

Rules and Regulations of the TAC Challenge for Unmanned Underwater Vehicles 2023

'Where concept meets reality'



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1 Introduction

Tau Autonomy Center are pleased to announce the TAC Challenge for Unmanned Underwater Vehicles 2023, which will be held at Tau Autonomy Center, outside Stavanger, Norway. This is the official competition handbook.

The goals of this competition are to advance the state-of-the-art of Unmanned Underwater Vehicles by challenging multi-disciplinary teams of students to perform piloted and autonomous mission in the industrial underwater environment and to foster ties between young engineers and the organizations involved in piloted and autonomous underwater technologies.

Please note that although this is a competition focusing on autonomy the tasks are designed for both autonomous and piloted drones (or a combination).

The official competition language is English.

Any questions or concerns regarding the contents of this document can be directed to the TAC Challenge organizers.

This document is still preliminary and is subject to changes.

2 Competition Overview

2.1 Competition Objective

The aim of TAC Challenge is to increase interest and innovation within the field of autonomous robotics for aerial and underwater application amongst young engineering students. The competition is divided into an aerial competition and a subsea competition. This document will only address the subsea competition. The rules and regulations for the aerial competition are detailed in a separate document.

The subsea competition challenges teams of university students to conceive, design, fabricate, develop, and compete with small Unmanned Underwater Vehicles. We encourage the teams to challenge conventional solutions.

2.2 Competition Theme

The competition is designed to replicate real-world industry problems. The challenges are provided by sponsors and contributors where some of the challenges are relevant to the drone industry today.

Drone technology has evolved rapidly during the last years. The development of autonomous underwater vehicles is highly relevant today and presents a series of challenges. Some of these challenges include underwater residency and charging, communication, navigation, positioning.

Successful implementation of the new technology is dependent on multi-disciplinary teams working together for safe integration and operation of the untethered vehicles.

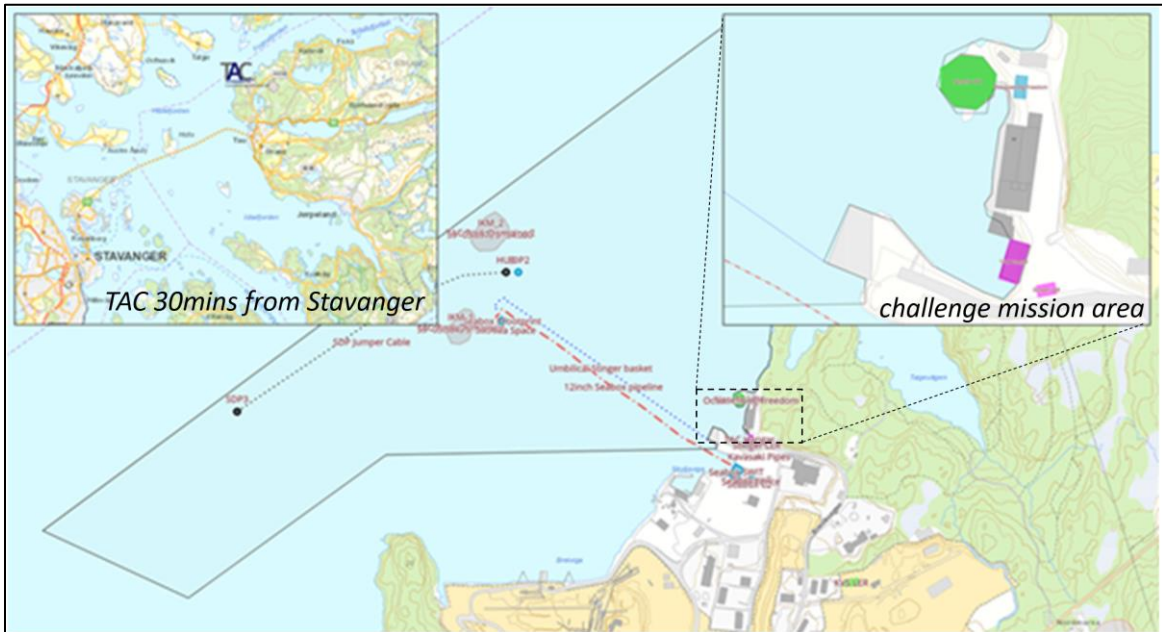
The 2023 competition focuses on the following:

1. Underwater docking to a Subsea Docking Station.
2. *Underwater data transfer/charging via induction (not yet confirmed).*
3. Underwater navigation and positioning.
4. Object and image recognition underwater.
5. Acoustic localization and navigation.
6. Visual inspections.
7. Pipeline inspection.
8. Drone intervention by operating standard subsea interfaces by use of manipulator.
9. Launch and recovery philosophy.

