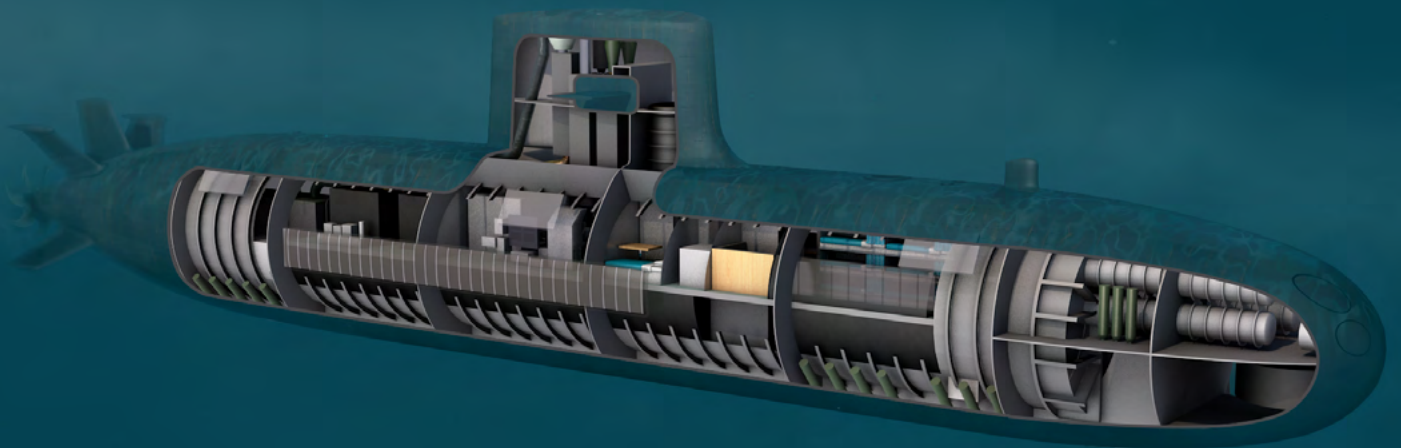


Submarines & Underwater Systems

Services: **UK**

Helping deliver capable, secure and safe submarines & underwater systems





Front cover
WYVERN® SSK

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Welcome

BMT offers design solutions, asset management, programme delivery and technology services to customers in the Defence and Security markets. Our teams tackle the most complex engineering and programme challenges, blending capabilities from the entire spectrum of engineering disciplines to deliver enduring and value-adding benefits. We have experience of delivering agile practices to rapidly tailor solutions to meet customers' needs.

Submarines and underwater systems operate in the most challenging of environments, often requiring the most complex engineering solutions. We work with our customers to navigate complexity, bringing a whole enterprise perspective to the many technical and programmatic issues involved, and building a full understanding of costs and risks.

From concept submarine designs to the in-service support of the Royal Navy's submarine fleet – whatever the project, we work with our customers to engineer the right outcomes, optimise their assets, improve performance and increase efficiency.

We use our operational experience and our technical ability to deliver practical solutions to these complex issues, and we assure the viability of those solutions through our domain, safety and regulatory knowledge.



As BMT is an Employee Benefit Trust, our assets are held in beneficial ownership for staff, helping us to maintain our independence and impartiality from defence systems and equipment manufacturing interest. This means we can support our customers as a trusted and independent partner.

Global expertise, locally available

BMT's **Submarine teams** are located throughout the UK, at our offices in **Bath, Fareham, Plymouth, Weymouth** and **Glasgow**. As an organisation, however, BMT has global reach with **over 40 locations worldwide** – this includes offices in the **USA, Australia** and **Canada** which, together with **the UK**, comprise BMT's Defence & Security division.

We invest in our people to ensure that our customers have access to agile, Suitably Qualified and Experienced capability in order to **deliver** cost effective, pragmatic and robust **solutions**.



