ARCHIVED REPORT

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Project 677 (Amur)

Outlook

- Program canceled due to widespread technical failure
- Details of problems bear close resemblance to those afflicting the Collins class
- One boat to be kept as trials submarine; rest canceled and will be scrapped
- All work now concentrating on proven and effective Project 636 class boats

Orientation

Description. Diesel-electric submarine.

Status. Project canceled.

Sponsor. Russian Ministry of Defense, through the Russian Navy.

Total Produced. One submarine being retained for test purposes; all others canceled.

Pennant List

Number & Name	Builder	Laid Down	Launched	Commissioned
Russia				
B-100 *Sankt Petersburg*	Rubin	12/97	11/04	5/2010
B-101 *Khronstadt*	Rubin	7/05	2008	*
B-102 *Sevastopol*	Rubin	11/06	2009	*
Petrozavodsk	Rubin	2007	2010	*

*Canceled February 2012

Mission. Tracking adversary submarines and surface ships in and around territorial waters, defense of friendly missile submarines, and laying of mines in protected zones, as well as participation in joint operations during large-scale regional conflicts.

Price Range. A $300 million to $350 million price is estimated, based on corporate management statements in 1997.

Contractors

Prime

Rubin Central Design Bureau for Marine Engineering	http://www.ckb-rubin.ru, ul.Marata, 90, St Petersburg, 191119 Russian Federation, Tel: + 7 812 113 5132, Fax: + 7 812 164 3749, Email: neptun@ckb-rubin.spb.su, Prime
Aurora Research and Production Association	15 Karbyshev St, St Petersburg, 194021 Russian Federation, Consortium Member

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Morskaya Tekhnika Fig	67 Bolshaya Morskaya, St Petersburg, 199000 Russian Federation, Consortium Member

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Technical Data

	Metric	**U.S.**
Dimensions		
Length	66.8 m	219.2 ft
Beam	7.1 m	23.6 ft
Draft	6.7 m	14.4 ft
Displacement		
Surfaced	1,765 tonnes	
Submerged	2,650 tonnes	
Performance		
Max diving depth	250 m	820 ft
Speed – submerged	39 kmph	21 kt
Speed – surfaced	18 kmph	10 kt
Cruising range – submerged, on batteries	1,200 km at 5 kmph	650 nm at 3 kt
Cruising range – submerged, snorting	11,100 km	6,000 nm
Endurance	45 days	
Crew	35	

	Type	**Number**
Weapons		
Torpedo tubes	533 mm	6
Torpedoes	SET-80 UGST	(total of all weapons) 18
ASW missile torpedoes	90-R Tsakra	
Cruise missiles	Novator Alfa	
Mines	PM-1, RM-2G	
Electronics		
Sonar	Towed array (Lira)	1
	Bow array	1
	Side array	2
Combat management system	Litiy (integrated, domestic-made)	1
Periscopes	Non-penetrating type	2
Navigation system	Inertial	
Radar	Active, passive antenna on mast	
Machinery		
Diesel generators		2x 3,499 hp
Electric propulsion motor		1x 5,576 shp
Generators	AC generators with rectifiers (brush-type collector)	2
Propeller	Skewed 7-bladed, on one shaft	1

Design Features. The Project 677 class is a further evolution of the basic Project 877 Kilo class by way of the Project 636 (Advanced Kilo) class. The hull uses AB-2 steel and features quieting characteristics developed for the earlier designs. These include the use of anechoic coatings on the outer hull and a skewed seven-bladed propeller. The stern control surfaces are in a cruciform arrangement. Diving planes are mounted on the sail to prevent them from interfering with the operation of the sonar arrays.

The Amur is the export version of Project 677 and comprises a family of non-nuclear submarines ranging from 550 to 1,850 tonnes. The extensive use of standardized and modular components has allowed the same basic design to be adopted across this size range. The individual models differ in the output of the propulsion motor, battery capacity, submerged speed, endurance, and onboard facilities for the crew.

