

The way ahead

○ Kockums A26 – The world's most modern submarine designed to meet future challenges

KOCKUMS

The way ahead

Along the world's coastlines – especially the littoral zones – the submarine is invaluable to maintaining maritime security and national wellbeing. Using the latest stealth technology, it becomes undetectable. While hidden, advanced network-centric communication integrated with similar systems on land, sea and in the air allows tight tactical control. And operational flexibility together with a comprehensive weapons suite enables it to carry out a wide variety of missions.

These are the hallmarks of the Kockums Maritime Security Concept regarding air-independent propulsion (AIP) submarine design and construction.

The best technology

But as we live in a world of constant change, we need to keep ahead in developing the best technology crucial to crisis-response, deterrence, peacekeeping operations and peace enforcement operations. For Kockums, the way ahead is building the next-generation submarine for Littoral Supremacy™ with ocean-going seaworthiness, a submarine that can withstand rough seas and travel long distances – the Kockums A26.

Kockums A26 is the world's most modern AIP submarine designed to meet future challenges. This brochure shows you how.

A formidable AIP submarine for ensuring maritime security

Many acknowledge Kockums as the shipyard with the accumulated experience to build the best non-nuclear submarines. This can be seen in the refinement of all the latest technology and systems needed to ensure maximum maritime security.

Traditional security involves national defence, intelligence gathering, surveillance and reconnaissance, offensive operations, anti-submarine warfare, mine-laying and special operations. Today, however, submarines are also being used to counter new types of security threats such as international terrorism, drug smuggling, human trafficking and illegal immigration. These new threats put greater demands on submarines to integrate their communications with those of other defence forces and civilian agencies.

The powerful Kockums A26 submarine is designed for the following missions:

- Maritime security operations including detection and attack against illegal activities.
- Intelligence operations, covert in hostile areas, including acoustic, visual, electronic and communication intelligence, which may entail deployment of unmanned maritime vehicles.
- Covert mine countermeasure operations, including mine searching and clearance using unmanned underwater vehicles.
- Special operations by carrying, deploying and retrieving special forces along with equipment and underwater vehicles.
- Anti-submarine warfare by searching, locating and classifying approaching and attacking submarines, and by countering other submarines.
- Anti-surface warfare where both own sensor data and/or external target information is used.
- Mine laying in covert mode.
- Underwater work such as manipulating, deploying, retrieving or destroying underwater objects and installations.



The Kockums A26 submarine secures Littoral Supremacy™

It is now a common assumption that the centre of attention for naval operations has shifted from blue water to the littoral zones of the world. Intelligence gathering, surveillance and sea denial along coastlines are becoming increasingly important. Operations in shallow water enable submarines to carry out covert monitoring of targets on land or sea using a range of electro-optical and electromagnetic sensors. Moreover, the ability of a submarine to lie motionless on the ocean floor, or “bottom out”, makes it almost impossible to find.

Securing total control

Submarine operations in the extreme littorals are also facilitated by the difficulty of carrying out anti-submarine warfare (ASW) in shallow water. A confusing combination of big thermal variations in water layers, unpredictable tides and currents, high reverberation and highly directional ambient noise defeats ASW measures.

This is why the next-generation Kockums A26 submarine, with superior GHOST® (Genuine Holistic Stealth) properties and AIP, is a valuable asset in securing total control in the extreme littoral zones, or as we call it, Littoral Supremacy™.

Blue water capability

Not only does the Kockums A26 submarine have excellent transit capability, but it can also operate in big oceans because of its:

- Long transit range
- Extensive endurance
- High snorting speed
- Deep diving ability
- High seakeeping performance
- Excellent crew comfort



The littoral zone – the shallow part of oceans nearest to the shore – is found along the coasts of many countries worldwide and is where much maritime activity occurs.



Freedom

Innovations contributing to greater freedom of action by the Kockums A26 submarine include optimized GHOST® for virtual invisibility, high invulnerability to underwater explosions, and excellent hydrodynamic properties that allow exceptional manoeuvrability. Thus the Kockums A26 submarine is practically impossible to detect and defeat.



Endurance

The Kockums advanced Stirling AIP system enables prolonged submerged endurance and its silence is key to maintaining GHOST®. A comfortable environment for the crew increases its staying power and smart procedures are implemented to maximize submarine availability. The Kockums safety concept along with extremely effective rescue methods helps maintain high crew moral and confidence in the submarine.



Modularity

Our modular approach comprises flexible payloads for multi-mission capability, including sending special forces directly into the ocean and retrieving them via the Kockums Multimission Portal™. A sectional hull also facilitates building the submarine and confers future-proofing through rapid updating and reconfiguration.



