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Poland's 'Orka' submarine programme. Part 3. The A26 submarines – Swedish Offer

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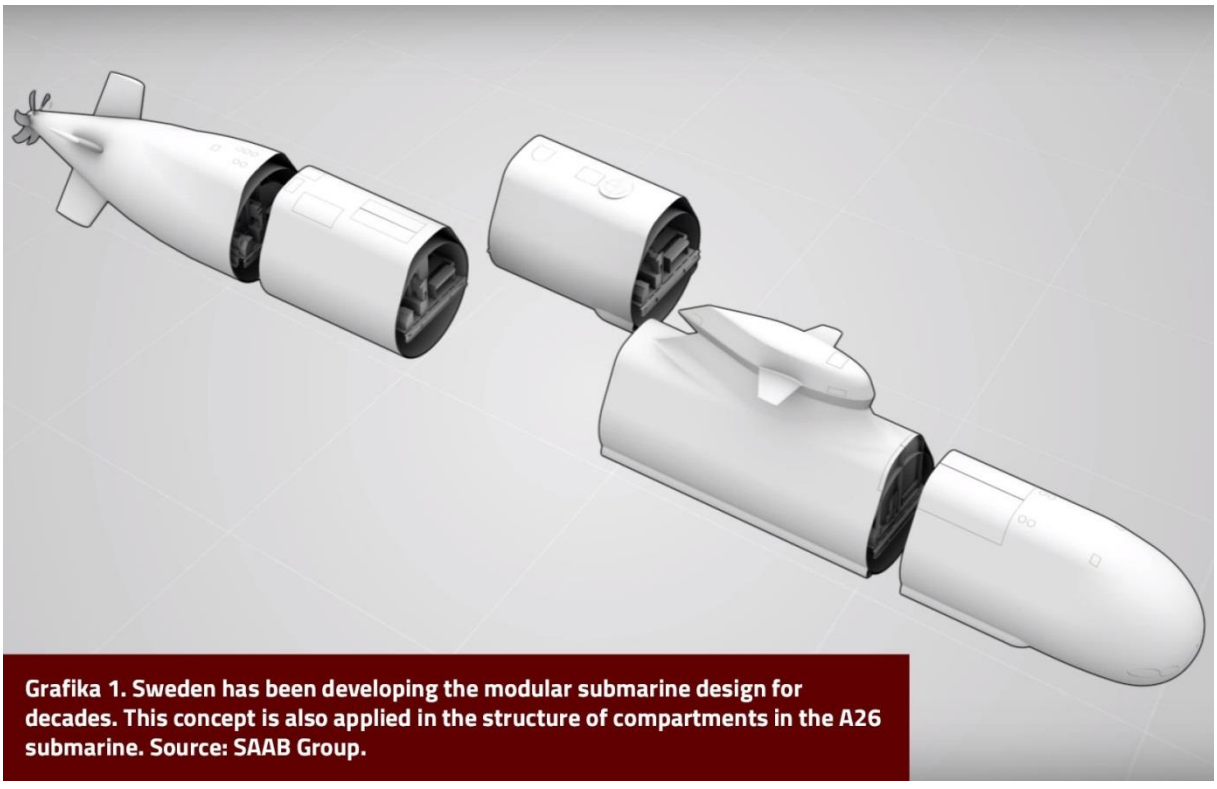
On June 21st, 2017, the Casimir Pulaski Foundation organised the third and last seminar concerning technologies and combat capabilities of conventional submarines competing in the 'Orka' program, which is intended to select the next generation submarine design for the Polish Navy. The participants had an opportunity to familiarise themselves with the experience of the Swedish Royal Navy and detailed information on the Swedish offer and A26 submarine.

