and video control station is located in this aisle. There is a major hazard in the ceiling of this area: unshielded high voltage power cables that power the carriages the test basin uses. Contact with these cables can kill you. Do not handle long poles, pipes, etc. in this area.

There are numerous underwater objects (sharp metal fragments, debris, etc.) in the area between the dry-dock and the concrete "beach" structure. Divers should not descend in this area and should swim only on the surface from the dry-dock to the beach.

The beach structure is not solid; there is water under it. **Do not enter or swim under the beach structure**. Be careful not to catch toes or equipment between the slats of the beach structure. Divers or support staff wearing fins are not allowed to climb or walk across the beaches if in water less than knee deep (approximately 2.5-3” deep). This is to prevent falls.

There are slatted steel walkways along both sides of the basin. To avoid injury, always look up prior to ascent, especially near the walls. There is a carriage-arresting gear structure that hangs over the water at about the 200-foot mark. There are also Navy Zodiacs on the surface with spinning propellers. Again, always look up prior to ascent, particularly near the walls.

There may be debris on the bottom, especially within 3-4 feet of both walls. Be careful of any cabling, string, rope, etc.

Be advised that water in the basin is untreated.

Lighting may be limited depending upon an individual's location in the tank. Also, summer electrical storms can cause power failures. The basin can get very dark, very quickly. Dive lights are recommended. Dive lights also work well as signaling devices and enhance the ability of others to see you.

The dry-dock may be operated only by an NSWC Carderock Division employee.

All contestants inside the tow tank carriage rails (on longitudinal side of the tank) MUST wear either a United States Coast Guard Approved Type I, II, III, or Type V Personal Flotation Device (PFD) that is in good serviceable condition and appropriately sized for the intended user. A wet suit with sufficient buoyancy to float the wearer is an acceptable substitute.

9. OPERATIONS

9.1. Facility Description

The David Taylor Model Basin consists of a large, in-ground, freshwater basin approximately 3000 feet long, 51 feet wide, and 22 feet deep. **It is fully enclosed in a heated building, but the temperature of the water is a chilly 60-65 degrees F. A full wetsuit is recommended for support and safety divers. Submarine drivers may wear a "shorty" for short periods of time in the water.** The water is filtered and kept very clear, but because of the extremely large volume of water in the tank, the filtration cycle is very long, and suspended sediment will cloud the water all day if stirred up. To maximize visibility, all divers are requested to minimize disruption of the water near the bottom of the tank. There are separate bathroom and showering facilities for women and men. There is a cafeteria on the premises open to all event participants.

Sensitive research is conducted at this facility, so access to areas outside of the ISR™ 14 event is limited and guarded.

Please see the latest Race Week Schedule which will be posted on the ISR™ website http://www.InternationalSubmarineRaces.org for the times of the basin's opening and closings. It is important to arrive early to allow everyone 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. At the end of the day, everyone must be prepared to leave by the published time, so start wrapping things up and cleaning beforehand.

If you are competing within a time constraint during race week, you may elect to come to the ISR™ for just long enough to run your submarine and get a good performance time. Accordingly, contestants should notify the Race Director of any time constraints so appropriate arrangements can be made. However, we encourage all teams to attend the races for as long as possible, especially in light of the fact that submarines and their teams will be judged in categories other than speed.

The 14th ISR™ race operations will be staged at the East end of the tank, as we did for the 13th ISR™ . Some of the model basin's main equipment consists of large platforms mounted on wheeled carriages which move up and down the tank on rails placed upon the tank walls. These rails are extremely sensitive, even when covered. Care must be taken not to walk near or place anything on them.

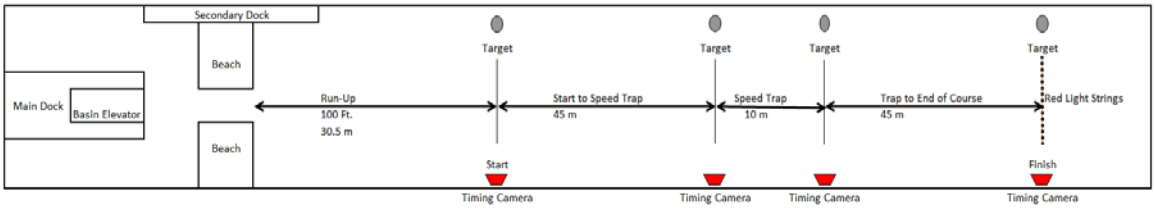
AT NO TIME SHALL ANY DIVER CROSS OVER A TOW CARRIAGE RAIL.
NSWC Carderock personnel and their generous support make this event possible. Therefore, give them your highest respect, obey their directions, and honor their workplace.

9.2. Crew Comfort

The model basin water is not heated and even though **the building is fully enclosed, the temperature of the water is a chilly 60-65 degrees F.** It is strongly recommended that the crew and support divers wear dry or wet suits, gloves, hoods, and booties to **protect against possible hypothermia**. The contestants are also advised to leave the water, when they are not actively preparing or operating their submarine, in order to **limit exposure time**. Contestants are advised to bring hand-held, battery-operated underwater lights to facilitate work on their submarines when submerged.

9.3. Course Layout and Marking

The course will run up the approximate center of the basin and its general layout is as follows:



The center of the course shall be marked along its entire length by rope lights that will be weighted to stay on the bottom. There will be a 100-foot acceleration zone leading to the start gate at 0 meters. Timing target gates will be at 45 meters and 55 meters and at the finish gate at 100 meters. These gates will be constructed of white PVC tubing approximately 25 feet apart and will be precisely measured and located. They will be rigid enough to support their equipment, but flexible enough to sustain a major collision; and the measuring system used will allow them to be precisely and quickly re-located.

