STEM HUB

NAVY

ROYAL AUSTRALIAN NAVY

NUCLEAR-POWERED SUBMARINE PROPULSION CHALLENGE

Guidelines

1. INTRODUCTION

The Department of Defence and STEM Hub present the Nuclear-Powered Submarine Propulsion Challenge, a project-based learning experience.

The Challenge aims to encourage young minds to think like engineers and scientists by engaging them in science, technology, engineering and mathematics (STEM) skills, inspiring innovation, self-confidence, communication, and teamwork. The Challenge also aims to develop students' interest in STEM subjects, the Australian Defence Force, and submariner careers in the Navy.

This Challenge has been developed for students in Years 7 to 12 to use STEM disciplines to explore the technology involved in nuclear-powered propulsion systems used in submarines.

High School teams from each State and Territory will have the opportunity to submit their design for review and the winning teams will have the opportunity to travel to Western Australia for the ultimate experiential prize; a tour of HMAS *Stirling* and an immersive submariner experience. HMAS *Stirling* is the home base of the Australian Collins class submarines.

1.1 Background

Australia's acquisition of conventionally-armed, nuclear-powered submarines (SSNs) was announced by AUKUS partners, Australian Prime Minister Anthony Albanese alongside United Kingdom's (UK) Prime Minister Rishi Sunak and United States' (US) President Joe Biden on 14 March 2023.

Australia's nuclear-powered submarine pathway begins in 2023 with Australian submariners training with UK and US Navies on nuclear-powered submarines. From 2023, the US plans to increase nuclear-powered submarine port visits to Australia, with Australian sailors joining US crews for training and development. The UK will increase port visits to Australia from 2026.

Building on these increased port visits, from as early as 2027, the UK and the US plan to establish a rotational presence of one UK Astute class submarine and up to four US Virginia class submarines at HMAS *Stirling*, Western Australia. This initiative will be known as Submarine Rotational Force-West (SRF-West).

In the early 2030s Australia will acquire three Virginia class nuclear-powered submarines from the US. These will be Australian submarines crewed by Australian submariners and will be put into service for the Australian Navy.

In the late 2020s Australia will begin construction of the new AUKUS submarine known as the SSN-AUKUS. The SSN-AUKUS will be a new nuclear-powered submarine, based on a UK design, incorporating cutting edge Australian, UK and US technologies. Australia will deliver its first SSN-AUKUS, built in South Australia, in the early 2040s.

Australia's acquisition of conventionally-armed, nuclear-powered submarines will transform Navy's capability. No other platform matches the stealth, endurance, mobility and mix of capabilities a nuclear-powered submarine provides.

2. BRIEF OUTLINE

2.1 What will students learn?

- An understanding of the vision that science provides in everyday life and the nature of scientific inquiry, and the ability to use a range of scientific inquiry methods, including questioning, planning, evaluating concepts, and drawing critical, evidence-based conclusions.
- To communicate scientific concepts and findings to a range of audiences, to justify ideas based on evidence, and to evaluate and debate scientific arguments and claims.
- To solve problems and make informed, evidence-based decisions about current and future applications of science.
- To collaborate within a team (teams will consist of 3-5 students).
- STEM based careers, in particular in submariner roles with the Navy.
- Establish a fact-based analysis of the capabilities of nuclear-powered submarines vs diesel-electric powered submarines.

2.2 Key Concepts

This Challenge supports key aspects of the Science Inquiry Skills strand and contributes to developing students' appreciation of career pathways related to STEM.

Form and function

Students will explore the use of varying materials and their related functions and uses, based on their observable behaviours and physical properties.

Scale and measurement

Students will be challenged to work with scales that are outside their everyday experience, such as what makes certain materials stronger or weaker. As students gain an understanding of relative sizes and rates of change, they can conceptualise events and phenomena at a wider range of scales.

