

SUBS in Schools Australia



Trident
St Philips Christian College-Newcastle, NSW
Level 4 Submarine
2020 National Champions

2021 Technical Regulations Level 4: Submarine Version 1.0



Proudly Supported by

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An initiative of

RE-ENGINEERING AUSTRALIA
FOUNDATION



Trident, St Philips Christian College - Newcastle Campus, NSW

Left to Right: Anita Gorton, Angus Clayton, Oliver Taylor, Edward Andrews, David Bonzo (Teacher) & Jack Fraser

AUTHORISED AGENT

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Re-Engineering Australia Foundation Ltd.

PO Box 136

Castle Hill NSW 1765

P: 61 2 9620 9944

F: 61 2 8079 0622

E: contact@rea.org.auW: www.rea.org.au**COPYRIGHT NOTICE**

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CONTRIBUTORS

Re-Engineering Australia Foundation Ltd. acknowledges the valuable contributions of the Australian Government Department of Defence and SAAB Australia in the development of this Challenge

SUPPORTERS

UNSW
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TABLE OF CONTENTS

Preface.....	4
Summary of Main Revisions from Review of 2020 Season	4
ARTICLE T1 - Definitions	5
T1.1 Australian Competition Season	5
T1.2 Language Used	5
T1.3 Penalties	5
T1.4 Surface Finish & Decals	5
T1.5 Hand Finishing	7
T1.6 Engineering Drawings	7
T1.7 SUBS in Schools Submarine	7
T1.8 Vertical Reference Plane	8
T1.9 Fully Assembled Submarine	8
T1.10 Body	8
T1.11 Fore cap / Bow cap	8
T1.12 Aft cap / Stern cap	8
T1.13 Propeller / Propulsor	8
T1.14 Fore Control Surfaces	8
T1.15 Aft Control Surfaces	9
T1.16 Fin / Sail	9
T1.17 Moving Components	9
T1.18 Ballast System	9
ARTICLE T2 - General Principles	9
T2.1 Regulations Documents	9
T2.2 Interpretation of the Regulations	9
T2.3 Amendments to the Regulations	10
T2.4 Safe Construction	10
T2.5 Compliance with Critical Regulations	10
T2.6 Rectification of Critical Regulation Infringements	10
T2.7 Measurements	10
T2.8 Trailing aerial / Satellite receiver	10
T2.9 Design, Manufacture & Construction	10
T2.10 Finishing & Assembly	11
T2.11 Decals	11
T2.12 Undefined Features	11
ARTICLE T3 - General Regulations	12
T3.1 Overall Length	12
T3.2 Overall Width (Beam)	12
T3.3 Overall Height	12
T3.4 Status During Trials	12
T3.5 Repairs / Maintenance	12
T3.6 Body Construction	13
T3.7 Virtual Cargo	13
T3.8 Virtual Cargo Identification	13
ARTICLE T4 - Fore and Aft Cap Regulations	13
T4.1 Construction Material	13
T4.2 Positioning	13
ARTICLE T5 - Control Surface Regulations	13
T5.1 Control Surface Identification	13
T5.2 Bow Control Surface Positioning	13
T5.3 Stern Control Surface Positioning	14
T5.4 Construction & Rigidity	14
ARTICLE T6 - Fin / Sail Regulations	14
T6.1 Fin / Sail Positioning	14
T6.2 Fin / Sail Length	14
T6.3 Fin / Sail Height	14
T6.4 Fin/Sail Width	14
ARTICLE T7 - Appendices	15
T7.1 Example Orthogonal Drawing	15

PREFACE

This document only contains 'Technical Regulations'. A separate document encompasses the 'Competition Regulations'.

These regulations **WILL** be valid for all 2021 State Finals and the 2021 National Final.

Diagrams and images used in this document are an illustrative representation only and do **NOT** necessarily constitute a 'legal' design.

Summary of Main Revisions from Review of 2020 Season

The following summary provides an overview of all technical related regulations that have been revised from the 2020 season's regulations.

It is each team's responsibility to thoroughly read this document in order to identify wording changes and to understand any impact this **MAY** have on their project.

All changes between this season and last season are identified within the document by using red underlined text.

Updated Regulation Articles

C1.4.5 - C1.4.6 Updated wording

ARTICLE T1 - Definitions

T1.1 Australian Competition Season

State and National Finals events are managed by Re-Engineering Australia Foundation Ltd., are generally held over 2 - 3 days and **MAY** include various programmed social and competition activities. These events aim to provide all participants with an educational and personal development experience.

T1.2 Language Used

The language of the rules is tiered. Those clauses expressed as "**MUST**" are mandatory and failure to comply **WILL** attract objective penalties - points and/or trial and/or in the extreme, disqualification. Those expressed as "**SHOULD**" or "**MAY**" reflect some level of discretion and choice.

Some clauses **WILL** be satisfied through team registration processes or declarations signed as complied with as part of the Challenge Terms and Conditions, whilst others **WILL** be tested through a variety of objective and subjective judging.