Over the past few years, Sweden has been developing its defence and shipbuilding industry through the construction of new vessels as well as the modernisation of their older ones. The A26 submarine offered within the framework of the 'Orka' programme is the result of the experience gained during the construction of the Västergötland-class (A17) submarines, Gotland-class (A19) submarines, and subsequent modernization of these older boats. In the mid-1990s, the Swedish Navy launched three Gotland-class submarines, fitted with the Air Independent Propulsion (AIP) modules based on the Stirling engine. In 2003 and 2004, the Kockums shipyard rebuilt and modernised Västergötland-class (A17) vessels by inserting an additional hull section with the AIP module. Ultimately, this enhanced new type of submarines was renamed as the Södermanland class. In turn, two Västergötland-class submarines were sold to Singapore and modernised following the Södermanland-class design. Currently, these submarines are in active service in the Republic of Singapore,

> *The Swedish boats are based on an evolutionary approach to the submarine design and experienced gained during the construction of the Västergötland (A17) and the Gotland-class (A19) submarines. The principal attribute of the A26 submarine is that it is modern, has a stealthy design developed by the GHOST (Genuine HOlistic STealth) technology, which is intended to decrease the risk of detection of both submerged and surfaced submarines.*

designated as the Archer class. In 2015, the Swedish government ordered two new boats based on the A26 design from the SAAB company. Independently, the Swedish government decided to upgrade two out of three Gotland-class submarines. The modernised submarines are expected to be equipped with new technologies and systems designed for the A26 submarines with an anticipated launch date between 2018 and 2019.

All sections and modules of the A26 submarine are independently built and designed to simplify the final assembly of the boat and integration of electronic systems to ensure the modular structure of the submarine is recognised as its key asset. There is a plethora of advantages related to the Swedish model such as the submarine's flexible design, which allows user to modify its configuration and capabilities without significant changes to the main objective.



Grafika 1. Sweden has been developing the modular submarine design for decades. This concept is also applied in the structure of compartments in the A26 submarine. Source: SAAB Group.

The A26 submarines represent the newest design out of all boats offered within the framework of the 'Orka' programme. However, due to the early stages of construction of these vessels, it is possible that the first units will encounter technical issues at the very beginning. Nevertheless, the Swedish Navy has ordered the A26 submarines, and most of its electronic systems will also be installed on their modernised Gotland-class submarines, what reduce risks for Poland. Furthermore, the A26 submarine has been uniquely

designed to conduct operations in the littoral zone just as the German 212A class submarines. The Swedish producer has applied stealth technology into the design to reduce acoustic (sonar) cross-section (SCS) of the warship. Undoubtedly, the Swedish submarines are one of best in the world. In 2005, the HSwMS Gotland was deployed to San Diego, USA for two years (2005-2007), where it played the role of an adversary of the US Navy. The boat proved its quality and interoperability with NATO units during the training exercises, and this astonishment was confirmed by Americans who pointed out difficulties related to detection of the Swedish submarine due to its Air-Independent Propulsion system.

Technical aspects

The Swedish A26 submarine is based on a multirole design with particular attention placed upon the hydrological specificity of the Baltic Sea. According to its Swedish manufacturer, A26 submarines are designed to be capable of accomplishing the following objectives and missions: 1) maritime security operations; 2) intelligence, surveillance and reconnaissance operations (potentially entailing deployment of unmanned underwater vehicles); 3) mine-laying and mine-countermeasure operations; 4) conducting special operations with participation of special operations troops; 5) anti-submarine and anti-surface warfare; 6) support for underwater work, including infrastructure and underwater installations.

The A26 type ship is constructed using stealth technology. The pressure hull is made using the Weldox 700EM steel, enabling the vessel to be operated at a depth of approximately 200-250 m.[i] Stealth features are also discernible in the shape of the fin – according to engineers, the innovative design is to minimise the risk of detection even when the ship is surfaced. Ship's hull and fin are also going to be covered with anechoic (sound absorbing) coatings and paint, designed to absorb signals emitted by hydroacoustic stations.

A host of solutions developed by the Swedes in order to reduce the effective surface reflection, as well as the magnetic and acoustic signature are referred to as GHOST (Genuine HOlistic STealth). The version designed for the Swedish Navy will be 62 m long and about 6,7 m in diameter, with an underwater displacement of about 2,000 tons. In case of the Polish Navy offer however, a considerably larger version of the ship may be

considered, with the addition of a nearly 10-meter long section, equipped with up to three vertical launch pods for the UGM-109 Tomahawk cruise missiles.