An air-independent propulsion (AIP) system is offered as an alternative to the traditional diesel-electric propulsion. This can also be retrofitted as a plug-in unit on existing submarines, including the latest Project 877 (Kilo) models. The first boat to be delivered to the Russian Navy was originally to be equipped with AIP. Although that plan has since been shelved, AIP does continue to be offered as a future option. In standard fit, the Amur class features a single-shaft propulsion plant with a 2,000-kW propulsion motor (1,650 kW in the export version) and a storage battery, which consists of two groups of battery cells used for underwater operations. In surface mode and in periscope depth, propulsion is provided by two AC diesel generators equipped with rectifiers.

The weaponry offered includes a mix of heavyweight torpedoes, cruise missiles, mines, and the unique Russian "underwater rocket," Shkval. In its basic form, the Amur is offered with indigenous electronic systems, including a new Russian-designed integrated combat system, based on distributed processors that are connected by databus. The design places a great deal of emphasis on modular packaging and cooperative teaming with non-Russian suppliers.

The default sonar system on the submarine includes high-sensitivity direction-listening arrays: two bow sensors and two flank array units in the forward section of the submarine. According to the manufacturer, the arrays have been made as large as possible, covering most of the bow. They are said to be larger than on any other Russian or foreign submarine of this type. The design of the bow has been hydrodynamically optimized through tank testings at the Krylov Research Institute.

An integrated, reelable towed array is fitted as part of the Lira sonar suite. This package replaces the MGK-400K installed on the Project 877s. A new feature on the Amur class is a non-penetrating periscope. The periscope has a low-light TV/night vision camera and a laser rangefinder.

Besides standard radio communications facilities for operation in periscope depth, a trail antenna is included for data transmission at greater depths.

Special attention has been paid to the design of the crew facilities, including the galley, mess, and sleeping quarters. The quality of food is said to have improved, thanks to the modern kitchen equipment featured on board. Moreover, fresh water is stored in stainless steel tanks for use by the crew. Also new for a Russian submarine is the amount of attention paid in the design to modern environmental practices and requirements. The manufacturer notes the onboard waste processing and recycling capabilities of the submarine, including wastewater treatment plants, trash compactors, and waste processors.

Operational Characteristics. The Amur is claimed to be superior to the Project 636 in both capabilities and performance. The Amur is specially designed for shallow-water operations. According to the manufacturer, experience was drawn from World War II combat operations, supplemented by testings in the shallow parts of the Baltic Sea and the Gulf of Finland. These littoral areas have very different aquatic conditions than blue-water areas, where the temperatures and water streams are more predictable. The Amur class submarines can be operated in any region of the ocean that is free from continuous ice cover. And the use of the optional AIP system could extend the operational range to include short-term operations even in those areas.

The Project 677 submarine is said to be 8 to 10 times quieter than the 636s, but it is unclear how this can be supported. The designers claim that fine-tuning of the hull form, along with vibration suppression, reduces self-generated noise. The maximum submerged speed is quoted as 21 knots, and the top surface speed as 10 to 11 knots. Maximum quoted diving depth is 250 meters, and, at 3 knots of speed, the maximum operating range is 650 miles. Submerged endurance is up to 10 days.

The Project 677 is quoted as carrying a load of 12 reload torpedoes on board. The torpedoes can be discharged from the tubes in 15 seconds. The weapons load might include a combination of the S-10 Granat (SSN-21) missile, heavyweight torpedoes, the Shkval supercavitating underwater rocket, and the 83-R and 90-R torpedo-carrying rockets. Sea mines (PM-1 and RM-2G) can be carried on a two-for-one basis as a replacement for torpedoes. Reloading of torpedo tubes reportedly takes only two minutes, indicating the use of powered reload equipment.

Variants/Upgrades

Harmony. Russian Navy project name for the construction of Project 677 class submarines**.**

Air-Independent Propulsion (AIP). The Amur class submarines are expected to be available optionally with an AIP system, and eventually will be equipped with oxygen/hydrogen electrochemical regenerators. These propulsion systems are offered in a 10- to 12-meter-long module, including the plant and a stock of reagents, in a special modularized compartment of the submarine. These modules are also offered for plug-in retrofit on existing submarines.

