

ARCHIVED REPORT

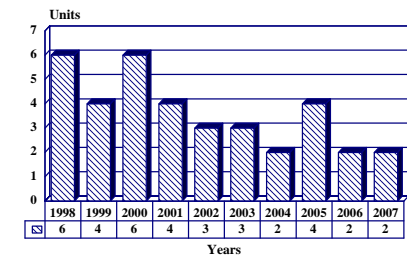
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SAGEM Periscopes - Archived 6/99

Outlook

- Limited production, with most going to the French navy
- Minor export sales expected
- Possibility of becoming Western source for Russia's Amur
- Chile's *Scorpene* sale another promising export opportunity
- Competition from US Kollmorgen

10 Year Unit Production Forecast
1998 - 2007



Orientation

Description. New-generation search-and-attack periscopes, incorporating a variety of sensors on a single mast.

Sponsor

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Licensee. As far as is known, no production licenses have been granted.

Status. Production and service.

Total Produced. It is estimated that SAGEM had built 21 periscopes by early 1998.

Platform. The PIVAIR integrated periscope system is deployed on French nuclear-powered attack submarines of the Rubis and Amethyste class. The non-penetrating optronic developments of these systems are being used on French SSBNs and the projected new French SSN.

Price Range. In common with many French military systems, no official cost data are available. The unit cost of a SAGEM non-penetrating electro-optical mast system, based on known costs of comparable systems, is estimated to be US\$10.5 million.

Technical Data

Characteristics

Line of sight deflection:
Magnification:
Fields of view:
IR field of view:
Pressure resistance:

SPS

-10 to +80°
x1.5/x6/x12
36°/9°/4.5°
13° or 5°
60 bar

APS

-10 to +30°
x1.5/x6/x12
30°/7.5°/3.75°
60 bar

	<u>SPS</u>	<u>APS</u>
Characteristics		
Operating temperatures:	-19°C/+49°C	-19°C/+49°C
MTBF:	1,350 hours	2,500 hours
MTTR (inboard):	30 minutes	30 minutes
MTTR (outboard):	8 hours	8 hours
Dimensions		
<u>SPS Periscope</u>		
Head diameter:	320 mm	12.7 inches
Tube diameter:	200 mm	7.9 inches
<u>APS Periscope</u>		
Head diameter:	140 mm	5.5 inches
Tube diameter:	180 mm	7.1 inches

Design Features. The PIVAIR integrated periscope system forms the optical and electronic sensor suite for the Rubis and Amethyste nuclear-powered attack submarine classes. It incorporates a CTX thermal imager usable during both day and night conditions. Both the optical and IR channels are fully gyrostabilized. The base of the search periscope mast contains a sextant, a 35 mm camera and the IR monitor.

The FLIR is cooled by the Joule-Thomson system and operates within the 8-12 micron range. The output can either be viewed directly or output to a CRT. All the periscopes in this system can be equipped with a GPS receiver, outputting into the eyepiece of the scope. The periscopes are linked to the combat system of the submarine so that target designation (elevation and true bearing) can be relayed to the fire control solution computer.

In the non-penetrating designs evolved for the CA class, the submarine had three masts; an optical search periscope, an optronic attack periscope and an ESM antenna. All three were contained within a single waterproof chamber outside the pressure hull with the search-and-attack periscopes side-by-side. The pressure hull was penetrated only by electrical cabling, hydraulic piping and the optical

path from the search periscope. The latter was served by a fixed eyepiece regardless of the rotation of the periscope head.

The search periscope eyepiece forms part of a console which also includes two CRTs for the optronic mast. Each position contains a handwheel to power-turn the mast. This arrangement has the advantage that the periscope observer can compare the direct-path image from the search periscope with the electro-optical image from the non-penetrating unit. The observer can also view other instruments and displays used for navigation and fire control.

Operational Characteristics. The console arrangement does not permit the user to make direct (superimposed) comparisons between the various sensors at his disposal. There is also no provision for windowing several displays onto the same CRT. This implies that the console electronics are still analog rather than digital. The display from the search periscope still has to be viewed from very close range as with conventional layouts.

This periscope console system appears to be a halfway stage between the current optical system and control room layout and a pure electro-optical system with a radically different control room configuration.