Matter and energy

Many aspects of science involve identifying, describing, and measuring energy and/or matter. Students are introduced to the forces and energy transfer and transformation. They use these understandings to develop further knowledge about nuclear energy.

Systems

Science involves systems thinking, modelling and analysis. Students will be utilising concepts of involving forces and changes acting in opposing directions and that for a system to be in a steady state, these factors need to be in a state of balance or equilibrium.

Scientific investigations

Scientific investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modelling and simulations. Students will be required to use scientific investigations to justify their solutions to the Challenge.

Information Communication Technologies and Science

Information Communication Technologies (ICT) are powerful tools that can support student learning. It is also important that students know how to use ICT efficiently and responsibly, as well as learning how to protect themselves and secure their data. This Challenge will require that students utilise visualisation tools to describe and explain how nuclear-propulsion systems work. Similarly, students will be required to present their projects using video technologies.

3. THE CHALLENGE

3.1 Suggested Challenge Implementation

Schools

In-Class Activity:

Teachers may incorporate the Challenge into classroom learning. The Challenge supports key learning areas in STEM, and general capabilities of digital literacy, critical and creative thinking, personal and social capability, ethical understanding, and a cross-curriculum priority of sustainability; the Challenge may be incorporated into Science, Design, Art, and Technology.

Expected Engagement

It would be beneficial for teams to concentrate on the program **1 session per week over 10 weeks** and allow students to work on the project as an extended homework task. This will allow project supervisors or teachers to check in and discuss the progress of the student research and development of their projects.

Extra-Curricular Activity:

Schools may opt to schedule activities outside school hours. Students are encouraged to form teams early in the program and to work collaboratively to address the Challenge deliverables. Where possible, teams may also utilise lunchtime for additional activities, as the submission deadline approaches.

Expected Engagement

Students would benefit from a **2 sessions per week over 5 weeks** commitment, where teams are collaborating in a team environment. This will allow project supervisors or teachers to check in and discuss the progress of the student research and development of their projects.

Home-School Groups

Students would benefit from a **1 session per week over 10 weeks** commitment, where teams are collaborating in a team environment. Parents/guardians are encouraged to contact STEM Hub if additional guidance is required. If home school students are unable to find fellow teammates, please contact STEM Hub on nuclearchallenge@stemhub.com.au and we'll endeavour to connect you with a cohort.

3.2 Challenge Deliverables

Presentation

Teams are to develop a presentation (no more than 8 minutes), to be submitted in MP4 format. The presentation is to address and answer all the questions in Part A and Part B.

Part A

1. Compare the diesel-electric with the nuclear-powered propulsion system and address their capabilities.
2. Outline the operational factors of both submarine propulsion systems (e.g. submarine speed, noise pollution, endurance, repairs and maintenance, etc).
3. Outline the safety factors of both submarine propulsion systems.
4. From your learnings, describe potential future uses of nuclear-powered propulsion (e.g. uses in the aerospace industry).

Part B

1. With the aid of an animated diagram, demonstrate how the nuclear reactor is used to power a nuclear-powered submarine.
2. Explain the processes in your animation, including the nuclear fission process and the principles of submarine propulsion.

3.3 Challenge Guidelines

1. Teams must address Challenge Deliverables - Part A **and** B (above).
2. Teams shall have no more than 5 students.
3. Teams must be comprised of either:
    a. Years 7 to 9 (Junior Division) or
    b. Years 10 to 12 (Senior Division)
4. Presentations must be no more than **8 minutes** long and must be submitted in MP4 format.
5. Schools may submit multiple team applications.

3.4 Registration & Cost

1. It is **FREE** to enter the Challenge.
2. Teams **must** register their interest to participate in the Challenge via the STEM Hub website. Once teams register, they will be provided with all required material.
3. To register your school/team go to: www.stemhub.com.au/nuclear-submarine-challenge/registration
4. Teams are to accept the Competition Terms and Conditions.

