Surface and Underwater Robotics Facility (SURF)

Standard Operating Procedures and Regulations

Last Updated: 16-Mar-2026

Version History:

- v1.0 adopted 1/20/2021
- v1.1 adopted 2/17/2021: Added reference to ENGRWPSINST 1601.2
- v1.2 adopted 3/24/2021: Minor updates
- v2.0 established 3/16/2026: SOP refresh following SURF repair

Table of Contents

Facility Administration and Points of Contact

Weapons, Robotics and Control (WRC) Engineering Lab Director
Prof. Levi DeVries, devries@usna.edu, 410-293-2941

SURF Lab Director
CAPT Paul Frontera, frontera@usna.edu, 410-293-6126

Vectrus Pool Maintenance
Capt Dave Trierweiler, dtrierwe@usna.edu, Hopper Hall 1st LT, 410-293-6163

Mr. Robert Schiller, robert.schiller1@navy.mil, Assistant Public Works Officer, NAVFAC USNA-PWD Annapolis, 410-293-1063

Emergent Pool Issue
NSAA CDO - (c) 443 336-2635

Technical Support Division – WRC – SURF points of contact
Mr. John Seargeant, seargean@usna.edu, 410-293-6196
Mr. Stephen Galindo, galindo@usna.edu, 410-293-6194
Ms. Arianna Adams, aradams@usna.edu

1. Overview of Facility

The Surface and Underwater Robotics Facility (SURF) is a state-of-the-art aerial, surface, and underwater testing facility. At a basic level, the SURF is a 43.5’ by 36’ by 15.5’ deep pool with a capacity of 182,707 gallons of water. A movable catwalk spans the 43.5’ dimension allowing users to reach any portion of the pool surface without entering the water. Figure 1 shows an illustration of the SURF floorplan and pool layout. Throughout this document, the sides of the pool are referenced by their nearest associated room or point of reference, as shown in Figure 1. On the College Creek side, there is an entry/exit ramp for ease of access into the water. The ramp area is 23 feet 3 inches long, descending to a depth of 2 feet 6 inches.