Variants/Upgrades

The current family of SAGEM periscopes consists of the following members:

APS – Attack Periscope with Rotating Ocular. The head is 140 mm in diameter and the tube 180 mm.

APS-F0. Attack periscope with a fixed ocular. Head and tube diameters are the same as those for the basic APS.

IMS. SMS periscope fitted with a thermal imaging camera.

IMS-1. Version of IMS modified for Danish Narhvalen class.

OMS. IMS periscope fitted with an integral navigation radar. Although not explicitly stated, assuming this radar also has a fire control function would be quite reasonable.

PIVAIR. An integrated periscope suite consisting of the SPS-S and APS periscopes together with a dedicated ESM mast.

SMS. New-generation non-penetrating optronic search periscope.

SPS. A 320 mm head gyro-stabilized search periscope using a 200 mm tube.

SPS-S. The SPS periscope modified to include a sextant. The tube diameter is increased to 250 mm.

Program Review

Background. French postwar periscope design used German technology from the Type XXI as a basis. Derivatives of the German periscopes equipped the submarines of the Narval and Arethuse classes (built between 1949 and 1955). These were succeeded by the nine submarines of the Daphne class which used an entirely French-designed periscope suite. This included the ST-3 attack periscope and the M-41 search periscope, both being designed and produced by SOPELEM.

An advanced version of this suite was produced for the Agosta class submarines. This featured the ST-5 attack periscope and the Type J search periscope. The latter differed from the M-41 in that it included an APA-4 navigation-and-attack radar set and an ARUD omnidirectional radar warning system. ARUD is an early version of the DR-2000U. Later, the Type J scope was modified to Type K standards by the inclusion of an image intensifier. The final version was Type K. This has a redesigned fairing to reduce splash and RCS.

A minor modification of the Type K periscope was adopted for the La Redoubtable class ballistic missile submarines. Designated the Type L, this omitted the sextant from the Type K. The La Redoubtable class SSBNs do not have an attack periscope but do have a separate starsight periscope, the MRA-2.

Experience had shown that the existing force of French diesel-electric submarines was not capable of providing adequate escort to the SSBNs. As a result, the French navy elected to adopt a nuclear-powered solution for its next class of hunter-killers. The shift to a nuclear-powered attack boat design brought with it a need for significantly improved sensors. The Rubis class was tasked largely with anti-ship warfare, establishing a requirement for periscope operations under all conditions. To meet this need, a new, integrated periscope system, PIVAIR, was designed.

PIVAIR integrated the functions of three masts; the search periscope, the attack periscope and the ESM mast. The capabilities of each of these were substantially enhanced by the addition of thermal imaging, gyro-stabilization, low-light television and an improved periscope sextant. The hoisting and rotation systems were greatly improved and the periscope head was streamlined and coated with radar absorbent materials.

The PIVAIR system was fitted to the six Rubis/Amethyste class SSNs. It continues to be promoted on the export market. However, it quickly became apparent that its technology, although very advanced, represented only an intermediate stage and that a fully electro-optical non-penetrating periscope mast represented the design of the future.

The new SAGEM family of non-penetrating periscopes was originally developed for the CA class of minimally manned export submarines. These submarines were never sold, but some of the systems developed for them have been incorporated in later French submarine designs. The electro-optical non-penetrating periscope intended for these boats was undergoing trials on the submarine *FS Psyche* in 1994/95.

The launch order for the new design was by the Danish navy, which ordered two sets for its Narhvalen (Type 205) class submarines. This retrofit program (which also involved new sonars and batteries) started in 1993; the second boat was scheduled to complete retrofit by 1996.

The first French order for the new non-penetrating periscopes was to equip the new Le Triomphant class SSBNs. Originally, six of these submarines were planned, but the program was cut back to two – with the balance to be replaced by a new, third-generation design. This plan was reversed early in 1995 when two of the canceled boats were reinstated and work on a successor class discontinued. Each of these submarines will carry two periscopes.