Extending the ship to nearly 72 m would increase the displacement of the unit to around 2,400-2,500 tons. The SAAB project assumes placement of four 533 mm torpedo tubes in the bow section of the ship with a total payload of over 15 torpedoes or missiles[ii] (and additional four stored in the launchers), as well as the MMP (Multi Mission Portal) with a length of approximately 6 m and diameter 1.5 m, which significantly increases the ship's capabilities. MMP can be used as a special gate for launching naval divers or unmanned underwater vehicles (UUV), as well as other mission payloads.

Majority of the sensors, and communication systems are fitted inside the ship's fin, alongside the 30 mm cannon, which can be used to combat asymmetrical threats. The vessel's Combat Information Center (CIC) is placed in the forward bow section, along the command post. In the outer, upper part of the aft section of the ship hydroacoustic station antenna is located.

Both the aft and the bow outer part are also fitted out with a modular space, in which anti-torpedo decoy launchers, as well as hermetically sealed containers are located, among other equipment. In the aft part of the ship an engine room will be located, alongside the propulsion system with an AIP module, based on Mk V Stirling engines. The ship will be equipped with the 30 Series AOM (Attack Optronic Mast) and the 30 Series SOM (Search Optronic Mast), with both systems being manufactured by SAGEM. The ship will also most likely be equipped with the Atlas Elektronik CSU 90-2 sonar sensor. Information systems, armaments and ship's sensors will be integrated in the SAAB 9LV Mk4 CMS (Combat Management System) combat control system.

The ship's crew will consist of 26 people, including five officers (with the manufacturer also designing a 17 sailor configuration), although it is possible to embark additional staff, such as special operations assets (the producer specifies a maximum crew of 31 people).

A26 type ships are characterised by a somewhat lower autonomy than their French and German rivals, with this parameter stated to be 45 days (for the sake of comparison, in case of the Scorpène class vessels, autonomy period is up to 70 days, and 50-70 days for the 212A/214 German made submarines). The AIP system installed on the ship enables operation under water at a patrol speed (6 knots) for approx. 18 days.[iii] It is worth noting that the Stirling engine is characterized by lower energy conversion efficiency than fuel

cells (40% as compared to nearly 80% for fuel cells), but higher than the competitive MESMA power plant (only 25%) (this comparison of the actual engine shall not be regarded as efficiency for the whole submarine system). On the other hand, the solutions developed by the Swedes are significantly more simple and cheaper to operate, as they do not require specialised infrastructure for maintenance, unlike fuel cells used on German ships.

Stirling engines allow for the renewal of operational readiness, after replenishment of stocks (including at sea), in just a few hours – this is undoubtedly a strong point of the Swedish submarines' propulsion system – especially considering the maximum speed in the underwater position of about 20 knots. Even though Stirling engine is characterised by relatively low acoustic (the systems are encapsulated, and placed on rubber mountings and baffles) and thermal signatures when compared with the MESMA power plant, it seems that fuel cells are currently unrivalled in this regard, mainly due to their lack of any mechanical parts. Swedish Stirling engines have also gained recognition abroad – Japanese Sōryū-class submarines, produced under license from Kawasaki Heavy Industries, and the Archer class submarines of the Republic of Singapore Navy are also equipped with Stirling engines.

A significant drawback of Stirling and MESMA engines is the need for the removal of exhaust gases (after dissolving them in sea water) by releasing them into the sea. This problem does not occur in case of polymer membrane fuel cells developed by Germans, minimising the risk of submarine detection.

According to the manufacturer, the technical solutions employed in designing the A26 will allow for minimalizing the unit life cycle cost. The modular structure of the ship will not only allow to accelerate the process of building the vessels (work on individual sections can be carried out in parallel at several shipyards), simplify the final assembly process and systems integration, but also reduce the costs associated with future modernisation of the A26 fleet. Far reaching systems automation and the simplicity of technologies used (such as the Stirling engine) are to ensure high efficiency of units and the ability to commence repairs of the propulsion system and other small defects in situ by the crewmembers. An important advantage is also the ability to quickly re-establish combat readiness while at sea which entails the replenishment of both fuel – including liquid oxygen (LOX) for the AIP modules, and armaments.