The first gate will be clearly marked with lights of a particular color so as to differentiate it from the center gates and finish gate. The second gate will be equipped like the first and will mark the beginning of the ten-meter run. From the starting gate to this gate is 45 meters. The third gate marks the end of the ten-meter run. The end of the course is 45 meters farther, with a fourth gate positioned at the end, again with lights and a camera mounted on it. The entire course length from the first to the last gate is 100 meters. The speed will be recorded for both 100-meter and 10-meter distances

Underwater video cameras will be running continuously to record the submarine as it passes through each timing gate. The cameras will be placed at about mid-depth on the timing gates and will have a wide-angle view so that they will see the submarine pass by at most depths. Contestants should be aware that there will be continuous white incandescent lights illuminating each gate area so that the timing cameras can view the submarines clearly. Every effort will be made to clean all accumulated silt from the bottom of the basin. The water itself is filtered and is completely clear. Reduced visibility produced from bottom sediments being stirred up can cause a problem with the visibility of the submarine crews and the timing cameras. Therefore, all divers are strongly discouraged from swimming close to the bottom anywhere within the racecourse boundaries, and the areas just before and after it, unless in an emergency situation. **Submarine support personnel must never go beyond the START line.**

In addition to red lights marking the last gate and the presence of safety and Navy recovery divers, the area after the end of the course will be vividly marked. Submarines passing this point will find the tow basin quite dark and there will be little surface

support in this area. A cargo net is hung to catch submarines from going too far beyond the finish line.

Teams are strongly discouraged from hitting the timing gates. Damaging them can close the race course for repairs causing delays in the race. Also avoid hitting the manned and unmanned mobile and fixed cameras located at various places on the course. These cameras feed non-timing-related video to the surface.

9.4. Submarine Preparation

Upon arrival, each team will be assigned an area outdoors in the parking lots adjacent to the working end of the basin. The exact size of the area for each sub and crew will be determined by the number of submarines that will have to be positioned there. The space should be large enough to contain a storage vehicle, the submarine, dive gear, tools, tables and sufficient working space. There will be limited power available both in and outside of the building. In the outside area, where all the submarine teams will be located, power is very limited. ***It is strongly suggested that contestants supply their own generators.*** NSWC Carderock environmental regulations require storing the gasoline for the generators in a secondary containment system such as a hard plastic capture concrete mixing pan or similar item to prevent spillage onto the ground.

It gets very hot during June and July in Washington, DC. Shade cover and sunscreen is strongly recommended.

It may be helpful if teams come with a van or large truck in which to store nonessential gear and work on their submarine. The use of power tools, epoxies, paint, etc. is permitted, but please be aware that teams are responsible for completely cleaning up any debris or stains resulting from the process. Any chemical which is considered to be hazardous to health or environment should be accompanied by a Material Safety Data Sheet (MSDS). Be as considerate as possible of the other teams and the people who work at the basin. The disposal of any epoxy, paint, solvent, or petroleum-based product is expressly forbidden unless supervised by NSWC Carderock personnel.

When the work on a submarine is complete and the crew is ready to deploy, a crew representative will notify the Surface Operations Director. The ISR™ committee will send Judges and safety divers to your area to perform the dry safety inspection. All entry to the building is coordinated by the Surface Operations Director. However, space inside the building is somewhat limited and priority will be given to those in their final stages of preparation or already in the queue. Once passed, you will join the queue awaiting entrance into the basin. It is likely that additional racing time will be available for those who are prepared when others are not. There will be a big advantage in coming to the races as early and staying as long as possible.

9.5. Submarine Launching

For ease of transportation around the facility and for launching, it is recommended that your submarine have a cradle with wheels or some sort of cart to move it around on. If you launch your submarine using this device, it must be negatively buoyant or secured to the dry dock elevator so that it does now float during launch and recovery. The working end of the basin has a platform with an elevator built in. Submarines will be moved into position on the elevator one at a time. The elevator will then be lowered, and the sub eased off by the crew and support divers. Recovery will be by the same process. Cradles should have a minimum of 4" diameter wheels for easy movement over the elevator grates.

9.6. Submarine Staging

In the working end of the basin beyond the lowering elevator there will be staging areas. After the dive supervisor has cleared your team to launch, you will be directed to one of these spots. The purpose of this is to give your crew time to ballast and balance the submarine and check out all of the systems. At the beginning of the week, your submarine will be scheduled for an in-water inspection. The goal is to ensure that everything is working and your team is completely prepared when your turn comes to get on the course. When your team and submarine are ready, an in-water judge will request that your crew perform an emergency egress from the submarine and demonstrate the pop-up release mechanism from all crew positions while the submarine is on the bottom. If you pass this inspection, you are clear to proceed. A sticker will be applied to your submarine signifying compliance so that the inspection will not have to be done every time you wish to launch. Your submarine will still receive a safety inspection by the Dive Staff every time it is launched. When you are prepared to race, one of your support divers will surface and notify the Racing Coordinator that you are in hot standby and ready. It might be prudent to bring an anchor or some lead weights so that the submarine can be moored or weighted down at your staging area in the event that the course waiting line is long. In that case it is wise to get out of the water and stay warm; but be ready to go as soon as you are called.

9.7. Course Operations

When your submarine is called, prepare to move it into the course starting area. Try to keep your support diving crew small so as to avoid excessive traffic in the starting area. If there is a submarine already poised to launch in that position, avoid it and allow it to launch unhindered, and then move into the start position. From this time on you will have up to five minutes for final preparation for launching your submarine. If you exceed this time without launching, you may have to move out of position and be placed at the back of the queue if other submarines are ready. There are 100 feet between the line marking the start of the course and the first timing gate. All submarines have the option of starting anywhere along this acceleration area. You can

use the whole 100 feet, or start right at the gate or anywhere in-between. Since every submarine will be allowed as many runs as possible, you may wish to experiment with this factor. Similarly, the crew can elect to start the run at any depth from the surface to the bottom. Bear in mind that by definition, a submarine travels completely submerged, so a run down the course where the submarine never quite submerges cannot be declared official. The same also applies if the submarine fails to pass between the vertical markers marking each gate. The submarine is allowed to wander off course a little during the run, but must pass through all four gates properly. Striking the gate uprights and disturbing the cameras or targets may cause the run to be declared unofficial.