AIP increases the submerged endurance and the cruising range of the submarine by a factor of magnitude, and also enhances its stealth characteristics by reducing operating noise. Still, a representative of the Russian design bureau stated in 1999 that "there is no immediate requirement for AIP." In other words, the company would continue to hone the AIP technology while offering the Project 677 and Project 877 with the traditional diesel-electric propulsion for the time being.

General designer Yuri Kormilitsin indicated in 1999 that the Kilo would remain in production for a number of years, saying that the AIP plant should be tested on three or four submarines for a couple of years before being put into serial production. The AIP plug apparently was to be offered as a retrofit unit for both Kilos and Amurs at a later date.

Italian-Russian Joint Venture. Russian and Italian naval designers are collaborating on a 1,000-ton submarine that is primarily intended for the Indian Navy. The submarine will apparently be based on the Amur 950 design and will be equipped with an AIP system.

Amur 550. The Amur 550 is a smaller version of the base design offered for export markets. The hull length is 46 meters; beam, 4.4 meters; and height, 5.2 meters. Displacement is only 700 tonnes fully submerged and 550 tonnes in normal operation mode; fully submerged speed is 18 knots. The submarine has a cruising range of 250 miles at submerged cruising speed and a range of 1,500 miles in submerged dieseling mode. Maximum diving depth is quoted as 200 meters, and endurance, 20 days. A crew of 18 is required for this model.

The model 550 has four torpedo tubes, carrying eight 400mm torpedoes but no missiles.

Amur 750. This is also a smaller version of the base design intended for the export market. The hull length is 48 meters; beam, 5 meters; and height, 5.8 meters. Displacement is 900 tonnes fully submerged and 750 tonnes in normal operation mode; fully submerged speed is 17 knots. The submarine has a cruising range of 250 miles at submerged cruising speed, but in submerged dieseling mode, the range is up to 3,000 miles. Like the 550, the maximum diving depth is quoted as 200 meters, and endurance, 20 days. A crew of 21 is required.

The model 750 has four torpedo tubes but carries 16 400mm torpedoes. It has no missile capability.

Amur 950. This is another smaller version of the base design intended for the export market. It is also referred to by the project name Lada. The hull length is 56 meters; beam, 5.6 meters; and height, 6.4 meters. Displacement is up to 1,300 tonnes fully submerged and 950 tonnes in normal operation mode; fully submerged speed is 19 knots. The submarine has a cruising range of 350 miles at submerged cruising speed; in submerged dieseling mode, the range is up to 4,000 miles. The maximum diving depth is up to 250 meters and endurance is 30 days. A crew of 21 is required, as on the 750.

The model 950 also has four torpedo tubes, but they are for 12 heavyweight (533mm) torpedoes; it carries no missiles.

Amur 1450. This is a slightly smaller version of the base 1650 design, similarly aimed at the export market. The hull length is 58 meters; beam, 7.2 meters; and height, 8.2 meters. Displacement is quoted as 2,100 tonnes fully submerged and 1,450 tonnes in normal operation mode; fully submerged speed is 17 knots, probably because of the larger size of the vessel. Consequently, the cruising range is 300 miles submerged (at 3 kt), and 4,000 miles in submerged dieseling mode. The maximum diving depth is the same as the 950's at 250 meters, and its endurance of 30 days is likewise the same. A crew of up to 34 is required with a two-shift watch, and up to 41 with a three-shift watch.

The model 1450 is more heavily armed than the lighter versions of the boat. The 1450 has six heavyweight torpedo tubes and carries 16 torpedoes on board. It also is quoted as having anti-ship cruise missile capability.

Amur 1650. This is the base export model of the series. Its specifications are listed in the **Technical Data** section above. According to Rubin, the 1650 is essentially identical to the domestic Russian version, the only differences being in "certain characteristics of the anti-ship missile system" and the number of crew required. The former probably refers to the carriage of

nuclear weapons, the latter to the watch-keeping routines practiced in each country.

