

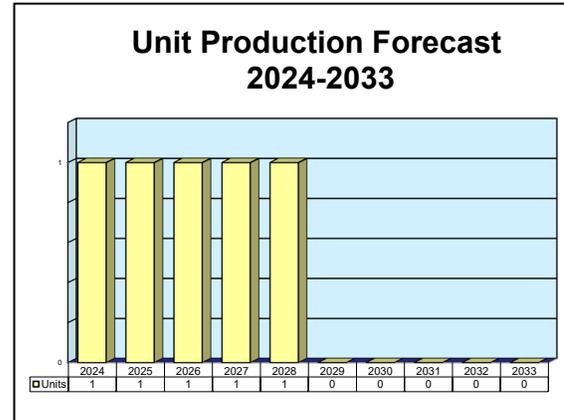
ARCHIVED REPORT

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Soryu Class

Outlook

- Soryu class production complete
- Next construction is the follow-on Taigei class (graph at right represents forecast for Taigei class only)
- Taigei class will be covered in a separate report in the near-future



Orientation

Description. Patrol submarines, diesel-electric (SSK).

Sponsor. Japan Maritime Self-Defense Force.

Licensee. No production licenses have been granted.

Status. In production and service.

Total Produced. Ten Soryu class and two Improved Soryu class boats have been commissioned.

Three Taigei class in service. A fourth is under construction. A total of seven submarines planned.

Pennant List (Planned Schedule)

<u>Name</u>	<u>Builder</u>	<u>Laid Down</u>	<u>Launch Date</u>	<u>Commission Date</u>
Soryu Class				
SS 501 <i>Soryu</i>	Mitsubishi	3/31/2005	12/5/2007	3/30/2009
SS 502 <i>Unryu</i>	Kawasaki	3/31/2006	10/15/2008	3/25/2010
SS 503 <i>Hakuryu</i>	Mitsubishi	2/6/2007	10/16/2009	3/14/2011
SS 504 <i>Kenryu</i>	Kawasaki	3/31/2008	11/15/2010	3/16/2012
SS 505 <i>Zuiryu</i>	Mitsubishi	3/16/2009	10/20/2011	3/6/2013
SS 506 <i>Kokuryu</i>	Kawasaki	1/21/2011	10/31/2013	3/9/2015
SS 507 <i>Jinryu</i>	Mitsubishi	2/14/2012	10/8/2014	3/7/2016
SS 508 <i>Sekiryu</i>	Kawasaki	3/15/2013	11/2/2015	3/13/2017
SS 509 <i>Seiryu</i>	Mitsubishi	10/22/2013	10/12/2016	3/12/2018
SS 510 <i>Shoryu</i>	Kawasaki	1/28/2015	11/6/2017	3/18/2019

Soryu Class

<u>Name</u>	<u>Builder</u>	<u>Laid Down</u>	<u>Launch Date</u>	<u>Commission Date</u>
Improved Soryu Class				
SS 511 <i>Oryu</i>	Mitsubishi	11/16/2015	10/4/2018	3/5/2020
SS 512 <i>Toryu</i>	Kawasaki	1/27/2017	11/6/2019	3/24/2021
Taigei Class(a)				
SS 513 <i>Taigei</i>	Mitsubishi	3/16/2018	10/14/2020	3/9/2022
SS 514 <i>Hakugei</i>	Kawasaki	1/25/2019	10/14/2021	3/20/2023
SS 515 <i>Jingei</i>	Mitsubishi	4/24/2020	10/12/2022	4/8/2024
SS 516 <i>Raigei</i>	Kawasaki	3/26/2021	2023	3/2025
SS 517 TBA	Mitsubishi	2022	2024	3/2026
SS 518 TBA	TBA			
SS 519 TBA	TBA			

TBA = To Be Announced

(a)The Taigei class will be covered in a separate report in the near-future.

Application. Patrolling of territorial waters, underwater surveillance and defense against hostile underwater threats, and power projection by the Japan Maritime Self-Defense Force.

An Improved Soryu class submarine has been reported to cost an estimated \$710 million.

A Taigei class (Soryu follow-on) submarine reportedly costs approximately \$639 million per boat.

Price Range. The cost of a Soryu class was estimated to be around \$540 million.