 **T1.3 Penalties** A range of penalties **WILL** be applied for non-compliance with identified regulations. These penalties include:

T1.3.1 Point Penalty

Invoked from non-compliance with technical regulations and some competition regulations governing portfolio or trade display restrictions. These are identified as [Point Penalty].

T1.3.2 Time Penalty

Invoked from non-compliance with Technical Regulations which are identified as critical through the use of the danger symbol at left and listed in ARTICLE T2.5. These **WILL** be identified as [Time Penalty] and **WILL** be applied as 30 seconds to every voyage trial for every critical regulation violated up to a maximum of 3 minutes.

T1.3.3 Eligibility

Teams need to meet certain eligibility criteria to compete at a State or National Final. Failure to comply with certain eligibility criteria **MAY** lead to disqualification from the competition, a judging element or class of competition. [Eligibility].

T1.4 Surface Finish & Decals

A surface finish on a SUBS in Schools Submarine is considered to be any applied visible surface covering the profile of the submarine. A decal is material adhered to a component or surface finish. To be defined as a decal, 100% of the area of the adhering side **MUST** be attached to a surface. Surface finishes and decals are included when measuring the dimensions of any components they feature on. Refer to the Competition Regulations for more information.

T1.4.1 SUBS in Schools Logo Decal

This consists of the SUBS in Schools logo graphic printed on either black or white. Teams choose to use either the black or the white background decal so as to provide maximum contrast with the colour of the surface the decal is being adhered to. Official decals are supplied by Re-Engineering Australia Foundation Ltd. prior to event registration. The SUBS in Schools logo decal **MUST** have minimum dimensions of 90mm x 50mm.



T1.4.2 REA Foundation® Logo Decal

This consists of the Re-Engineering Australia Foundation Ltd. logo text and globe graphic printed on either black or white. Teams choose to use either the black or the white background decal so as to provide maximum contrast with the colour of the surface the decal is being adhered to. Official decals are supplied by Re-Engineering Australia Foundation Ltd. prior to event registration. The REA Foundation logo decal **MUST** have minimum dimensions of 90mm x 50mm.

**T1.4.3 Australian Government - Department of Defence Logo Decal**

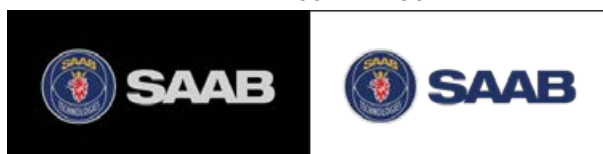
This consists of the Australian Government Department of Defence logo text and coat of arms graphic. Teams choose to use either the black or the white background decal so as to provide maximum contrast with the colour of the surface the decal is being adhered to. Official decals are supplied by Re-Engineering Australia Foundation Ltd. prior to event registration. The Department of Defence logo decal **MUST** have minimum dimensions of 90mm x 50mm.

**T1.4.4 Visual Connections Logo Decal**

This consists of the Visual Connections logo text and graphic. Teams choose to use either the black or the white background decal so as to provide maximum contrast with the colour of the surface the decal is being adhered to. Official decals are supplied by Re-Engineering Australia Foundation Ltd. prior to event registration. The Visual Connections logo decal **MUST** have minimum dimensions of 90mm x 50mm.

**T1.4.5 SAAB Logo Decal**

This consists of the Saab logo graphic printed on either black or white. Teams [mentored by Saab](#) choose to use either the black or the white background decal so as to provide maximum contrast with the colour of the surface the decal is being adhered to. Official decals are supplied by Re-Engineering Australia Foundation Ltd. prior to event registration. The SAAB logo decal **MUST** have minimum dimensions of 60mm x 30mm.

**T1.4.6 ASC Logo Decal**

This consists of the ASC logo graphic printed on either black or white. Teams [mentored by ASC](#) choose to use either the black or the white background decal so as to provide maximum contrast with the colour of the surface the decal is being adhered to. Official decals are supplied by Re-Engineering Australia Foundation Ltd. prior to event registration. The ASC logo decal **MUST** have minimum dimensions of 60mm x 30mm.



T1.5 Hand Finishing

Hand finishing is defined as use of a hand controlled device (e.g. abrasive paper) for removing only the irregularities that **MAY** remain on the surface of the submarine.

T1.6 Engineering Drawings

CAD-produced drawings and models of the submarine. Along with a compatible 3D Printing files, a third party should be able to produce a fully assembled submarine. These drawings should include all relevant dimensions, tolerances and material information. SUBS in Schools engineering drawings include detail to specifically identify and prove compliance for the virtual cargo.