Amur 1850. This is a larger and more capable version of the same base design. The hull length is up to 68 meters; beam, to 7.2 meters; and height, to 8.2 meters. Displacement is 2,600 tonnes fully submerged and 1,850 tonnes in normal operation mode; fully submerged speed is up to 22 knots. The 1850 has a larger storage capacity battery and a more powerful propulsion motor than the 1450. Consequently, its cruising range is up to 500 miles, and in submerged dieseling mode the range is up to 6,000 miles. The maximum diving depth is the same, 250 meters, but endurance is up to 50 days. A crew of up to 37 is required, compared with the 1450's 34. Thanks to its more powerful motors, this model offers substantially better living conditions than the other models. The model 1850 has six torpedo tubes, for 16 heavyweight torpedoes, and has missile capacity.

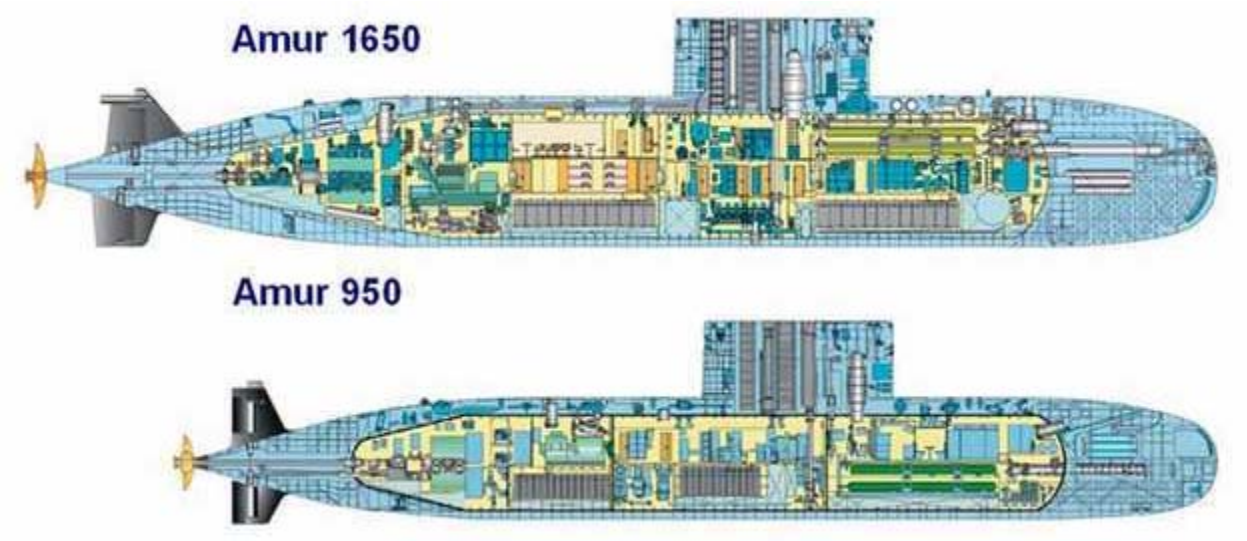
Project 677. Official Russian program designation for the domestic version of the ship.

Project 041 Yuan Class. There is increasing evidence that the Chinese Project 041 Yuan class submarines are license-built versions of the Project 677 or Amur designs. (Further details of this class can be found in the report "Chinese Diesel-Electric Submarines," located in this tab.) The Chinese Project 041 is larger than the Russian Project 677 but the overall design similarities are compelling. Project 041 may well be a Sinified Amur 1850.

B-100 *Sankt Petersburg*

Source: Russian Navy

Project 677 (Amur)



Source: Rosoboronexport

Program Review

Background. The Project 677 was a further development of the design family starting with the Project 877 class, and bears a close relationship to the latest version of that series, the Project 636. The program had its beginnings in 1989, when Rubin was tasked with developing a new, fourth-generation diesel-electric submarine for the Russian Navy, as well as for export markets. The Project 877 class had already been modified with additional modules which, in turn, led to the creation of the Project 636.

A New Submarine

The design bureau took a non-conventional route of creating the new boat by starting with a scale model that was exhibited at the IDEX-93 arms trade show in Abu Dhabi. The idea was to use the model as a teaser to invite opinions and questions from the field so as to determine the optimum direction of the program.

The design concept aroused significant interest at the show, partly because of the location, but also because the strategic and tactical needs there were very much in line with the future worldwide trend. A decision was subsequently made to offer a design available in a range of versions, varying in displacement, armament, cost, and construction time.