Contractors

Prime

Mitsubishi Heavy Industries Ltd, (MHI)	http://www.mhi.com , 2-3, Marunouchi 3-chome, Chiyoda-ku, Tokyo, Japan, Tel: + 81 3 6275 6200, Prime
Kawasaki Heavy Industries, (KHI), Kobe Shipyard	http://global.kawasaki.com/en/ , 1-1 Higashikawasaki-cho, 3-chome, Chuo-ku, Kobe, Japan, Tel: + 81 78 682 5501, Fax: + 81 78 682 5503, Second Prime

Subcontractor

GS Yuasa	http://www.gs-yuasa.com , 1 Inobanba-cho, Nishinosho, Kisshoin, Minami-Ku, Kyoto 601-8520, Japan, Tel: + 81 753121211 (Lithium-Ion Battery System)
Japan Radio Co Ltd	http://www.jrc.co.jp/eng/ , 6-10-1 Nishi-Shinjuku, Shinju-Ku, Nittochi Nishi-Shinjuku Bldg, Tokyo, Japan, Tel: + 81 3 3348 0151 (ZPS-6 Radar)
Kawasaki Heavy Industries Ltd, (KHI)	http://global.kawasaki.com/en/ , 1-14-5 Kaigan, Minato-ku, Tokyo, Japan, Tel: + 81 3 3435 2111, Fax: + 81 3 3436 3037 (12V25S Diesel)

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 75 Glen Road, Suite 302, Sandy Hook, CT 06482, USA; rich.pettibone@forecast1.com

Soryu Class**Technical Data**

<u>Soryu Class</u>	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Length	84.0 m	275.6 ft
Beam	10.5 m	33.8 ft
Draft	9.1 m	29.9 ft
Displacement		
Surfaced	2,950 tonnes	2,905 standard tons
Submerged	4,200 tonnes	4,133 standard tons
Performance		
Speed – Surfaced	22.2 kmph	13 kt
Speed – Submerged	37 kmph	20 kt
Operational Range	11,300 km	6,100 nm
Diving Depth	350-400 m (est)	1,150-1,311 ft (est)
Crew	69 (10 officers)	69 (10 officers)
Weaponry		
	<u>Type</u>	<u>Number</u>
Torpedo Tubes	HU-606 533mm	6
Missiles	UGM-84 Sub-Harpoon SSM	
Torpedoes	Types 89 (GRX-2) & 80	Total number of weapons: 30
Electronics		
Countermeasures: ESM	ZLR-3-6	1
Weapons Control	ZYQ-3	1
Radar		
Surface Search	JRC ZPS-6F I-band	1
Sonars		
Hull and Flank Arrays	Hughes/Oki ZQQ-7	
Towed Array	ZQR-1 (BQR-15)	
Propulsion		
Diesels	Kawasaki 12V25SB	2x 2,760 shp
AIP Diesels	Kawasaki-Kockums V4275R	4
Power Generation	Kawasaki alternators	2
Electric Motors	Fuji	2x 3,875 shp
Propeller	Single shaft	1

Design Features. The Soryu class submarines represent a lineal development of the previous Oyashio class. They feature a double hull with an anechoic coating on the outer surface, a cigar-shaped deck casing, and a faired sail structure. The primary difference between the Soryu and the Oyashio class lies in the introduction of an air-independent propulsion (AIP) system and the revision of the aft control surfaces where an X-plane arrangement replaces the cruciform design used on the Oyashio class.

The cylindrical bow sonar of the Soryu class is mounted in the chin position, with the six 21-inch torpedo tubes mounted over the array. The submarine is also fitted with two flank arrays: a long upper system running virtually the whole length of the submarine, and a short lower system running from just in front of the sail to approximately amidships.

Photographs of the launch of the second Soryu class boat, the JMSDF's *Unryu*, were somewhat surprising in that they showed the boat to be equipped with a conventional propeller (albeit a sophisticated scythe-bladed multiple-axis design) rather than a pumpjet. One might have expected these advanced Japanese submarines to have a pumpjet, but this option appears not to have been adopted.

Operational Characteristics. The Soryu class has a top speed of 20 knots submerged and 12 knots when surfaced. The incorporation of flank arrays is probably the primary reason behind the change in hull form that was initiated with the Oyashio class. The adoption of a cylindrical hull section allows these arrays to provide range data by triangulation. This is not possible with the curved hull section of the Albacore design. In addition, the parallel center section is easier to build and provides greater usable internal volume.

