

ARCHIVED REPORT

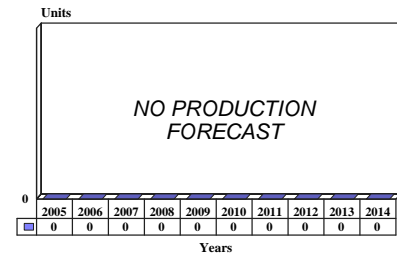
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Moray Class - Archived 3/2006

Outlook

- Not in serious contention for any known orders
- Market dominated by Type 214 and Scorpene
- Unlikely any future countries will consider the Moray design
- Report will be archived next year

10 Year Unit Production Forecast
2005 - 2014



Orientation

Description. Diesel-electric torpedo-attack submarine design tasked with anti-submarine warfare (ASW) and anti-ship roles.

Sponsor

Ministeries van Defensie
Plein 4
The Hague
The Netherlands

Status. Advanced development.

Total Produced. None produced to date.

Application. To locate and destroy enemy submarines and surface ships.

Price Range. When the design was first announced, the quoted cost for a Moray 1800 pfH was approximately \$320 million (in 1990 dollars).

Contractors

Rotterdamsche Droogdok Maatschappij, PO Box 913, Rotterdam, NL-3000 AX Netherlands, Prime

Northrop Grumman Ship Systems, Division HQ, <http://www.ss.northropgrumman.com/index.cfm>, 1000 Jerry St Pe' Highway, PO Box 149, Pascagoula, MS 39568-0149 United States, Tel: 1 (228) 935-1122, Fax: 1 (228) 935-1126, Email: info@ngc.com, Licensee

BAE Systems - Submarines, <http://www.baesystems.com>, Barrow-In-Furness, Cumbria, LA14 1AF United Kingdom, Tel: 44 1229 823 366, Fax: 44 1229 873 772, Email: media@baesystems.com, Licensee

Technical Data

The following specifications relate to the Moray 1800 design.

Characteristics

Speed, surfaced	10 kt
Speed, submerged	20 kt
Speed, snorting	12 kt
Max diving depth	1,000 ft

Max range	10,000 nm
Endurance	60 days
Crew	6 officers, 24 enlisted and 6 trainees

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Length	64.0 m	210 ft
Beam	6.4 m	21 ft
Draft	5.5 m	17 ft
Displacement, surfaced		1,800 tons
Displacement, submerged		2,000 tons

	<u>Type</u>	<u>Quantity</u>
Armament		
Torpedo tubes	21 in	6
Torpedoes	Mk 48	20

Electronics		
Radar	ZW-07	1
Sonar	Hull array	1
	Towed array	1
EW	User-specified	1

Propulsion		
Diesel	MTU 16V-396 SB-83	3 x 1,040 kW
Alternators	Pilar rated at 980 kW	
Propeller	7 bladed	1

Design Features. The Moray submarine is a modular single-hull design. The pressure hull is constructed of HY 100 steel using a largely cylindrical section with inner hull frames about 0.7 meters apart. The fore and aft ends are slightly tapered, providing space for an echo-sounder and the cabling of a towed array. The pressure hull is closed at the bow end by a flat plate rather than the usual dome bulkhead. Officially, this means the size of the pressure hull openings for the torpedo tubes can be restricted, reducing stress on the pressure hull seals. The aft end of the pressure hull is closed with a conventional hemispherical bulkhead. The ballast tanks are grouped fore and aft of the pressure hull with a single tank amidships. Total ballast tank volume is 200 m³.

The control surfaces use a cruciform arrangement for the tail fins, each fin having an independent hydraulic actuator. Separate sail-mounted diving planes are provided.