Technical Information &
Documentation Managers



Programme Managers



Systems Engineers



Safety, Environmental
& Reliability Managers



Naval Architects



Information Systems
Managers



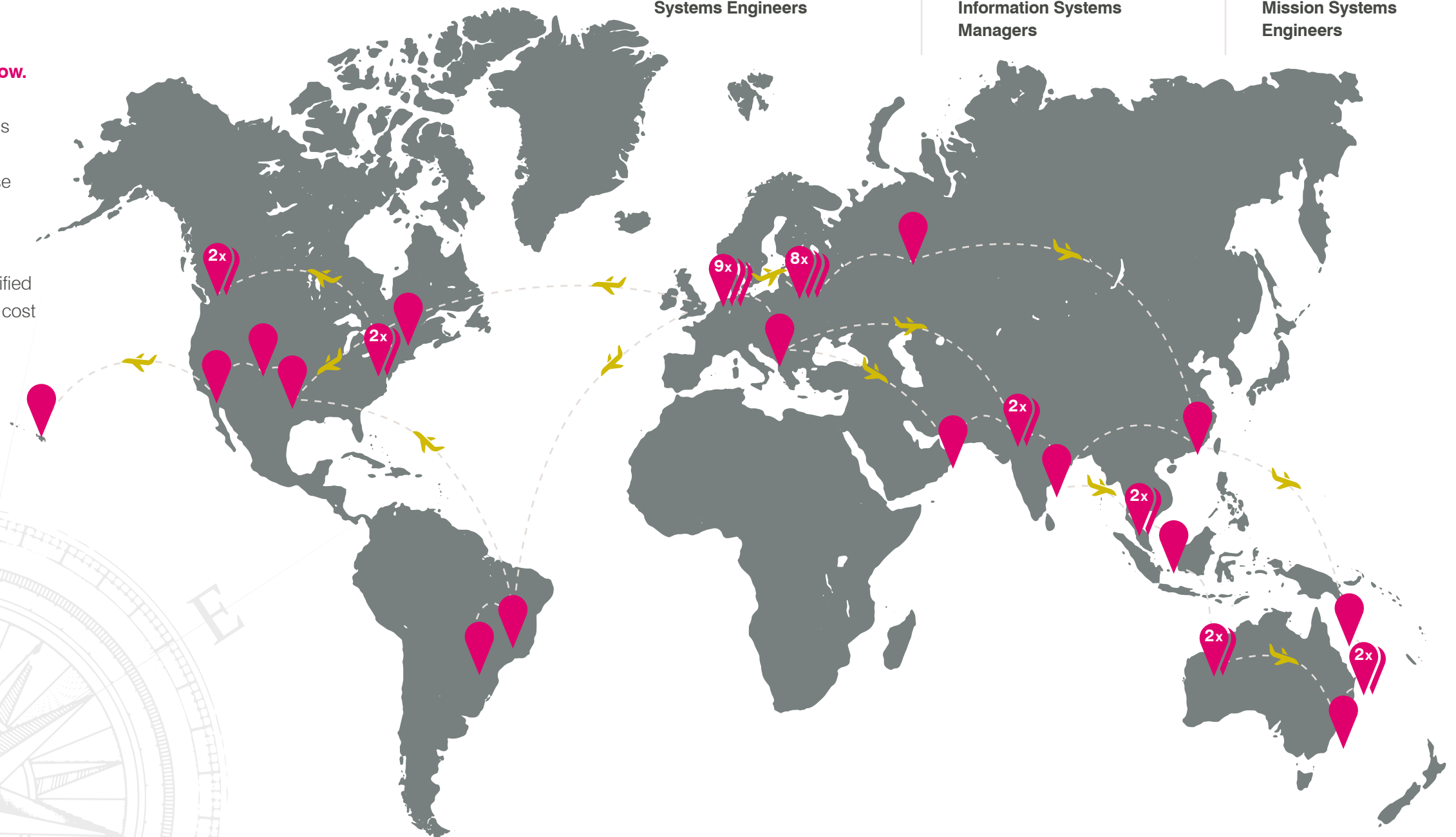
Through Life
Engineers



Naval Engineers



Mission Systems
Engineers

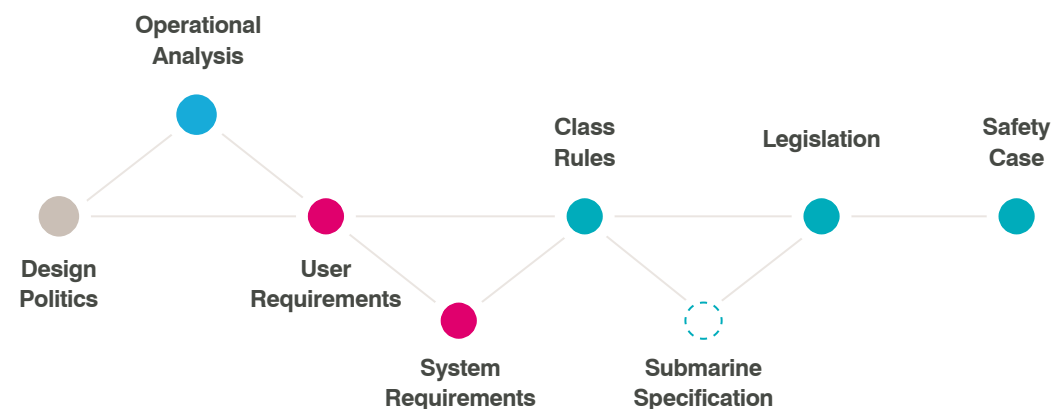


01 Acquisition Support – Customer Friend

Submarine acquisition programmes usually come with a significant investment and do not occur that regularly. For many countries it is a once in a generation project and there are a limited number of shipbuilders. Defining the right requirements and understanding best practice is vital if the programme is to deliver a submarine that meets the needs of the country. Requirements that are poorly defined are the root cause of cost overruns and late programme delivery. BMT has extensive globally experience in ensuring these requirements are clear and concise.

BMT delivers worldwide support to our customers. Our independence – we do not build submarines or ships – means that we can give objective and impartial advice to our customers.

Through BMT's involvement in national and international submarine programmes, we are well placed to offer a Customer Advisor role. Working alongside the country's procurement team, we are able to apply our experience, transfer knowledge and provide extra capability and capacity to help the customer gain confidence in their programme.



HMS Vigilant

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Submarine Project Assurance Review

The customer required an independent review of the maturity of their submarine programme. At the early stages of the project lifecycle the customer required assurance, at enterprise level (organisation, technical and management), that their programme had developed to support key milestone dates and performance metrics. BMT embedded a team to carry out a review of documentation and held interviews with key stakeholders to understand the programme strategies, activities and collateral produced. By using our submarine SQEP and our 'Value Engineering' approach to understand risks and issues, and understanding the root causes, we were able to identify mitigation actions to support the aims of the programme.

02 Engineering Design Services