Integration

The General Management Services System (GMSS) is the backbone of all information systems on board the submarine and comprises an open architecture distributed system that integrates combat, ship control and administrative systems to assure exceptional mission control. A comprehensive, state-of-the-art sensor suite along with electronic warfare suites and network-centric communication enable outstanding situational awareness.

Optimized GHOST® for virtual invisibility

Over the last decade, Kockums has come a long way in optimizing its GHOST® (Genuine HOlistic STealth) technology, thus making the Kockums A26 submarine effectively invisible as all its signatures are lower than those of the Kockums Gotland-class submarines. Extreme stealth is the heart of the Kockums A26 submarine and it depends on good design right from the very beginning. The holistic nature of optimized GHOST® covers all types of signatures to make it almost impossible to spot during silent service.

A very silent submarine

Kockums has long experience in designing very silent submarines. In the Kockums A26 submarine, an extremely resilient platform technique incorporating extensive rubber mountings and baffles are used to minimize noise from operating machines and transient noise, as well as absorbing shocks. To further reduce emitted noise, the space between the frames is equipped with acoustic damping plates. This approach is used in combination with, for example, encapsulated Stirling and diesel engine modules; flexible hoses and compensators; and specifying maximum flow speed in air ducts, minimum bending radius on cables and pipes, and the design of out-board holes and cavities.

Further ways of keeping silent

To become invisible, further ways of keeping silent are exploited by the Kockums A26 AIP submarine:

The target strength of the Kockums A26 submarine is minimal because of the vessel's unique hull shape, the unique fin design, sonar and equipment accommodation, and a new type of surface acoustic absorption or reflection coatings. This highly optimized design also cuts the hydrodynamic signatures and flow noise around the submarine, both in deep water and near the surface.

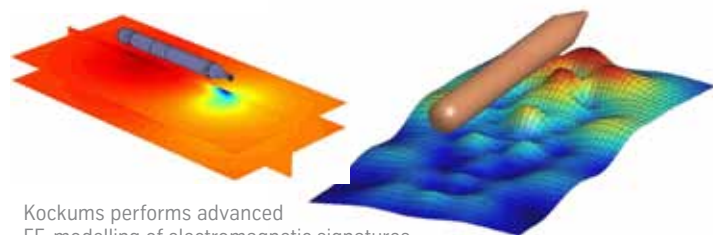
The magnetic signature is suppressed by an advanced degaussing system that is controlled by external sensors to facilitate compensation in all geographical locations and headings.

Galvanic signatures, primarily electrical but including secondary magnetic signatures are reduced by a specially designed

cathodic protection system and careful material selection that minimize electrical signatures without compromising the corrosion protection of the submarine.

Radar cross-section has been reduced by carefully analyzing and selecting the masts and mast-mounted sensors along with different coatings.

Infrared signatures are also minimized using different coatings and smart system solutions. In addition, the IR signature is not an issue with the Kockums Stirling AIP engine because the pressure reduction of the exhaust gases reduces the temperature dramatically before they are totally dissolved in sea cooling water and released into the ocean.



Kockums performs advanced FE-modelling of electromagnetic signatures



Highly invulnerable to underwater explosions

The Kockums A26 submarine is designed to withstand significant shock loads from underwater explosions, primarily of mines and depth charges. As mine detection by a submarine takes place at short range, shock resistance is imperative.

The hull of the submarine is constructed from special steels and the welding is tested using non-destructive methods to ensure its integrity and pressure-tightness. Materials technology, dimensioning and structural engineering are used to select the best materials to meet specifications, and strict quality assurance is applied to all construction and assembly procedures. All pressure-tight boundaries, including the weapon tube rear doors, are designed to withstand large underwater explosions at a near distance.

Kockums performs full-scale shock tests

Kockums is one of few submarine builders to carry out realistic full-scale shock tests using depth charge explosions at only a few meters from a complete vessel. The submarine is filled with sensors to monitor shock waves at different aspect angles and distances to produce a series of shock acceleration spectra.

Not only do such realistic tests enable Kockums to test a hull's resistance and the response of onboard equipment shocks, but they also provide the crew with valuable experience with explosions. The full-scale shock tests, carried out with a full crew onboard, are part of the acceptance tests for the submarine and also provide invaluable information for Kockums to develop its program of continuous improvement.

In good shape for exceptional manoeuvrability

Being able to quickly turn, rise and dive are valuable tactics when the occasion demands. A number of features makes the Kockums A26 submarine highly manoeuvrable, a feature that contributes significantly to freedom of action. The X-rudder configuration with four independently controlled control surfaces enables the submarine to quickly change position or direction. When submerged, a very tight turning circle can be achieved at all speeds. Moreover, changes in depth can be performed quickly even at low speed because of the well-balanced metacentric height.