A diesel-electric configuration is provided, in which the three MTU 16V-396 SB-83 diesels act as power sources for the Pilar alternators. This arrangement produces 970 kW at the switchboard/alternator. The main drive is via a water-cooled, double-armature, DC compound motor capable of a maximum power output of 5,000

kW. As with most Western-built submarines, the output from the diesels is used to continuously charge the batteries, which then run the electric motor. RDM claims that this powerplant will enable a Moray 1800 pFH to achieve underwater speeds of 20 knots, with higher bursts of short duration. The engine rooms are manned to reduce automation costs.

The diesel engines are provided with a special submarine turbocharger, consisting of a radial exhaust gas turbine and a radial compressor delivering 960 kW at 1,800 rpm, with a backpressure of 1,400 millibars. A telescopic snort is fitted, equipped with a dry snort induction system that enables the diesels to start as soon as the induction head breaks surface. Access from the engine rooms to other compartments is provided. This means the diesels are not stopped by momentary interruptions in the air supply when the induction valve closes through wave action. Speed of advance while snorting is 12 knots. However, indiscretion time is 3 hours at 6 knots – a remarkably high level for an otherwise advanced submarine design. This may point to a mismatch between battery capacity and the charging capability of the diesels.

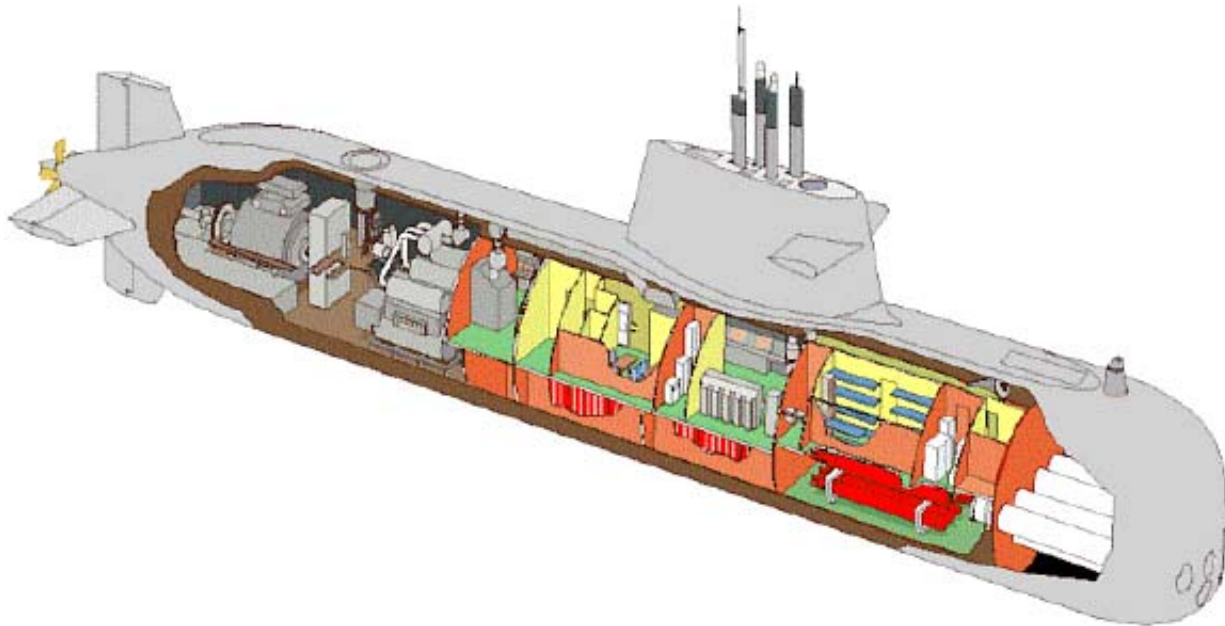
The Moray 1800 design can be provided with an air-independent propulsion (AIP) system. This is built into

a 9-meter special module containing two Kreislauf-cycle diesel engines, each driving a diesel generator with 440 kW output; liquid oxygen storage tanks; a water management system; and a special weight compensation tank. This extra module increases the displacement of the submarine by 200 tons and reduces underwater speed by 1 knot. The Moray AIP module uses a Cosworth CCD (closed-cycle diesel) water management system to dry the exhaust gases prior to oxygen injection and recycling.