When your submarine is straight and level, is pointing down the course properly, and is far enough off the bottom so that nothing will hit, the support diver shall check to see that everyone else is out of the way, both fore and aft of the submarine. The support diver will then surface and notify the Racing Coordinator that the sub is "ready to race". The Race Coordinator, through an underwater loudspeaker, will give permission to race. The support diver will sign to the crew to commence propelling in case they could not hear the race command. This sign will be to rotate one arm as though cranking, and shall be universal so that any diver in the area will be aware of what is going on and can avoid the submarine. The Racing Coordinator will notify all subsea personnel by underwater loudspeaker that the submarine is under way and on course. **The dry support crew will then traverse the course on the concrete aisle on the left side of the race course to assist divers at the other end in retrieving your submarine.** Subsurface support crew shall not follow the submarine onto the course, nor can your support personnel follow on the surface by boat or swimming. This is to minimize traffic on the active race course.

Once the submarine has traversed the course (or has stopped along the course) the crew should not exit the submarine until instructed to do so by Navy divers. The submarine is then towed to side of the basin by the Navy divers. The submarine's support crew is then responsible for towing the submarine back to the beach area of the basin. Care should be taken to hug the basin wall to avoid obstructing the race course. When the submarine gets back to the beginning of the start line, you may be vectored right back onto the start line, or be put in the queue, or waved back to the underwater staging area, depending on the traffic at that moment.

Check all crew and support diver air supplies; if any are low, request positioning into the staging area immediately. The goal will be to have each submarine run several times during each immersion. If for any reason your crew cannot repeat runs, you should request positioning back to the staging area for removal of your submarine from the water. Do not move submarines to the lift or carts into the building before checking

with the Diving Supervisor and Surface Operations Coordinator. The submarines will be allowed to make as many runs as time will allow. Thus every team needs to be as fully prepared as possible before entering the race queue. Be considerate of other teams: if you come up with a problem that takes a little time to fix, allow other teams to pass by to keep everything moving.

9.8. Submarine Braking

Submarine braking at the end of the marked course will not be a major problem at the NSWC Carderock facility because of its great length, but crews are encouraged to stop their submarines in as short a distance as practical. Speed brakes, flaps and propeller reversals are acceptable methods, but drogue chutes or sea anchors are discouraged because of their tendency to snag on other objects. Braking by rapid ascent or breaching is strongly discouraged as there is a potential for embolism in even a few feet of water. **Once the submarine has stopped, the team's dry support crew must assist in disembarking the crew and returning the sub to the staging area**. Suggestions will be made by the OPS people for the return process.

9.9. Safety Concerns During Submarine Operations

There are three primary hazards to the crew during human-powered submarine operation:

1. **DON'T PANIC! If you remain calm, keep breathing from the regulator, and stay in/with the sub until the Navy divers arrive and instruct you what to do, almost any situation can be controlled.**

2. **Ascent is controlled by the vehicle and may be more rapid than free diver ascent. This means that crewmembers must continue breathing during the entire human powered submarine operation. NEVER HOLD YOUR BREATH!! The vehicle should always operate near the bottom, unless there is a control problem or emergency.**

3. **Air supply can be lost by simply dropping your regulator from your mouth, or by running out of SCUBA air, or other equipment malfunction. KEEP YOUR REGULATOR IN YOUR MOUTH AT ALL TIMES!! If there is an air supply problem, reach for your alternative air source first, and then open the hatch. If at all possible remain inside your submarine until Navy Divers come to you for rescue.**

The support divers have control of the vehicle prior to the start and must make sure the crew is okay at all times.

Some submarines may have buoyant hatches. If the hatch is opened on the surface, the loss of buoyancy may cause the submarine to descend. Ensure crew members have access to SCUBA regulators and that support personnel are not trapped underneath.

Be careful of hand placement when closing the hatch, especially in the water. Always hold the sub with your hands away from the hatch opening and say "CLEAR" before closing the hatch. Also, be careful not to let SCUBA equipment get in the way of closing.

Never position yourself under the submarine during any operations, either in or out of the water.

The support divers control the descent of the vehicle to the bottom and must make sure the crew is not experiencing ear clearing problems or any other distress during descent. Visual contact is needed with all crew members during the entire descent.

BEWARE OF THE PROPELLOR/PROPULSION UNIT DURING OPERATION AND STAY CLEAR WHEN IT IS ROTATING.

The submarines may have sharp edges, bolt heads, hoses and hatches that can cut or pinch hands and snag SCUBA equipment. BE CAREFUL.

A moving submarine has a lot of inertia. Never be between a moving sub and the basin walls.

Support divers should never attempt to keep up with the submarine when it is underway. It has the potential to be 2-4 times as fast as a swimming diver. **Submarine support personnel must never go beyond the START line.**

The water is cold and can cause cramps. Be sure to stretch prior to diving, eat appropriate foods, and drink plenty of fluids to help reduce the risk of cramps. The crewmembers are more susceptible to cold because they are moving only during the run. It is okay to exit the water to warm up.

Be an asset, not a liability. If you have a diving or equipment problem, stop diving. You will become a liability at that point and will not help anyone, including you. Make sure the Diving Supervisor is aware that you are getting out of the water.

9.10. Timing System

The timing system uses four underwater video cameras that look across the course at targets placed on the opposite side of the course. The camera/target pairs are located at the start of the measurement course (0 meters) and at the finish of the course (100

meters). Two more camera/target pairs bound a 10-meter section at the mid-point of the course. The video from these four cameras is combined to make one 4-part split screen video signal. This video is recorded along with television time code. The time code generator counts each 1/30 of a second television frame as well as seconds, minutes and hours. Each frame consists of two fields, which are viewed separately in the still frame playback mode, so the time resolution is actually 1/60 of a second.

After each run, the recorded video is examined to find the exact television field where some identifiable marking or component of the submarine crosses each of the four targets. The time the submarine takes to travel between each target is determined by the difference in time and frame number. A spread sheet program calculates the time difference and then the submarine's average speed over the 10 meter and 100 meter sections of the course.