In uncertain economic times, selecting the right submarine concept design is crucial if the programme is to be cost effective – a key consideration in defence procurement – as the majority of programme costs are committed at this stage. As a leading independent engineering consultancy, our experienced team of naval architects, engineers and safety professionals can provide domain expertise and technical advice on the complexity of the design and whole platform system issues, including safety, at all stages of the procurement cycle.

For the early phases of the project lifecycle we have a portfolio of submarine concept designs which we can develop to meet specific needs.

During the detailed design and manufacture phase we support design assurance, applying our valuable experience gained as client advisor on submarine programmes such as the SEA1000 in Australia and the new Norwegian submarine programme.

During the in-service phase we provide design change services and the expertise needed to ensure that design intent is maintained through life. We have supported each of the UK's new and future submarine design programmes since the concept design of Batch 2 Trafalgar, which evolved into the Astute Class.



We offer

Concept and whole ship design:

- ✓ Technical and performance characteristics feasibility
- ✓ Total cost of ownership including Non-Recurring Expenditure, Unit Production Costs and Through Life Costs
- ✓ Programme implications and design strategy risks
- ✓ Commercial procurement strategy

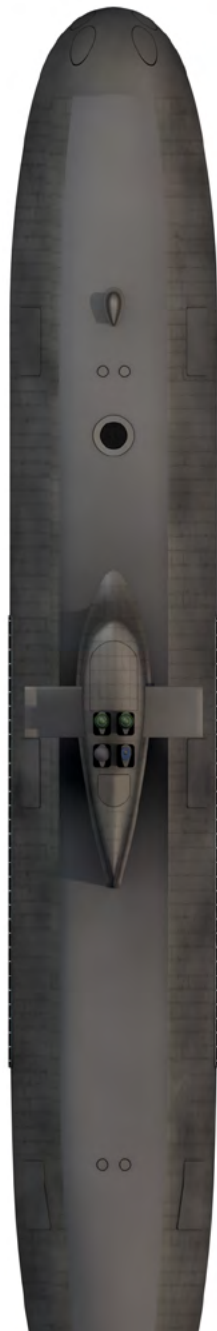
Post design services and engineering

- | | |
|-------------------------------------|-----------------------------------|
| ✓ Systems Engineering | ✓ In-Service Support |
| ✓ Technical Assurance and reporting | ✓ Software Development |
| ✓ Technology Management | ✓ Technical Documentation |
| ✓ Naval Design and Engineering | ✓ Engineering Surveys |
| ✓ Acquisition Support | ✓ Obsolescence management |
| ✓ Combat Systems Engineering | ✓ Design Change and Modifications |
| ✓ Hydrodynamics | |

Our Submarine Design Concepts: WYVERN®

The WYVERN design was originally developed as a small SSK suitable for coastal waters. In the last few years the design has evolved to incorporate new capabilities and the impact of these new capabilities on the balanced design assessed. These new capabilities include external batteries, a hull plug for launch and recovery of AUVs and novel pressure hull end closures. Recently the WYVERN concept was used to develop a Coastguard variant, optimised for non-warfighting functions such as Exclusive Economic Zone (EEZ) surveillance. This required optimisation for low through life cost as well as inclusion of a remotely operated gun.

