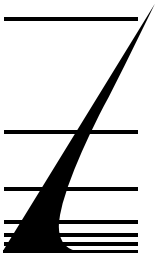
The Market for Submarines

Product Code #F673

SAMPLE

A Special Focused Market Segment Analysis by:



FORECAST INTERNATIONAL

Analysis 1
The Market for Submarines
2011-2020

Table of Contents

Analysis 1

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PROGRAMS

The following reports are included in this section: (**Note:** a single report may cover several programs.)

A26 Class
Astute Class
Barracuda
Chinese Diesel-Electric Submarines
Chinese Nuclear Submarines
Dolphin Class
Indian Nuclear Submarines
Le Triomphant Class
Project 677 (Amur)
Project 877 (Kilo)
Russian Nuclear Submarines
Scorpene
Soryu Class
SSBN(R)
SSBN(X)
SSN-774 Virginia Class
Type 209
Type 214
U-212A

Introduction

An examination of navies around the world shows an interesting pattern. When they run out of money, the last capability they abandon is their submarine fleet. Their submarines are seen as the most cost-effective part of their overall fleet and thus are preserved as long as possible. This effect can be seen in the most recent British defense review, where the surface combatant fleet saw savage cuts, the amphibious warfare squadron only slightly less so, but the submarine fleet was preserved intact.

Why this should be was demonstrated half way around the world when the South Korean corvette *Cheonan* was torpedoed and sunk by a North Korean coastal submarine. The corvette was specifically designed for operations in littoral waters and built with full knowledge of the threat spectrum she would face. Yet, she was blown in half by a torpedo she never saw coming and never had a chance to defend herself, let alone prosecute any submarine contact she might have made. Even more remarkably, it took several weeks of investigation and some sophisticated forensic work before it could be proved that the corvette was in fact the victim of a hostile submarine.

The sinking of the *Cheonan* was a classic example of the menace a submarine can exert when it is operating within its chosen environment. The force multiplier effect was clearly evident here. The *Cheonan* was designed to provide an economical asset for patrolling coastal waters, but the submarine used to sink her cost an order of magnitude less – and that submarine got away with her attack cold. It is quite clear which asset was the most cost-effective in this particular scenario.

However, direct cost comparisons are not the whole story. Submarines are an expensive commodity to operate and require a sophisticated infrastructure to maintain their operational capability. This level of infrastructure investment climbs almost exponentially as the navy in question moves toward more effective, but also more complex and costly, submarines. This trend reaches a peak with the ballistic missile submarines that are extremely expensive in terms of command & control and support facilities. So, it is fair to ask, what is the operational role that these submarines are expected to fill at any given level of expense?

Searching for a Role

This question does not have an easy answer. As the sinking of the *Cheonan* showed, the submarine has its roles and has been very effective at some of them. However, its periods of having a definable, dominating role have been separated by equivalent periods when they appeared to be floundering, looking for a part to play in the strategic scenario in which they operated. It appears that we are now in one of those interludes. This is not a new situation, and in each case it has been followed by the emergence of a new and defined role for the submarine. In many cases, though, that new role has arrived unexpectedly and has had little to do with those that dominated earlier cycles.

Early in the history of the submarine, a significant principle was established. The operational role of the submarine fleet was defined by the technical capabilities available at the time. In fact, no submarine operations at all were possible until some key issues had been resolved. One was the need to provide the submarine with a means of underwater propulsion that allowed a reasonable operational radius. The other was to provide the craft with a weapon that would allow it to attack an enemy without destroying itself in the process.

These challenges proved hard to overcome. For most of the submarine's early career, its operations could best be summarized by saying that if the submarine didn't kill its crew, the weapons they tried to use would. However, after a stumbling start in the 19th century, technology evolved to a point where a practical submarine and its weapons became a reality.

Coastal Defense. The submarine was initially envisioned as a short-range coastal defense system, based in harbors to defend those installations against attack. Since the element of strategic surprise is always on the side of the offensive, the mobility allowed by the sea means that the attacker can pick his spot and concentrate overwhelming force against a defender. The submarine, however, offered an answer to this dilemma. Because it was essentially invisible, the enemy would not be able to concentrate against it; indeed, it would be the coastal defense submarines that could concentrate against ships entering the waters they defended.

In this manner, the submarine promised to be the long-sought-after "equalizer" that would allow a small navy to maintain an effective operational capability in the presence of a large and hostile enemy fleet. This was the logic followed by the first operator of serviceable submarines, the Confederate States of America Navy. It saw the submarine as a submersible harbor defense craft that would make a close Union blockade too costly to execute. The idea was right, but the technology to execute it was lacking. The H.L. *Hunley* sank the Union frigate *Housatonic* but was herself lost in the

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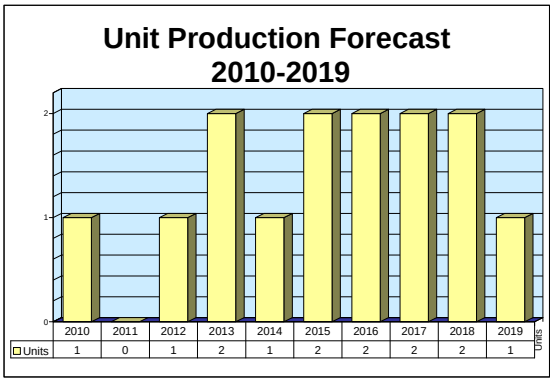
Scorpene

Outlook

- Pakistani negotiations reopened
- Chile earthquake may open requirements for two more submarines to replace those written off by tsunami
- Brazilian nuclear Scorpene may open up whole new market sector



Orientation

Description. A family of diesel-electric patrol submarines (SSKs).