The three primary factors that determine the accuracy of the speed measurement are: 1. the frame rate of the television system; 2. the time uncertainty of the submarine crossing the target because the cameras are not synchronized; and 3. the accuracy of the distance between the camera/target pairs.

1. The frame rate of the television system is measured using a universal counter/timer with a high stability temperature controlled crystal oscillator reference. The required correction for the television system frame rate is embedded in the formula of the spread sheet program.

2. The split screen combiner can accept video from sources that are not synchronized. In order to assemble the videos into a single split screen image, the individual videos must be brought into proper time alignment. The combiner does this by adding delay as needed to each camera's video. The model of combiner used in this system adds delay of 0 to 1/60 second to each camera's video to bring it into time alignment with the other cameras. Thus there is an uncertainty of the time of occurrence of an event seen by any one camera relative to an event seen by the other cameras of up to 1/60 second. A test of the timing system has been performed to determine the maximum uncertainty of the time of occurrence of an event seen by the cameras. During the test, all four cameras were pointed toward a strobe that flashed approximately once per second. A test recording was made and examined field by field. The strobe flash appeared either in the same or an adjacent field of the split screen image of the four cameras. This test proved that the uncertainty of the time of occurrence of an event seen by the cameras in this system is no more than 1/60 second.

3. Course layout alignment targets on the north and south walls of the basin were positioned by the staff of Naval Surface Warfare Center, NSWC Carderock Division

using a calibrated, and computer controlled laser measurement system. The distance between these targets was measured then averaged to determine the course centerline distance. The accuracy of these measurements is tied directly to a 60-inch calibration bar that has been calibrated using a coordinate measurement machine (CMM) which has traceability to a NIST standard. The television cameras and their targets are positioned using plumb lines suspended from horizontal lines running across the course between the alignment targets.

The dominant speed error component is the 1/60 second time measurement uncertainty. For a submarine traveling 8 knots through the 10-meter section, the error could be up to 0.055 knots or 0.69%. Over the 100-meter course, the same 1/60 second timing uncertainty could cause an error up to 0.0055 knots or 0.069%. Note that for slower speeds, the error decreases because the 1/60 second uncertainty is a smaller fraction of the travel time. Note also that these possible errors are worst-case maximums, using the assumption that the cameras are as far out of synchronization as possible. Statistically, the average errors are likely half these values.

9.11. Timing Guidelines

Every submarine run will be observed through four underwater television cameras whose signals will be combined in a video processor and recorded. The elapsed time on the course of each submarine will be based on analysis using frame-grabbing of the recorded timing camera video. The timing will start and stop when an easily identifiable part of the submarine passes between each timing target and camera. A time will be determined for both the 10 and 100 meter sections of the course and the speeds will be calculated from these times. A contestant speed form will be generated for every run of each sub, and will be authenticated by the timing officials.

9.12. Timing Results

Submarine speeds will be displayed on television monitors and posted on a status board as soon as they are available. A section of the status board will show the highest speed in each category. As each speed is bettered, a new higher speed will replace the previous maximum. When races are in rapid succession, speed determination may be delayed, but the speed will be posted as soon as it is available. Please do not ask the timing officials for speed data during active racing. **REMEMBER you are not allowed up the center aisle.**

10. Details on Fees, Forms, Dates and Schedules

A $1,250.00 entry fee will be assessed from each submarine racing team for each submarine**, $300.00 of which is to be submitted along with the completed Team Entry Form 5.1 by 3**

November , 2016 with the balance of $950 due on 2 February 2017. Checks must be made payable to Foundation for Underwater Research and Education, FURE.

Send the checks to:

F.U.R.E.
c/o Chip Chase
PO Box 543
Haymarket, VA 20168

- **3 November, - 2016**
  Deadline for submission of Team Entry Form (5.1) with the $300.00 non-refundable portion of the entry fee.

Mail to:
F.U.R.E.
c/o Chip Chase
PO Box 543
Haymarket, VA 20168

- **2 February, 2017**
  Deadline for remainder of application fee of $950.00. This portion of the application fee is refundable at the discretion of the ISR™ Directors Committee. Basic design report outline and 20 minutes presentation suggested format are available upon request from the Contestant Liaison.

Mail to
F.U.R.E.
c/o Chip Chase
PO Box 543
Haymarket, VA 20168

A second submarine may be entered by a team for same amounts and schedule.

Contestants who submitted the Team entry Form with the $300 entry fee on time, but failed to meet the 2 February 2017 deadline with the $950 fee, will be required to pay a plus $250 late fee no later than 16 March 2017, resulting in a total payment of $1500.

Applications that missed the 3 November 2016 date will require a FULL PAYMENT of $1500.00 ($1250 plus $250 late fee) at the time of application, but no later than 16 March 2017.

NO APPLICATIONS WILL BE ACCEPTED AFTER 16 March, 2017

The ISR™ reserves the right to cut off registration for the event if the number of registered boats that have made full payments exceeds the capacity of the race facility. It is important to register as soon as possible.

WIRE TRANSFER OF FUNDS
A wire transfer option exists to transfer funds. There is an additional fee of $30.00 for U.S. bank funds transfer and $45.00 for International bank funds transfer. Contact the Contestant Liaison (Susan Rovner) for details on wire funds transfers. Contact:

Contestant Liaison
S. Rovner
contestant.liaison@internationalsubmarineraces.org

10.1. ISR™ 14 Required Forms

10.1.1. ISR™ #14 Team Registration

All teams need to submit the following registration form from the ISR™ website:

5.1 Team Entry Form

Where does this form get mailed?

Form 5.1 is due no later than 3 November, 2016 with the $300.00 non-refundable portion of the entry fee to:

F.U.R.E.c/o Chip Chase
PO Box 543
Haymarket, VA 20168

10.1.2. ISR™ 14 Registration for Individual Contestants, Visitors, Volunteers and Spectators

The registration process for individual contestants, visitors, volunteers and spectators for ISR™ 14 is includes a digital registration and hardcopy submissions of forms The due date of all individual registrations will be May 1, 2017.