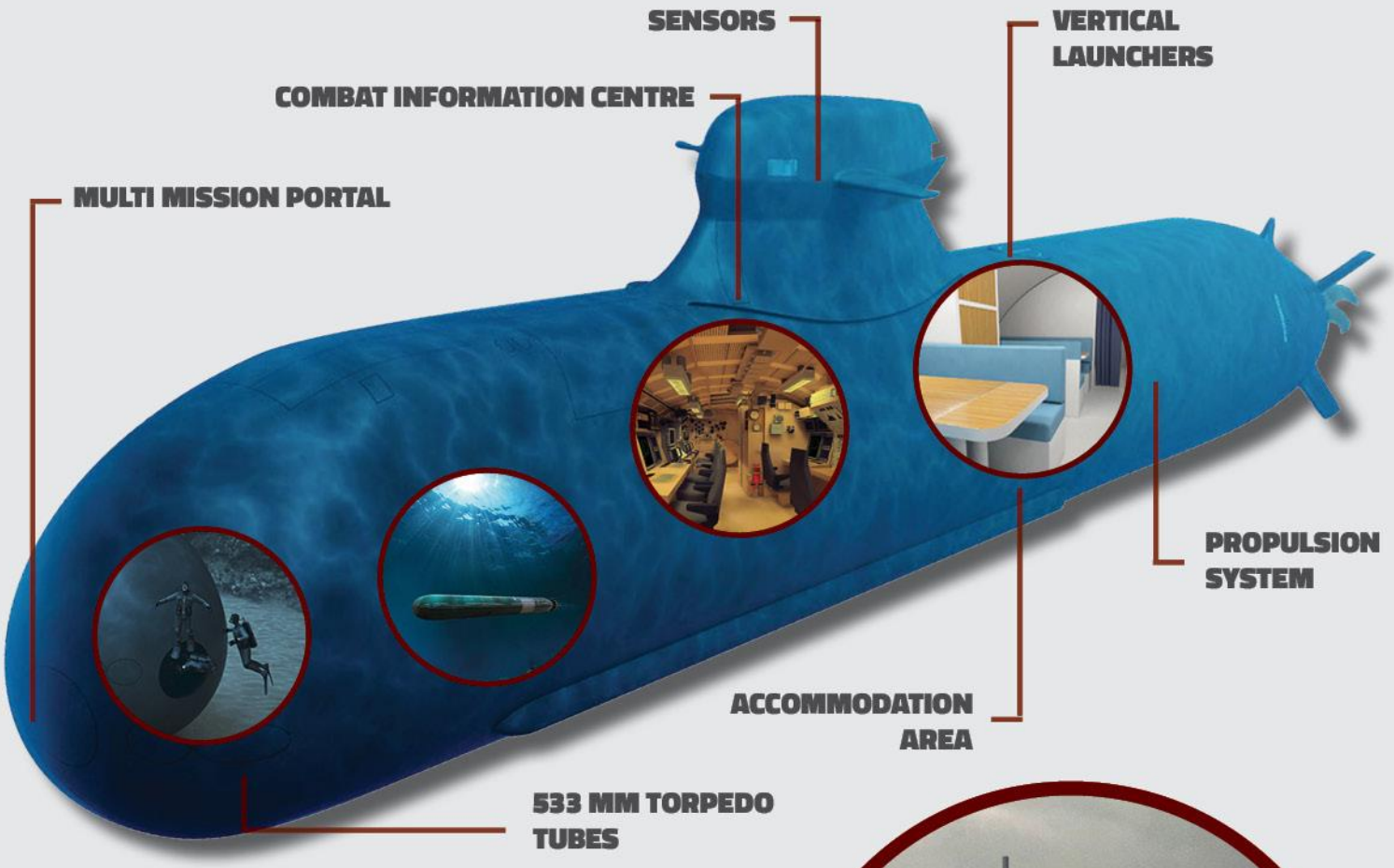
As far as the Swedish and German offers are concerned, equipping the ships in cruise missiles remains the main issue (the French company Naval Group offers MBD MdCN missiles as a package with their submarines). The only weapons system potentially available to Poland if 212A/214 or A26 ships were to be selected is the American made UGM-109 Tomahawk missile. This however means, that the missile systems for the new vessels would have to be purchased as a separate tender following bilateral negotiations with the United States government. France has declared that MdCN/NCM will only be sold with ships designed by the Naval Group itself.