Enhanced AIP performance for greater submerged endurance

The Kockums A26 submarine is dimensioned for nominal missions of 45 days and the Air-Independent Propulsion (AIP) technology allows the submarine to stay fully submerged for significantly long periods of time during a mission.

The Stirling AIP system is regarded as the main propulsion system and is used for all submerged operations at patrol speed. It is extremely silent and does not create any thermal (IR) signature. The diesel engines are used only for long distance transit at medium speed in either surfaced or snorkeling condition.

Our Stirling AIP has proven its success over decades

Kockums has been involved with the development of Stirling AIP systems since the 1980's, and it is now proven, mature and robust technology. It has been delivered to several export customers and attained over 20 years of operational service and several tens of thousands of running hours onboard submarines. All Swedish submarines today have Stirling AIP.

Taking care of the Kockums AIP system is just as easy as keeping a common internal combustion engine in good condition. It is compact, modular and manageable, important spare parts can be stored on board, and the system can be maintained and repaired in-situ by crew members, even while in operation during a mission.

The AIP system burns a mixture of gasified pure industrial liquid oxygen (LOX) and diesel fuel. The same low-sulphur diesel is used for both the diesel and Stirling engines. Thus both LOX and diesel enable cost-effective energy production and simple logistics.

A contented crew boosts staying power

A happy crew contributes to increased working efficiency and smoother operations. Crew accommodation on the Kockums A26 submarine is good for work and leisure time, as well as for physical and mental wellbeing. It is based on Scandinavian design to give more comfort to crew members. In accordance with Swedish Navy requirements, the accommodation is based on the "hot bunk principle" where two crew members share the same bunk in rotation. In this way the number of

bunks can be kept low, thereby allowing the cabins to be made relatively spacious and comfortable in a light and pleasant environment. This is an important factor in recruitment.

One can say that a new way of thinking for modern submarine missions has now been matched by new thinking applied to habitability by Kockums.

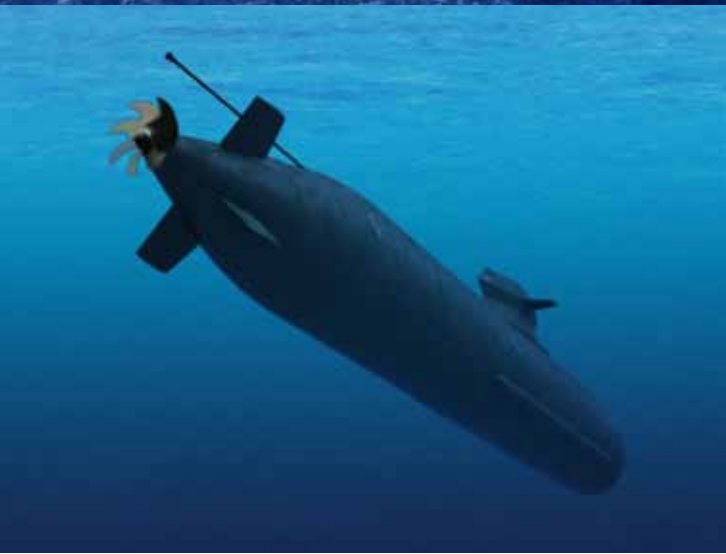
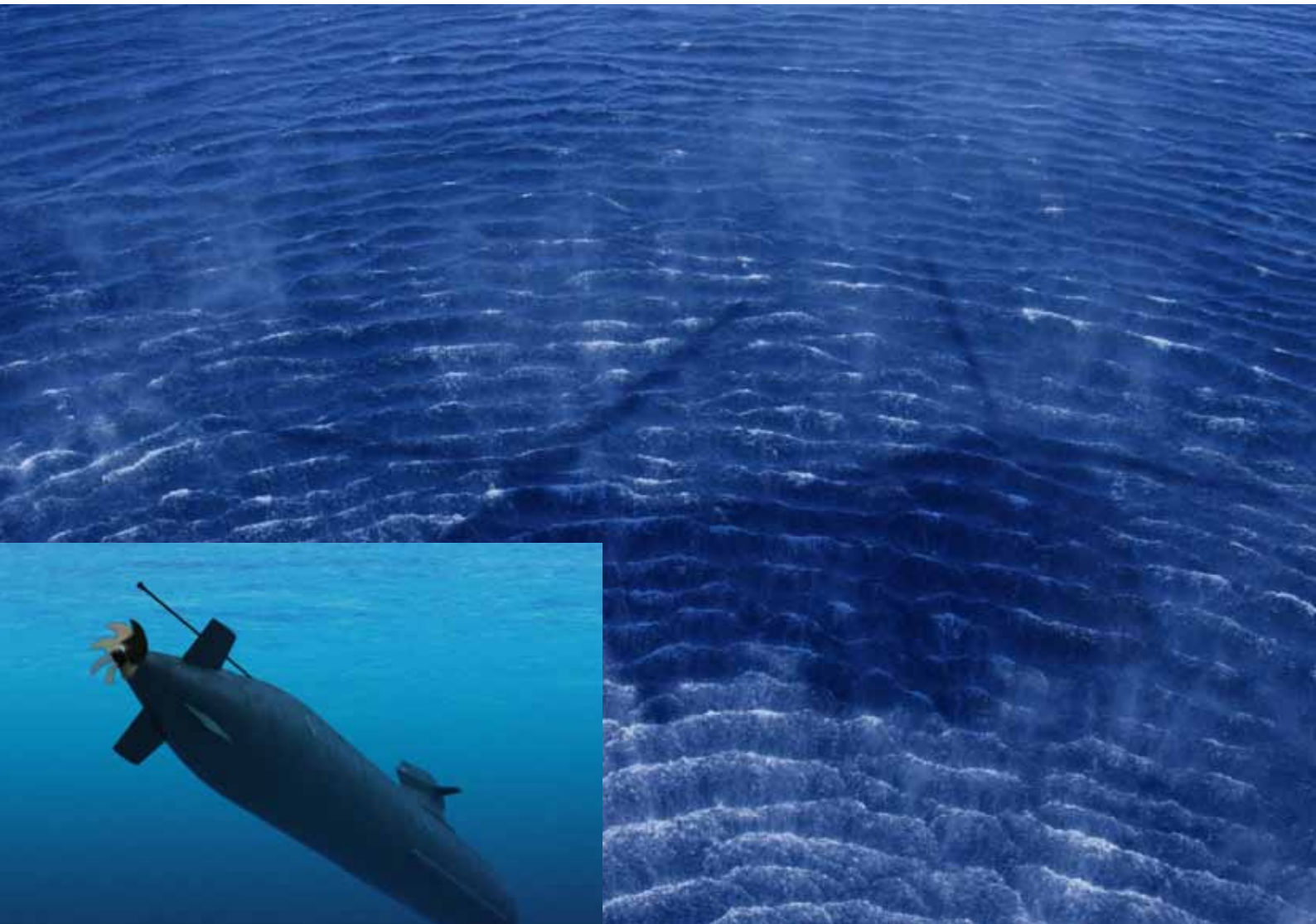
Putting safety first