Adherence to this deadline will be critical for the proper processing of all personnel for ISR™ purposes and for review and approval by NSWC Carderock, especially for non-U.S. citizens. Delay in submission by this date may result in denial or delay in approval to enter NSWC Carderock.

11. BASIC DESIGN REPORT

Each submarine team will be required to submit a basic design report to the ISR™ judging panel. This report shall completely document the team's efforts in the conception, design, construction, and testing of its submarine. Entry to the races will not be allowed if this document is not presented by the assigned date. There are three reasons for this requirement. The judges will use the design report to determine if the submarine conforms to the design guidelines and rules set forth in this contestant's manual. In addition, they reserve the right to reject from competition any contestant or team whose design or intentions are not in keeping with the honor and tradition of the races. Deficiency in design from the standpoint of crew safety is also cause for rejection.

The report for each submarine will be compiled and a journal produced to provide educational benefit to those interested in human-powered submarine engineering. An award shall be given to the submarine crew that develops the most complete and informative report for their project. ISR™ organizers firmly believe that one of the most important aspects of the races is the educational benefit that these reports will offer. ISR™ Judges can provide a generic format of the report and 20 minutes presentation if requested by a team. Below are the dates of all deliverables. Note that there is also a date listed for final submission of the basic design report. This allows an opportunity to modify the original design. All modifications should be detailed and submitted to the judging panel for review. All reports are to be copyrighted to the 12th ISR™ ™ and will become the property of the ISR™ . It is the intention of the ISR™ to compile the reports into one volume at a later date. Copyright forms will be supplied after the 1 February 2017 registration deadline.

2 April 2017 Final Design Report Draft OUTLINE

4 May 2017 Final Design Report – 2 CDs (Along with copyright form described below.)

Mail both to:

International Submarine Races
c/o Michael Ales – Head Judge
38 Elliott Rd
Trumbull, CT 06611

If you have questions, you can e-mail the head judge at:
Head.judge@internationalsubmarineraces.org

11.1. 20-Minute Presentations

Each team must make a 20-minute presentation to the Judging Committee for each submarine entered. The format and schedule of the presentations will be supplied to each team by the contestant liaison, Susan Rovner. The critical dates are:

15 April 2017	20-minute Presentation: Sign-up Sheet
4 May 2017	20-minute Presentation: Schedule Issued
26-30 June 2017	20-minute Presentations during race week (2 CDs with presentation(s) are required.)

11.2. ISR™ 14 Race Program

The ISR™ Race Program provides overall information about the race and the specifications of each submarine entered. The Contestant Liaison will issue to each team the Microsoft Office template for the information required from each team for each submarine. The critical dates are:

17 April 2017	Each team receives Microsoft Office Template for required information
8 May 2017	Completed MS Office templates due to Contestant Liaison
V	via Email) contestant.liaison@internationalsubmarineraces.org

11.3. Copyright Forms

Documents submitted to ISR™ 14 must be copyrighted to the Foundation of Underwater Research and Education (FURE). The Final Design Report and the 20-Minute Presentations must be copyrighted to FURE. Each team will be supplied the required format and information requested by the Contestant Liaison no later than 1 April 2017. The due dates for the forms are as follows:

4 May 2017	Final Design Report Copyright form submitted with Final Design Report
26-30 June 2017	20-Minute Presentation Copyright form due.

11.4. ISR™ 14 Race Week Schedule Overview

The final detailed race week schedule will be published on the web site http://www.Internationalsubmarineraces.org in advance of race week.

24-25 June 2017
14th ISR™ course setup by ISR Staff Only
Race week registration at host hotel.

25 June 2015 (Sunday)
We will expedite the sub race schedule and offer dry safety checks starting at noon Sunday, 25 June, for those submarine teams that are on site and prepared for the safety check. Wet inspections may or may not be available on Sunday. Because it is anticipated that the number of entries will increase, it is very important that all participants make maximum use of the time available to be in the water.

Contestant Briefings in evening at host hotel.

25 June 2017
Race Week.

30 June 2017 (Friday)
Races conclude.
Submarine/Contestant Site breakdown. Return everything you borrowed.
ISR™ gear break-down and removal.
Organize all rental gear in central location for pickup.
Awards ceremony and dinner.

12. Miscellaneous

12.1. Directions to David Taylor Model Basin/NSWC Carderock Facility and Parking

The website will contain the latest set of directions and maps. Building Number 4 will house the races, and parking will not be allowed at the east end of the building and along the side of the building.

Parking will be available at the David Taylor Model Basin - NSWC Carderock Facility, including space for large vehicles. People will not be allowed to stay there during the night in motor homes or otherwise and must be off the facility by the times posted in the final race week schedule posted on the website. Teams are encouraged to bring as few vehicles as reasonable, since the facility likes to keep the traffic flow to a minimum.

12.2. Submarine Shipping and Delivery Instructions

The shipping address is:
Naval Surface Warfare Center
NSWC Carderock Division
Receiving Code 3341 Bldg 143
9500 MacArthur Blvd
West Bethesda, MD 20817-5700

The contact person at NSWC Carderock :
Charlotte George
(301) 227-8869
charlotte.george@navy.mil

Mark containers **INTERNATIONAL SUBMARINE RACES** in very large letters. Allow sufficient transport time so that your gear will get there before you do. **Do not however ship before mid-May 2017** Please call & email one week prior to shipping date to confirm expected arrival date. (The crate's dimensions and weight(s) would also help determine forklift requirements ahead of time). NSWC Carderock does not provide recommended shipping companies or deal with customs. Teams must verify with your foreign shipping company that arrangements have been made stateside for customs processing and final delivery to NSWC Carderock. NSWC Carderock should only be contacted for final delivery and delivery signature.

Non-US citizen truck drivers are not allowed on NSWC Carderock property. If trucking companies do not heed this, their drivers will be prohibited from entering the property. This will lead to delays and possibly increased shipping costs for the contestants.