Sponsor

Direction des Constructions Navales (DCN) International
18-21, rue du Colonel Pierre Avia
F-75015 Paris
France
Tel: + 331 41087171
Fax: + 331 41080027

Chilean Defense Ministry
Santiago, Chile

Ministerio De Marina
Madrid, Spain

Status. In production.

Total Produced. Two completed.

Pennant List

Number & Name	Builder	Launch Date	Commission Date
Brazil			
S35	Arsenal de Marinha, Rio de Janeiro		2015
S36	Arsenal de Marinha, Rio de Janeiro		2016
S37	Arsenal de Marinha, Rio de Janeiro		2017
S38	Arsenal de Marinha, Rio de Janeiro		2018
Chile			
S22 *O'Higgins*	DCN International/Navantia, Cherbourg	11/2003	5/2004
S23 *Carrera*	DCN International/Navantia, Cartagena	11/2004	12/2006
India			
	Mazagon Shipbuilding, Mumbai		2015
	Mazagon Shipbuilding, Mumbai		2016
	Mazagon Shipbuilding, Mumbai		2017
	Mazagon Shipbuilding, Mumbai		2018
	Mazagon Shipbuilding, Mumbai		2019
	Mazagon Shipbuilding, Mumbai		2020

Scorpene

Number & Name	Builder	Launch Date	Commission Date
Malaysia			
Tunku Abdul Raman	DCN International/Navantia, Cherbourg	12/2007	1/2009
Tun Razak	DCN International/Navantia, Cartagena	10/2008	10/2009
Spain			
S81	Navantia, Cartagena	2/2010	10/2013
S82	Navantia, Cartagena	8/2011	10/2014
S83	Navantia, Cartagena	7/2012	10/2014
S84	Navantia, Cartagena	7/2013	10/2015

Mission. The Scorpene class will be capable of anti-submarine and anti-surface warfare missions, as well as coastal patrol, special warfare, and open-sea operations.

Price Range. Depending on precise configuration, the price of a single Scorpene is set at about $450 million.

Contractors

Prime

DCNS	http://www.dcns.fr, 2, rue Sextius Michel, Paris, 75732 France, Tel: + 33 1 40 59 50 00, Fax: + 33 1 40 59 56 48, Email: info@dcn.fr, Prime
Navantia Shipbuilding	http://www.navantia.es, Velázquez St, 132, Madrid, 28006 Spain, Tel: + 34 91 335 84 00, Fax: + 34 91 355 86 52, Email: navantia@navantia.es, Prime

Subcontractor

Avio SpA	http://www.aviogroup.com, Via I Maggio, 99, Rivalta di Torino, 10040 Torino, Italy, Tel: + 39 011 00 82111, Fax: + 39 011 00 82000 (Navigation Equipment)
Calzoni Srl	http://www.calzoni.com, Via A De Gasperi, 7, Calderara di Reno, Bologna, 400 12 Italy, Tel: + 39 0514 1377, Fax: + 39 0514 1375 55, Email: calzoni@calzonispa.com (Hoistable Masts)
EPCOTS	http://www.epcots.fr/anglais/index.html, 66 Impasse Branly, Zone Industrielle BP99, Toulon, 83079 France, Tel: + 33 498 080000, Fax: + 33 498 080008 (Sound Isolation)
Eurotorp	http://www.eurotorp.com, 525 Route des Dolines, Sophia Antipolis, 06903 France, Tel: + 33 4 92 96 38 50, Fax: + 33 4 92 96 38 55, Email: et@eurotorp.com (Torpedoes)
Indra Sistemas SA	http://www.indra.es, Avda. Bruselas 35, Alcobendas, Madrid, 28108 Spain, Tel: + 34 91 480 50 01, Fax: + 34 91 480 50 58, Email: indra@indra.es (Electronic Defense Systems)
Jeumont Schneider	31 32 Quai de Dion Bouton, Puteaux, F-92811 Cedex, France (Submerged Propulsion System)
Kollmorgen Electro-Optical	http://www.eo.kollmorgen.com, 347 King St, Northampton, MA 01060 United States, Tel: + 1 (413) 586-2330, Fax: + 1 (413) 586-1324, Email: sales@eo.kollmorgen.com (Model 76 Periscope)
L-3 Communications - ELAC-Nautik GmbH	http://www.elac-nautik.de, Neufeldtstrasse, Kiel, 24118 Germany, Tel: + 49 431 883 0, Fax: + 49 431 883 496, Email: elac.marketing@]L-3com.com (Echosounders)
MTU Friedrichshafen GmbH	http://www.mtu-on-line.com, Maybachplatz 1, Postfach 2040, Friedrichshafen, 88040 Germany, Tel: + 49 7541 90 0, Fax: + 49 7541 90 2724, Email: info@mtu-on-line.com (Diesel Engine)
Sagem	http://www.sagem-ds.com, Le Ponant de Paris, 27, Rue Leblanc, Paris, 75512 France, Tel: + 33 1 58 11 78 00, Fax: + 33 1 58 11 78 50 (Sagem Periscope)

