Rules and Regulations

Subsea

TAC Challenge 2023

'Where concept meets reality'

Revision 2.3

Contents

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, not far from 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 concerning the contents of this document of other competition details can be directed to TAC Challenge via the TAC Challenge Community Forum:

https://tacchallenge.vbulletin.net/

The link to the TAC Community Forum, as well as other information, can also be found on the TAC Challenge website:

https://tacchallenge.com/.

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 STEM students. The competition is divided into an aerial competition and a subsea competition, which act as separate competitions. This document will only address the subsea competition. The rules and regulations for the aerial competition are detailed in a separate document (see https://tacchallenge.com/).

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 all 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.

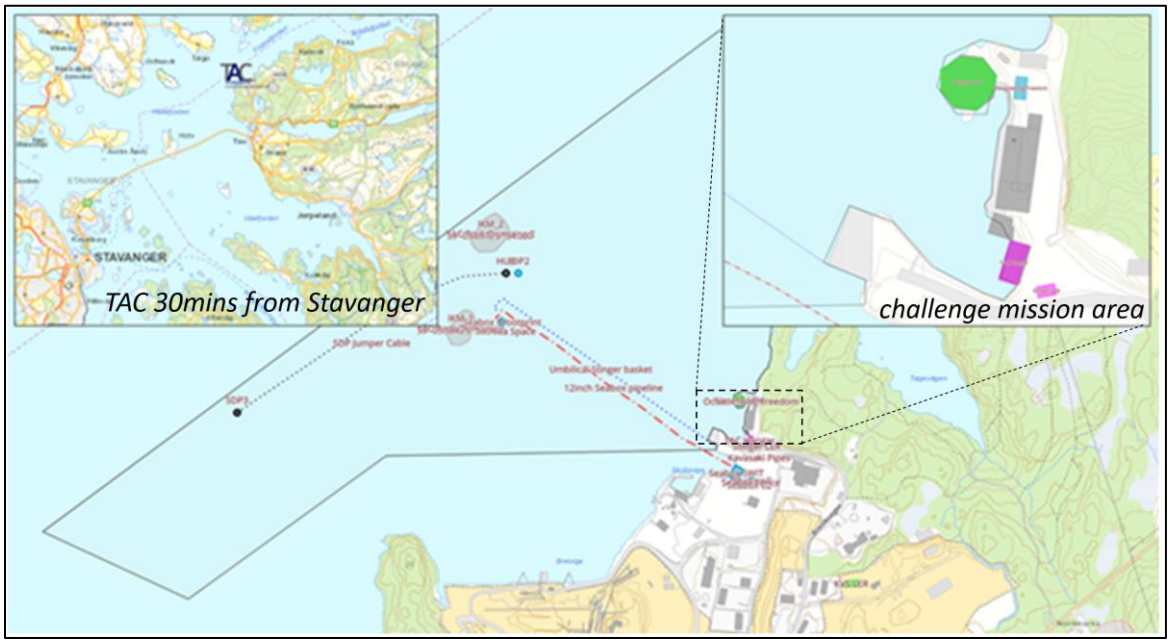
The 2023 competition focuses on the following:

1. Underwater docking to a Subsea Docking Station.
2. Underwater data transfer and charging via induction connectors.
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 and is approximately 20 m by 20 m. All missions will pe 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 static events are mandatory for all teams. ***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 method* (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. If your team is unsure if your planned strategy is allowed, contact TAC Challenge. 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 (Missions)	Maximum Points
Docking	180
Pipeline Inspection	200 (approximately)
Visual Inspection	TBA
Valve Intervention	160

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 (this is limited to the internal subsea competition, meaning a person is allowed participate in both aerial and subsea competitions).

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 schools/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 sat by TAC Challenge. Failure to use this procedure can lead to disqualification from the competition. The LARS method is further detailed in the Vehicle Requirements section.

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 machining 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 June, 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

The competition judges will notify the teams if the weather conditions are beyond these limits.

4 Rules

4.1 Rules of Conduct

4.1.1 Alteration to competition schedule

The officials reserve the right to change 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 during missions, including the use of Unmanned Surface Vessels(s) (USV) to support the underwater vehicle(s). USVs are not weight restricted.

5.2 Vehicle Requirements

5.2.1 Weight Requirements

The team will also 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	+50p	
25 – 50 kg	+20p	
50 – 100 kg	0p	
> 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 safely secured 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 50 m** is sufficient to maneuver freely in the area of operation (the tether should not be shorter than 30 m). If this is a problem, contact the TAC Challenge organizers.

5.2.6 Buoyancy

All untethered vehicles must be positively buoyant.

5.2.7 Indication light

In the Docking Mission, the team can use a light to indicate power transfer between the inductive connectors (power puck). This light must illuminate when the secondary power puck receives power from the primary side (i.e., when docked). The light is only allowed to be powered by the power puck (i.e., it cannot be controlled and powered by the vehicle). This will be verified by the judges on land before the mission attempt starts. This light will be monitored by an observing ROV at the competition and must therefore be **visible from a distance under water**. The light-system will not be provided and must be developed by the team.

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
- Visual inspection of subsea structure
- Valve intervention

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

A docking station is positioned at an unknown position on the sea floor in the operational area. The vehicle will locate the docking station and then attempt to dock to this station. The docking station is equipped with an inductive 250W Subsea connector (Power Puck), developed by Subsea USB, which can transfer data and power to the vehicle. The team will demonstrate power transfer by illuminating a light equipped on the vehicle connected to the secondary power puck; retrieve the data from the inductive puck and return to the launch and recovery area with this data. The docking station will also be equipped with visual indicators (ArUco Tags). Specific autonomous behavior will also award points.

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 Visual inspection of subsea structure

An underwater structure, located on the sea floor in the operational area, must be inspected. Known images or objects are positioned on the structure and must be recognized to achieve points. Specific autonomous behavior may also award points.

7.1.4 Valve intervention on subsea structure

Two valves are positioned on the same underwater structure from the previous mission. The valves have a standardized subsea interface and can be turned either clockwise or anticlockwise

in a 90-degree sector. Before the mission starts, a judge will inform the team on which way the valves must be turned and its final position. To achieve points, the team must operate the valves according to the information given by the judge. Specific autonomous behavior will also award points.