2.3 Dates and Venue

TAC Challenge 2023 will be held 9 – 13 June 2023 at Tau Autonomy Center outside Stavanger, Norway. The missions will be completed in the marked area in the top right corner and carrying the following coordinates: **59.09246°N, 5.9101°E**.

The venue consists of, but is not limited to, a drone docking station, a pipeline, a subsea structure, and launch and recovery area.



The area of operation is located in the harbor at TAC Autonomy center. All missions will be performed in this area.





2.4 Competition Scoring

The competition is divided into *static* and *dynamic* events.

The **static events** include the Technical Documentation and Team Presentation, and the Dynamic events include the missions. The presentations will be held in-person during the competition, while the documentation will be submitted in advance. The static events will be evaluated and scored by a jury of professionals within the field. ***The criteria for the static events will be specified in a later revision of this document.***

The **dynamic events** (i.e., missions) will be scored based on the *results* of the mission as well as the *execution* (i.e., demonstration of autonomous behavior). A combination of autonomous and piloted mission strategy is allowed. To encourage creativity and innovation, the teams are free to decide how to solve a mission, as long as they stay within the rules and framework of the competition. Autonomous behavior will award the highest scoring, but also represent the highest risk for success. The missions are detailed in the Mission Booklet.

| Competition Scoring | |
|-------------------------|---------------------|
| Static Events | Maximum Points |
| Technical Documentation | 100 |
| Team Presentation | 100 |
| Dynamic Events | Maximum Points |
| Pipeline Inspection | 200 (approximately) |
| Docking | TBA |
| Valve Intervention | TBA |
| Structure inspection | TBA |

3 Regulations

3.1 Eligibility

3.1.1 International teams

The competition is international and welcomes teams from all over the world.

3.1.2 Team members

The majority of the team members must be full-time students at university level or lower. This does not include PhD students and candidates. A team member may only be part of one team and take part in static and dynamic events for one team only.

3.1.3 Professional involvement

The vehicles are meant to be conceived, designed, and maintained by the student team members with limited involvement from professionals. The students are, in other words, expected to be a significant part of the development process.

3.1.4 Team supervisor

Each team must have one team member identified as the team supervisor. The team supervisor is the main contact person for the officials during the registration process and the competition.

3.1.5 Number of teams

A university can register several teams. Teams which are formed with members from two or more universities are treated as a single team.

3.2 Safety

3.2.1 Responsibility of equipment

Competition organizers are not responsible for any damage or loss of the vehicles or equipment before, during, or after the competition.

3.2.2 Launch and recovery.

The teams commit themselves to use the standard launch and recovery procedure set by TAC Challenge. Failure to use this procedure can lead to disqualification from the competition. Please see the Mission Booklet for more information.

3.2.3 Separated charging area

There will be a separated charging area on the competition site. Charging of main power batteries is only allowed inside this area. No grinding, drilling, etc. is allowed in the charging area. At least one team member who has knowledge of the charging process must stay with the batteries during charging. Batteries must not be charged inside of sealed vessels at any time.

3.2.4 Grounds for disqualification

Organizers reserve the right to penalize or disqualify a team registered for their competition in case of unsafe operating behavior, especially if the reputation of the competition, sponsors and other teams is compromised.

3.2.5 Limitations

Since the competition will be arranged outdoors and Norway has a lot of different weather, even in July, the following weather and condition limitations apply:

| Weather limitations | |
|--------------------------------|------------|
| Precipitation | Light rain |
| Wind speed average | 8 m/s |
| Maximum gust speed (10 minute) | 10 m/s |
| Significant wave height | 1.5 mS |
| Sea current | 0.3 knots |

4 Rules

4.1 Rules of Conduct

4.1.1 Alteration to competition schedule

The officials reserve the right to revise the schedule of the competition and/or interpret or modify the competition rules at any time and in any manner that is, in their sole judgment, required for safe and efficient operation.

4.1.2 Mannerisms

All teams are required to cooperate with and follow all instructions from the TAC Challenge organizers. This is mainly meant for the efficiency of the competition and the safety for everyone involved.

4.1.3 Punctuality

It is the responsibility of each team to be in the right place at the right time.

4.1.4 Misconducts

Misconducts or failure of a team member to follow an instruction directed specifically to that team or team member can result in penalty points being deducted from the team's overall score or, in extreme cases disqualification.