03 WYVERN[®] SSK Submarine



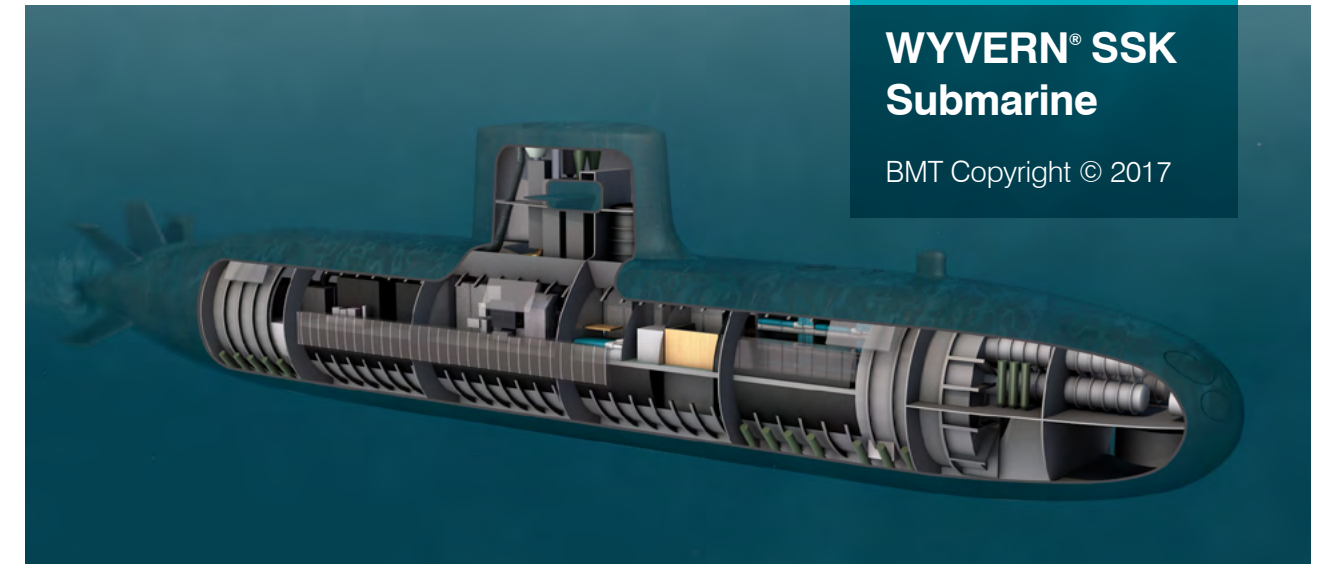
BMT has developed WYVERN SSK to meet the requirements of customers looking to establish a new submarine capability or to upgrade existing platforms to a more competent design based on 21st century technology. The philosophy behind WYVERN places considerable emphasis on taking a simplistic approach to design. WYVERN's design is based on a generic requirement set, underpinned by open source design standards, equipment suppliers' data and an assumed end user concept of operations. The use of commercial off-the-shelf (COTS), military off-the-shelf (MOTS) equipment and allowing flexible equipment specification affords greater design tailoring to meet the varied requirements of prospective end users.

Building on BMT's previous concept designs, experience and research into submarine availability and limiting energy consumption, emphasis has been placed on balancing requirements whilst maintaining design flexibility to suit sovereign nation needs.



WYVERN[®] SSK Submarine

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Key Features

- Improved resilience to weapon effects enabled by a double hull cross section
- Maximised payload and weapon fit for high mission effectiveness
- Extended submerged endurance and reduced susceptibility
- Adaptable air independent propulsion (AIP) system options depending on customer technology preferences
- Sea-going capability with maximised radius of operation and mission endurance
- Maximum manoeuvrability and slow speed control to assist shallow water operations

Key Benefits



Through-life
cost minimised



Minimum unit
production costs
and increased
operability



High range
and endurance
capability



Open standards
allowing the ability to
fit COTS or country
specific system



VIDAR[®] Submarine

Developed using the extensive submarine expertise at BMT, the VIDAR family of conventional submarine designs showcases the comprehensive understanding of requirements, technology and costs required for effective submarine design.

