Review of the Size Differences between Project 885 *Severodvinsk* and Project 885M *Kazan*

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On 31 March 2017, the lead unit of the Project 885M/Yasen-M class of nuclear-powered submarines, *Kazan,* was rolled out of the Sevmash Workshop 55 construction hall in Severodvinsk, Russia.

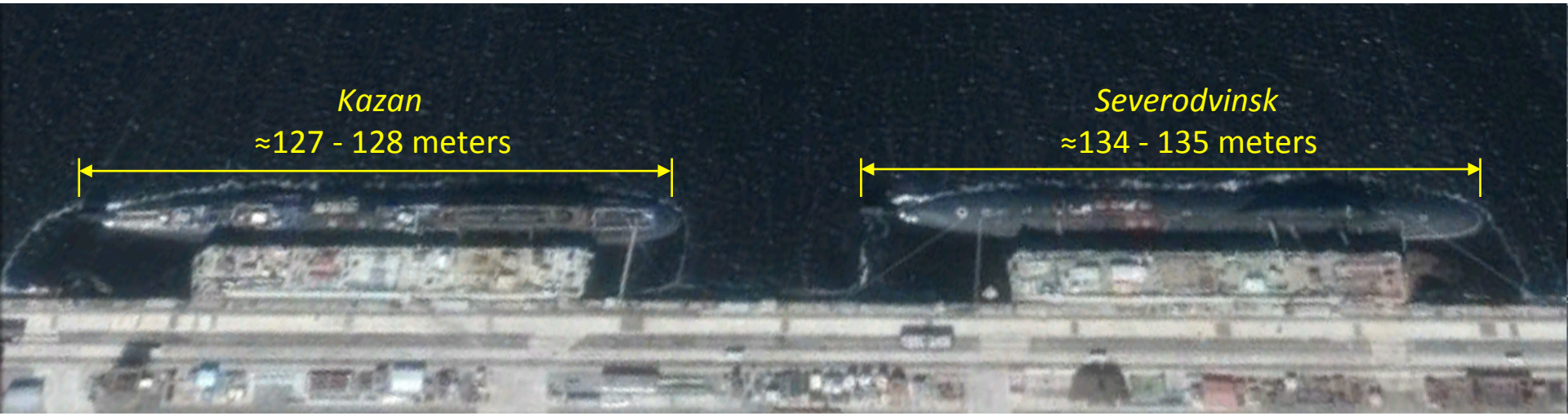
Upon being removed from the launch dock, it was noted that *Kazan* was shorter than her older sibling.

– Most Russian reports state *Kazan* is 10 meters shorter with 4 meters being taken from the living compartment.

As *Kazan* started her sea trials, additional photos also indicated the bow was shorter than *Severodvinsk*'s.

If Russian press announcements are accurate, then an additional 6 meters of trimmed length needs to be identified. This presentation investigates the possible locations where the Russians reduced *Kazan*'s length from that of the original Project 885 hull, as well as the potential reasons for the reduction.