Sener Ingenieria & Sistemas SA	http://www.sener.es, Severo Ochoa, 4, Parque Tecnológico de Madrid, TRES CANTOS (Madrid), 28760 Spain, Tel: + 34 91 807 7000, Fax: + 34 91 807 7201, Email: dep.ambiente@sener.es (Engineering and Production Software)
Thales Underwater Systems	http://www.thalesgroup.com/naval, 525 Route des Dolines, BP 157, Sophia Antipolis, 06903 France, Tel: + 33 4 92 96 30 00, Fax: + 33 4 92 96 41 24, Email: TUS@thales-underwater.com (DSUV 22 Sonar)

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

	Metric	**U.S.**
Dimensions		
Length	61.7m	201.5 ft
Beam (pressure hull diameter)	6.2 m	20.3 ft
Draft	5.8 m	19.0 ft
Surfaced	1,450 tonnes	
Submerged	1,700 tonnes	
Submerged – with AIP	1,900 tonnes	
Performance		
Speed (dived)	37 kmph	20 kt
Operating Range (dived)	1,000 km at 7.5 kmph	550 nm at 4 kt
Surfaced	12,000 km at 15 kmph (± 16%)	6,500 nm at 8 kt (± 16%)
Maximum Diving Depth	300+ m	1,000 ft
Endurance	50 days	
Crew	6 officers, 25 enlisted	
	Type	**Quantity**
Armament		
Torpedo Tubes	53 cm (21 in)	6
Torpedoes/Missiles	Heavyweight torpedoes or SM39 Exocet missiles	18 total
Electronics		
Sonar	TSM-2233 Eledone	1
Radar – Navigation	Kelvin Hughes Compact Submarine radar	1
ESM	ASR 900, intercept	1
Command System	SUBTICS	1
Periscope – Attack	Sagem APS	1
Search	Sagem SMS optronic	1
Datalink Terminal	SISDEF	1
Machinery		
Diesel Engines	MTU 16V396 SE84	4x 748 shp
Electric Motor	Jeumont Schneider	1x 3,808 shp (2.8 MW)
Propeller	7-bladed skewed	1

Scorpene

Design Features. The Scorpene hull design traces its lineage to the proposed diesel-electric version of the nuclear-powered Amethyste-class attack submarines. This design has been downsized to eliminate the size penalties that are automatically associated with nuclear power. The hull form itself is a derivative of the hydrodynamically efficient Albacore design, with an extended parallel midships section and rounded bow. The stern form is elongated and features fin-mounted hydroplanes and "+" shaped tailplanes.

Internally, the layout is very conventional, with two decks. The accommodations are on the upper deck, with the ship's diesels and batteries situated on the lower deck. The torpedo tubes are forward, firing out through the bow, with the sonar arrays in the chin position under the tubes. The ship has accommodations for 31 men, with a standard watch team of nine. The control room and the living quarters are mounted on an elastically supported and acoustically isolated floating platform. All living and operational areas are air-conditioned. The submarine also has space for six additional fold-down bunks for a special operations crew.

Much of the technology used in the Scorpene class is derived from the French Amethyste and Le Triomphant class nuclear submarines, such as the submarines' automated platform control system and the fully integrated Submarine Tactical Integrated Combat System (SUBTICS). The ship uses up to six multifunction common consoles and a centrally situated tactical table. It comprises a command and tactical data handling system, a weapon control system, and an integrated suite of acoustic sensors with an interface to a set of Air Surface Detection sensors and to the Integrated Navigation System.

The Integrated Navigation System combines data from global positioning systems, the log, depth measurement, and the ship's trim/list monitoring system. The Scorpene monitors the environment, including seawater density and temperature and the submarine's own noise signature.

High-tensile HLES 80 steel (equivalent of HY 80) is used for the hull to optimize the pressure hull's weight in relation to durability. Consequently, the submarine offers a larger and more useful load of ammunition and fuel on board than would be offered by conventional designs.

Extensive use is made of commercial off-the-shelf (COTS) hardware and software components, contributing to the modular structure of the boat. Examples of such components include the high-speed RISC processors, the TCP/IP protocol for communications, and the X-Windows graphical user interface along with the UNIX operating system.

Operational Characteristics. The submarine's modular structure has enabled the manufacturer to carry out full testing of each component prior to its final assembly and integration into the submarine. As a result, the onboard tests are fewer in number and easier to perform.