VIDAR-36

BMT's VIDAR-36 submarine concept design is a high capable ocean-going platform designed with flexibility in mind and an emphasis on low risk and affordability.

This SSK submarine offers a number of versatile benefits including:

- ✓ Ocean-spanning reach and persistence
- ✓ A high capability combat system, which accommodates refined sonar options as well as land attack, anti-surface, anti-submarine and special operations capabilities
- ✓ Competency in both deep water and the littoral, as well as being a silent and covert platform

Designed to be modified in-line with the latest technological advances and to meet specific market requirements, VIDAR-36 offers modular payload options utilising current commercial and military off-the-shelf technologies and includes:

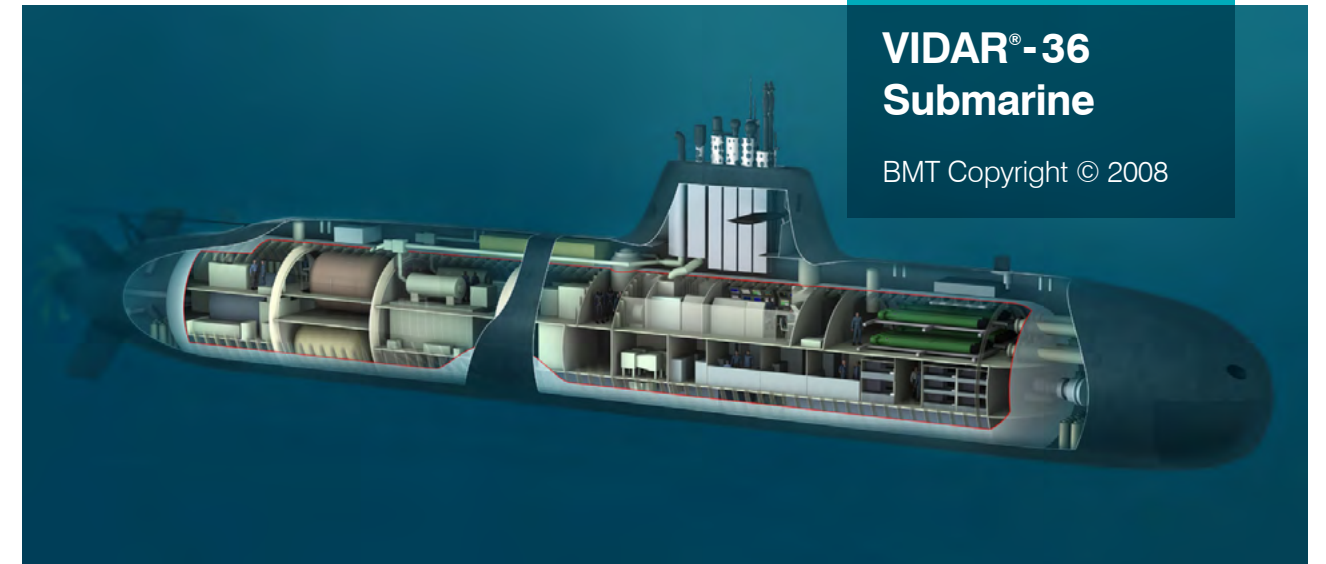
- ✓ Dry/wet deck hangar
- ✓ Special Forces mission packages
- ✓ High frequency communications systems
- ✓ Reelable towed-array plus modular mast systems

The diesel electric propulsion may be complemented by an optional modular AIP system.



VIDAR[®]-36 Submarine

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VIDAR-7

VIDAR-7 is a small affordable SSK submarine concept designed to cover a multitude of covert roles and flexibly meet requirements within an increasingly challenging economic and operational climate.

This latest addition to the Vidar family is capable of covering a vast number of role including ASW, ASuW, ISR, Special Forces, training, coastguard, antipiracy and land strike operation and boasts:

Through-life cost minimisation

Minimum unit production costs and increased operability

Multi-Mission capable, achieved through reconfigurable spaces to suit customer needs Tailorable AIP solutions to meet customer preference

Advanced Mission Effectiveness and Survivability High Range & Endurance

The design philosophy behind VIDAR-7 takes advantage of COTS and MOTS technology in order to maximise availability, range and endurance, flexibility, payload capacity, stealth and survivability, emphasising the minimising of overall cost of ownership.