ThyssenKrupp Marine Systems and the Naval Group plan to integrate cruise missiles in their designs in a way that will allow for launching them from the 533 mm weapons tubes. This means that the prospective Polish craft will have to carry mixed munitions payload inside the torpedo compartment (if the ship is to be capable of defending itself against enemy submarines and surface ships) – consequently, any given ship would likely have only several cruise missiles at its disposal. The Swedish manufacturer, however, proposes a completely new solution in the form of vertical launchers, typically employed on the nuclear-powered submarines. So far, this type of launcher has not been integrated into conventional vessels – SAAB's announcement was met with scepticism from its competitors, who claim, that the size of ships planned under the "Orka" program will not allow for installing such a weapon system.

Nevertheless it does appear, that the criticism of the SAAB group is not justified – according to information provided by the Swedish manufacturer, the British company Babcock International will be responsible for the design, construction and integration of the ten meter hull section, which is going to house the three six-chamber vertical launch pods. Babcock International has been involved in carrying out projects related to the integration of missile weapons systems into ships since the 1970s, and their portfolio includes work on US and British nuclear-powered submarines, while SAAB representatives assure that adding the vertical launchers module will not have a significant impact on the overall duration of the A26 construction.

KOCKUMS A26 SUBMARINE

Specifications



General Data

Length	approx. 62 m / 72 m*
Draught Surfaced	6 m
Diameter	approx. 6,7 m
Displacement	approx. 2000 t / 2500 t*
Crew	26 (max. 31)
Pressure Hull Material	HY-100
Total Mission Endurance	45 days (18 with AIP)
Maximum Diving Depth	> 200 m
Max Speed / Submerged AIP Speed	> 20 w / 6 w
Propulsion System	Hybrid: Diesel Generator / AIP - Stirling Engine
Weapons	4 torpedo tubes (533 mm) 15 torpedoes / missiles aboard (+4 in launchers) / 3 vertical launchers with 18 Tomahawk missiles

*Submarine equipped with vertical launchers

The Swedish Royal Navy ordered 2 A26-class submarines, which are expected to join the Swedish fleet in 2022-2024. The government plans to acquire further 3 submarines.

Author: Rafał Lipka. Source: SAAB Group. Pictures: SAAB/Calisto Data AB.

The use of a vertical launcher would make the Polish A26 submarine one of the most heavily armed vessels of its class in the world (with the payload of over 15 heavy torpedoes or anti-ship missiles[iv] or mines, complemented by an additional 4 munitions in the launchers, and 18 Tomahawk cruise missiles).[v] A26 type submarines will most likely be integrated with the Tp 62 heavy torpedoes (533 mm caliber, 130 kg warhead, range over 40 km); Tp 47 torpedoes; NSM missiles (currently fielded by the Maritime Missile Unit; "Morska Jednostka Rakietowa"); and Mk-42 mines.

It can also be assumed, that if necessary, integrating weapons made by other producers into these vessels will also be possible, pertinent to the requirements set by the Ministry of National Defence.