Comprising the primary armament of these submarines are the WASS (Whitehead Alenia Sistemi Subaquei) Black Shark heavyweight torpedoes. The Black Shark is a dual-purpose, wire-guided torpedo that is fitted with an Astra active/passive acoustic head and a multi-target guidance and control unit incorporating a counter-countermeasures system. It has an electrical propulsion system based on a silver oxide and aluminum battery. The two Scorpene vessels for the Royal Malaysian Navy are also to be armed with the Black Shark. The ships can carry up to 18 weapons, with the mix variable between the two ships. Mines can be used as part of the weapons mix, replacing torpedoes on a two-for-one basis and providing a maximum capacity of 36 mines if chosen as the sole weapon.

Variants/Upgrades

AM-2000. An AIP derivative of the Scorpene CM-2000, featuring a 200-ton hull stretch to accommodate the 2,800-kW MESMA air-independent propulsion (AIP) system. The resulting effect is increased underwater endurance at 4-knot speed from 500 to 750 nautical miles.

CA-2000. Downsized coastal submarine based on the CM-2000. Standard displacement is 940 tons; surfaced displacement, 1,070 tons; submerged displacement, 1,190 tons. Length is 60.26 meters. The reductions in size are obtained by sacrificing one set of torpedo tube reloads (reducing load-out to 12 weapons) and reducing tactical radius to 300 nautical miles at 3 knots and range to 4,000 nautical miles at 7 knots, with a 17 percent indiscretion ratio. Speed is maintained at 20 knots but can only be sustained for five minutes. The electric motor is DC rather than AC.

CM-2000. The conventional diesel-electric version of the design, as described in this report.

Brazilian SSN. The Brazilian Navy has signed an agreement with France for the construction of a nuclear-powered submarine. First, France will help Brazil build

a shipyard in Rio de Janeiro that will have capacity for the construction of a nuclear sub fleet. An enlarged derivative of the conventional Scorpene will be used as a pattern design for the nuclear-powered vessels.

Project 75. This is the Indian designation for the program to build up to 24 Scorpene class submarines over the next 25 years. The Indian government admits that the Project 75 program to build the first six Scorpene class submarines at the Mazagon shipyard in Mumbai has been hit by massive slippages, which in turn would adversely impact the Navy's underwater combat capabilities.

Originally, the first of the Project 75 class submarines was to have been delivered in December 2012, with the balance following at annual intervals. The first submarine is now expected to be delivered in the second half of 2015. The delays are due to problems associated with the provision and absorption of the technology needed to build the submarines, along with delays in the reconstruction of the Mazagon shipyard necessary to handle the construction project.

Due to these problems, the Project 75 program has been opened up to other submarine designs for the seventh and subsequent hulls.

S-80A. This is the enlarged derivative of the Scorpene class for the Spanish Navy. Navantia sources are emphatic that the development of the S-80A class has resulted in the new design having only a superficial resemblance to Scorpene and that the S-80A is essentially an entirely new design produced to meet Spanish Navy requirements. The S-80A submarines are 71 meters long and displace 2,300 tons.

SMX-23. In May 2007, DCN introduced a new diesel-electric submarine design that builds on the Scorpene basis. The SMX-23 is a double-hulled boat displacing 885 tons and having a hull length of 48.7 meters. It is armed with six torpedo tubes, and has a maximum diving depth of 200 meters and a maximum submerged speed of 15 knots. It will have a crew of 19 and an endurance of 10 days.

Lithium Battery Upgrade. DCNS is investigating the integration of new-generation batteries with Scorpene submarines. This new technology is intended to double submerged endurance at high speed while reducing the indiscretion rate, increasing range, improving safety, and requiring less maintenance – all essential criteria for submariners.

The Scorpene design is compatible with both Li-ion batteries and the MESMA AIP. MESMA alone enables a Scorpene to patrol at low speed for three weeks at a time without broaching the surface. To achieve this, DCNS has been working in close cooperation with battery producer Saft. Saft assembles Li-ion cells to form battery modules into a battery system, complete with the necessary control electronics and software, that will power a submarine in complete safety. The Li-ion cells developed by Saft for this application are similar to those used on satellites and have already proven their long lifetime. Saft is also a major supplier of Li-ion batteries for both manned and unmanned underwater vehicles.

Program Review

Background. The Scorpene design has its origins in a proposed French replacement for the old Daphne (S-60) class submarines, which were reaching the end of their operational lives and had limited effectiveness. The follow-on design to the Daphne class, the S-70 Agosta class, still used an older hull design that did not meet modern requirements for underwater performance.

A False Start

A new design, designated the S-80 class, was then developed to fulfill these underwater performance requirements. The design featured a new teardrop hull equipped with entirely new weapons and sensors. As with many other French naval programs, the S-80 fell afoul of budgetary pressures and the squeeze on naval expenditures that resulted from the priorities assigned to the SSBN and aircraft carrier programs. Although not formally abandoned, the S-80 design was discarded in favor of limited improvements to the Agosta, designated the S-90B. This, too, failed to receive funding. The Agosta S-90B was later exported to Pakistan.