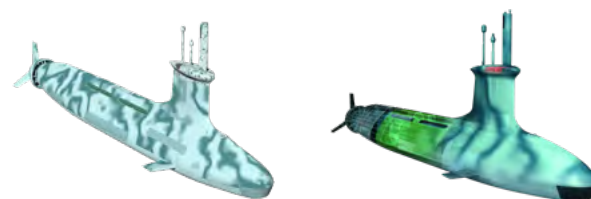
05 SSGT[®] Submarine

The SSGT design from BMT offers a high speed, long endurance transit capability, made possible by an innovative propulsion design.

SSGT's range, speed and endurance, both when in transit and on station, are wholly beyond the capabilities of current and forthcoming SSKs. BMT's concept design offers high mobility through key features including:

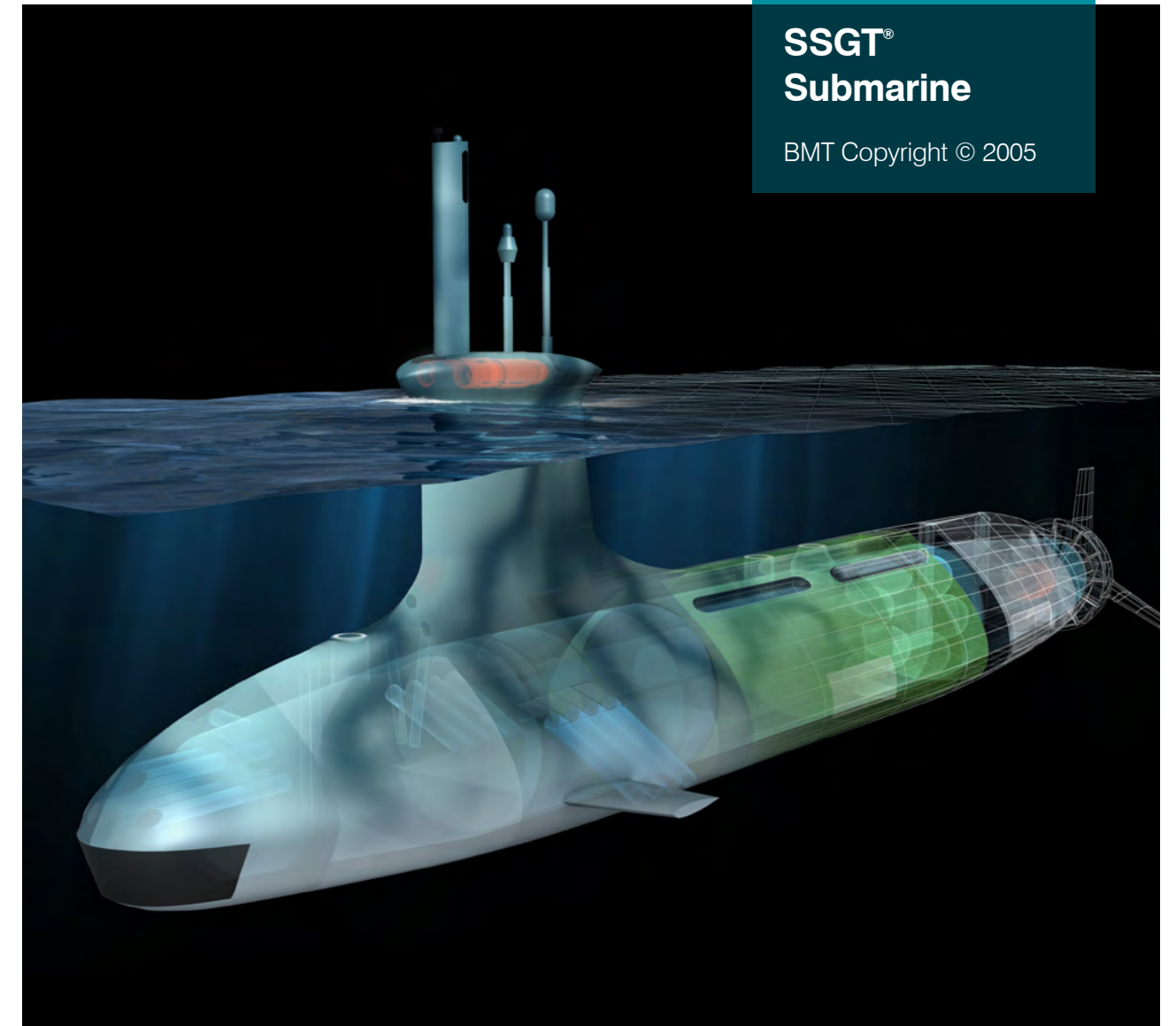
- ✓ Sustained transits at 20 knots for many thousands of nautical miles
- ✓ Fully covert mobility on station for at least 25 days whilst operating a high capability combat suite
- ✓ High speed 'sprints' up to 30 knots to gain tactical advantage

The versatility and endurance capabilities that SSGT can sustain are made possible by an innovative propulsion design, which uses twin independent gas turbine-alternator sets, housed in the 'bulb' on top of the fin. When semi-submerged, SSGT can operate at a fast transit mode, achieved by its gas turbines burning kerosene with air inducted through an extendible mast.