Construction Started. Tooling up and prefabrication work for the new design began in 1996. The first order, from the Russian Navy, was finalized in August 1997. This order was reportedly for the Project 677 design, the Russian Navy version of the Amur 1650. Projected delivery was estimated for 2001-02, depending on funding availability. The project has already suffered from delays in parts procurement due to a shortage of cash.

The first sections for the first two submarines (one for the Russian Navy and one for a possible export client) were laid down on December 26, 1997. The second hull was laid down on a speculative basis, since the builder marketed the design extensively to export clients. The builder apparently was confident that a deal was imminent, and started construction in anticipation of a final contract. Although there were reports in 1998 that this boat was destined for India, they appear to have been inaccurate. Neither of the first two units were to be fitted with air-independent propulsion.

Searching for Customers

Rubin reported that four countries had shown interest in the Amur as of 1997. These were presumably countries already operating the Project 877 or Project 636 Russian Kilo submarines. Potential buyers of the ship could include (in addition to the Russian Navy) India, Turkey, and Indonesia. Reports in early 1999 indicated that those countries had been offered the Amur by Russia as a form of debt payment.

Reports did emerge in 1999 that the Amur had been offered to South Korea to offset Russia's outstanding debt to that country. It appeared, however, that Korea considered the offering by the Russians of the Project 877 submarines more realistic, characterizing the Amur design as only a "paper submarine" at this point. Moreover, the idea of a Russian submarine for Korea was reportedly unpopular among the Navy's senior officers and the country's political decision-

makers, who denounced the concept early on. In September 1999, focus groups were reportedly set up to evaluate the feasibility of financing such a project using extra-budgetary funds. The results of those studies are not known, but can be guessed from the subsequent order for German-designed Type 214 submarines.

On November 5, 1999, India and Russia signed a broad-based bilateral technology transfer agreement. The deal covered military and technical cooperation between the two countries from 2000 to 2010. In that context, a naval official from India confirmed that a plan for the acquisition and licensed production of the Amur class submarines had been drafted. However, the Indian Navy said no order would be placed until an "in-depth technical evaluation of the submarine type" had been carried out. The preliminary plans called for buying one Amur made in Russia, followed by two others built locally in India under the technology transfer deal described above.

This interpretation was thrown into doubt by a report in the *Times of India* that the Franco-Spanish Scorpene consortium had been approached by the Indian government to negotiate a license to build Scorpene class submarines in India. Apparently, neither of the HDW submarines already being built in India, nor the Russian-designed boats being imported, fully satisfied Indian requirements. These reports were confirmed, and an agreement was eventually signed between France and India for the construction of at least six Scorpene class submarines at Indian yards under the designation Project 75. Although Russian sources continue to refer to a possible Indian purchase of Amur, this is not supported by any other reports.

Construction Slows to a Crawl

Meanwhile, in Russia, a shortage of funds slowed the submarine construction program across the board. By the end of 1998, it was being reported that all submarine construction had come to a halt, and resumption in the near term appeared unlikely. At the end of 1999, the builder reported that the Russian unit, the *Sankt Petersburg*, was about 30 percent complete, while the second hull was described as being 7 percent under way. At that time, all equipment was supposed to have been delivered by January 2000, with systems installation on the first boat starting in March. If this schedule had been adhered to, sea trials would have begun before the end of 2000, followed by service entry in 2001. In any event, the yard never even came close to complying with this schedule.

By the end of 2001, progress on these two submarines was reported to be extremely slow, and plans for a second production line at Severodvinsk had been abandoned. Although the launch date for the *Sankt Petersburg* was still reported to be August 2001, this also proved to be optimistic. By mid-2002, it was being claimed that the *Sankt Petersburg* would be launched in August 2002 for completion by the 300th anniversary of the founding of the city. These statements were followed by an announcement in late 2002 that the submarine would be launched in June 2003. It was further reported that the submarine was less than 20 percent complete and that no decision had been made on whether the submarine would be completed using company funding, or if work would be halted until an export customer was found.