A Joint Program

The Spanish Navy also faced the impending obsolescence of its Daphne class submarines. After examining a number of proposals, it elected to design a submarine optimized to its requirements. However, when the new design began to look much like the suspended French S-80, Izar and DCNI agreed to combine efforts and develop the S-80 design as a joint venture.

The joint venture's new design was unveiled during the October 1990 Le Bourget Navale exhibition. At that time, sources indicated that both France and Spain would buy four submarines of this class, with the first to be delivered in 1999. However, Spanish sources contradicted this report, stating that Scorpene was an

export design only and that no decision had been made by the Spanish Navy to adopt it.

The Scorpene hull form started tank testing in August 1993. By May 1994, the Spanish Navy still had not confirmed that an order would be placed for this design, although it had few options other than Scorpene for a Daphne replacement. In addition, the French Navy had yet to confirm its interest in the design. However, Thailand asked for full details of the class in pursuit of its perennial requirement for up to four coastal submarines.

Orders Fall Through

The Cabinet approved the Thai submarine requirement in April 1995 and gave authorization to initiate a competitive selection process. The Scorpene was a favored candidate at this time, but the program was suspended again the following March. As had become common with the Thai submarine program ever since it was originally floated in 1959, the proposal was subsequently suspended and revived several times until it was finally canceled in May 1996. It was revived (and canceled again) in 1998, 2000, and 2003.

The French government also suggested that four Scorpene class submarines be supplied to South Africa as part of a proposed larger package aimed at reconstructing that country's Navy. However, South Africa eventually chose to go with the German package for its Navy, including MEKO corvettes and Type 209 submarines.

Finally, an additional export order from Pakistan fell through when that country opted for the Agosta 90B design instead. The Agosta 90Bs are now under construction, with the first mainly built in France, and subsequent units are being finished locally in Pakistan under a technology transfer program.

In April 1995, the French Navy launched a program for the design of next-generation nuclear-powered attack submarines. At that time, the French Navy stated that the new submarines would replace both the existing Rubis/Amethyste nuclear-powered hunter-killers and the Agosta class diesel-electric boats. There were no plans to maintain a diesel-electric element in the submarine fleet once the Agosta class was retired. The assessment was confirmed when a French defense policy review announced that the diesel-electric submarine force was to be retired without replacement. This policy decision appears to eliminate future procurement of Scorpene for the French Navy.

In March 1997, Chile announced that it intended to acquire two diesel-electric Scorpene submarines after reviewing offers from at least four countries, according to the Chilean newspaper *El Mercurio*. The announcement came as a surprise, because most observers expected Chile to go with the German bid due to the country's long-standing experience with Type 209s. The Swedish bid (for Gotland/Collins class submarines) fell out of competition in the final stages of the bidding, reportedly due to a monumental diplomatic faux pas by the Swedes.

Success at Last!

Still, as of the end of 1997 no confirmation of the Chilean order had been received. The final decision was left hanging, implying that an alternative would still have a chance. But in April 1998 the Scorpene deal was made official, and the contract was finally signed on December 17. The order was for two boats from the DCN/Izar team, plus an option for one more to be built as part of a license agreement at the Talcahuano shipbuilding facility in Chile. At this stage, however, the contract included no technology transfer elements.

The launch order for the new program was badly needed by the bi-national team in order to win credibility for the design. According to an interview with Chilean Defense Minister Edmundo Perez Yoma, the silent operation of the Scorpenes presumably proved to be a deciding factor in the bidding race, in addition to the favorable financial aspects of the package.

Under the work share agreement between DCN and Izar, the French company is responsible for 60 percent of the man-hours estimated for the project, with Izar accounting for the other 40 percent. DCN's Cherbourg yard is responsible for the manufacture of the pressure-resistant sections of the hulls for the two submarines, in addition to the outfitting and assembly of the front parts for both boats. Izar's Cartagena yard, however, is handling the aft parts of the submarines. Following the necessary transport of components between the two sites, final assembly of the first boat will take place at the French yard; assembly of the second boat will take place in Spain.

The December 1998 order also had the expected effect of pulling Spain into the fold. The Spanish government stated in 1998 that it would buy four Scorpenes to replace its aging Agostas, starting in 2004. Considering the government's fiscal constraints, however, that timeframe appeared ambitious. No contract was placed by 2002, which meant that delivery of the first boat would be impossible before late 2006 or 2007. Later reports from Spanish sources suggested that the Scorpene was too expensive and over-designed for Spanish needs. Such reports were supported by information published by Izar suggesting that the next-generation Spanish submarine would be the S-80 class.

The Chilean Navy was deeply perturbed by a campaign mounted by a Spanish judge to secure the extradition from Britain of Chile's former president, Augusto Pinochet, for alleged crimes against human rights. Eventually, the British government repatriated ex-President Pinochet to Chile, but not before the diplomatic imbroglio reached a point where the Chileans threatened to cancel the Scorpene deal if Spain did not formally terminate those efforts. Nevertheless, the logistics and the costs to transfer or cancel the contract made it too expensive for the Chilean government to back out of it at that stage. Chile has also suggested on several occasions that the submarines be built entirely by DCN in France, eliminating Spain's Izar altogether, but even that would mean renegotiating the contract, as well as paying high penalties for rearranging the procurement patterns.