T1.7 SUBS in Schools Submarine

This is also referred to as 'the submarine', and **MUST** be designed and manufactured according to these regulations for the purpose of participating in trials at the SUBS in Schools State or National Final events. Controlled remotely using chosen control surfaces, the submarine **WILL** need to navigate a course containing obstacles, while avoiding collisions. "The submarine assembly" refers to the external visible assembly of components/features that make up the submarine, all other components including motors, servos etc. **MUST** be internal. The submarine assembly **MUST ONLY** consist of the components and/or features listed below.

The submarine assembly **MUST** consist of the following MANDATORY components and/or features:

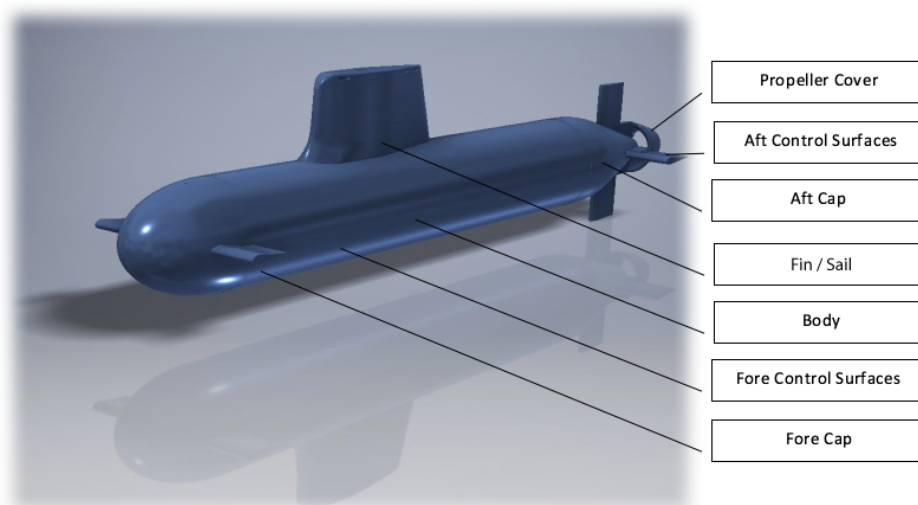
- A body (which includes a virtual cargo)
- Fore cap / Bow cap
- Aft cap / Stern cap
- On and off switch
- Fin / Sail

The submarine assembly **MAY** also consist of the following OPTIONAL components and/or features:

- Trailing antenna / Aerial
- Trailing satellite receiver (Including receiver housing floating on the water surface)
- Propeller(s) including propeller cover(s) / Propulsor(s)
- Surface finish and decals
- Fore control surfaces / Mechanisms
- Aft control surfaces / Mechanisms
- Internal systems as necessary
- Ballast system(s)

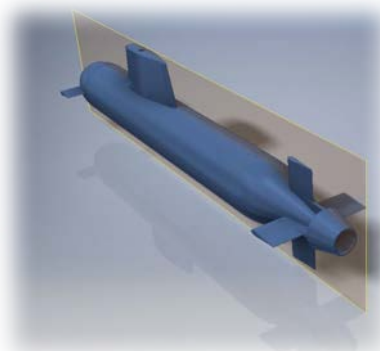
Adhesives are permissible for joining components.

Failure to have any of the listed mandatory components or features **WILL** result in all relevant penalties being applied.



T1.8 Vertical Reference Plane

To assist with describing dimensions, it is assumed that a two dimensional invisible vertical plane exists along the longitudinal centre line of the submarine. This is known as the vertical reference plane.



T1.9 Fully Assembled Submarine

A SUBS in Schools submarine, presented ready for trials, resting in a cradle on a horizontal solid surface, free of any external force other than gravity.

T1.10 Body

The body is defined as the primary connective structure of the submarine. It can be made up of multiple pieces or a single piece to form the outer hull of the submarine, the body must encompass the virtual cargo. For dimensional purposes the body also includes any attached decals and surface finishes.

T1.11 Fore cap / Bow cap

Defined as a feature connected to the front of the submarine body, satisfying overall dimensional rules. This **DOES NOT** include the fore control surfaces.

T1.12 Aft cap / Stern cap

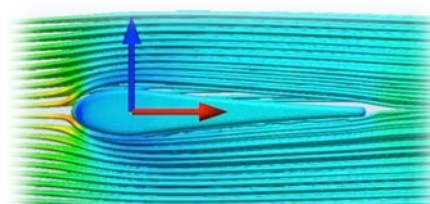
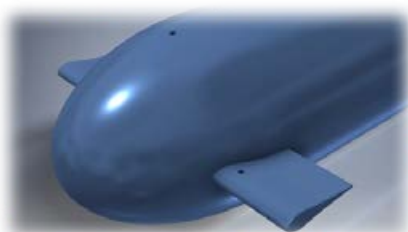
Defined as a feature connected to the rear of the submarine body, satisfying overall dimensional rules. This **DOES NOT** include the aft control surfaces.

T1.13 Propeller / Propulsor

A propeller on a SUBS in Schools submarine is a small impeller designed to move water when rotating. This movement of water causes the connected body to move as well, as per Newton's third law.