The latest application for these periscopes in the new construction market is the proposed French New SSN class. The Rubis/Amethyste class has not proved as successful as hoped, and it will be replaced by a new class. Detail design of these was to start in 1996, and they will carry the same periscope outfit as the new SSBNs. Meanwhile, Spain is reported to have ordered SAGEM non-penetrating periscopes for its mid-life upgrade of the Galena (Agosta) class, while similar periscopes will be fitted to the three *Agosta* S-90B submarines ordered by Pakistan.

Funding

The SAGEM periscopes intended for French navy use were developed under French government funding. Corporate resources were used for products intended for the export market. It is impossible to draw any meaningful distinction between these sources.

Recent Contracts

No contractual information is currently available.

Timetable

<u>Year</u>	<u>Major Development</u>
1980	New-generation periscopes introduced
1992	Orders for new periscopes reach 25
1993	Danish order launches non-penetrating periscope family
1994	Trials of non-penetrating periscope begin

Worldwide Distribution

Denmark. 2 IMS-1 on Narhvalen class SSK

France. 8 SMS on 4 Le Triomphant class SSBN, 2 SPS on *FS L'Inflexible* SSBN, 12 SPS on 6 Amethyste class SSN, 1 on *FS Psyche* trials submarine

Pakistan. 6 SMS ordered for 3 Agosta 90B class SSK

Spain. 6 SMS ordered for 3 Agosta class SSK

Forecast Rationale

Historically, French periscope sales have been limited to French-built platforms. Thus, the French navy is by far the largest user and is set to remain that way as future programs move forward to replace obsolescent tonnage. These will include the remaining two ballistic missile submarines of the Le Triomphant class and the new French SSN. The latter will replace the nuclear-powered submarines of the Amethyste and Rubis classes and the diesel-electric submarines of the Agosta class. This implies a requirement for 10 hulls if one-for-one replacement is contemplated. We regard this as unlikely; we believe that the new class will be restricted to six boats built at a slow rate and that the diesel-electric submarines will go unreplaced.

French submarine exports have been steady if unexciting. Both the Daphne and Agosta class submarines sold in limited numbers, but the market at that time was dominated by the Type 209 family. These had, of course, German Zeiss periscopes. The French naval industry still

offers a range of submarines, including the *Scorpene*, an updated *Agosta* and a conventional version of the *Amethyste*. Of these, only the updated *Agosta* has been successful, three having been purchased by Pakistan for delivery in 1998-2001. The *Scorpene* will probably sell in greater numbers, but we expect the market will still be dominated by German and Swedish designs.

More outer-limit possibilities are the Chinese and Russians. Some Chinese submarines may carry French periscopes. The Ming class are basic Romeo class boats with French sensors and combat systems. They are good candidates to have received the periscopes as well. It is also possible that the Han class SSNs could have received French periscopes — they are known to carry French or Israeli ESM. The Russians have launched a submarine project, Amur, which is deliberately designed to place Western sensors and equipment in a Russian-built hull. If this gains acceptance, the SAGEM periscopes are a good possibility for adoption.

The following forecast is based on the delivery of known platforms of the various SAGEM periscopes and a significant allowance for future sales. These will primarily be on the Scorpene class submarines and are based on a

rate of two periscopes per Scorpene (spread out over a number of years). With the exception of Spain, an allowance of two periscopes per submarine is made.

Ten-Year Outlook

		ESTIMATED CALENDAR YEAR PRODUCTION												
		<u>High Confidence Level</u>				<u>Good Confidence Level</u>				<u>Speculative</u>				Total 98-07
Designation	Application	thru 97	98	99	00	01	02	03	04	05	06	07		
SAGEM PERISCOPES SSBN (FRANCE)		4	2	0	0	2	0	0	0	2	0	0	6	
SAGEM PERISCOPES SSK (PAKISTAN)		0	2	2	2	0	0	0	0	0	0	0	6	
SAGEM PERISCOPES SSK (VARIOUS)		0	2	2	4	2	2	2	1	1	1	1	18	
SAGEM PERISCOPES SSN (FRANCE)		14	0	0	0	0	1	1	1	1	1	1	6	
SAGEM PERISCOPES Prior Prod'n:		3	0	0	0	0	0	0	0	0	0	0	0	
Total Production		21	6	4	6	4	3	3	2	4	2	2	36	