Consequences of selecting the offer

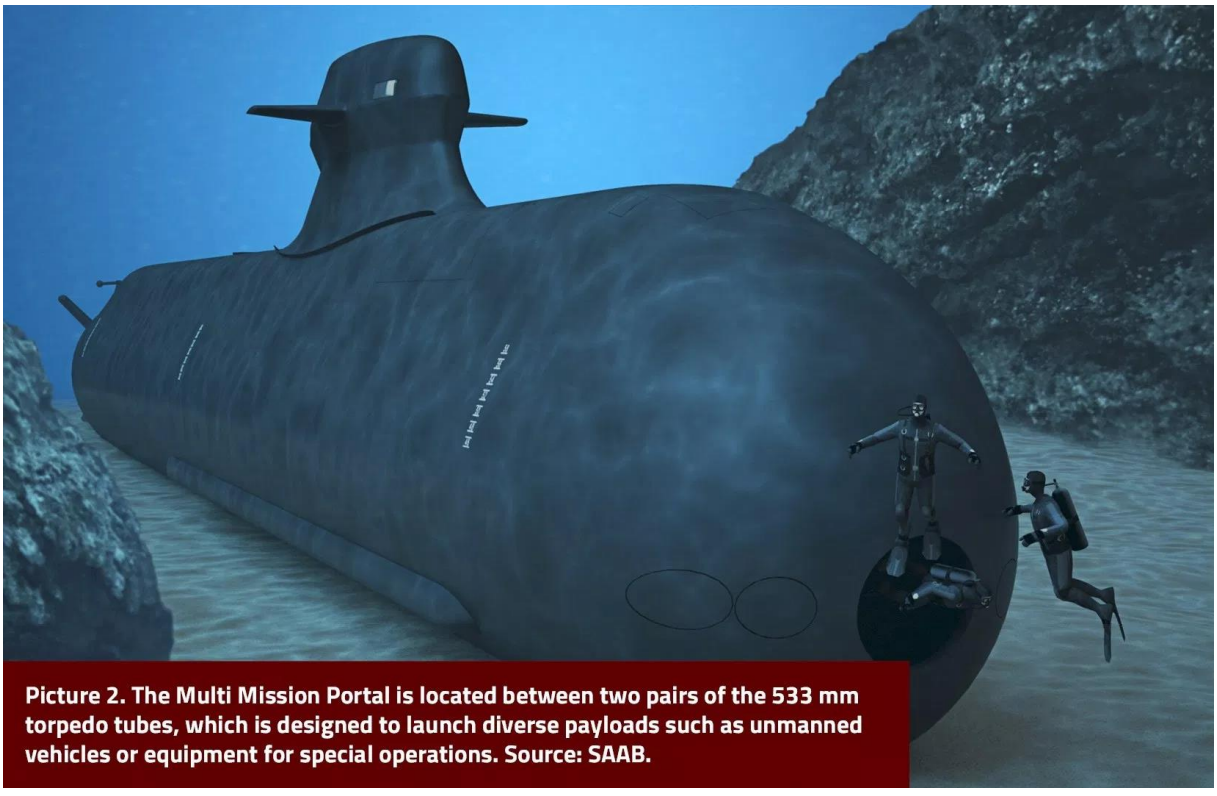
Unquestionably, the A26 boats represent a modern and flexible submarine design that will allow the craft to be utilised for many years through continued advancement and modernisation of the vessel in future. However, the first submarines for the Swedish Royal Navy, currently under construction, are expected to be commissioned between 2022 to 2024. Therefore, it is necessary to consider potential technical difficulties and unforeseen changes to the preliminary project of the submarine. Moreover, these issues might affect the construction of the Polish A26 submarines as well. Both the German and French submarines, despite certain technological differences in the proposed 'Polish' variant of these boats, represent a 'mature' design, which has been applied in several Naval forces around the world. The statement that the A26 submarine 'just looks good on paper' is simply not true; however, the first boats of this class will remain under construction until the 2020s. Consequently, it will be possible to verify their actual performance and capabilities after sea trials, certification, and commissioning.

Sweden–as opposed to Germany and France–remains outside of structures of the North Atlantic Alliance. Nevertheless, this state, however, shares Poland's perspective on relations with the Russian Federation. Therefore it does perceive Russia as the principal source of instability in Eastern Europe and as a potential adversary. The aggressive policy of the Russian Federation is also one of the reasons why Sweden decided to strengthen bilateral cooperation with the United States of America. Sweden is particularly concerned about the hypothesised Russian attempts to take over the Swedish island of Gotland,