Malaysian Order

On June 5, 2002, the Malaysian Ministry of Defense awarded the DCN International/Izar consortium a contract to build two medium-sized Scorpene class submarines. The first submarine was assembled in Cherbourg (France) and was commissioned in January 2009; the second ship was built at Izar's Cartagena shipyard in Spain and was to have entered service in October 2009. However, the lead submarine developed problems that left it unable to submerge. "The submarine can still dive but when we detected the defects, we were advised that it should not dive," Defense Minister Ahmad Zahid Hamidi said. "The defects are still covered by warranty, so the supplier and contractor are repairing them," he added.

This was the third fault found with the Scorpenes built for Malaysia. Malaysian Navy commander Abdul Aziz Jaafar said the first problem to emerge involved the submarine's cooling system. This problem was discovered last December and delayed the submarine's voyage from France to Malaysia. In January 2010 another defect was identified, but in a different system. These faults delayed the delivery of the second submarine, the KD *Tun Razak*. This submarine was originally scheduled for delivery in late 2009 and finally entered service in July 2010.

The problem discovered in January 2010 appears to have been identified as part of the ballast system. This was quickly resolved and the fix was verified in a series of trials off the coast of Malaysia that saw the KD *Tunku Abdul Rahman* carrying out numerous test dives. At that time, the second submarine ordered by the Royal Malaysian Navy, the KD *Tun Abdul Razak*, was still at the French shipyard in Toulon where remedial work was completed.

Indian Saga Starts

In July 2001, Thales and the Indian government signed a major technology transfer/coproduction agreement that involved a license for the construction of an indeterminate number of Scorpene class submarines at the Mazagon Shipyard previously used to construct the IKL-designed Type 1500 submarines. The Indian-built Scorpenes are intended to replace the old Project 641 (Foxtrot) class submarines (only three of which remain in Indian service), the Type 1500s, and the older Project 877 Kilos. The Indian statement suggested that up to 24 Scorpenes could be built, but this number may prove to be overly optimistic. The initial production agreement appears to be for six submarines. Later reports amended the 24-submarine target to a total of 26 to be built over the next 25 years.

The Indian Scorpene deal took a lot longer to finalize than had been anticipated. The deal was approved by the Indian Ministry of Defence in September 2002 and then went to the Cabinet for its final approval. However, in January 2003, reports surfaced that the Indian Cabinet had suggested that the purchase of secondhand diesel-electric submarines would be cheaper. These concerns were quickly eliminated, but by April 2003, the Indian government had shifted its position. It now wanted all six submarines of the initial group to be built in India, instead of the original plan to build two in France and the remaining four in India. The final arrangement was for all six submarines to be built in India.

Finally, in October 2005, India placed an order for six Scorpene submarines. The submarines will be built at the state-owned Mazagon dockyard in Bombay, with technical assistance and equipment from French companies DCN and Thales. The submarines are to be delivered between 2012 and 2017. At the same time, India also placed an order for 36 MBDA SM39 Exocet anti-ship missiles to arm the submarines.

Other Export Orders

During late 2003, the long-delayed Spanish order for four submarines was confirmed. The new submarines were described as being of the S-80 class and significantly larger than the existing members of the Scorpene family. The new submarines will displace 2,345 tons and be 71 meters long; plans are for them to be commissioned between 2007 and 2010.

This development was balanced by the wholly unanticipated loss of the Portuguese contract to the German Submarine Consortium. It had been assumed that the long-standing relationship between the

Scorpene

Portuguese Navy and the French shipbuilding industry made the Scorpene a virtual certainty. The Portuguese decision to opt for the Type 209PN was, therefore, a significant blow to the Scorpene program.

Deliveries Under Way

In November 2003, the first of the Chilean Navy's Scorpene class submarines, the *O'Higgins*, was completed; it was launched the following May. During sea trials in 2004, the submarine successfully test-fired both Black Shark and surface and underwater target (SUT) torpedoes. These trials followed a successful diving test to the boat's maximum design depth of more than 300 meters on November 2, 2004 – a critical test for the submarine's structure, validating the basic principles behind Scorpene's design and construction. During the trials, the *O'Higgins* was based at DCN's Lorient shipyard, under the control of a Chilean crew assisted by DCN specialists. The submarine has since been delivered to the Chilean Navy.

During 2005 and early 2006, a number of possible new clients for Scorpene emerged. These included the Indonesian Navy, which was seeking to acquire additional diesel-electric submarines to replace the two Type 209s in service; between four and six submarines could be purchased. But although the Scorpene was prominently mentioned as a possible contender, by mid-2007 Indonesia was reported to have ordered six Russian-built submarines of the Project 677 class.