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The adoption of a German-style hull form has also provided extra room in the bows for the torpedo tubes, permitting the abandonment of the U.S.-style amidships tubes. This makes the use of wire-guided torpedoes considerably easier and reduces the incidence of wire breakage.

The effective range of the Type 89 torpedo has been quoted as 30 kilometers at a maximum speed of 70 knots; at 40 knots, its range should reach 50 kilometers (presumably on the surface). The total

load of 30 weapons split between torpedoes and Sub-Harpoons assures that the Soryus are effective in their intended role of patrolling for hostile surface vessels and submarines. Design of a new torpedo to replace the Type 89 was funded in Japan's FY12 defense budget.

Contrary to many reports, Japanese submarines do not use spherical bow sonars, and the Soryu class carries the ZQQ-7, a development of the cylindrical ZQQ-6B carried by the Oyashio class. The submarines also carry the ZQR-1 towed passive array.

Variants/Upgrades

Improved Oyashio Class. The Soryu class is also known as the 2,950-ton class or the Improved Oyashio class.

Second Flight of Soryu Class. There was a year's break between the first group of five submarines and the remaining members of the class. This was due to funding shortages, but it has been reported that the sixth and subsequent members of the class have detail improvements over the first five. These may include an improved sonar (the ZQQ-7B) and enhanced countermeasures.

Improved Soryu Class. The submarines *Oryu* and *Toryu* have lithium-ion batteries, resulting in improved underwater endurance. A new power handling system that can deal with high power loads and optimize efficiency is also included in the concept. Also, a specialized fire extinguishing system is installed aboard advanced Soryu boats to neutralize a fire quickly and automatically in its battery compartments should one occur. These two submarines are essentially testbeds to confirm the operational capability of the lithium-ion batteries for use in the follow-on Taigei class.

Taigei Class. The Taigei class is a follow-on to the Improved Soryu class submarines. A total of seven

submarines are planned. The first submarine, *Taigei* (SS-513), was commissioned in March 2022. The second submarine of class, *Hakugei* (SS-514), commissioned in March 2023.

A separate report on the Taigei class will be issued in the near future.

Australian Proposal. Discussions took place between the Japanese and Australian governments over the incorporation of some Japanese SSK technology into the new Australian SSK program. This evolved into the Japanese being asked to bid a submarine derived from the Soryu class for the new Australian SSK program. Although the Soryu class was in a leading position for this requirement, eventually the French Shortfin Barracuda proposal was chosen, only to be discarded in favor of a groundbreaking deal to build nuclear submarines based on U.S. nuclear submarine technology.

Indian Proposal. The Indian government has invited Japan to bid the Soryu class design in response to India's long-delayed Project 75I program for six diesel-electric submarines with land-attack capability and AIP. Changes to the basic Soryu class design to meet Indian specifications would be limited.

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Japanese Submarine *Soryu*

Source: Japan Maritime Self-Defense Force



Japanese Submarine *Taigei*

Source: Japan Maritime Self-Defense Force

Soryu Class

Program Review

Background. The Oyashio class was authorized in the FY93 budget, after which one new boat was approved each subsequent year. While all the earlier Japanese submarines had been derivatives of the U.S. Barbel class design, the Oyashio class marked a distinct break with that design tradition and appears to reflect considerable German influence. It may be significant that the name *Oyashio* honors the first Japanese postwar-built submarine, the SS 511 *Oyashio*, laid down in 1956 at Kawasaki in Kobe, as well as the Second World War destroyer sunk in May 1943 by U.S. dive bombers.

In FY04, construction shifted to the Improved Oyashio class, a version of the Oyashio class lengthened to 84 meters and equipped with AIP. This class started with hull SS 501, effectively going back to the beginning of the Japanese submarine pennant number sequence. The lead ship of the Improved Oyashio class was launched in December 2007 and commissioned in March 2009. At this point, the class became known as the Soryu class. The second ship of the class, *Unryu*, was launched in October 2008 and commissioned in March 2010.

Changing the Guard

For almost three decades, Japanese submarine construction has run on a set schedule. One submarine per year would be funded, and the contracts for construction awarded alternately to Mitsubishi and Kawasaki Heavy Industries. This pattern kept everybody happy, and the steady workload provided two yards with an adequate order backlog.