SSGT[®] Submarine

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When SSGT has slower, more covert requirements, services and propulsion power is provided by fuel cell stacks using the reaction of hydrogen with air drawn in through a snort mast. On station, covert tactical mobility is achieved using the fuel cells in full AIP mode. In this mode, sprints of up to 30 knots are made possible by power drawn from a large advanced Zebra battery.

BMT's SSGT design allows for a flexible mix of weapon discharge tubes, as well as UUV stowage to satisfy a range of mission profiles. These systems have sufficient energy stored to operate them.

06 Programme Support

Assessment and evaluation

Our experts, many of whom have been in the Armed Forces, guide selection with impartial advice and provide robust risk assessments, technical options, feasibility assessments, cost systems and well-defined and measurable service level agreements. Our in-depth knowledge of the defence environment enables us to apply cutting-edge thinking and technology solutions to complex defence projects. By not being directly involved in manufacturing or construction, BMT can provide an independent view across build activities. Our services range from supporting improvements at policy level through to assisting governments and their suppliers to respond effectively to safety and environmental issues associated with specific projects.

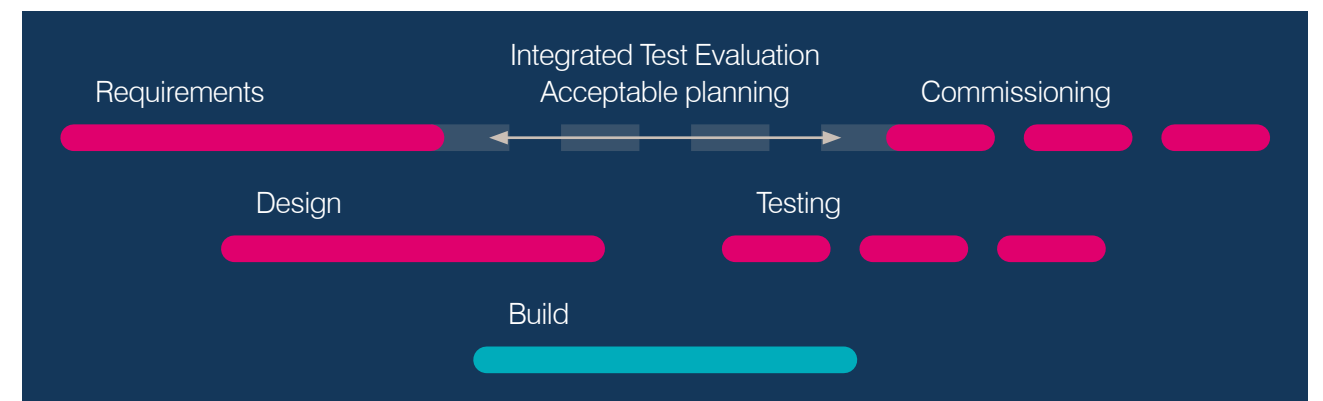
Delivery programme

We have unrivalled understanding and knowledge to help you navigate and interpret the complexities of the transition from design through build into end user ownership. We are able to provide clear acceptance planning and management, stakeholder identification and engagement, risk identification and mitigation; our impartial expert advice ensures that the critical path and key decision makers and influencers, understand their roles in the acceptance of major platforms, projects and programmes.



Concept and whole ship design:

- ✓ Acceptance planning and management: We have used our experience of defence acquisition projects to develop key techniques to give you the confidence you have fully understood and mitigated any risks.
- ✓ Trials and validation: We develop and implement the processes and services you need to measure the performance of your asset against its requirement and specification, whether that asset is a platform, a system, a service or a product.
- ✓ Training: We develop training strategies informed by our training analyses to develop, deliver and audit programmes to support our customers' teams on complex projects.



Dreadnought Schedule Review

BMT led an independent team of UK/US Subject Matter Experts to undertake an independent review of the Dreadnought build schedule. As a result of this review, major programme issues were identified with a number of potential opportunities for reducing the duration of the build programme and for achieving an earlier in-service date. Numerous recommendations were implemented into the Dreadnought programme or are being developed further.