Operational Characteristics. This class will be able to dive to a depth of 1,000 feet, have a range of 10,000 nautical miles, and be able to remain at sea for 60 days. All rotating equipment will be rafted – that is, mounted on special shock mounts to reduce the radiated noise of the submarine. The Moray class will be equipped with the Spectrum data/combat system. Apparently, the sonar data computers are included in the associated

SIASS sonar system rather than in Spectrum. The system has sufficient signal-processing capability to conduct LOFAR (low-frequency omnidirectional acoustic frequency analysis and recording) analysis in each preformed beam (and sufficient memory to store the results).

The active transducer and cylindrical receiving arrays of the sonars feed into a common processor (with separate preprocessors for active and passive operation); the passive ranger and acoustic-intercept arrays share a common processor (with separate front-end preprocessors); and the non-acoustic sensors (ESM, radar, periscope, and navigational aids) share a common processor. Spectrum can maintain 35 simultaneous tracks, and it can control four missiles (such as Harpoon) and four wire-guided torpedoes simultaneously. The classification library holds up to 300 signatures.



Moray Class Submarine

Source: RDM Submarines

Variants/Upgrades

The Moray design is available in three variants, Moray 1100, Moray 1400, and Moray 1800. All three can be produced in either pFH (fitted for the AIP

module) or H (fitted with the AIP module) configurations. The pFH versions can be converted to H variants with minimum dockyard time.

Program Review

Background. The Moray project was started in 1984 as a private venture by RDM (Rotterdamsche Droogdok Maatschappij BV), financed by the Dutch Ministry of

Defense, Ministry of Economics and RDM to design a class of submarines for the export market using the technology employed on the Royal Netherlands Navy

Walrus class. The concept was to design a class of submarine covering the range of 1,100 to 1,800 tons. Although the design was primarily aimed at the export market, RDM hoped that the top end, 1,800 tons, would be compatible with the Royal Netherlands Navy's requirement to replace the aging Zwaardvis class submarines.

In 1985, the Moray program expanded when RDM and NEVESBU (the Dutch Navy design bureau) started to evaluate a new range of advanced technologies to produce flexible submarine designs incorporating the latest developments in sensors and weapons data handling, as well as RDM-developed air-independent propulsion (AIP).

By late 1989, design work had advanced far enough for the Dutch government to allocate funds for RDM to begin project definition. The project definition stage relates to the Moray 1800H design, fitted with AIP. The first phase of the program was broken down into two stages. The first stage was to develop a land-based test site and the AIP system. The purpose of the land-based test site was to prove the feasibility of the closed cycle engine, ensuring that it remained within the sound parameters. The second phase was to develop the AIP system and test the system at sea. This first phase was completed using a 400 kW land-based unit built by Cosworth of England.

The closed-cycle engine and the AIP system were tested during the early 1990s. The Royal Netherlands Navy began phasing out the triple-hulled Potvis class submarines and transferred one, the KNS *Zeehond*, to RDM to act as the test platform. During 1990 and 1991, RDM actively developed the SPECTRE system. As part of this program, Kockums and MAN Technologies worked together to develop a 600 kW V12 Sterling engine for the main propulsion system. This proved abortive, and the Moray AIP system has reverted to using the Cosworth CCD Kreislauf cycle engine.

In 1991, the Taiwanese government approached RDM with an order for six Moray 1800H submarines. This was initially approved by the Netherlands government, but approval was rescinded under pressure from China. The process was repeated in 1992, with approval first being granted, and then rescinded under Chinese pressure.

Originally, the Dutch Navy stated a requirement for at least two, possibly four, Moray class submarines. This program was canceled in 1991 in response to pressure to reduce the defense budget. The Netherlands submarine fleet is now restricted to four Walrus class (SSK) boats. No new submarine construction contracts are expected to be placed until 2005.