Systems Integration Problems Loom

By June 2003, reports from Russia were surfacing that the *Sankt Petersburg* would not be launched until November 2003 at the earliest; these reports warned that additional delays could further postpone launch to April 2004. The submarine was claimed to be 85 percent complete at that time. If true, this would suggest that work on the submarine had picked up speed substantially during 2003. To much surprise in the naval community, the *Sankt Petersburg* was finally launched in early November 2004. Apparently, systems integration problems had been added to financial difficulties as a source of delays.

The sea trials for the *Sankt Petersburg* began in December 2005. Prior to this, it was stated that a sister ship, the *Khronstadt*, had been laid down in July 2005. It may well be that this ship uses the components assembled for the much discussed, but never seen, "export" submarine. A third submarine of the class was laid down in November 2006.

Exports at Last?

During 2008, the Project 677 design appeared to have achieved its long-awaited break into the export markets with parallel sales to Indonesia and Venezuela. Both countries were reported to be placing orders for a mix of submarines, including older Project 636/877 designs and the new Project 677.

According to these reports, Indonesia planned to buy four Project 636 Kilo class and two Amur 950 (Lada class) diesel submarines from Russia, rather than their German and French equivalents, because they were superior in terms of reliability and cost. Judging by size, it would appear that the two Amur 950 class submarines are replacements for the old Type 209s in the Indonesian Navy, while the 636s are a force enhancement. At the same time, Venezuela announced its intention to sign a contract for five Project 636 Kilo-class diesel submarines and four Project 677 Amur 1650 class submarines.

Project 677 (Amur)

Just to complete this apparently successful year for the Project 677 design, the construction of a fourth boat for the Russian Navy was started at Admiralty Shipyards. Thus, a Russian production line for these boats appeared to be established and seemed likely to remain open into the future.

This picture was effectively to collapse in 2009. The Venezuelan contract was the first to vanish when it became apparent that the Venezuelan Navy would actually be expected to pay for its new submarines. The Indonesian "contract" died next when Indonesia released the actual documents relating to the prospective purchase. This, it turned out, was a Request for Tenders for two boats, and was issued to all the usual suspects in any submarine procurement contest.

The one remaining export order is the Indian Project 75I requirement for six advanced diesel-electric submarines. The Russians offered the Amur 1650 variant of the Project 677 design to fulfill this requirement.

Domestic Requirements

Under the Russian State Armaments Program for 2007-2015, the Navy was projected to receive several dozen surface ships and submarines, including five Project 955 Borei nuclear-powered strategic ballistic missile submarines equipped with new Bulava ballistic missiles, two Project 885 Yasen nuclear-powered attack submarines, and six Project 677 Lada diesel-electric submarines. As with all Russian building programs, this is believed to be seriously over-optimistic and unlikely to be fulfilled within the allotted time span.

Rumors that something was seriously wrong with the Russian Project 677 class submarine program had started to spread as early as 2009. There were reports that serious technical problems were the reason why the lead submarine of the class, *Sankt Petersburg*, was still running trials three years after being handed over to the Russian Navy. An extended first-of-class trials period is not unusual, but the long delays affecting this ship had reached the point where they were attracting adverse attention. The *Sankt Petersburg* was eventually commissioned into the Russian Navy on May 8, 2010.

It soon became apparent that this was nominal only. A year passed without the new submarine being put to sea, and work on the three boats under construction came to a virtual halt. Then, in mid-2011, came news that four new submarines had been ordered. These were not the Project 677 design but the older, tried and tested Project 636.

The ax fell in November 2011 when the Russian Navy announced that the Project 677 class would not be accepted into service, as the lead ship had fallen far short of requirements during her sea trials. The statement said the lead boat would be retained as a test vessel to experiment with various systems, while construction of the remaining boats of the class was to be suspended.

Then, in February 2012, the Russian Navy announced that the entire class of Project 677 submarines had been canceled, with the remaining boats being broken up on the stocks despite one being only a few weeks from launch. The statement was keen to emphasize that "this is the final decision." The problems appear to be that the diesel engines failed completely, being unable to develop more than half the power specified. In addition, the sonar system, the cost of which was RUB1.3 billion ($44 million), didn't work and its integration with the combat information management system had been unsuccessful. The torpedoes also failed, although this may have been due to further integration problems with the combat management system.