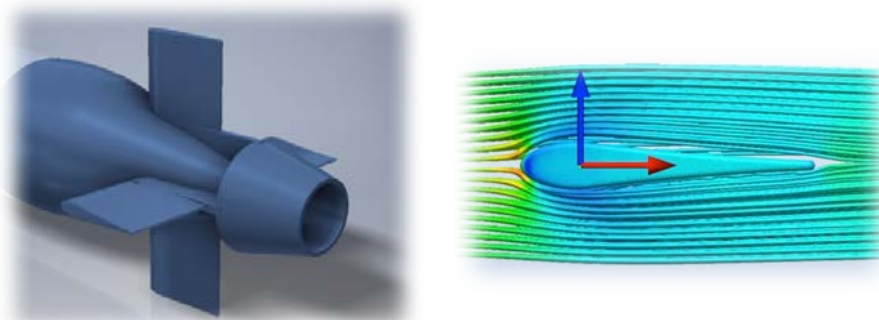
T1.14 Fore Control Surfaces

Are fin shaped features connected to the fore control mechanisms on the fore cap, used to control the flow of water around itself and produce motion. These **MUST** satisfy overall dimensional rules once connected to the fore cap.



T1.15 Aft Control Surfaces

Are fin shaped features connected to the aft control mechanisms on the aft cap, used to control the flow of water around themselves and produce motion. These **MUST** satisfy overall dimensional rules once connected to the aft cap.



T1.16 Fin / Sail

A feature which is connected to the submarine body, mimicking the appearance of a normal submarine. This feature **MUST NOT** protrude past the body into the area of the fore or aft cap, and **MUST** satisfy overall dimensional rules once connected to the body.

T1.17 Moving Components

Moving components are permitted on a submarine. A moving component is defined as any part or assembly of parts that is attached to another part of the submarine via either sliding, rotational or flexible joints and is **NOT** prevented from moving by some locking feature. The range of motion of a moving component is defined as the full motion of the component. A submarine **MUST** remain legal over the entire range of motion of any moving components. During specifications compliance judging, a submarine **WILL** be measured with moving components positioned at the extents of their range of motion and at any other location within their range of motion required to determine the compliance with rules over the full range of possible motion. Components intended to be “rigid” but exhibiting minor flexure **WILL NOT** be classified as “moving components”.

T1.18 Ballast System

Defined as a system to add ballast to the submarine mounted either internally or externally. Static and dynamic systems are allowed. The system **MUST** comply with overall dimensional rules.

ARTICLE T2 - General Principles

T2.1 Regulations Documents

Re-Engineering Australia Foundation Ltd. issues the regulations, their revisions and amendments made.

Technical Regulations - This document. The Technical Regulations document is mainly concerned with those regulations that are directly related to SUBS in Schools submarine design and manufacture. Technical Regulation article numbers have a ‘T’ prefix.

Competition Regulations – A document separate to this one which is mainly concerned with regulations and procedures directly related to judging and the competition event. Competition Regulation article numbers have a ‘C’ prefix.

T2.2 Interpretation of the Regulations

The final text of these regulations is in English should any dispute arise over their interpretation. The text of a regulation, diagrams and any related definitions should be considered together for the purpose of interpretation.

Text Clarification - Any questions received that are deemed by Re-Engineering Australia Foundation Ltd. to be related to regulation text needing clarification **WILL** be answered by Re-Engineering Australia Foundation Ltd. The question received, along with the clarification provided by Re-Engineering Australia Foundation Ltd., **MAY** be published to all competing teams at the same time on the Re-Engineering Australia Foundation Ltd. website.

T2.3 Amendments to the Regulations

Any amendments **WILL** be announced and released by Re-Engineering Australia Foundation Ltd. by email notification to all teachers nominated in the school registration, as well as the updated revision being uploaded to the website at <http://rea.org.au/subs-in-schools/>. Any amended text **WILL** be indicated thus (using red underlined text).

T2.4 Safe Construction

[Eligibility | 20pt Penalty]

Specification Compliance Judging - All submitted submarines **WILL** be inspected closely to ensure that they are engineered and constructed safely for the purpose of conducting underwater trials. If the Judges rule any aspect of the submarine to be unsafe, the team **WILL** be given an opportunity to rectify issues without penalty. Failure by teams to rectify any unsafe issues prior to the commencement of the trials **WILL** result in the submarine being withdrawn from the trials and no points **WILL** be awarded.

During Trials – The Officials **WILL** routinely inspect submarines for safety during scheduled trials. If the Officials rule a submarine to be unsafe, repairs **WILL** be permitted however penalties **MAY** apply as published in the Competition Regulations.

T2.5 Compliance with Critical Regulations

Points are deducted for non-compliance with the technical regulations. These penalties are only imposed once, per infringement.