In September 1993, Vickers Shipbuilding & Engineering Ltd (VSEL) and RDM signed a collaborative agreement to jointly promote exports of the Upholder and Moray class submarines to six prospective client nations. These were believed to include Canada, Chile, Malaysia, and Saudi Arabia. Under the terms of the agreement, VSEL would build hull sections or other components of any Moray class submarines sold to the target countries. The agreement also covered joint marketing of the two companies' air-independent propulsion technologies, fuel cells in the case of VSEL and CCD for RDM. Beyond this initial step, no further action appears to have been taken.

By 1995, any proposed sales of the Moray class were becoming more closely linked with the fate of two older Dutch submarines, the *Zwaardvis* and her sister boat, the *Tijgerhaai*. Decommissioned by the RNLN in 1994 after 22 years of service, both of the *Zwaardvis* class were acquired by RDM Submarines for resale the following year. The two 2,400-tonne submarines were placed in care and maintenance storage in Rotterdam while RDM shipyard negotiated their sale and that of a newly built Moray 1400 submarine to Indonesia. The package was to cost Indonesia about \$340 million.

This deal with Indonesia fell through, but it was followed in 1998 by the start of a long-running series of negotiations with Egypt. These involved a government-to-government deal for a U.S. Foreign Military Funding (FMF) package to finance the purchase, refit, and modernization of the *Zwaardvis* class submarines, and would include follow-on options for up to two new-build, RDM-designed Moray 1400 submarines. The U.S. Defense Security Assistance Agency, which oversees the FMF program, gave the plan its conditional endorsement. Litton's Ingalls Shipbuilding division would be prime contractor for the deal, with Lockheed Martin Federal Systems undertaking systems integration and RDM Submarines responsible for platform design and support issues.

However, by mid-1999 these proposals had collapsed, and Dutch efforts to sell the *Zwaardvis* and Moray classes had reportedly been refocused on Taiwan's planned construction of up to a dozen diesel submarines (despite a previous prohibition by the Netherlands government against military sales to Taiwan). These claims were denied, and in January 2000 the Egyptian government renewed its interest in purchasing the *Zwaardvis* class submarines, but with no mention of any Moray construction. At this time, rumors started to spread that Malaysia had made a positive decision to establish a submarine force (an action considered in 1996 but delayed by the Far East economic crisis), and was negotiating for a lease on the two *Zwaardvis* class boats to provide a training base. This would be

followed by the procurement of Moray class submarines once a cadre of trained submarine crews and support facilities had been established.

At the end of August 2000, the Egyptian government and the Dutch RDM shipyard signed a Letter of Intent for the sale of two Moray submarines to the Egyptian Navy. Under the terms of the letter, these would be constructed at Ingalls Shipbuilding in the U.S. RDM Submarines would be presented "on site" in order to assist the American builders. This Letter of Intent was stated to be the first step toward a contract. According to the letter, after the final contract was signed, negotiations would be held regarding technical and personnel support from the Royal Netherlands Navy. At that time, it was stated that the negotiations would probably be concluded in early 2001, and that the construction of the submarines would take about five years. Ingalls Shipbuilding would be prime contractor for the order, with RDM Submarines (Rotterdam, the Netherlands) and Lockheed Martin Naval Electronics & Surveillance Systems (NE&SS) Undersea Systems (Manassas, VA) major subcontractors. The industry arrangements are designed to address FMF program stipulations. Egypt is entitled to use FMF funds to buy submarines, but the program mandates reinvestment of at least half of the funds in the U.S. economy. As the U.S. has no existing conventional submarine manufacturing base, an overseas partner would be required. As far as can be determined, the Egyptian LoI has yet to be converted into a formal contract.