To prevent flooding, the Kockums A26 submarine is designed in compliance with the Swedish Navy standard on submarine safety. All major pressure hull penetrations have double shut-off valves remotely controlled and activated by a flooding indication system, although manual override is possible. Should flooding occur, the emergency high-pressure air-blowing system is dimensioned to surface the submarine from a hovering state at maximum diving depth.

Fire protection is designed according to SOLAS requirements and further functional fire-protection requirements can be incorporated as demanded by the customer.

The submarine is divided into two pressure-tight compartments separated by a pressure-tight mid-tank section accessible from both compartments. If crew members need to evacuate, it is done through the escape tower located on top of the mid-tank section. Either a submarine rescue vehicle (SRV) can be used for collective rescue down to collapse depth or single escape could be carried out at a maximum depth of 180 m.





Smart procedures designed for maximum availability

A submarine should be designed to allow good accessibility to all units requiring maintenance and to minimize maintenance times. This is what you get with the Kockums A26 AIP submarine, where increased availability, reliability, maintainability and supportability are key objectives. Preventive, corrective and mission-critical maintenance activities can be performed on the submarine by ordinary crew members using onboard spare parts and support and test equipment. And wherever possible, Kockums uses COTS equipment rather than MIL-standard to reduce repair costs and simplify work.

Flexible payloads enable multimission capability

A key benefit in the design of the Kockums A26 submarine is its modularity, which provides an amazing degree of operational flexibility, futures-proofs the vessel and contributes significantly to cost-effective construction and assembly. For example, it facilitates:

Flexible payloads – which applies to weapons and sensors, allow for the allocation of space for future but yet to be identified equipment. Up to eight divers including their equipment can be launched and retrieved through the Kockums Multimission Portal™. Unmanned undersea vehicles (UUVs), including remotely operated underwater vehicles (ROVs), can also be deployed through the portal.

Payload exchange – adaptable according to mission type. Mast modules can be exchanged, external payload space can be used for different equipment such as pressure-tight containers and underwater vehicles, and reconnaissance and rescue systems can be selected.

Distributed component production and assembly – like pre-outfitted deck platforms, and encapsulated Stirling AIP and diesel engines.