T2.5.1 List of Critical Regulations

Some regulations have been identified as critical regulations and **WILL** attract both a 4 Point Penalty and a 30 second Time Penalty as per ARTICLE T1.3. The critical regulations are:

T3.1/T3.2/T3.3/T3.6/T3.7/T4.1/T6.2/T6.3

T2.6 Rectification of Critical Regulation Infringements

Any team whose submarine has been deemed by scrutineers to have infringed a regulation attracting a Time Penalty, **WILL** be given an opportunity to rectify this prior to trials with the effect of removing the time penalty. The original point penalty however, **WILL** stand.

T2.7 Measurements

T2.7.1 Dimensional measures

All submarine component dimensions are inclusive of any applied paint finish or decal. A series of specially manufactured gauges **WILL** be used to verify dimensional compliance.

Whilst your CAD design **MAY** comply with dimensional regulations, the process of machining, painting and assembly **WILL** individually impact on the final dimensions of the finished product submitted for scrutineering. It is the actual product that is measured in scrutineering. It is **NOT** the design intent that is judged in scrutineering.

Scrutineering of submarines **WILL** be conducted by examining submarines throughout all possible configurations, including where there are moving parts that affect dimensions.

T2.8 Trailing aerial / Satellite receiver

For the purpose of scrutineering judging and trial judging, non-rigid trailing aerials and trailing satellite receivers (including waterproof housing and servo wires) **WILL NOT** be considered as part of the submarine assembly. Rigid aerials **WILL** be considered to be part of the submarine assembly and therefore **WILL** count towards scrutineering measurements and trial judging.

T2.9 Design, Manufacture & Construction

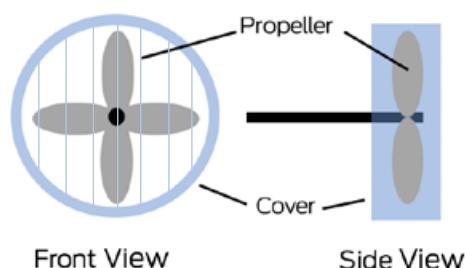
[Eligibility | 20pt Penalty]

T2.9.1 CAD/CAM Designs

All submarines **MUST** be designed and engineered using CAD (Computer Aided Design) and CAM (Computer Aided Manufacture) technology. CAD software used should provide for 3D part modelling, assembly and 3D realistic rendering. The CAM package should allow students to construct and print 3D models, and show evidence of these in their portfolio. We recommend the use of DASSAULT SYTEMES 3D Experience design suite.

T2.9.2 Propeller Cover**[Eligibility | 20pt Penalty]**

For safety purposes all propellers **MUST** be enclosed by a guard/cover around its entire circumference and width. Propeller covers **MUST** be designed to prevent contact with hands and fingers. Propeller covers **WILL** be checked by scrutineering judges and those deemed unsafe **MAY** be ineligible to attempt trials.

**T2.10 Finishing & Assembly****[Eligibility | 10pt Penalty]****T2.10.1 High Standard Finish**

All submarines are expected to be finished to a high standard and **MUST** reflect the features of the documented CAD design.

T2.10.2 Team Members Only

All team submarines **MUST** be assembled, painted and finished by team members only. A signed Watercraft Finishing Declaration form **MUST** be submitted as per C2.4.1.3 and C2.7.2 in the Australian Competition Regulations.

T2.10.3 No Water Soluable Finishes

Teams **MUST NOT** use water soluble surface finishes or other products on their submarine and any applied surface finish **MUST** be thoroughly dry prior to trials.

T2.11 Decals**T2.11.1 REA Corporate Partner Logos****[2pt Penalty]**

These sticker decals **MUST** be displayed on all submarines at State, National and International Events and will be supplied by REA at event check-in. Refer to T1.4 for more information. Each decal infringement attracts a 2pt penalty.

T2.11.2 Minimum Dimensions

ALL REA Corporate Partner sticker decals **MUST** maintain their minimum dimensions as per ARTICLE T1.4. Any trimming of decals will result in a 2pt penalty for each infringement.

T2.11.3 Positioning of Corporate Partner Sticker Decals**[2pt Penalty]**

All edges of the stickers **MUST** be visible in the side view. Refer to ARTICLE T1.4, each decal infringement attracts a 2pt penalty.

T2.11.4 Decal Integrity**[2pt Penalty]**

Teams **MUST** ensure that all decals are waterproof and do **NOT** separate from the submarine during trial activities. Each decal infringement attracts a 2pt penalty.

T2.11.5 Regional Sponsors**[Advice]**

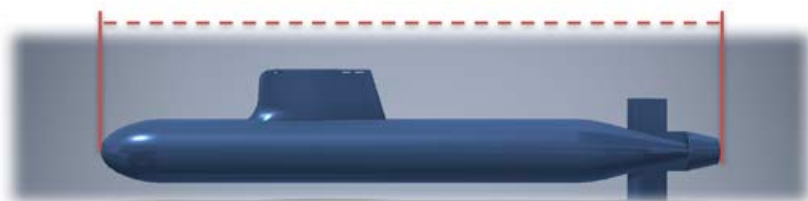
If your region is supported by a sponsor, corresponding sponsor recognition **MUST** be included in displays, portfolio and on the submarine.