Through Life Support

We provide Through Life Support, or 'Integrated Logistics Support', across a range of engineering and technical domains to support pre and post-delivery logistics for new or modified submarines and underwater systems. From spare parts, training, technical manuals and packaging to shipping and warranties, we focus our expertise on ensuring delivered vessels achieve targets for availability, reliability and maintainability. This is further supported by the required technical documentation and management programmes essential to a long and reliable service life.

We offer

- Damage tolerance and structural integrity: BMT applies engineering and analytical tool expertise to a submarine's structural and mechanical systems throughout its life, from corrosion and mechanical damage to vibration, cracking, fabrication and design faults.
- Integrated Logistic Support and Reliability & Maintainability analysis: BMT undertakes Reliability and Maintainability (R&M) management, analysis and assurance activities to assess and improve the design and supporting functions throughout an asset's lifecycle, improving availability and contributing to reduced whole life costs.
- Life Extension (LIFEX) / Feasibility Studies: BMT works with Operating Authorities and industry alike to help get the most out of existing platforms and provide assurance that they can remain safe, capable and available during and beyond a Life Extension programme.
- Safety & environmental engineering: BMT supports duty holders and Project, Service and System (PSS) suppliers to deliver Safety & Environmental (S&E) Management, compliant with current legislation and Defence policy.

HMS Vanguard

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- P3M & Systems engineering: BMT provides proven P3M and Systems Engineering (SE) expertise to work as an integrated part of industry teams, to ensure projects are well defined, launched, and mobilised effectively. With the right controls established, the likelihood of delivery success is also increased.
- Design change: BMT undertakes design change for all parts of the lifecycle from end of life extensions to complex capability upgrades and combat systems integration. Our Chartered Engineers bring a comprehensive range of skills to support, maintain and improve naval platforms. The aim, as always, is to facilitate design change that supports a high level of fleet time availability and operational readiness through affordable and timely solutions.
- Disposal: BMT provides deep technical understanding of complex legacy platforms across all naval platform design disciplines. This allows us to understand and develop disposal or sales solutions as platforms reach the end of their useful life.

Vanguard Class Life Extension

The UK MOD had a requirement to extend the life of the Vanguard Class submarines. BMT developed a methodology and worked with stakeholders to assess the material state of individual systems. This included reviews of the original design intent, safety cases, ARM, maintenance and survey reports as well as literature reviews and assessment of age related degradation mechanisms. This work led to recommendations to the customer and proposed work packages for various fit opportunities.

Submarine Combat Systems

Combat systems are at the heart of a submarine's operational capabilities and BMT provides independent and trusted advice and support to our combat systems customers. We have expert knowledge of the requirements and constraints of the underwater battlespace and the challenges of operating and managing submarine combat systems equipment.

We have no vested interest in equipment solutions so we are able to take a genuinely independent view that can challenge and support our customers and their suppliers alike.



We offer

- ✓ Independent and trusted advice on the acquisition and spiral development of modular open architecture based combat systems.
- ✓ Customer support for integration configuration management, testing, trials and evaluation of existing, new and upgraded capabilities at both shore facilities and at sea.
- ✓ Subject matter expertise on submarine combat systems based on experienced staff who have served in the Royal Navy's submarine service.
- ✓ Support to all stages of the acquisition process covering project and programme management to Systems Engineering, Requirements & Acceptance, Business Case formulation, and supplier selection assessment.
- ✓ Engineering and Technical Services for the production of Guidance Information and technical specifications for the insertion of new equipment updates and upgrades.
- ✓ Safety Management including dynamic and functional safety, independent advice, and safety case assessment.
- ✓ Technical authoring and publication services for specialist combat system documentation, handbooks, and procedural guides.
- ✓ Availability, Reliability and Maintainability (ARM) analysis and assessment, data collection and performance analysis/assessment.

Independent & Trusted Expert (I&TE) support for the Submarine Common Combat System (CCS)

BMT is providing support to the UK Ministry of Defence (MOD) Submarine Delivery Agency (SDA) for the formulation and delivery of the UK's Common Combat System (CCS) strategy across both in service and new build submarines. BMT provides independent and trusted advice to the Combat System Delivery Team (CSDT) on the programme management, architecture and design, requirements and acceptance, functional safety, spiral development, and project delivery of the system and torpedo fire control subsystem.



Get in touch



Our team in the UK are on hand to discuss any aspect of Submarines & Underwater Systems engineering consultancy. Please feel free to get in touch via any of the contact methods below.



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