Extending systems – prepared for future upgrades. For example, a hull section can be inserted in the forward or aft compartment. In the forward section, additional space for accommodation, workstations and other equipment can be inserted. In the aft section, another diesel and/or Stirling AIP engine can be installed. An electrical system may also be extended to supply more consumers.

Extending range – by installing larger fuel tanks.

Easy system integration – with an open network having basically plug-in/plug-out equipment instead of time-consuming integration with complex wiring.

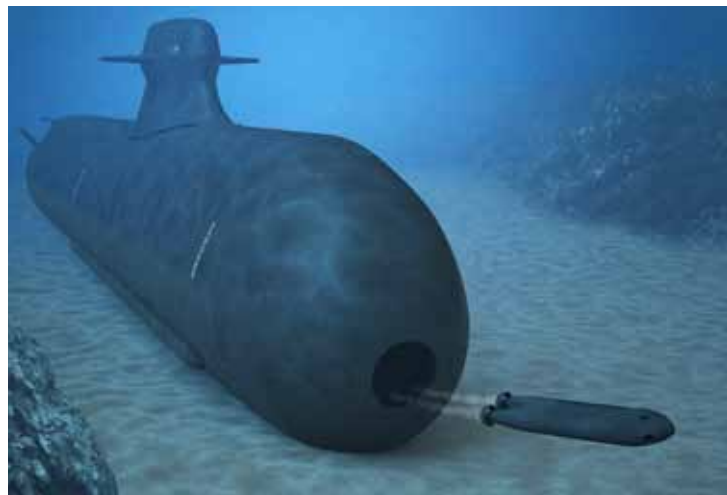
Software modules – modularity also covers the vast array of software programs that can be selected as modules to customize user needs.

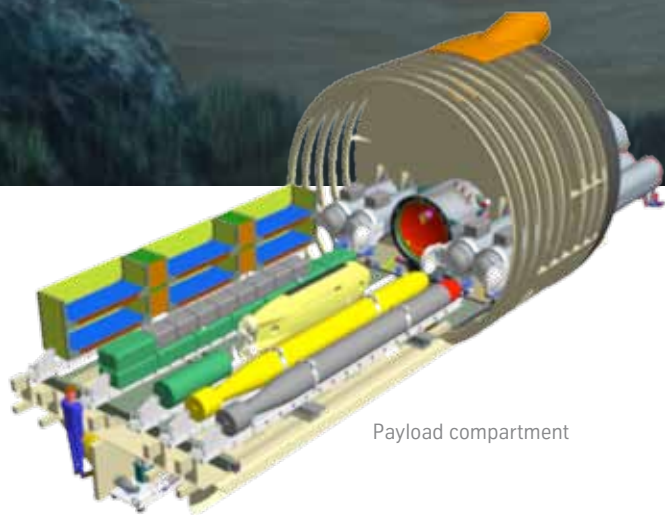
The Multimission Portal™ for diverse missions

A key unique feature of the Kockums A26 submarine is the Multimission Portal™ designed to launch and retrieve diverse mission payloads, including those for special operations. The portal is arranged between the 53 cm weapons tubes and has a length of 6 m and diameter of 1.5 m in which up to eight divers can sit ready for a mission in the sea.

At the end of the Multimission Portal™ is an ocean interface through which both divers and equipment used in various missions, including UUVs and ROVs, pass while the submarine is hovering or lying on the sea bottom. Mine countermeasures can also be launched through the portal. BIBS connections are present for use by divers, if necessary, while waiting to leave the Multimission Portal™.

The flexibility of design enables the Multimission Portal™ to be prepared for future payloads of unconventional shape





and size such as different types of non-specified UUVs, sensor devices or other bottom-laying devices. Support systems for the portal include those for pressurization and decompression of the portal, supervision and communication.

Weapons to deter any adversary

The Kockums A26 submarine weapons suite will deter any adversary. The main weapon is the 53 cm heavyweight torpedo, and 40 cm torpedoes and mines can also be carried and launched through the weapon tubes. A total payload of more than fifteen 53 cm weapons is possible. A missile system and a mast-mounted gun can also be integrated with the weapon system.

The submarine has a large flexible payload stowage compartment and other types of payload can also be carried externally in dedicated spaces under the deck. The weapon tubes and associated handling systems are dimensioned to allow various types of weapons to be used, including all existing torpedoes, missiles, mines and UUVs. As the tubes are flooded and drained by gravity, noise is suppressed during preparation for a weapon launch by eliminating the use of pumps or compressed air.

The submarine is equipped with all the necessary equipment onboard to embark and disembark weapons at any harbour or from a service ship at sea. Weapons are embarked through a dedicated hatch in the deck and slid down on the weapon handling rack to the payload storage platform where they are lowered to the horizontal position. Disembarkation follows the reverse route.