T2.12 Undefined Features**[2pt Penalty]**

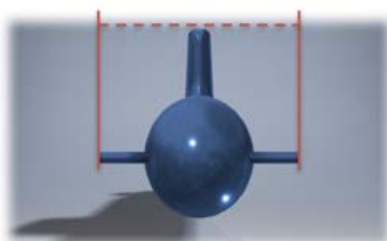
The submarine assembly **MUST** only consist of components listed in T1.7.

ARTICLE T3 - General Regulations

- T3.1 Overall Length** [30 Time Penalty | 4pt Penalty]
- ⚠ The overall length of the complete submarine measured between the longitudinal extremes of the submarine product, including all components, **MUST NOT** exceed 1200mm.



- T3.2 Overall Width (Beam)** [30 Time Penalty | 4pt Penalty]
- ⚠ The overall width of the complete submarine product including all components measured transversely **MUST NOT** exceed 300mm.



- T3.3 Overall Height** [30 Time Penalty | 4pt Penalty]
- ⚠ The overall height of the complete submarine product including all components measured vertically **MUST NOT** exceed 300mm.



- T3.4 Status During Trials** [2pt Penalty]
- The submarine assembly **MUST** be designed so that no items are removed, replaced or added to the assembly during scheduled trial events.

- T3.5 Repairs / Maintenance** [Disqualification]
- Teams are **NOT** permitted to change the design of their submarine during the competition, however teams are permitted to fix and maintain their submarine throughout the competition. This **MAY** include but is **NOT** limited to replacing or fixing batteries, motors, servos, propellers etc., so long as the submarines initial design remains unchanged.

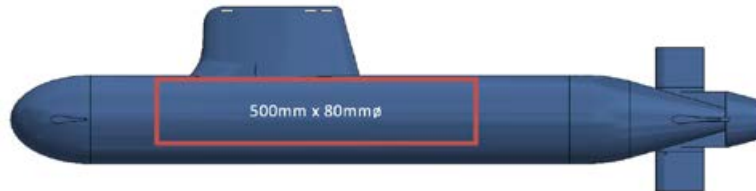
Teams are **NOT** permitted to substitute with alternate designs or delete from the fully assembled submarine any of the following components.

- Fore cap / Bow cap
- Aft cap / Stern cap
- Body
- Pressure hull
- Sail / Fin
- Control surfaces

These components **WILL** be marked by scrutineers in parc ferme and teams found to have breached this rule **MAY** be disqualified.

T3.6 Body Construction [30 Time Penalty | 4pt Penalty]
 The body can be made up of multiple pieces or a single piece to form the outer hull of the submarine, the body **MUST** exist between the fore and aft caps, encompassing the virtual cargo. It **MUST** ensure the overall dimensions remain within specifications. It **MUST** consist of purely rigid components.

T3.7 Virtual Cargo [30 Time Penalty | 4pt Penalty]
 A virtual cargo is a volume that **MUST** exist completely within the submarine body. The virtual cargo **MUST** have minimum dimensions of 500mm in length and 80mm in diameter.