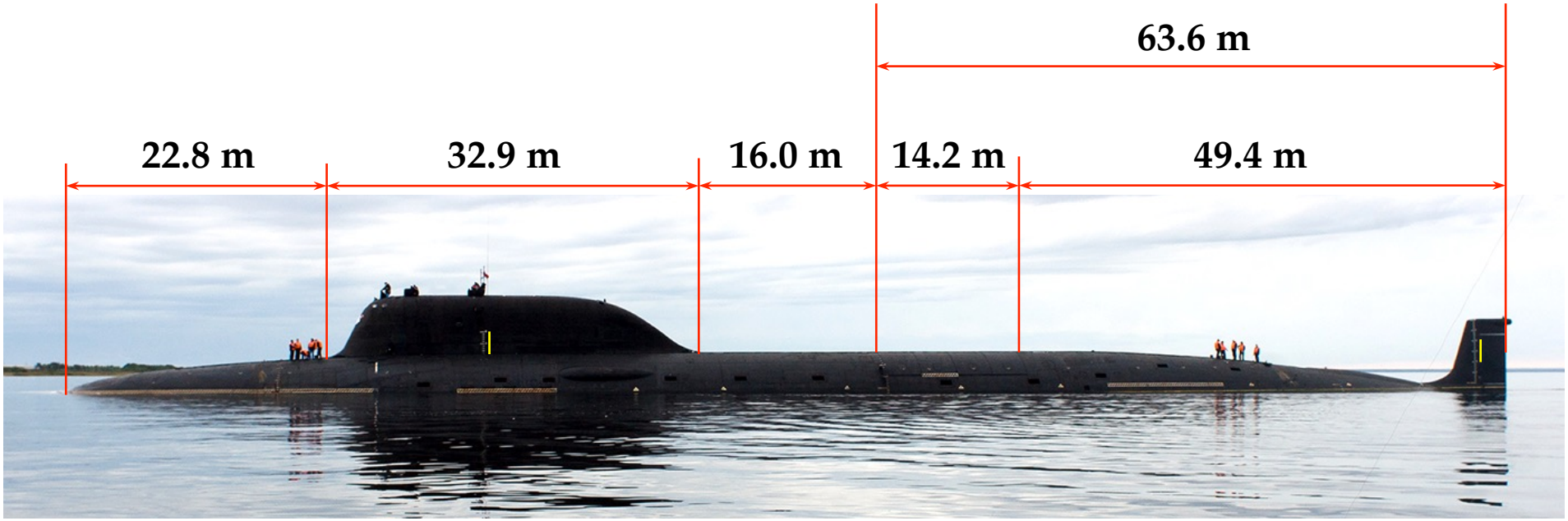
Google Earth Comparison



Hull Segment	*Severodvinsk*	*Kazan*	Difference
Bow to sail:	22.3 m	19.1 m	-3.2 m
Sail length:	32.9 m	33.6 m	+0.7 m
Sail to missile compartment:	16.1 m	12.3 m	-3.8 m
Missile compartment to stern:	63.1 m	62.7 m	-0.4 m
Total waterline length:	134.5 m	127.7 m	-6.8 m

A review of Google Earth imagery clearly indicates that *Kazan* is noticeably shorter in the bow and amidships locations. The table above is an average of all Google Earth images that could support measurements. *Kazan*'s 3.8 meter difference from the aft end of the sail to the forward end of the missile compartment is consistent with Russian press releases of a 4 meter reduction in the berthing compartment. The bow, above the waterline, is also much shorter. The imagery review also suggests possible differences in the sail length, and the length of the hull from the forward end of the missile compartment to the end of the ship.