3.5 Technology

Teams will be required to demonstrate how a propulsion-system operates using automation methods. Teams are encouraged to use any of the following free or low-cost educational tools:

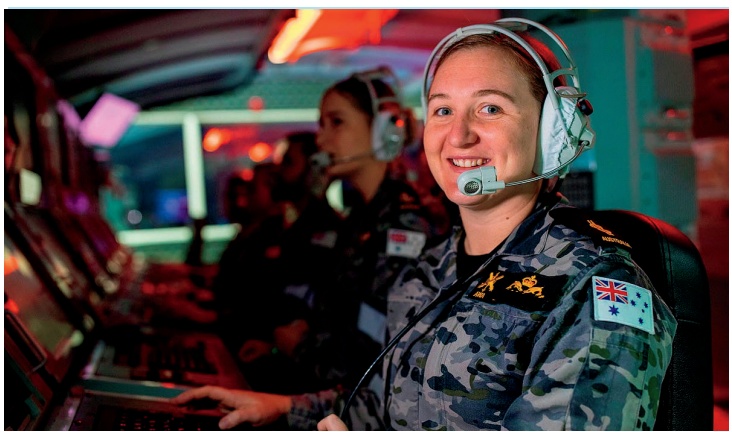
- **Free**:
  - Autodesk Tinkercad
    https://www.tinkercad.com/
    https://www.tinkercad.com/things/60BGr0YaX4g
    (submarine design example)
  - Autodesk Fusion 360
    https://www.tinkercad.com/fusion360
  - Microsoft Powerpoint
- **Low-cost:**
  - Powtoon
    https://www.powtoon.com

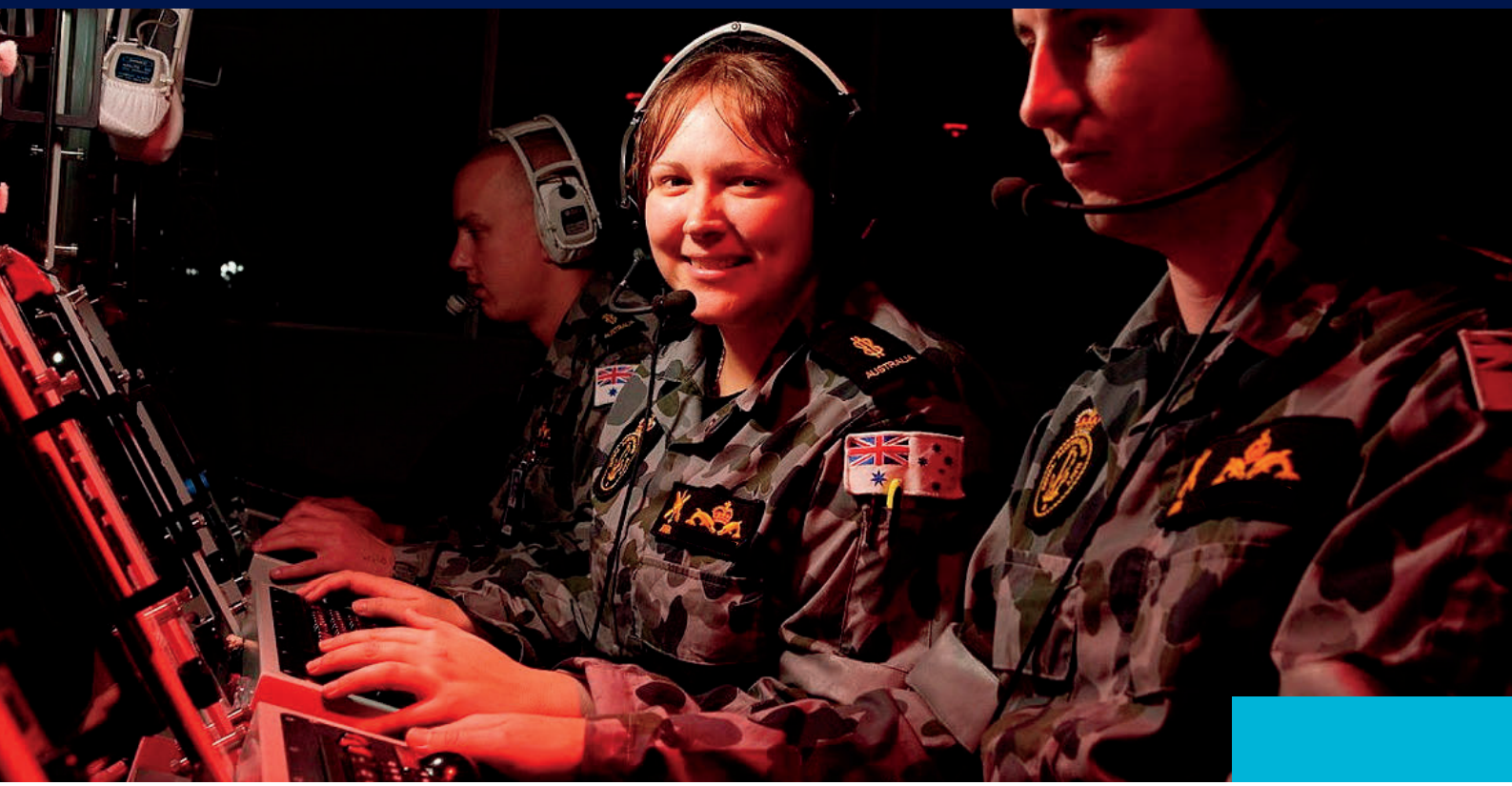
Please note, teams are not limited to any of the listed resources and may use alternative platforms. Teachers/home-school educators may contact STEM Hub for assistance with the Autodesk suite listed above.