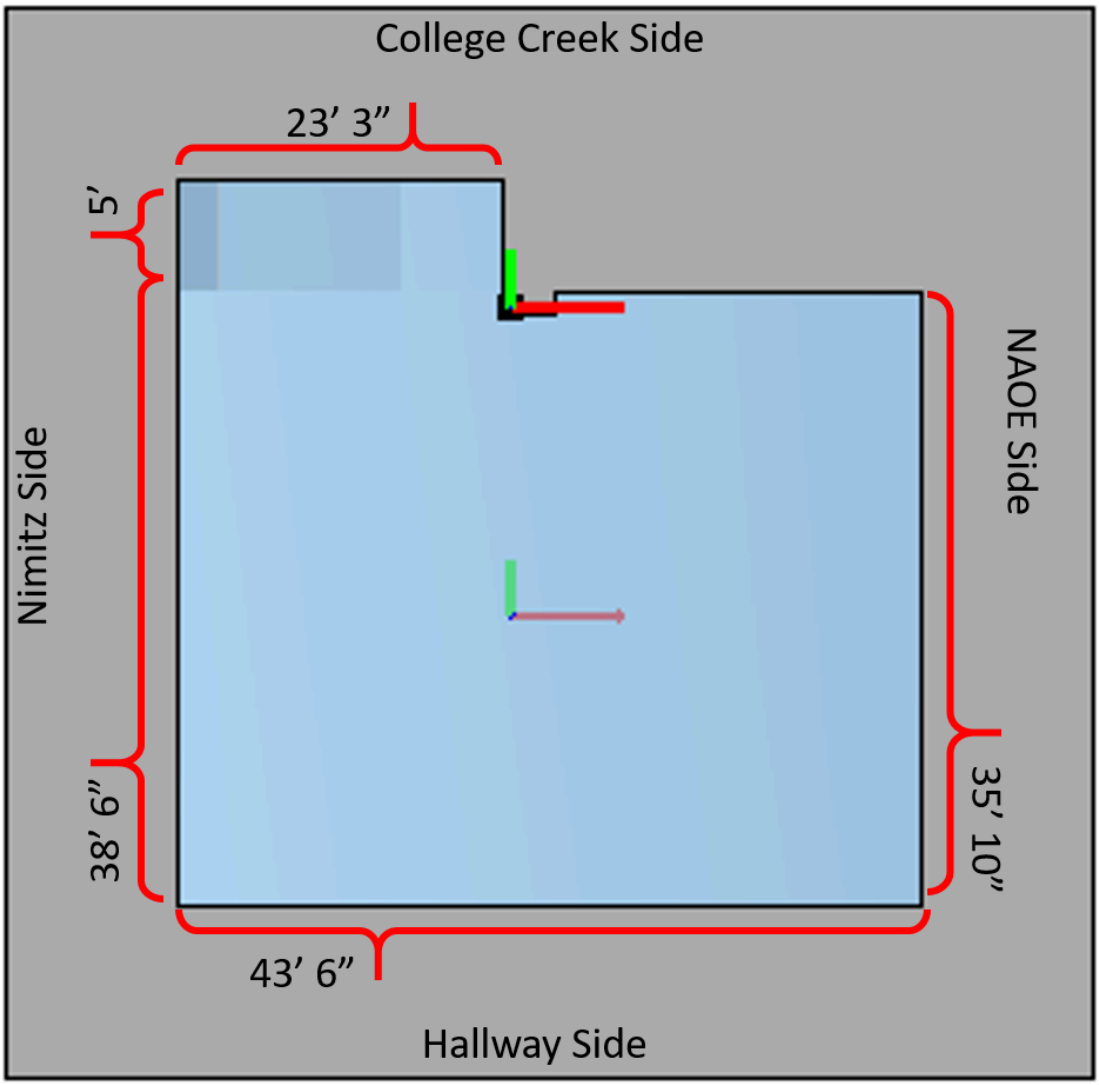

Figure 1: SURF pool dimensions and side naming conventions.

Above the SURF there is an overhead grid with standard 120V outlets. Outfitted to the overhead grid are twenty-two (22) Qualisys Oqus 7+ motion capture cameras and two (2) Miqus video cameras to provide motion tracking in the air and surface surrounding the SURF. This system is referred to as the “Airside” motion capture (MoCap) system for the remainder of this document.

The walls of the SURF pool are outfitted with eighteen rails used to mount equipment under the water. The rails are designed to hold eighteen Qualisys underwater motion capture cameras, but can be outfitted with any compatible object or reconfigured as needed. Sixteen Oqus7+UW underwater motion capture cameras measure the position and orientation of objects outfitted with reflective markers. Two Miqus UW underwater video cameras are synchronized and co-calibrated with the motion capture cameras, allowing the user to overlay motion capture data on top of their video feed. This system is referred to as the “Underwater MoCap'' for the remainder of this document. Power and data cables for the underwater cameras run to a dedicated desktop computer through cable troughs within the floor that surround three sides of the pool.

The airside and underwater motion capture systems can be operated independently or can be twin-calibrated to enable simultaneous tracking of air, surface, and underwater objects and track objects through domain transitions. Each system has a dedicated computer to operate its connected cameras. When paired, the complete motion capture solution is called the “Twin System” for the remainder of this document. In twin system mode, the airside computer is the leader and the underwater side serves as the follower, providing data over a dedicated network connection.

2. Rules of Operation

The SURF is a robotics and marine research facility, not for recreational use. The combination of autonomous robots, state of the art motion capture technology, a large body of water, and industrial support equipment present numerous safety concerns for users of the facility. This section presents general safety rules, guidelines, and best practices for users of the SURF. When in doubt, do not touch any equipment with which you are unfamiliar or untrained in using.

The Qualisys underwater cameras are to be installed and removed by trained faculty and staff only. MIDSHIPMEN ARE NOT ALLOWED TO HANDLE THE UNDERWATER CAMERAS UNLESS INSTRUCTED BY A TRAINED FACULTY OR STAFF MEMBER.

Access to the SURF after normal hours is governed by Engineering and Weapons Instruction 1601.2: POLICY FOR UNSUPERVISED MIDSHIPMEN ACCESS TO LABS AND SHOPS .

2.1 General Safety

It is recommended to wear a properly fitted personal flotation device (PFD) if accessing the pool outside of the ramp area, unless granted permission otherwise as part of the experimental procedures of the research. Avoid working alone in the facility after hours. **When working alone, USERS ARE REQUIRED TO WEAR A PFD when inside the trough surrounding the SURF, no exceptions**. PFDs are available on the College Creek side of the facility. When entering the water, users are not allowed to work alone, a spotter or research assistant must be in the room for all activities involving humans in the water. If a spotter is needed, contact the SURF Lab director. Figure 2 illustrates the trough boundary area which when working inside requires a PFD if a safety observer is not present.

Operation of the movable catwalk bridge is only to be performed by qualified personnel. Prior to catwalk movement, ensure that the tracks on both the Nimitz and NAOE sides of the pool are clear of obstruction and warn any personnel in the vicinity to remain clear. Personnel should not be on the catwalk bridge when it is in motion, unless required for experimentation that has been authorized by the SURF Lab Director. E-Stop switches are available on the remote control and main control panel.

Only qualified personnel may operate the 2-Ton overhead crane that traverses the SURF pool area and Waterfront Activities Lab. The crane is capable of lowering loads within its rating down to the pool deck level.