4.2 General Rules

4.2.1 Forfeit

If a team is not present and ready to compete at the scheduled time they forfeit their attempt at that event.

4.2.2 Mission Briefing

Team supervisor, pilots, and other members of the team are required to attend a team briefing related to the event they partake in.

4.2.3 Competition officials

The competition officials disassociate themselves from all activities of the teams besides their own competition and associated events.

4.2.4 Usage of common sense

All teams are advised to follow common practices and common sense when working on the vehicle and when operating the vehicle, before, during and after a competition.

4.2.5 Competition supervision

Stinger Technology AS will observe the underwater activities with their own Unmanned Underwater Vehicles. The video footage will be streamed for the judges and participants.

5 Technical Requirements

5.1 General Requirements

5.1.1 Engineering practices

The vehicle must be designed and fabricated in accordance with good engineering practices. Good environmental practices are emphasized.

5.1.2 Safety inspection

Vehicles can and will be inspected by any competition officials at any time to ensure that there is no unreasonable safety hazard to participants, staff, or the host facility. This also includes equipment supporting the operation (e.g., power and control panels). The organizers, sponsors, partners are in no way liable for any injury or damage caused to or by any vehicle.

5.1.3 Using multiple vehicles

Multiple vehicles may be used for a single assignment, including the use of unmanned surface vehicle(s) to support the underwater vehicle. These are not weight restricted.

5.2 Vehicle Requirements

5.2.1 Weight Requirements

The team will be awarded points based on the weight of the underwater vehicle. A vehicle under 25kg will award the most points, due to this being a limit used by the offshore industry for man portable equipment. The vehicle will be weighed before each mission. If the drone's weight varies between the missions, the highest weight will count.

| Weight including batteries | Points | Comments |
|----------------------------|--------|--------------|
| < 25 kg | TBA | |
| 25 – 50 kg | TBA | |
| 50 – 100 kg | 0 | |
| > 100 kg | --- | Disqualified |

5.2.2 Vehicle emissions

Due to environmental concerns, the drone is not permitted to emit anything besides air and water during the competition.

5.2.3 Batteries

If the team decides to use batteries, all batteries must be sealed to reduce the hazard from acid or caustic electrolytes. The open circuit voltage of any battery or battery system in a vehicle may not exceed 60 VDC.

5.2.4 Launch and Recovery System (LARS)

TAC Challenge will provide a LARS for the underwater vehicles. The method is based on a crane that lowers the drone from the quay to the ocean's surface. Once the drone reaches the surface, the crane is detached from the drone. For the vehicle to be compatible with the LARS, it must have the possibility to be attached to carabiner hooks or a sling.

5.2.5 Tether

Since the area of operation connects to the open ocean, teams are strongly encouraged to use a tether to avoid loss of the vehicles. A tether length of 30 m should be sufficient to maneuver freely in the area of operation. If this is a problem, contact the TAC Challenge organizers.

5.2.6 Buoyancy

All untethered vehicles must be positively buoyant.

6 Static Events

This section is coming soon.

7 Dynamic Events

7.1 General Overview

The dynamic events consist of the missions and are all performed at the venue during the competition. The missions include:

- Subsea docking
- Pipeline inspection
- Valve intervention
- Visual inspection of subsea structure

The following subsection will present a general description of each task. The detailed mission descriptions are found in the Mission Booklet. *All missions are still preliminary and are subject to changes.*

7.1.1 Subsea docking on docking station

The vehicle will locate a docking station positioned at an unknown position in the operational area and then attempt to dock to this station. The docking station will be equipped with visual and/or acoustic indicators. Specific autonomous behavior will also award points.

(TAC Challenge is attempting to include an inductive charging/data transfer unit to this task, but this is not confirmed yet.)

7.1.2 Pipeline inspection

A pipeline positioned on the seabed in the operational area needs to be inspected. The pipeline has an unknown path and position. There is an unknown number of ArUco markers along the pipeline which need to be identified. Delivering this code in the correct order will award maximum points. Specific autonomous behavior will also award points.

7.1.3 Valve intervention on subsea structure

Two valves are positioned on an underwater structure. To achieve points, they must be closed by the vehicle. The valves have a standardized subsea interface and must be turned either clockwise or anticlockwise, depending on their current position. Specific autonomous behavior will also award points.

7.1.4 Visual inspection of subsea structure

The subsea structure mentioned above must also be inspected. Known images or objects are positioned on the structure and must be recognized to achieve points. Specific autonomous behavior will also award points.