Tightly integrated data network

In order to facilitate system integration, future upgrading and expansion, as well as reduce costs, all applicable management and control systems of the Kockums A26 submarine are interconnected through the vessel's information network system, the General Management Services System (GMSS). This is the backbone of all information systems onboard and comprises an open architecture distributed system that integrates combat and ship control systems along with administrative applications. To cut lead times and costs, the GMSS is mainly based on easily obtainable commercial off-the-shelf (COTS) products, technologies and standards, adapted and/or applied to naval military applications.

All applicable subsystems are interconnected through the GMSS and operated from common multifunctional consoles (MFCs). GMSS access points throughout the submarine enable easy connection for a large number of additional MFCs, workstations and laptops.

All major ship systems are managed through the Ship Control and Monitoring System (SCMS), which is normally operated from selected operator positions, although it can also be operated from any MFC in the submarine. The SCMS is also based on COTS parts, and most components, network,

processors and power supplies are redundant with hot swap standby to ensure full functionality if the primary system becomes damaged.

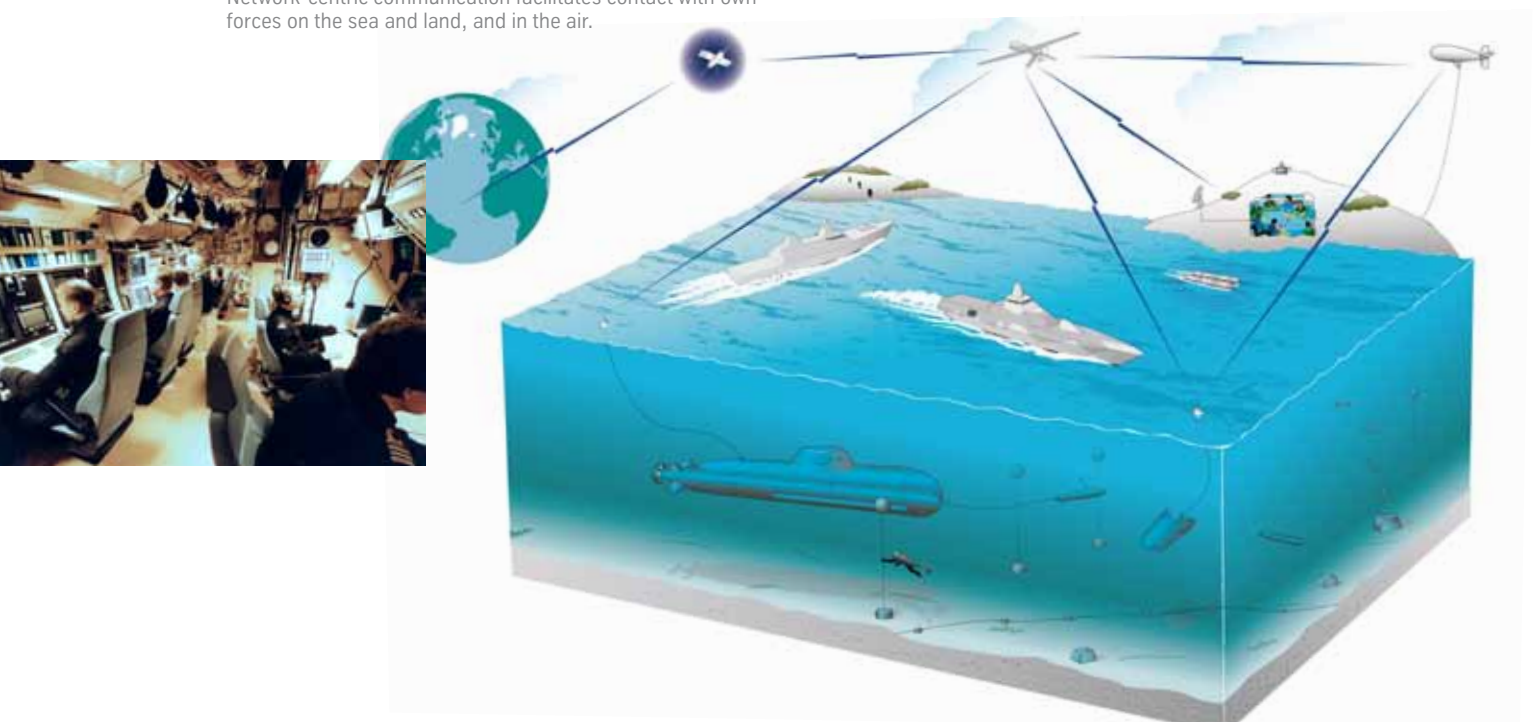
Decentralized combat management

The combat system of the Kockums A26 submarine is managed from a Saab combat management system (CMS) specially developed for this submarine. Notably, instead of being a central system to which all other systems are integrated, the CMS is a subsystem linked to the GMSS and communicates using open standards. This allows integrated systems, including the CMS, to be individually upgraded or exchanged, thereby greatly reducing project risks typically found with large, complex and highly integrated systems.