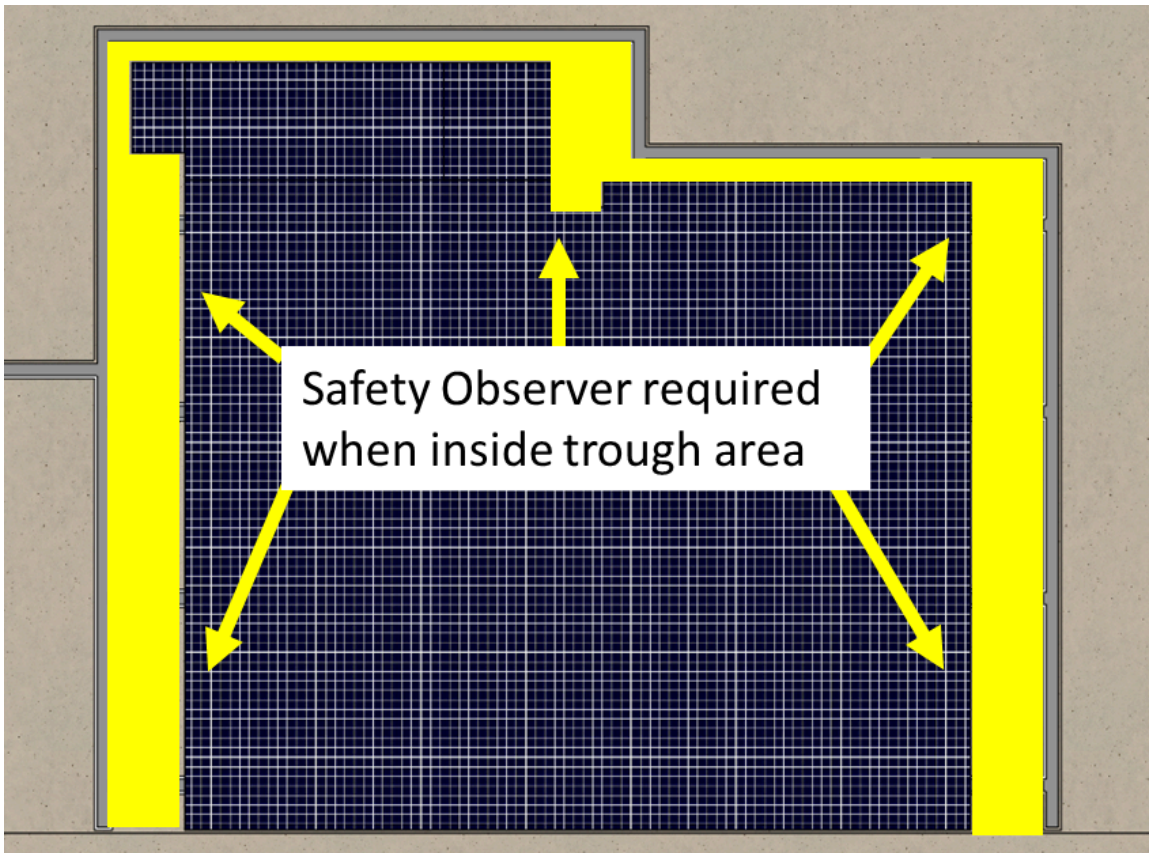

Figure 2. The SURF cable troughs designate the boundary where a safety observer is required for access without a PFD. When inside the trough outline any users MUST wear a PFD if a safety observer is not present in the room.

2.2 Required Trainings and Qualifications

Users must receive training and pass qualifications pertinent to their work prior to using the SURF. There are 4 separate trainings/qualifications including:

1. Safety - Mandatory for all users
2. AirSide MoCap - Optional, required to operate the AirSide MoCap
3. Underwater MoCap - Optional, required to operate the Underwater MoCap
4. Twin system MoCap - Optional, required to operate the Twin MoCap. Note, Trainings 2. and 3. are pre-requisites to 4.

Safety training is mandatory and the remaining training sessions are offered based on the operator's use case. A summary of the topics in each training/qualification is provided in the following sections.

2.2.1 Safety equipment locations and usage:

This training is mandatory. All users must be aware of the safety equipment in the lab, laboratory rules, and how to use safety and rescue equipment in the event of an emergency.

2.2.2 AirSide motion capture:

This training teaches users how to operate the airside motion capture system. Training 1 is a pre-requisite and must be completed before Training 2. Training 2 is required for all users who wish to operate the AirSide MoCap system. Topics include:

1. Introduction to Qualisys Track Manager (QTM) software
2. Best practices for starting, setting up, and troubleshooting the system hardware
3. Calibration procedures
4. Reference frame conventions in the lab
5. Outfitting objects with markers and defining rigid bodies in QTM
6. Streaming, saving, and exporting motion capture data

Once qualified in both the safety and Airside motion capture training, a user can schedule and reserve time in the SURF lab by submitting a calendar request to the SURF calendar.