3.6 Resources

Upon school/team registration the following resources will be made available for download:

- **Marking Rubric.docx**
- **Classroom Learning Material.pdf**





3.7 Important Dates

- Presentations **must** be submitted via the STEM Hub website found at www.stemhub.com.au/nuclear-submarine-challenge by 5PM on **15 September 2023**.

- Teams will be notified of their success no later than 5PM on **16 October 2023**.

- Winning teams will travel to HMAS *Stirling* (WA) during the period 10 – 15 December 2023. The travel dates for winning teams will be confirmed following notification.
    - Note: Team travel will include 2 nights accommodation in WA.

3.8 Judging

Presentations will be assessed by a team of Navy submariners and industry experts. Student teams that request feedback on their performance will be provided with a score (out of 30) and accompanying comments as set out in the Marking Rubric.

Selection of Winning Teams

Winning teams will be selected for each State and Territory for the Junior Division (Year 7-9) and Senior Division (Year 10-12).

3.9 Prizes

Winning teams, including 2 teachers/guardians, will be provided with flights (and accommodation) to HMAS *Stirling* (WA).

The following are also included:

- Return transport costs from your school to the nearest domestic airport.
- Return airfare for each team to Perth (WA). Each team may consist of up to 5 students and is to include 2 teachers/guardians.
- Transport from Perth Airport to hotel accommodation (accommodation will be shared).
- Daily transport to and from HMAS *Stirling*.
- Daily activities and tour of HMAS *Stirling* to gain a realistic view of life in the Navy and as a submariner and will include:
  - Tour of an Australian submarine (subject to availability and operational requirements).
  - Experience 3D motion training simulators.
  - Lunch with Australian submariners.
- All meals whilst undertaking tours and activities.
- Editorial in STEM Hub's HEADJAM Magazine.

3.10 ADF Engagement

Schools will have the option to indicate if they wish to receive further engagement from Defence with opportunities to discuss career information, share experiences, education, training and more.

For further questions about the Nuclear-Powered Submarine Propulsion Challenge please contact STEM Hub on **nuclearchallenge@stemhub.com.au**