Funding

This program has been financed and managed by the Morskaya Tekhnika consortium, whose initial partners were Rubin, Admiralty Shipyards, and Inkombank. Inkombank, a commercial lender based in Russia, was designated the chief financier in the program. It was responsible for funding the research and development efforts, as well as for the procurement of materials and accessories necessary for construction. Using a commercial financier to find private capital was expected to generate savings in R&D and purchase costs and, consequently, to make the program more lucrative and flexible for export markets. Additionally, revenue from export sales was expected to recoup part of the R&D expenditures.

Financing of the export models was initially arranged through Inkombank, while the domestic versions were financed with Russian Defense Department funds from the state budget. The pooling of budgetary and extra-budgetary funds for construction has been one of the driving forces in maximizing the efficiency of the program. However, the collapse of Inkombank in 1998 forced the team to look for a new financial partner.

Contracts/Orders & Options

Contractors	Award ($ millions)	Date/Description
Rubin CDBME	N/A	Aug 1997 – First boat ordered by Russian Navy.

N/A = Not Available

Timetable

Month	Year	Major Development
	1989	Rubin commissioned to design fourth-generation diesel submarine
	1996	Prefabrication work, tooling-up begun
Aug	1997	First boat ordered by Russian Navy
Dec	1997	First two boats laid down at St. Petersburg
Nov	1999	India signs bilateral technology transfer agreement
Nov	2004	Lead ship of class launched
	2005	Second ship laid down
Nov	2006	Third ship laid down
May	2010	*Sankt Petersburg* commissioned
Nov	2011	Construction suspended
Feb	2012	Entire class canceled

Worldwide Distribution/Inventories

Russia One submarine to be a trials boat. Rest canceled.

Forecast Rationale

With news of the almost complete technical failure of the Project 677 class, the Amur program can be considered dead. The Russian Navy has reverted to the construction of Project 636 class boats, with four being ordered to replace the planned Project 677 class. After a technical failure of this magnitude, no export customer will touch this design.

The problems appear so widespread that it is hard to isolate any single main point of deficiency. In the words of the traditional Russian judgment on a failed program, "There is blame enough for all to share." In fact, when reading the list of problems that afflicted the Project 677 design, they appear eerily similar to those that plagued the Australian Collins class more than 10 years earlier.

The most serious mechanical problems are associated with the diesel engines, which failed completely, being unable to develop more than half the power specified. Why these engines should have been so severely compromised is hard to discern. Russian submarine diesels might not be at the top end of the technology arc, but they are usually solid and reliable. This leads to the suspicion that it was not the diesels per se that failed but the air-independent propulsion system that was supposed to support them. This system is based on fuel cells, a technology that caused some initial problems when installed on the Type 214 submarines. Because the AIP system is key to the performance of the Project 677, a failure of this type would be disastrous.

Another factor reminiscent of the Collins class debacle is that the electronics outfit of the Project 677 suffered severe systems integration failure. According to the Russian Navy, the sonar system, the unit cost of which was RUB1.3 billion ($44 million), didn't work. The key here is a statement that the integration of the combat information management system was unsuccessful. It was also stated that the torpedoes failed. This is most unlikely when taken in isolation, since the torpedoes in question are already in widespread service and there have been no reports of any unusual problems with them.

Project 677 (Amur)

The most likely explanation of what has happened is that the combat management system proved incompatible with the ship's sonar systems and fire control system, with the three units being unable to work together. Again, by analogy to the Collins class, it seems likely that the combat management system was unable to keep up with the flow of information being generated by the sonar system and fell behind the time loop. Thus, the fire control system was being fed with data that was progressively more out of date. Eventually, the whole system would have overloaded and crashed. This problem took years of hard work to fix with the Collins class and it seems likely the Russian Navy decided that since it had a perfectly workable and viable design in Project 636, further investment in Project 677 was not worthwhile. Under the circumstances, this was probably a sensible decision.

The final conclusion must be that the Harmony program to build the Project 677 submarine for the Russian Navy and for export is dead. This report will be archived next year.

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