which is of strategic importance for the Baltic Sea region. Given common political and military concerns, capabilities of the Polish defence industry, and the economy as a whole, Poland is perceived by Sweden as a potential long-term partner. SAAB has been building its business relations through partnerships for decades; therefore, the cooperation with the Swedish producer seems to be a chance not only to modernise the Polish Navy but also provide the Polish shipbuilding industry with an opportunity to participate in the construction of new vessels for the Swedish Royal Navy. According to the representatives of the SAAB Group, Polish companies are capable of providing Sweden with a plethora of technologies at competitive prices. Moreover, the SAAB Group assured that potential supplies from Polish corporations are currently under consideration and the process is not related to the 'Orka' program. SAAB can provide Poland with technology transfers; therefore, the range of technology transfer depends solely on the Polish partner as well as economic factors because of high costs of production lines. Sweden has also pointed out the importance of geographical factors and a short distance (approx. 250 km) between Karlskrona, where the Kockums shipyard is located, and the Polish coast of the Baltic Sea. Selection of the A26 submarines is undoubtedly an opportunity to establish a strong business partnership between the Polish Armaments Group and SAAB. On the other hand, it seems rather unlikely to negotiate equal relations with either German or French companies where the construction of submarines is concerned. The technical details of potential cooperation remain under negotiation; therefore, it is still unclear whether all the modular compartments of the ship's construction will be divided between Swedish and Polish shipyards (SAAB representatives state that from 0 to 100 percent of submarine construction work can be carried out in Poland). It is nevertheless under determination that both Polish and Swedish shipyards will be implemented in the process. According to the Swedish producer, the Polish companies will be able to handle all repairs and maintenance of the A26 submarines.

The SAAB Group applied a different technological approach than its German (212A/214) and French (Scorpène class) competitors. The A26 submarines are equipped with four 533 mm torpedo tubes; both the 212A and Scorpène-class submarines are outfitted with six tubes, the Type 214 subs have eight torpedo tubes. The Swedish boat, however, has a similar or even vaster payload (over 15 heavy torpedoes or missiles); the Scorpène-class submarine can hold up to 18 heavy torpedoes/missiles; the German Type 214 and 212A have payloads that are outfitted with 16 and 12 torpedoes/missiles respectively. The

number of torpedo tubes does not reflect the actual combat capabilities of the Swedish boat. The A26 submarine will also be equipped with the Multi-Mission Portal, designed to launch a diverse range of ordinances such as unmanned vehicles or specialized equipment for special operations. The Polish variant of the Swedish submarine will potentially be outfitted with a vertical launching system for the Tomahawk Land Attack Missile; thus the boat could carry up to 18 cruise missiles apart from its main armament in the payload compartment. Therefore, the submarine could be simultaneously armed with a full payload of conventional anti-ship weapons as well as advanced cruise missiles with a range of over 1,000 km. All the missile systems are supposed to be carried by capsules and are ready to launch immediately. It should be considered that in the case of the torpedo tubes it is necessary to reload the missiles and, in turn, it makes it impossible to use all weapons at once. The total number of cruise missiles carried by the French and German submarines is limited by a number of other weapons in the armament compartment such as their 533mm torpedoes, which are the primary weapon of their subs.



Picture 2. The Multi Mission Portal is located between two pairs of the 533 mm torpedo tubes, which is designed to launch diverse payloads such as unmanned vehicles or equipment for special operations. Source: SAAB.

The AIP system based on the Stirling engine is another matter that should be carefully analysed. The performance of the Mk V system remains unknown; therefore, it is not reasonable to compare the Swedish system with the latest German and French propulsion

systems. On the other hand, the Swedish AIP system represents a 'mature' technology that was used for the first time over 30 years ago. In the late 1980s, the modernised Näcken-class submarine (A14) was provided with the Stirling engine. Thus the A14 boat was also the first submarine in the world that was equipped with the AIP system. The Swedish industry has been developing this technology over the past three decades, and currently, it is highly appreciated by the Swedish Navy thanks to its simplicity and low maintenance costs. The Swedish system will be certainly cheaper regarding maintenance in comparison with its German competitor, which requires specialized infrastructure to resupply storage cylinders with liquid hydrogen. This sort of specific equipment is not required in case of the Swedish submarine. Furthermore, according to the SAAB Group, the boat can be resupplied within 6 hours.