Also among possible customers for the Scorpene was the Venezuelan Navy, to replace its aging Type 209s. However, Venezuelan President Hugo Chavez has been forging a closer defense relationship with Moscow and has increased the amount of defense equipment purchased from Russia. For example, Venezuela has bought transport helicopters from Russia, as well as 100,000 AK-103 assault rifles. In addition, Russia was offering Amur class submarines armed with heavyweight torpedoes and the Club-S (Klub-S) missile. This offer won the day, with the Venezuelan Navy opting for the Russian submarines.

Other possible export candidates continued to emerge. Pakistan, for example, issued a requirement for at least three new-generation submarines to replace its aging Agosta 70 class boats. In addition, Turkey indicated a requirement for six to nine new submarines. Both countries eventually chose Germany's Type 214 to fill their requirements. However, in the case of Pakistan, the competition was reopened in 2010 with Type 214, Scorpene, and the Chinese Project 041 Yuan class recompeting for the order.

A Rift in the Family

During 2007, a problem arose between the two partners forming the backbone of the Scorpene submarine alliance. The French DCN group released details of a new submarine design called Marlin. The Marlin was advertised as a successor to Scorpene, exploiting advances made to the French Navy's Barracuda class nuclear-powered attack submarines. In fact, most of the technology for Marlin is a direct carry over from Scorpene, with the primary difference being that the Marlin is slightly larger.

Spain responded to this development by marketing its S-80A class submarine design as a successor to Scorpene. In fact, if anything, there is less in common between Scorpene and S-80A (it is debatable if any significant features of the Scorpene design are left in the S-80A) than there is between Scorpene and Marlin. Although both companies appeared locked in intractable positions, they left room for a future agreement to continue the highly successful Scorpene partnership. For a while it appeared as if this issue would end up in court, but late 2008 government-level talks led to meetings between the companies in April and May 2009 in which the matter was resolved. Marlin has now been absorbed into the Scorpene family.

The most recent development in the Scorpene saga has been the decision by the Brazilian Navy to purchase four conventionally powered Scorpene class submarines. In a related development, a nuclear-powered derivative of the Scorpene design is to be developed and built in Brazil. There is growing speculation that this is, in fact, a simplified Barracuda class SSN rather than an enlarged Scorpene.

Related News

More Funding for Indian Scorpenes **–** The Indian government has approved additional funding valued at INR20 billion ($438 million) for the Project 75 Scorpene submarine program. This is in addition to the INR187.9 billion ($4.1 billion) already allocated to this program. The funds are to cover the purchase of contractor-supplied equipment packages for the submarines. These packages include all major systems connected with the sensors, propulsion, and weaponry for the vessels. The cost of the contractor-supplied equipment packages had risen from $543 million to $950 million since the construction contracts were signed for the submarines. Negotiations over the price increase have been stalled so long – since October 2005 – that there is no combat system to put inside the submarine hulls under construction. This has delayed the Project 75 program by two years. The

Indian Navy has also been criticized for delays in the follow-on Project 75I program for a second tranche of six diesel-electric submarines. Without these boats, the Indian Navy could drop to five operational submarines by 2015. (*The Times of India*, 3/10)

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Scorpene Class Submarine

Source: Chilean Navy

Funding

The development of Scorpene was funded largely by the French and Spanish governments.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
DCN/Izar	410.0 (est)	Dec 17, 1997 – Chile confirms order for two Scorpenes, with deliveries in 2003-2004.
SEMT Pielstick	N/A	Sep 2003 – Order from Malaysia for diesel generator sets to equip Scorpene class submarines. Diesels are of the 12PA4V200 type.
Navantia	1,900.0	Sep 2003 – Order for four S-80 class submarines for Spanish Navy.

Scorpene

Contractor	Award ($ millions)	Date/Description
DCN/Navantia	3,500.0	Oct 2005 – Order for six Scorpene class submarines to be built at the Mazagon Docks in Mumbai. The contract also covers the work needed to reactivate the submarine-building facility at Mazagon, which built four TR-1500 class submarines in the 1980s but has been mostly idle since.
Kollmorgen	73.8	Aug 2006 – Periscopes for S-80 class submarines.
Indra	30.5	Aug 2006 – Pegaso EW equipment for S-80 class submarines.
Avio	N/A	Aug 2006 – Autopilots for S-80 class submarines.
DCNS	2,600	Dec 2008 – Four Scorpene class SSKs for Brazil.