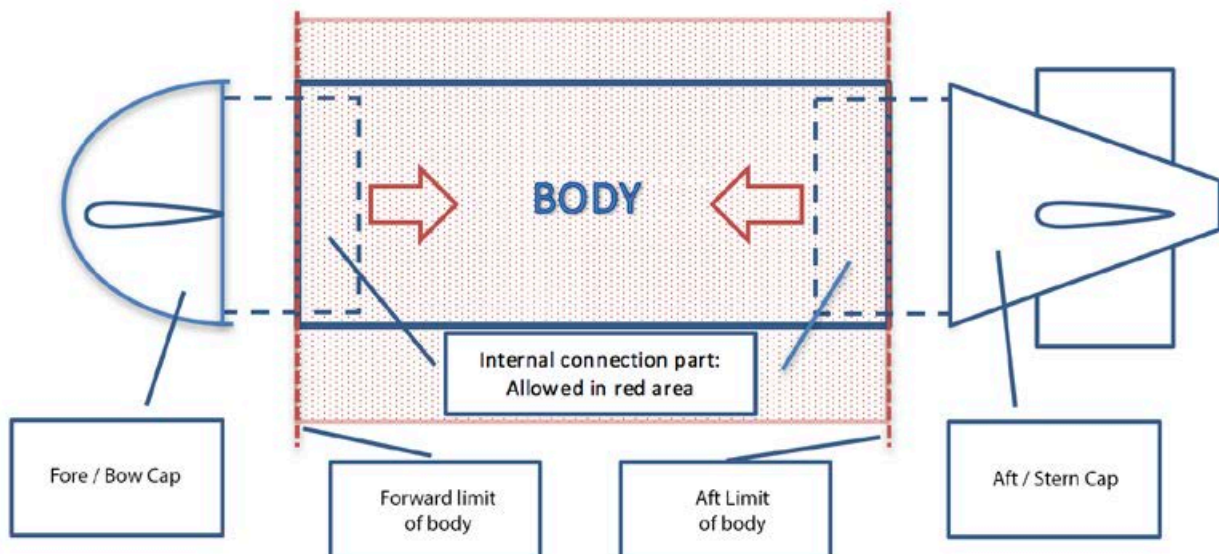


T3.8 Virtual Cargo Identification [2pt Penalty]
 The virtual cargo location and compliance **MUST** be clearly dimensioned and identified by hatching, shading or block colour within the Engineering Compliance Booklet drawings submitted for scrutineering judging.

ARTICLE T4 - Fore and Aft Cap Regulations

T4.1 Construction Material [30 Time Penalty | 4pt Penalty]
 The caps **MUST** be made of purely rigid components (no flexible or loose parts).

T4.2 Positioning [2pt Penalty]
 With the exception of the connecting components, the bow and stern caps **MUST NOT** enter into the body.



ARTICLE T5 - Control Surface Regulations

Teams **MAY** choose to control their submarine using optional bow and stern control surfaces. Where applicable, the following rules apply.

T5.1 Control Surface Identification [2pt Penalty]
 Where fitted, the surfaces defining both the bow and stern control surfaces **MUST** be identified clearly within the Engineering Compliance Booklet drawings submitted for judging.

T5.2 Bow Control Surface Positioning [2pt Penalty]
 Where fitted, the whole of the bow control surfaces **MUST** be entirely forward of the body.

T5.3 Stern Control Surface Positioning**[2pt Penalty]**

Where fitted, the whole of the stern control surfaces **MUST** be entirely behind the body.


T5.4 Construction & Rigidity**[2pt Penalty]**

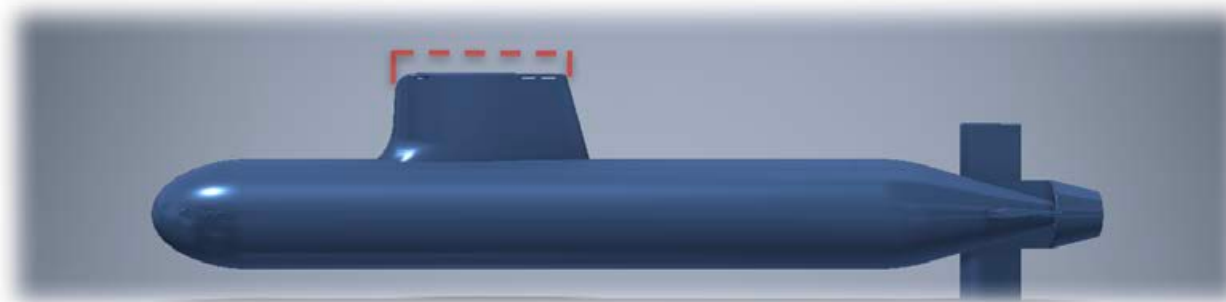
Where fitted, the control surface dimensions **MUST** remain unchanged during trials, i.e. **MUST** be rigid – ruled at the judge's discretion.


ARTICLE T6 - Fin / Sail Regulations**T6.1 Fin / Sail Positioning****[2pt Penalty]**

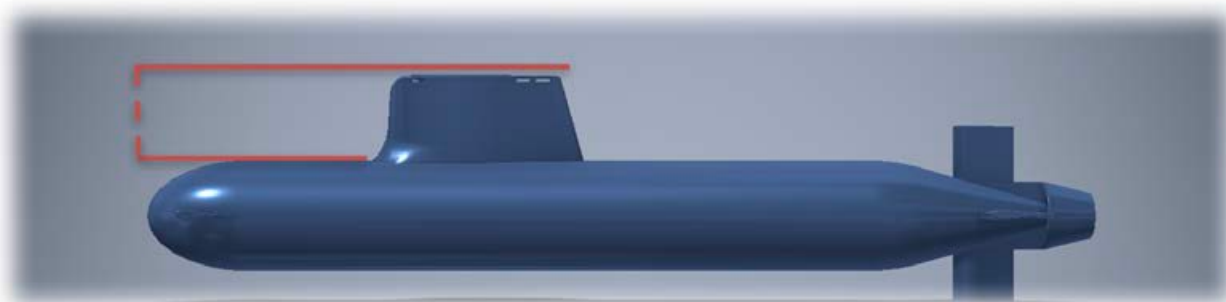
The fin / sail **MUST** be connected to the main body and be rigid. It **MUST NOT** exist past the bow or stern of the body, and **MUST** ensure that the overall height and width remain within specifications.