Deliveries must be made during the week (M-F) between the hours of 6:30 am and 2:00 pm. Please ensure your trucking company knows our hours of operation and the special driving directions. TELL THE SHIPPING COMPANIES TO ARRIVE BEFORE 2:00 PM WITH ONLY US CITIZEN DRIVERS/HELPERS OR THEY WILL BE PROHIBITED FROM ENTERING THE PROPERTY. The facility will unload the containers from the transport trucks and **store them outside** near the model basin. (There is no indoor storage available.) Calling one

hour prior to arrival will minimize unloading delays if a forklift is required for offload which is almost always required.

All submarines shipped into NSWC Carderock must be shipped out of NSWC Carderock by contestants within two weeks after the end of the races. **If not, the submarine will become property of the ISR™ .** Return shipping arrangements should be made prior to the end of the race week and communicated to Ms. George. All other submarines must be removed from NSWC Carderock by the end of the award ceremonies on Friday, June 28th, 2013.

12.3. Host Hotel

The Host Hotel for ISR™ 14 is:

Best Western Plus Rockville
1251 W. Montgomery Ave
Rockville, Maryland 20850
(301) 424-4940 Hotel
(301) 294-6024 Fax

The ISR™ Room Rates are:

Single King Bed: $99.00
Two Double Beds: $99.00
Suite – Studio: $99.00
Suite – Executive: $111.00

These room rates include a hot full American breakfast for all overnight guests. Breakfast will start at 6 am from Sunday, June 25, through Friday, June 30, 2015. (Note that the hotel cannot place rollaway beds in King rooms or rooms with two double beds due to safety reasons and fire code restriction.)

Reservations can be made by contacting hotel reservations at 301-424-4940 or 1-800-366-1251. Individuals must cancel 72 hours prior to arrival. Cancellations within 72 hours to arrival will be subject to a first night's room and tax fee. When making reservations be sure to mention “International Submarine Races” to ensure you receive the ISR™ rate. **Reservations are due to the hotel by 4pm eastern time on 05/24/2017**. Any unused rooms will be released at this time back to the hotel for general sale.

12.4. Visitors and Spectators

Visitors and spectators are welcome, if they are associated with a competing Team or as a guest of ISR™ staff. As discussed above, the registration process for all individual contestants, visitors, volunteers and spectators for ISR™ 14 is currently under development and the details will be available at a later date on the website. The due date of all individual registrations will be May 1, 2017.

12.5. Visas

Citizens of certain foreign countries must obtain a US Visa to attend the races. For more information, please check http://travel.state.gov/visa/

IMPORTANT! Participants who require a U.S. visa are encouraged to start the application process EARLY. Processing times vary by country and the embassy/consulate. SOME VISAS HAVE A PROCESSING TIME OF 1-2 MONTHS.

Letter of Invitation

If you require a Letter of Invitation from the ISR™ Organization, please include the following in an email request to contestant.liaison@internationalsubmarineraces.org (Contestant Liaison).

Full name, as shown on your passport – Indicate FAMILY NAME in ALL CAPS
Institution or Company
Complete Mailing Address including COUNTRY
Email address
Phone/FAX
Travel dates to/from the U.S.

Your request will be acknowledged within approximately 48 hours with the invitation letter.

12.6. Publicity and Reporter Clearance

Any media personnel interested in attending the ISR™ should contact the ISR™ Media contacts identified below. All media who want to come onto NSWC Carderock property must be cleared prior to and escorted by NSWC Carderock Public Affairs Office personnel while on NSWC Carderock property. The provision of the names of foreign media contacts one month prior to the races is greatly appreciated. ISR™ will provide all Media requests to NSWC Carderock Public Affairs Office for final approval while on NSWC Carderock property.

12.7. Team Photo

Every competing team will be given an ISR™ participation plaque with a team photo.

12.8. ISR™ Contestant Contact Information

At this time your points of contact regarding the 14th ISR™ are listed below. If they cannot answer your questions, they will direct you to someone who can.

ISR™ Contact List

ISR Executive Director
Kurt Yankaskas ISR.Executive.Director@internationalsubmarineraces.org
301-874-2965

Head Judge
Mike Ales head.judge@internationalsubmarineraces.org
203-261-2466

Contestant Liaison
Susan Rovner contestant.liaison@internationalsubmarineraces.org
843-235-0463

Media Relations
Ms Kristen Behrle kurleyhawk2@gmail.com

Foundation for Underwater Research and Education (FURE)
Charlie Behrle cd_behrle@comcast.net

ISR™ Mailing Address:

International Submarine Races
PO Box 543
Haymarket, VA 20168-0543

All relevant information can be found on our web site:

http://www.Internationalsubmarineraces.org

13. APPENDIX 1 - ISR™ HISTORY

Human-powered submarine racing has come a long way since its inception in 1988. In that year, the concept was brought forth and developed by the H.A. Perry Foundation and Florida Atlantic University's Department of Ocean Engineering. The first ISR™ was held in June 1989 at Riviera Beach, Florida. Nineteen entrants from academic institutions, corporations, and independent groups gathered to race their submarines and test their designs. The weeklong event was extremely educational for all involved, who learned just how complicated submarine racing can be. Many different factors had to be taken into consideration; not the least of which was weather, which forced the cancellation of these races prematurely. The U.S. Naval Academy's submarine 'Squid' garnered the overall performance prize for this first race.

In 1991 the second ISR™ was held at the same location. It was decided that the competition should be biennial, to allow time for new submarine development and construction. Because the first event had received much media attention, there were many more entrants, attendees and spectators. The ISR™ organization of the event had improved and grew considerably to meet the requirements. The original entry list consisted of thirty-six racing teams and was truly an international event, with one team coming from as far away as Germany. Again, many excellent lessons were learned, good weather prevailed and the competition was fast-paced and fierce. The 'Subasaurus', an entry from the oceanographic corporation Benthos, carried away the prize for best overall performance.

ISR™ 3 was back in 1993 with the third event. This time the races were staged off Ft. Lauderdale, Florida. Almost fifty teams participated in the competition. For two weeks these teams dealt with mechanical difficulties and unpredictable weather in the form of high winds and seas. The final race was terminated early by the failure of mechanical course components. Tennessee Tech University's 'Tech Torpedo II' was selected as overall performance winner.