All this came to an end in 2009 with the fall from power of the Liberal Democratic Party in Japan and its replacement by the Democratic Party of Japan (DPJ). The DPJ immediately acted on its fundamental questions about many Japanese defense programs. One of the earliest and most significant casualties was the Japanese submarine construction program. The FY10 submarine was canceled and it was announced that the Soryu class would be restricted to eight boats, to be built in alternate years. Even more radical was the directive from the Japanese government that Kawasaki and Mitsubishi compete for the remaining submarine orders.

As with most of the other radical changes promised by the DPJ, these proposed changes never materialized. While the FY10 submarine remained canceled, resulting in a one-year gap in submarines being commissioned, submarine construction reverted to the established pattern of one per year from FY11 onward, with the

yards alternating production. This was followed by news, first revealed in the Japanese newspaper *Sankei Shimbun*, that Japan intended to counter the Chinese naval buildup and the reduction of U.S. Navy submarine deployments in the area by increasing the size of its submarine fleet from 16 to 20 boats, with two additional submarines to be used as trainers.

In October 2010, the Maritime Self-Defense Force stated that it would be procuring six additional Soryu class submarines, to bring the planned total up to at least 12. With the 11 Oyashio class already in service, this would give a total of 23 submarines. Assuming the two oldest Oyashios would take over the training role, the fleet would number 21 modern diesel-electric boats, in line with the *Sankei Shimbun* report. This analysis was more or less confirmed when the *Japan Times* reported a MSDF announcement that the submarine fleet would be increased to 22 operational submarines plus two training boats. This suggested that only one of the Oyashios would be used for training.

Nomenclature

Prior to the Soryu class, the JMSDF named its submarines after ocean currents and used names that honored previous Japanese warships. With the Soryu class, this naming convention was changed and the submarines of the class were named after legendary animals. The first two submarines, *Soryu* (Blue Dragon) and *Unryu* (Cloud Dragon), honored World War II aircraft carriers. However, the practice of honoring previous warships ceased with the third submarine. *Hakuryu* (White Dragon), *Kenryu* (Sword Dragon), *Zuiryu* (Auspicious Dragon), *Kokuryu* (Black Dragon), and *Jinryu* (Benevolent Dragon) are all new to Japanese naval ships. They have no naval, geographical, or historical significance, and the first two names may have been chosen on the basis that they are popular Japanese anime characters.

Australian Interest

The history of the Soryu class had, up to 2012, been typical of post-World War II Japanese submarine construction – a program that went quietly along in a predictable and unchanging manner, with the only novelty being what particular technical development might be introduced with a particular new class. This changed abruptly when the Australian government dispatched observers to examine the Soryu program as a possible contender for the country's SEA-1000 program to replace the Collins class. Had it not been for the long-standing Japanese prohibition on selling defense equipment, the Soryu class would have seemed a good

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fit for the SEA-1000 specification. However, news of the contacts broke at a time when that policy was under reconsideration.

By January 2013, Australian interest was focusing on the air-independent propulsion system used by the Soryu class, giving rise to speculation that the Australian Navy would specify a similar system for the SEA-1000 submarines. This would fit two of the options specified for SEA-1000: an enlarged and upgraded Collins class or a new domestic design.

Then-Australian Prime Minister Tony Abbott and his Japanese counterpart, Shinzo Abe, reached an agreement on April 7, 2014, to launch talks on defense equipment and technology cooperation. As part of this growing relationship, the submarine issue grew steadily in importance. Australia has not hidden its interest in the drivetrain utilized in Japan's 4,200-ton Soryu class conventional submarines. While Japan is reluctant to impart such sensitive technology to another party, it did agree to begin a bilateral defense technology project with Australia involving joint research into "marine hydrodynamics." Traditionally in such agreements, attributing something to research is a polite way of saying, "Don't ask."

Through 2014 and 2015, the competitive position of the Soryu class continued to improve as the virtues of the design became more apparent. The political aspect of the bid, representing a de facto political alignment between Australia and Japan, also grew in importance. However, there was much political opposition within Australia to the idea of purchasing a Japanese submarine. This mainly centered on an organized labor campaign aimed at keeping shipbuilding jobs in Australia. This gained considerable traction and endangered the electoral prospects of the Liberal-Nationalist alliance. It was one contributor to the ultimate selection of the French Shortfin Barracuda class submarine for the Australian requirement. The major factor, though, was that the Soryu class was considered deficient in range

Despite the initial defeat, the story of the Australian submarine program did not end there. Relations between Australia and France began to go downhill almost as soon as the selection of the Shortfin Barracuda was announced. The issues centered on disputes over technology transfer and construction shares combined with a growing perception that the French yards and drawing offices were overworked and would not be able to adhere to the agreed-upon timetable. These disagreements reached the point that,

by late 2018, there was serious discussion of terminating the agreement and opening the project up for rebidding.