The CMS allows high-performance data exchange via the GMSS with other systems like sonar, Electronic Support Measures (ESM), weapon interface systems and the vessel control system. Like all other systems connected to the GMSS, the CMS can be operated from any MFC in the submarine.

Thanks to the mast-mounted optronic sensor, which eliminates a hull-penetrating periscope, an efficient arrangement is achieved with the control room located in the bow equipped with eleven MFCs in a U-shaped configuration.

Network-centric communication facilitates contact with own forces on the sea and land, and in the air.





Better tactical decision-making

The tactical picture held in the CMS provides the basis on which tactical situation assessments and decisions are taken by the CMS operators or by automatic CMS functions. The tactical picture symbolizes the tactical environment within the CMS based on sensor-detected entities in the environment of own ship (organic), information received via data links (non-organic) and manually added information from the operators.

The CMS includes functions for target motion analysis (TMA) of own submarine and the tracked target to calculate and present the optimal own-ship TMA manoeuvres. The exchange of tactical information and operational commands and plans with other force units is possible via CMS tactical digital information links (TADIL). This also provides the ability to select radio silence as required by defence forces emission control policies.

Collecting and sharing situational data

Both passive and active sonar systems are built into the Kockums A26 submarine. The comprehensive range of passive sonar arrays located around the submarine provides detection, tracking and analysis of hydro-acoustic signals in a large frequency range over a 360 degree span.

The active sonar system includes a mine and obstacle-avoidance sonar (MOAS) mounted in the bow.

The MOAS has large horizontal and vertical coverage with capability to detect and localize both moving and non-moving objects in the water, on the surface and on the sea bed. It also provides a 3D view of underwater terrain for navigational or other purposes.

Network-centric communication

Comprehensive and advanced network-centric communication is built into the submarine based on an open platform to suit customer needs. External communication is via radio, hydro-acoustic and shore-connected communication. Radio communication with other units, special forces, shore and global maritime distress and safety system (GMDSS) can be carried out both submerged and on the surface using VLF, LF, HF, UHF, GSM & 3G, IRIDIUM, IFF and UHF Satcom frequency bands. WAN/LAN connections and telephone lines are available in ports, and a communication buoy allows communication at large depths.

The navigation system, operated from any MFC, is separate from the CMS but closely integrated. The system provides continuously updated navigational and environmental data to the submarine, and tools for navigating the submarine. In covert mode, navigational data is estimated only from passive sensors: when active systems are used, signature control is performed.

A thorough approach to minimizing life cycle costs

As seen throughout this brochure, Kockums has taken numerous measures to minimize the life cycle costs of the Kockums A26 submarine. As the capital costs are huge, it is crucial to get the best out of this investment by implementing measures that minimize running costs over the lifetime of the submarine. The major ones are summarized below.

- The modular concept is production-friendly by allowing pre-outfitted platforms to be constructed offsite and delivered when required.
- Modularity allows continuous and straightforward adaptation or updating of systems and equipment to allow future-proofing of the submarine to attain the maximum life cycle.
- A high degree of automation of all management and control systems means that a smaller crew can carry out all the operational functions on board.
- Kockums Integrated Logistics Support (ILS) extends the operational lifetime of the submarine. Our condition-based maintenance concept is stepwise to ensure that everything does not have to be replaced at the same time. This also maximizes submarine availability.
- Advanced life cycle costs analysis is also conducted to ensure low operating and maintenance costs throughout the service life of the submarine.

- Kockums uses COTS components instead of MIL-standard parts where possible to reduce repair costs and simplify work.
- Onboard maintenance of the Stirling AIP engines can be performed by the crew.
- Replenishment of many requirements at sea can be carried out, including for the Kockums Stirling AIP system and torpedoes.