In 1994, a group of west-coast submariners looking to test the performance level of their vehicles in a controlled environment began laying plans for a new and different submarine event. Out of this was borne the 1994 West Coast Submarine Invitational (WCSI). This new event was held in March 1994 at the Offshore Model Basin in Escondido, California, the largest privately owned model basin in the United States. Touted as an event, not a design competition, WCSI '94 placed emphasis on the fact that the conditions would be controlled and would place minimal impact on the submarine teams, which would in turn maximize their efficiency. Speed was the ultimate goal, and the Guinness Book of World Records was asked to authenticate the timing system and publish the results. The event was a success,

with fourteen entrants participating. The official, ultimate speed record was set by the Florida Atlantic University entrant at 5.9 knots.

The escalation of growth in ISR™ led to increasing demands for funding and personnel. A restructured ISR™ emerged, led by several individuals who had been involved in ISR™ 1 – 3, and whose main concern and interest is for furthering the educational experience and technology of submarine design, construction and operation.

The 4th ISR™ event was held during December 1995. The David Taylor Model Basin in Bethesda, Maryland was selected as the location, and from all aspects the race was a complete success. The controlled environment facility turned out to be ideal for this event. Eleven submarines from three countries competed. All design categories were covered; one and two person, propeller and non-propeller driven, corporate, academic and private. Though the world speed record for a two-person submarine set at WCSI '94 was not matched, the record for single-person was set, by William Nicoloff's 'Substandard' at 5.0 knots. Another 'first' at this event were female competitors. In four days over 260 dives were made, with a total of 544 hours underwater, and dozens of runs were made by the submarines without accident or major mishap. Many lessons were learned by all and everyone had a lot of fun.

The 5th ISR™ was held at the NSWC Carderock model basin in June 1997. The one-person sub "OMER 3," from the University of Quebec's École de Technologie Supérieure, achieved a speed of 6.97 knots. The Canadian team swept the sub race prize categories. The team's two-person sub "OMER 2" won its class with a performance of 6.36 knots. In the history of human powered submarine racing, two-person teams have been the norm. However, three teams came to the 1997 races with brand new one-person designs in addition to their previously raced two-person subs. The 1997 ISR™ saw a number of other important "firsts." Winston Churchill High School of Potomac, MD, brought the world's youngest female submarine pilot to race. The first all-female crew in ISR™ history piloted and powered "Mermaid" for the Annapolis, MD Human-Powered Sub Club, becoming the first team of women ever to finish the regulation course. True to the spirit of the races, many teams worked through the nights, replacing damaged equipment and engineering performance improvements on the spot, ready to race again the next day. The sharing of tools, techniques, and solutions was common throughout the five-day event.

New world speed records and innovations in propulsion systems were highlights of the successful running of the 6th International Submarine Races held in 2001 again at the NSWC Carderock model basin. The award for Overall Performance, sponsored by the IEEE Oceanic Engineering Society, went to Virginia Polytechnic University, Blacksburg, VA. Judging was for speed and maneuverability in the water as well as high-tech design of composite materials, computerized advanced power-to-propulsion conversion and the team's response to challenging and changing circumstances during race week.

In other awards: Absolute Speed, Omer 4; Best Use of Composites, Omer 4; Innovation, 1st place Reef Cruiser, Robert Golobic, 2nd place Jonah, Merchant Marine Academy, 3rd place Neptune, University of Michigan; Spirit of the Races, Merchant Marine Academy and Lawrence Technical University, a tie. Best Design Guideline, Lawrence Technical University, Southfield, MI.

The 7th ISR™ was held at the NSWC Carderock model basin in June 2003. The OMER 5 team from the Ecole de Technologie Superieure, Montreal, Canada won the Absolute Speed Award with a sprint of 6.814 knots, and the Best Use of Composites Award for their unique use of sandwich-hull construction, comprised of carbon fiber, Kevlar and closed cell nautical foam and the overall performance award. Judges awarded the Best Design Outline and Report Award to Sussex County Technical High School of Sparta, N.J., whose first-time entry, Umptysquatch-1, was completely designed, built and operated by high school students. The Spirit of the Races Award went to the team from Florida Institute of Technology, whose submarine, Miss FIT, was a bright red 16-foot-long six-sided torpedo. This award recognizes overall spirit, gusto, fortitude and support of other teams, and is given to honor the late ISR™ high school contestant, Steve Barton of Florida. A new award, the Smooth Operator Award, went to Sirius, from the University of Washington. This award recognizes team efficiency.

2003 The top speed awards were: One-person, propeller, academic category - RSR Fournier, University of Maryland, 4.916 knots; One-person, propeller, independent category - Scuba Doo, Wheaton Submarine Works, Wheaton, MD, 4.875 knots; One-person, non-propeller, academic category - Specter 1, Virginia Tech, 3.520 knots; Two-person, propeller, academic category - Omer 5, Ecole de Technologie Superieure, 6.814 knots; Two-person, non-propeller, academic category - Miss FIT, Florida Institute of Technology, 3.417 knots. The design competition drew 19 teams from throughout the U.S., Canada and Mexico, including two high school teams.

The 8th ISR™, held at the NSWC Carderock model basin in June 2005, continued the trend of speeds increasing steadily over the history of the event. In the early days, speeds rarely exceeded three knots. In 2005, Omer 5, a sleek two-person submarine from the University of Quebec's Ecole de Technologie Superieure (ETS) in Montreal, Canada, set a new two-person speed record of 7.061 knots. The Canadians' women's team also set a record of 5.885 knots. Some of the hottest competition occurred in the first-ever side-by-side race between the fastest submarines. Event organizers also held the first ever race over a slalom course to judge maneuverability, however this category has not been continued due to increasing numbers of teams entering the basic competition.