Assuredly, cooperation with the SAAB group provides Poland with an opportunity to build a long-term partnership with the Swedish defence industry. Given the fact that Norway decided to construct submarines with the German government, Sweden ought to be eager to reach a compromise as far as industrial cooperation is concerned. Poland might become the first foreign user of the A26 submarines, which is a chance for the Swedish industry to find new export markets outside of the EU in future. Sweden has already established a long-term cooperation with Brazil regarding the production of the Saab JAS 39 Gripen multirole fighter aircraft. The latest successes of Thyssen Krupp Marine Systems and Naval Group (the French company was selected to build 12 conventional submarines for the Australian Navy) which should additionally encourage the Swedish producer to offer highly competitive terms for industrial cooperation. Given a distance between the two countries and the potential for partnership concerning training centres and simulators, Poland could also benefit from the optimisation of the maintenance costs. Poland could similarly tighten their military cooperation with the Swedish government, particularly concerning maritime operations in the Baltic Sea region. Apart from an industrial agreement, bilateral research and development (R&D) programs are another sphere of collaboration between the two countries. Details of this proposal are under negotiation; however, it seems possible that the Polish government could lease the Södermanland-class submarine (A17) from Sweden and subsequently modernise the boat in Poland. There is no denying that the A17 and A26 submarines differ and the former one is equipped with older generation systems. This ship, however, could be used adequately to support the training system in the Polish Navy.

Conclusions and recommendations

1. The Swedish boats are based on an evolutionary approach to the submarine design and experienced gained during the construction of the Västergötland (A17) and the Gotland-class (A19) submarines. The principal attribute of the A26 submarine is that it is modern, has a stealthy design developed by the GHOST (Genuine HOlistic STealth) technology, which is intended to decrease the risk of detection of both submerged and surfaced submarines. An essential feature of this design is an Air-Independent Propulsion system equipped with Stirling engine. The Swedish Stirling engines were also intended as the first AIP system that was used in a submarine design. Thus, the A26 submarine has a proven and reliable design and, furthermore, its maintenance costs are relatively low in comparison with other systems offered by SAAB's competitors.

2. The Swedish AIP system has both pros and cons; the most important advantages of the Stirling engine are: 1) simplicity, 2) low life-cycle costs, 3) a lack of specialized infrastructure required to maintain the system. On the other hand, the A26 submarine AIP submarine is no equal to the German fuel cell system due to: 1) lower energy conversion efficiency on a Stirling AIP engine compared to a fuel cell, 2) higher oxygen consumption on a Stirling AIP engine compared to a fuel cell, 3) lower maximum AIP speed. Therefore, the Ministry of National Defence ought to balance the costs and capabilities of the system to select the optimum solution.

3. A potential range of cooperation seems to be an important advantage of the Swedish producer, which seems to be the only one that can offer Poland a long-term cooperation based on a business partnership. It is also a chance for the Polish defence industry to participate in the construction of the Swedish submarines and, possibly, additionally other vessels for export markets. Given the fact that the Swedish military industry is highly specialised, whereas Poland can offer its products at competitive prices, it seems clear that Sweden is examining the potential cooperation with Poland based on economic factors taking into account a long-term business relation. Regardless of the result of the 'Orka' program, the SAAB Group is currently analysing the participation of the Polish companies in the construction of the Swedish A26 submarines (SAAB has already signed a contract with Base Group for delivery of components for two Swedish A26 submarines).

4. An interesting solution proposed for the A26 design is a special compartment for the vertical launching system with 18 Tomahawk cruise missiles. Despite certain technical

difficulties and risks related to this system, the primary partner of the SAAB Group is the British Babcock International Group that has an experience with similar projects for the US and British Navy.

5. Both Sweden and Germany can offer Poland a similar range of military cooperation. The distance between Poland and Sweden is one of the key reasons why mutual training centres and other specialised infrastructure such as simulators (to make the common training process more efficient) should be considered. Sweden could provide Poland with the earlier version Södermanland-class submarine (A17) to temporarily support the training system of the Polish Navy to become knowledgeable about the subs systems by the time the newer A26 submarines are commissioned into the navy.

6. The Swedish boats proved its quality and interoperability with NATO units during the training exercises in the United States of America (2005-2007), and this astonishment was confirmed by Americans who pointed out difficulties related to detection of the Swedish submarine (HSwMS Gotland) due to its Air-Independent Propulsion system.

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[i] *Modern Martime Security Kockums A26*, https://saab.com/globalassets/commercial/naval/submarines-and-warships/submarines/a26/saab_kockums-a26_brochure_a4_final_aw_screen.pdf
[ii] Ibid.
[iii] Ibid.
[iv] Ibid.
[v] Ibid.

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