This news was quickly followed by an announcement that the lease of the two Zwaardvis class submarines to Malaysia was rapidly being finalized, with one local newspaper claiming that the deal had already been signed. This was confirmed on October 20, 2000, when the heavy-lift ship *Smit-Transporter* took the two submarines aboard and departed for Malaysia. The fact that the subs were being shipped to Malaysia indicated that RDM Submarines was very confident the deal would be closed soon. The *Smit-Transporter* arrived in Lumut, Malaysia, on December 14.

Besides training future Malaysian submariners, the partnership would also provide the Malaysian government with a shipyard capable of supplying two newly built Moray class submarines to the RMN. The inclusion of PSC-RDM submarines in the race to supply Malaysia with a submarine fleet meant that there would now be three companies in the bidding, including the German Submarine Consortium offering Type 209 class submarines and France's DCN International with its Agosta class. PSC-Naval Dockyard Sdn Bhd said that, should its offer to sell the two submarines to the government fail, the partnership would try to market both submarines and the Moray class to other interested

countries. This is believed to be a reference to Thailand, which has a long-standing submarine requirement.

There was little movement beyond this point during 2001. During the course of the year, the Malaysian contract competition became a three-way battle among DCN (offering the Agosta class), RDM (offering the Moray), and the German-Turkish Submarine Consortium (offering the Type 209-1400). In each case, the competitors were offering two existing submarines as training craft prior to the delivery of new-build boats.

On November 20, 2001, the *Business Times* of Kuala Lumpur disclosed that the Malaysian government was finalizing negotiations to buy four submarines, and was expected to award a contract shortly. A government official said the talks were continuing with the three companies that had tendered for contracts to supply the submarines. The official added that "contracts will be awarded next month ... probably for two submarines first, and two more sometime next year." At the same time, it was disclosed that Malaysia would no longer be considering a proposal by the Netherlands-based RDM shipyard to supply two used Zwaardvis class, the *Zwaardvis* and the *Tijgerhaai*, and two new-build Moray class SSKs to the RMN. Finally, in the spring of 2002 Malaysia officially announced it had decided on a deal with the French. The following June, a deal for the delivery of two French Scorpene submarines (the first to be delivered in 2007) was signed. A refitted French Agosta 70 will be used to train RMN submariners.

The most important development in 2001 was the sudden and forceful re-emergence of the Taiwanese submarine contract onto the international market. Partly in retaliation for Chinese conduct over an incident involving an EP-3E Aries reconnaissance aircraft, the United States agreed to sell eight diesel-powered submarines to Taiwan. The subs would be assembled by Litton Industries Inc in the United States and tested by the U.S. Navy before being delivered to Taiwan in two batches of four vessels. The immediate Dutch reaction was to reaffirm their 1984 agreement with China not to sell any more weapons to Taiwan. Frank de Bruin, a Dutch Foreign Ministry spokesman, said, "The Netherlands maintains a one-China policy. That means no weapons are to be sold to Taiwan or to third parties for resale to Taiwan."

In late September 2001, a U.S. submarine sale project team arrived at Taiwan for coordination, and reached a consensus on the sale of the eight subs. The planning phase of the project would last three years. The U.S. will issue invitations to contractors for participation and select the submarine platform and combat systems. The

construction schedule of the first sub will last from six to nine years. In other words, Taiwan would receive the first sub from the U.S. in 2010 at the earliest. In October 2001, the U.S. requested that all the U.S. and European shipyards hand in their proposals on Taiwan's SSK issue before the middle of November 2001. The official bid request was held in January 2002. The U.S. Navy has a set of plans and guidelines for the participating shipyards to help them avoid PRC retaliation.

In March 2003, Taiwan formally announced the creation of a cross-ministerial committee for local build of submarines under the Executive Yuan. This new committee, presided over by Vice Premier Lin Hsin-I, is planning to push the U.S. government for Taiwan's right to build at least six of the eight diesel submarines.

Starting in early 2002, there were determined efforts in the United States Congress to reduce the annual military aid package to Egypt, recently totaling some \$1.3

billion per year, which in large part had been utilized to finance the bulk of the Egyptian Armed Forces modernization programs with Western-made equipment. This appears to preclude a major acquisition program such as the proposed Moray purchase.