T6.2 Fin / Sail Length **[30 Time Penalty | 4pt Penalty]**

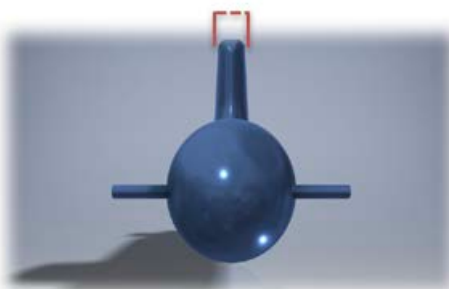
 The minimum length of the fin / sail (measured longitudinally in the vertical reference plane) at its smallest length is 100mm.

**T6.3 Fin / Sail Height** **[30 Time Penalty | 4pt Penalty]**

 The minimum height of the fin / sail measured from the submarine body extending vertically in the vertical reference plane is 50mm.

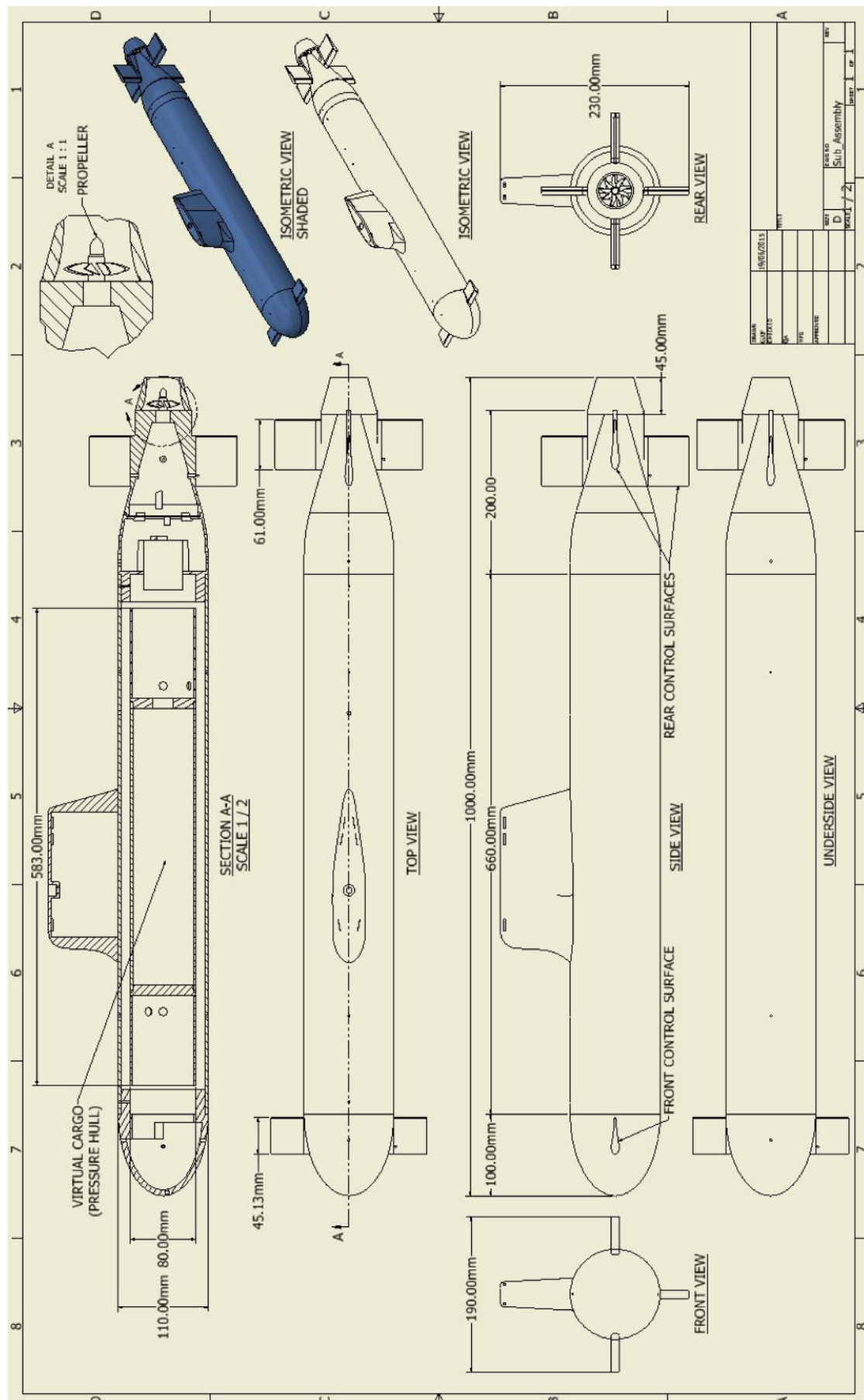
**T6.4 Fin/Sail Width****[2pt Penalty]**

The minimum width of the fin / sail on all zero trim waterlines, measured perpendicular to the vertical reference plane, at the widest point along its length is 30mm.



ARTICLE T7 - Appendices

T7.1 Example Orthogonal Drawing





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