2005 Top speed awards: Two-Person, Propeller Category - OMER 5 of the University of Quebec, ETS with a speed of 7.061 knots. One-Person, Propeller Category - WASUB from the Technical University Delft, Netherlands with a speed of 6.903 knots. Independent One-Person, Non-Propeller - Bruce Plazyk's FAUX FISH with a speed of 1.676 knots. Best Use of

Composites: UMPTYSQUATCH II, a second time this team from Sussex County Technical High School, New Jersey participated. Innovation: First Place: PHANTOM 5, Virginia Polytechnic Institute and State University. Second Place: SPARKY'S SUB, designed and piloted by independent Don Burton. Third Place: FAUX FISH designed and piloted by independent Bruce Plazyk.

Best Design Outline: sponsored by Compass Publications, parent company of Sea Technology magazine and given to the Technical University of Delft's submarine team WASUB. The Overall Performance Award: T U Delft, the Netherlands' WASUB who also won the Spirit of the Races award, which is selected by the submarine teams themselves. Smooth Operator: FA-U BOAT, Florida Atlantic University.

ISR™ 8 held the first-ever slalom competition with eight teams showing the maneuvering skills to complete the course in the basin. Technical University Delft, Netherlands led the way with WASUB completing all three of its slalom course runs with a top speed of 5.736 knots.

During ISR™ 9 in 2007, the consistently winning Canadian team set a new world speed record of 8.035 knots. The competition hosted 22 experimental human-powered submarine teams with 24 subs from the U.S., Canada, Mexico and England. The new speed mark, which won the Absolute Speed Award, was set by the OMER 5 submarine crewed by Sebastien Brisebois and Joel Brunet from the Ecole de Technologie Superieure at the University of Quebec, Montreal, Canada. The previous world record was 7.192 knots set by OMER 4 in June, 2001. OMER team members had predicted that they might finally break the eight-knot mark, a speed most enthusiasts previously deemed unachievable by human-powered submarines.

ISR™ 10 in June of 2009 marked the 20th Anniversary of the ISR™ . Eighteen teams competed the event featured a first-ever sweep of overall prize categories by a high school team. The Overall Performance Award went to team "Sublime" from Hernando County Schools, Florida. The high school team from Hernando County also beat out arch-rival Florida Atlantic University's "FAU Boat" in a special head-to-head Florida team's race. New international speed records were also set in a non-propeller-powered vehicle designed by the Ecole de Technologie Superieure, Montreal, Canada. A submarine team from Universidad Simon Bolivar, Caracas, Venezuela joined the other International contestants from Canada and England.

ISR™ 11 had 24 teams, competing with 28 submarines. The U.S. Naval Academy entered after an 18-year absence with the SSH-11 Mighty Mid, which earned the Overall Performance, Fastest two-person non-propeller submarine, and the Spirit of the Races Awards. Florida Atlantic University's sub Talon-1 also won several awards: Fastest Overall Speed of 6.814 knots and Fastest Speed in the one-person, propeller category. An all-

female FAU crew raced the submarine in successful runs, capturing record breaking speeds in that category, entering the record book.

ISR™ 12 had a total of 19 teams participating, entering 21 submarines, from the U.S., Canada, Mexico, the United Kingdom, Germany, the Netherlands and the Sultanate of Oman. The fastest submarine was from the University of Quebec's École de Technologie Supérieur in Montreal, Canada. This submarine, Omer 8, turned in the winning speed in the one-person propeller-driven category, 7.28 knots. Team Omer's current world record, set during ISR™ 9, stands at 8.03 Team Omer also won the Overall Performance award that included a cash prize of $2000, sponsored by the Platinum Sponsors, the Ocean Engineering Society of the Institute of Electrical and Electronic Engineers and Intelligent Decisions Inc. of Ashburn, VA. Omer took home the Third place prize for Innovation, that had a single bladed propeller with a counterweight for balance. The second place award for fastest speed, in the one-person, propeller-driven colleges and universities went to the University of Washington's WASUB-3 and third place was awarded to Florida Atlantic University's Talon 1. FAU also took home the Absolute Speed Award in the Women's subcategory, in Talon 1,

In the one-person non-propeller driven, colleges and universities category, the First place award went to El Pez Gordo, built by students of Carnegie Mellon University. In the One-person submarine - propeller driven; high school category, First place was awarded to Springstead High School of Brooksville, FL SUBLIME Race Team. This same team raced their second submarine, SubZero, to win First place in the Two-person propeller-driven; high school category. First place for One-person, non-propeller driven; Independents went to Carts Independent, a team consisting of seven home-schooled youngsters ranging in age from 6 to 16, from Accokeek, MD. This team also won the Best Spirit of the Races Award, chosen by all of the teams competing, for showing the best gusto, fortitude, support for other teams and overall best spirit. This award is given in memory of a late ISR™ contestant, Steve Barton, from team Sublime. In the Women's subcategory, one-person submarine - propeller driven; high school first place was won by Springstead High School of Brooksville, FL, racing in SUBLIME. Also in the Women's subcategory, for two-person submarine - propeller driven; high school first place was won by Springstead High School of Brooksville, FL, racing in SUBLIME.

Prizes also were awarded for the most successful examples of design and construction. First place for the Innovation Award went to Virginia Tech for Phantom 6, which had the pilot and co-pilot seated in tandem, with a single transmission to power two propellers equally. Virginia Tech received a trophy and a $1500 cash prize, contributed by Intelligent Decisions. Second place went to the University of Washington's Laurie Belle, which had a modular system with all components mounted on a single structural member secured to the submarine with two bolts at each end. Third place for Innovation, as previously

mentioned, was presented to Omer 8. FAU also won the $300 prize, and a trophy for the Best Use of Composite Materials for their second submarine, FAU-BOAT II. The award was given for a new material consisting of basalt that was combined with fiberglass, and the resultant material has a higher strength-to-weight ratio compared to standard fiberglass, and is significantly easier to lay up. A $300 award was given to the team from the Sussex Technical School of Engineering, Sparta, New Jersey who built UMPTYSQUATCH VI, for the Best Design Outline.

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In summary, the ISR™ committee intends to continue to embrace the original objectives as set forth in 1988. The committee is dedicated to making human powered submarine racing as safe and effective as possible, while striving to enhance and promote advancements in the field of marine technology.