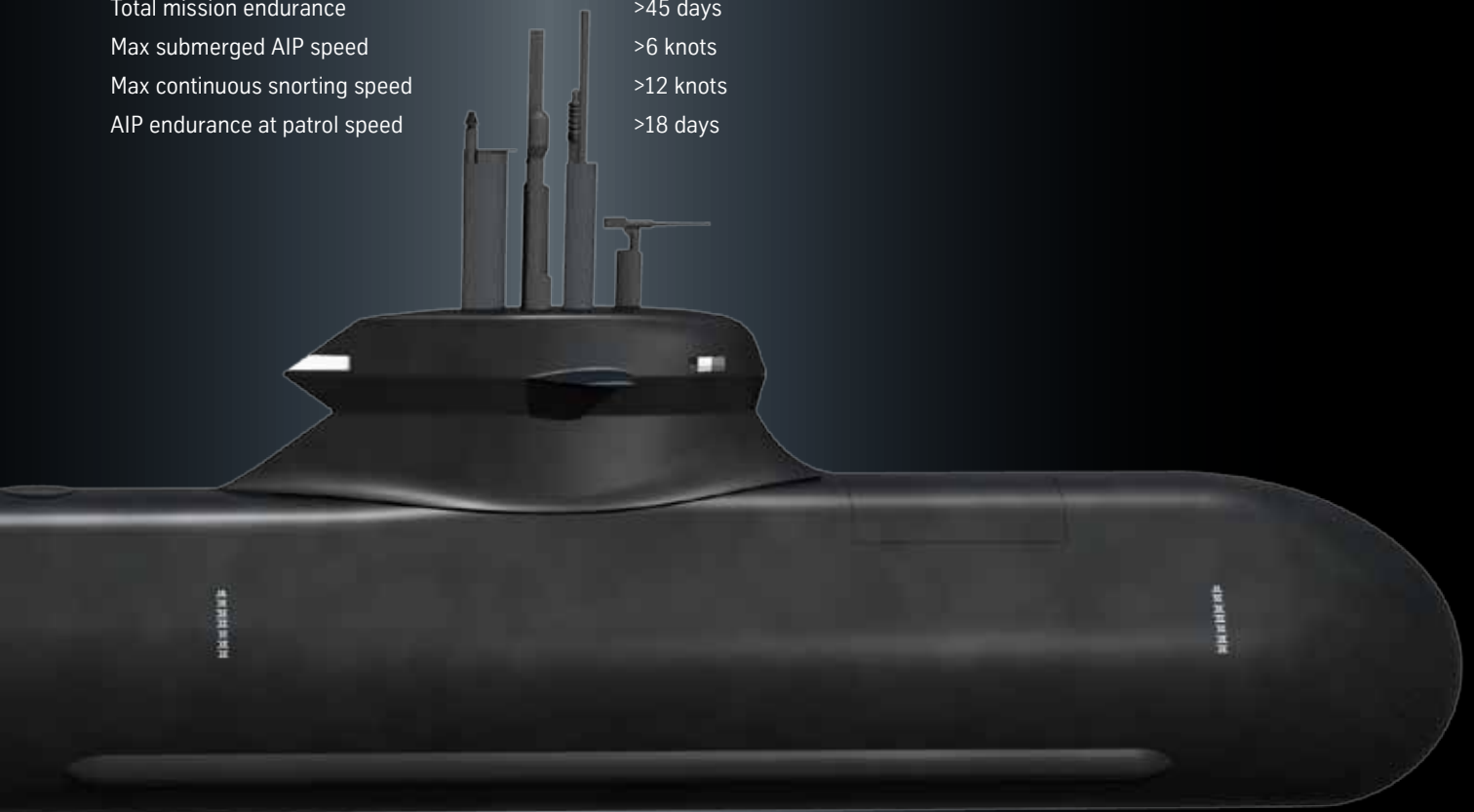
Thus, the Kockums A26 submarine is designed and developed from an economical perspective to provide a very cost-effective investment when considering the decades during which it will be operational.



Basic technical specifications

Kockums A26 submarine

Length	~62 m
Draught surfaced	~6 m
Displacement, surfaced	~1800 tonnes
Maximum diving depth	>200 m
Standard complement	26 persons
Number of weapon tubes	4
Weapons	53 cm torpedoes, 40 cm torpedoes, mines
Number of heavy weapons	>15
Multimission Portal™	Length >6m, diameter > 1.5 m
UUV capacity	Launch and recovery through the Multimission Portal™
Countermeasures	Inboard/outboard countermeasures launchers
Operating sea water temperature	From -2 to +32 °C
Operating sea water density	1003 – 1032 kg/m ³
Total mission endurance	>45 days
Max submerged AIP speed	>6 knots
Max continuous snorkeling speed	>12 knots
AIP endurance at patrol speed	>18 days





Take the next step with us

We hope this brochure has shown you the amazing capabilities of the Kockums A26 AIP submarine and that you agree with us that it is truly the world's most modern AIP submarine ready to meet future challenges.

We also hope that you now feel ready to take the next step – to contact us for an informal and open-ended discussion about the way ahead as regards the potential of this submarine to satisfy your naval mission needs.

Welcome to Kockums.

KOCKUMS

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