2.2.3 Underwater motion capture:

This training teaches users how to use the underwater motion capture system. Training 1. is a pre-requisite and must be completed before Training 3. The training is required to operate the Underwater MoCap system. Topics include:

1. Introduction to Qualisys Track Manager (QTM) software
2. Handling, inserting, and removing underwater motion capture cameras from the SURF
3. Operational considerations and best practices
4. Best practices for starting, setting up, and troubleshooting the underwater and twin system hardware
5. Underwater camera calibration and operation of the gladius ROV
6. Outfitting objects with underwater makers and defining rigid bodies in QTM
7. Streaming, saving, and exporting motion capture data

Once qualified in both the safety and Underwater motion capture training, a user can schedule and reserve time in the SURF lab by submitting a calendar request to the SURF calendar.

2.2.4 Twin system motion capture:

This training teaches users how to use the twin-calibrated motion capture system. Training 1, 2, and 3 are prerequisites to this training as the operator must be familiar with both the airside and underwater MoCap systems to operate the cameras in a twin configuration. Topics include:

1. Network architecture for twin camera system
2. Setup of computers and QTM for twin system operation
3. Twin system calibration
4. Streaming, saving, and exporting twin system tracking data

Because of pre-requisite requirements, completion of training 4 constitutes completion of all the offered training. A user having completed training 4 can submit calendar requests to the SURF calendar to reserve usage time.

3. Priority of access

Use of the SURF is scheduled in priority tiers on a first-come-first-served basis, with priority tiers stipulated by the USNA academic mission. Priority is granted as follows:

1. Course lectures, events, and laboratory exercises
2. Midshipman Capstone and research
3. Faculty and staff research
4. Non-USNA entities (e.g. faculty/staff collaborations with government and defense labs, industry, etc.)

Non-USNA organizations may use the SURF for research purposes. Usage is arranged on a case-by-case basis and must be coordinated with the Lab Director and USNA Research Office representatives.

4. Scheduling

Scheduling requests for the SURF are coordinated through the SURF lab director. Approved use requests will be added to the SURF/JCUSI calendar in Google Calendar and shared with those requesting usage time. **Requestors must be trained to the level necessitated by their use case BEFORE a scheduling request will be considered.** To begin the scheduling process for a new project, complete and submit the SURF Experiment Planning and Preparation Form. The form is mandatory and must be submitted to the SURF Lab Director to begin the scheduling process. The form must be completed once per project.

The SURF's normal operating hours follow that of the USNA academic buildings and, more specifically, Hopper Hall. Use of the facility before or after close of business must be approved through the SURF lab director.

5. Water safety and life-saving equipment

Life preservers (PFDs) are provided on the College Creek side of the SURF with signage showing their location. Life saving equipment (hook, rescue tube, and flotation devices) are located next to the SURF on the column nearest the ramp. Signage indicates their location.

6. Cleaning and maintenance

All users are expected to leave the lab as clean or cleaner than when they entered it. Users are expected to squeegee any water on the deck into the SURF or a floor drain. A floor squeegee is provided in the cleaning supply cabinet. **The wire troughs surrounding the SURF are NOT floor drains. Water from the deck must not be directed into the troughs.**

The SURF has a standard chlorination system. All surfaces made wet with SURF water should be washed to eliminate the formation of residue and/or eventual corrosion. Any equipment that comes into contact with the SURF water should be thoroughly rinsed at one of the two washing stations on the College Creek-side wall of the SURF. Towels and rags are provided in the adjacent cabinets and drying stations to assist rinsing and cleaning equipment.

The SURF facility is monitored via security cameras. Users who fail to clean equipment or leave the facility untidy will be given a warning. Subsequent violators will be barred from using the facility for a period of time to be determined by the WRC Lab director, SURF Lab director, and TSD staff.

Space is limited in the SURF. Therefore, it is expected that projects and equipment only be stored in the facility during the duration of testing. After tests have been completed, equipment must be removed to make room for subsequent projects and experiments. There are three rooms on the Nimitz side of the SURF. Arrangements can be made to store equipment on a case-by-case basis in coordination with the WRC Lab Director, SURF Director, and stakeholders of the rooms.

7. Water Quality and Maintenance

The SURF water is maintained by Vectrus, NAVFAC USNA Public Works Base Operating Contractor. Questions or concerns regarding water quality issues should be directed first to the SURF Lab director who will forward any concerns to NAVFAC USNA Public Works.

All equipment must be washed down thoroughly with fresh water if it has come into contact with non-SURF pool water (e.g. Severn River, College Creek, Hydrolab, etc) prior to placing it in the SURF pool. This is necessary to prevent transfer of biological material.

Water filtration circulation may be secured for up to 4 hours daily. Contact the SURF Lab Director if this is required in support of experimental goals.