On October 11, 2018, Japan's Foreign Minister, Taro Kono, stated that Japan would still be prepared to export its submarines to Australia if protracted contract negotiations between the Australian government and Naval Group eventually collapsed. In the two years that had elapsed since the contract was lost to France, the Japanese Navy had launched the first of the Soryu class equipped with lithium-ion batteries and had started design work on a stretched version of the Soryu with much-extended range. These developments addressed the primary objections expressed by the Australian Navy.

The first of a series of design and development contracts between the Australian Navy and Naval Group Australia were signed in March 2019.

Although the Soryu class was in a leading position for this requirement, the French Shortfin Barracuda proposal was ultimately chosen, only to be discarded in favor of a groundbreaking deal in September 2021 to build nuclear submarines based on U.S. nuclear submarine technology.

Indian Opportunities

In January 2015, the Indian government formally invited Japan to bid the Soryu class submarine in response to India's Project 75I requirement for a diesel-electric submarine. Project 75I is years behind schedule and represents a growing embarrassment to the Indian Navy, which has been unable to reach a satisfactory agreement with any of the existing bidders. In this context, the invitation to Japan is seen as an effort to break the logjam surrounding Project 75I. There were plans to select a Project 75I partner in 2016, with first metal cut in 2018 and the lead submarine commissioned in 2025. However, Indian procurement plans rarely run according to schedule, and this one proved no exception.

In June 2017, the Indian government announced that the contract to build the submarines would be awarded under the "Strategic Partnership" policy, which would exclude state-owned shipyards from competing. After Cabinet approval for the procurement lapsed in February 2018, the Defence Acquisition Council restarted the program in January 2019 with a budget of \$5.6 billion. In April 2019, an expression of interest was issued for six submarines capable of firing land-attack and anti-ship cruise missiles.

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Future Construction

The two submarines built with lithium-ion batteries, *Oryu* and *Toryu*, are the only members of their sub-class and primarily act as service test platforms for the

lithium-ion battery system. They are the last submarines of the Soryu class.

The Taigei class is the current submarine design under construction and is said to not differ much from the Soryu class.

Funding

This program was funded within the budget of the Japan Maritime Self-Defense Force.

Contracts/Orders & Options

No recent contracts have been identified.

Worldwide Distribution/Inventories

Japan. 10 Soryu class submarines in service
 Two Improved Soryu class submarines in service
 Three Taigei class in service, two under construction, two planned for future construction

Forecast Rationale

Switching to using lithium-ion batteries in submarines has resulted in a major operational improvement in the capabilities of the Japan Maritime Self-Defense Force (JMSDF). While these batteries offer higher speeds and longer endurance at specific speed settings than existing batteries due to their high charge density, they also offer a shorter indiscretion time due to the high applied charge current. These factors significantly increase the ability of the submarines to operate in hostile environments, particularly those where the main threat comes from maritime patrol aircraft and ASW helicopters. The previous need for submarines to recharge batteries while maneuvering is reduced by an operationally significant margin, and thus vulnerability to ASW techniques such as hold-down is decreased.

The Soryu class, particularly the improved version with lithium-ion batteries, has capabilities that place it at the forefront of modern conventional submarine technology. Indeed, arguably, only the Klasse U212CD for Norway and Germany is its equal.

It could also be argued that the Taigei class (latest Japanese submarine design based on the Soryu class) will be ahead of the German design. Whether this will be enough to earn the Taigei class a place in a highly competitive market remains to be determined.

Production of the Soryu class was completed in 2021.

The forecast is for the Taigei class, with the forecast numbers based on submarine commission date.

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Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			Total
	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
Kawasaki Heavy Industries (Co-Producer)												
Taigei <> Japan <> Navy <> Taigei Note: All forecast numbers are based on submarine commission date.												
	1	0	1	0	1	0	0	0	0	0	0	2
Mitsubishi Heavy Industries Ltd (Prime)												
Taigei <> Japan <> Navy <> Taigei Note: All forecast numbers are based on submarine commission date.												
	1	1	0	1	0	1	0	0	0	0	0	3
Total	2	1	1	1	1	1	0	0	0	0	0	5