Timetable

Month	Year	Major Development
	1980s	France launches S-80 program; Spanish Daphne replacement program begun
	1990	Franco-Spanish submarine programs merge
	1990	Scorpene program announced
Aug	1993	Tank testing of hull
Feb	1997	Chile moves closer to ordering two Scorpene submarines from DCN
Dec	1997	Chile confirms launch order for two Scorpenes
Early	1998	Spain states intention to order four Scorpenes to replace aging Daphnes
Apr	1998	Chilean contract becomes effective
Jul	1998	First steel cut on the first boat built for Chile
Nov	1999	First Chilean boat laid down
Jul	2001	Indian coproduction agreement signed
May	2002	Malaysian order signed
	2003	Chile's first unit launched
	2003	Spanish order for four S-80 submarines confirmed
	2004	Chile's second boat launched
	2004	First Chilean boat enters service
	2005	Chile's second boat commissioned
	2008	First Malaysian submarine completed
Dec	2008	Order from Brazil for four conventionally powered and one nuclear Scorpene
	2009	Second Malaysian submarine to be completed

Worldwide Distribution/Inventories

Brazil	Four boats on order plus one SSN
Chile	Two in service
India	Six under construction
Malaysia	Two in service
Spain	Four under construction

Forecast Rationale

A major change in the international submarine market took place when DCNS agreed to build a submarine operating base near Rio de Janeiro and provide the design art and operational expertise required to construct a nuclear-powered derivative of the basic Scorpene design. This means that the French will be transferring nuclear propulsion technology to the Brazilian Navy. Argentina has also expressed an interest in joining this Brazil-France agreement for the construction of nuclear submarines.

This is a massive change indeed. Until this deal was signed, nuclear submarine construction was restricted to a few countries that produced boats for their own navies alone. Now, this sector is being opened up and, potentially at least, other countries can buy into the nuclear-powered submarine game. One interesting question that must therefore be asked is whether the nuclear-powered Scorpene derivative will be offered to additional countries. A nuclear-powered attack submarine would be a very new and intriguing presence on the export market.

The primary problem with exporting nuclear submarines has been the vexed subject of fueling them. The reactor fuel used in nuclear submarines is of higher enrichment, and, potentially at least, is at or very close to weapons grade. This makes it subject to nuclear proliferation restrictions. The French appear to have circumvented this restriction by using a much lower level of enrichment than usual, compensating for the shorter core life by designing the submarines for easy core replacement. The contract contains a provision for a self-contained plant for the removal of the old cores that are then returned to France for reprocessing, while new cores are delivered from France for installation.

Other Orders?

Due to the earthquake in Chile that devastated the ASMAR shipyard, the Chilean Navy may well be driven to order two additional Scorpene class boats. One of its existing pair was in the yard and is reported to have received some damage from the quake and resulting tsunami. Of much greater significance is that the *Almirante Simpson*, a Type 209-1300, was also in the yard, having been drydocked for a refit. She is reported to have been thrown off the hull blocks by the force of the quake and very seriously damaged.

It must be seriously questioned if this submarine is worth repairing. She is almost 25 years old and well overdue for retirement. It would make more sense to put the money needed for her repair toward ordering a second pair of Scorpenes. A homogenous fleet of four submarines would be a more logical move in terms of both economics and logistics.

As a side note, the Ecuadorian submarine *Shuyri* was also in the ASMAR yard and was considered to be a total write-off. Replacing her may well figure in the negotiations over who repairs the ASMAR yard and the submarines damaged as a result of this natural disaster. Certainly, repairing ASMAR is a major priority for the Chilean Navy since it is the sole center in its fleet infrastructure for refits and maintenance. Navantia of Spain, DCNS, and Thyssenkrupp are all bidding for the ASMAR reconstruction contract, valued at $450 million. It can be taken for granted that all three bidders (all of whom are marketing submarine designs by a strange coincidence) will be including speculative bids for replacing the damaged submarines along with their rebuilding bids.

Somewhere East of Suez

News has emerged that the existing Scorpene program in India has not gone well, with technology transfer issues threatening to delay the program by a year or more. This could well result in a situation where India elects to opt for Russian-built boats for the second tranche of six submarines, which opens the way for Pakistan to order Scorpene. By now, the program has been delayed three years, and it is becoming increasingly likely that another submarine design will be selected for the next flight of Project 75 submarines.

One good piece of news for Scorpene is that it is back in the Pakistan contract bidding for the next three Pakistani submarines. The Type 214 had been selected for this requirement but, despite almost two years of negotiations, no firm contract was signed. Early in 2010, the contract was thrown open once again with the French being invited to bid Scorpene and the Chinese the Project 041 in competition with the Type 214.

The Scorpene class appears healthy but has lost its leading place in the SSK market due to the large orders signed for Type 214 class boats in 2008. The issue now is whether the sales team can convert some of the outstanding interest into solid orders. If they can swing the Pakistani requirement back their way and gain the replacement orders from Chile, they will have done much to restore their position.

Scorpene

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		**High Confidence**				**Good Confidence**			**Speculative**			
	Thru 2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
DCNS												
Scorpene <> Brazil <> Navy												
	0	0	0	0	0	0	1	1	1	1	0	4
Scorpene <> India <> Navy												
	0	0	0	0	0	0	1	1	1	1	1	5
Scorpene <> Malaysia <> Navy												
	1	1	0	0	0	0	0	0	0	0	0	1
Scorpene <> Spain <> Navy												
	0	0	0	1	2	1	0	0	0	0	0	4
Subtotal	1	1	0	1	2	1	2	2	2	2	1	14
Total	1	1	0	1	2	1	2	2	2	2	1	14

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