In mid-October 2003, Moray class submarines were offered to Indonesia to fulfill that nation's submarine requirement, the Indonesian Navy being offered two new-construction submarines, with the Indonesian Navy taking over the two Zwaardvis class submarines stored in Malaysia since 2000. However, the Indonesian Navy had already publicly announced its desire to procure the South Korean Type 209 class submarines when they are replaced by the Type 214s in 2007 and 2008. The Indonesian Navy currently operates two Type 209-1300 class submarines, and it would be easier to integrate the South Korean Type 209 than other candidate designs. This remains the last recorded action with regard to the Moray program.

Funding

The Moray class submarine program is funded by designer Rotterdam Drydock. The Netherlands government has supplied limited funding, with the condition that Rotterdam Drydock collaborate with developers of air-independent propulsion systems.

Recent Contracts

No details of any contracts related to the Moray class have been publicly released.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1984	Company starts private design venture
	1990	Dutch government funds design phase
	1990	Royal Netherlands Navy turns over Walrus class submarine as testbed
	1990	SPECTRE system development begins
	1991	Netherlands procurement of Moray canceled
		Taiwan order vetoed by Dutch government
	1992	SPECTRE development abandoned
		Taiwan order again vetoed by Dutch government
	1996	Indonesia explores Moray purchase
	1998	Egypt starts negotiations to buy U.S.-built Moray class
Mar	1999	Egyptian deal collapses
Aug	1999	Egyptian deal revived
Apr	2000	Malaysia expresses interest in Moray
Aug	2000	Egypt signs Letter of Intent for Moray
Oct	2000	Reports that Malaysia is leasing Zwaardvis class; has options on Moray
Dec	2000	Zwaardvis class delivered to Malaysia for modernization
Apr	2001	Taiwanese submarine requirement returns to life
Oct	2001	U.S. requests bids for Taiwanese SSKs
Nov	2001	Bids for Taiwanese construction received

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Dec	2003	Moray offered to Indonesia

Worldwide Distribution

No submarines of this class are reported to be under construction.

Forecast Rationale

The lack of any substantive news on the Moray program means that the viability of this project must now be considered extremely marginal. There is even a whiff of scandal surrounding the design now.

In September 2004 it was reported that a Dutch businessman, Joep van den Nieuwenhuyzen, head of RDM, had claimed a senior Dutch politician, Jozias van Aartsen (who was the Dutch foreign Minister from 1998 to 2002) had promised the government would compensate RDM if it backed off from a controversial deal to supply Moray class submarines to Taiwan. According to Van den Nieuwenhuyzen, he said that China had threatened to impose economic sanctions on the Netherlands if the deal went ahead. Van Aartsen dismissed Joep van den Nieuwenhuyzen's statement as "nonsense." The current Dutch Finance Minister Gerrit Zalm backed Van Aartsen's denial. The accusations followed the sacking of Rotterdam Port director Willem Scholten, who had secretly agreed a EUR100 million loan guarantee for RDM.

Whatever the truth of these allegations, they probably kill whatever chance is left for an order for Moray class submarines. In the present business environment, the mention of scandal is enough to damage the image of a given product, and where competitions are as tight as those in the diesel-electric submarine market, even the slightest disadvantage is fatal. It is therefore probable that Moray has now lost the last chance of receiving any orders.

The primary rivals to the Moray class are the German-Swedish designs and the Franco-Spanish Scorpene class. Undercutting these on price brings the seller against the Rubin Design Bureau with the Project 877 and Project 636 designs. It would now appear that Moray is moribund, and with its demise, RDM will cease to be part of the submarine market. This being the case, we have recorded a null forecast. This report will be archived next year.

Ten-Year Outlook

Due to the lack of existing orders or potential clients with real credibility, a null forecast has been recorded.

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