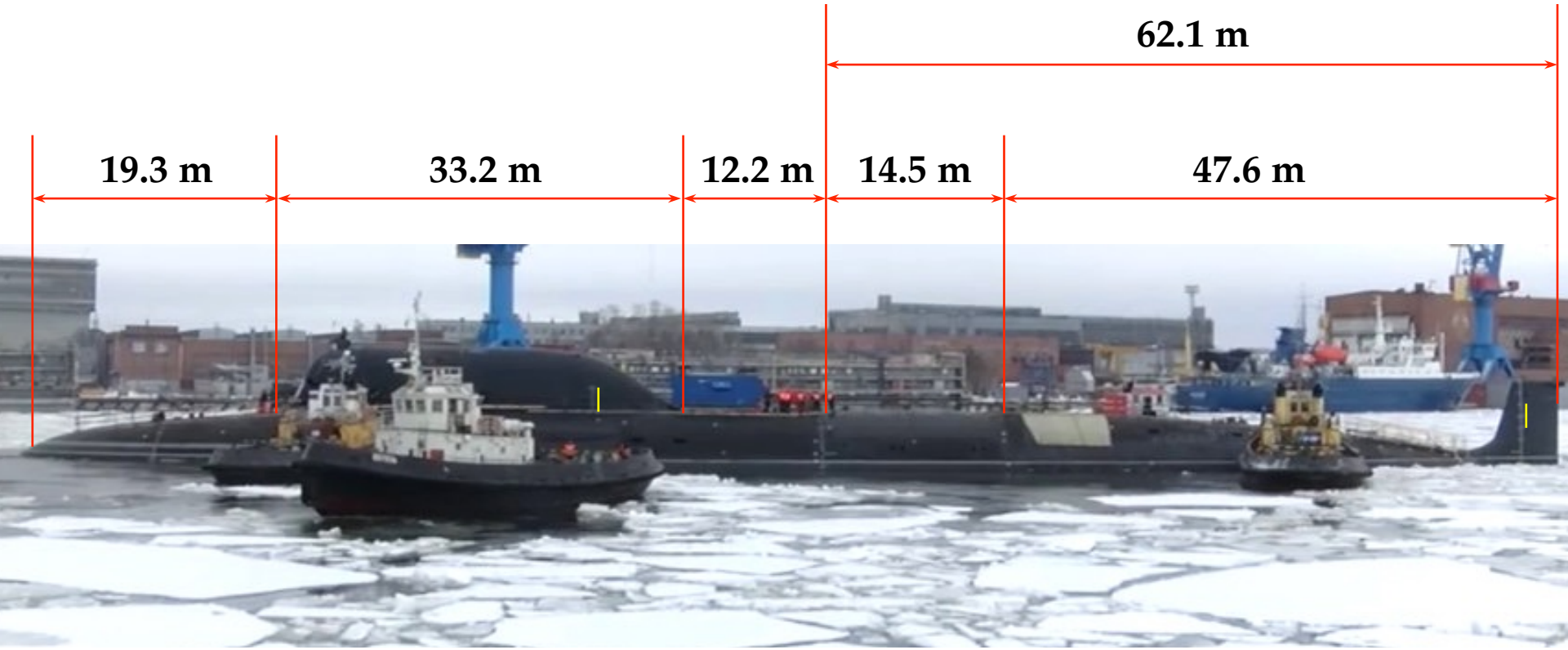
Project 885 *Severodvinsk*



Total waterline length: 135.3 meters

The ship's aspect in the hand held image, while not a perfect broadsides, is reasonably close to allow a valid comparison with both a similar shot of *Kazan* and the Google Earth imagery. For the most part, the section lengths shown above are largely in agreement with the Google Earth averages.

Project 885M *Kazan*



Total waterline length: 126.8 meters

As with the *Severodvinsk* photograph, the section lengths above are consistent with the Google Earth averages. In comparing the two hand held photos there is only a minor difference, 0.3 meters, in the sail length measurements, but the difference aft has grown to about 1.5 meters. If it is assume that the missile compartment is the same length on both submarines, the hand held photograph measurements were only 0.3 meters apart, then the difference must be in the engineering spaces.

Comparison of the Sail and Bow

A comparison of the two boats from a nearly identical aspect, with the sail draft markings in view, shows the bow of *Kazan* is about 3.5 meters shorter than *Severodvinsk*, above the waterline. The sail length on both submarines is essentially identical at 32.5 - 33.0 meters.

Length Reductions Summary

Analysis of satellite imagery and hand held photographs indicate that *Kazan* had her waterline length shortened in probably three locations.

1) The berthing compartment amidships was shortened by 4.0 meters. If we assume that the frame spacing on 4th generation submarines is the same as the 3rd generation, then we are looking at a reduction of 5 frames (800 mm between frames). This reduction is consistent with Russian news reports that claim *Kazan* has a compliment of 64. *Severodvinsk* is reported to have a crew of 85 – 90.

2) The engineering spaces probably had one, or perhaps two frames removed for a net loss of 0.8 or 1.6 meters in length. This reduction is likely located in the reactor compartment, as *Kazan* is reported to have a fourth generation KTP-6 natural circulation reactor. This reactor is described as a "monoblock" design that doesn't have separate steam generators and therefore takes up less volume. *Severodvinsk* was built with a third generation OK-650 series reactor.

3) *Kazan*'s bow is about 3.5 meters shorter than *Severodvinsk* (when reductions below the waterline are included, the overall length would be closer to 4.5 meters shorter). Since this area is outside the pressure hull, there really is only one reason for such a large reduction – *Kazan* has a different hull sonar system than *Severodvinsk*. Numerous Russian announcements have stressed the Project 885M class was going to have an improved large main hull array. There are two ways to enhance a sonar system's performance, better signal processing (processing power and algorithms) and an even bigger array. Historically, the Russians have leaned heavily on the latter.

MGK-600 Irtysh Amphora Sonar Suite

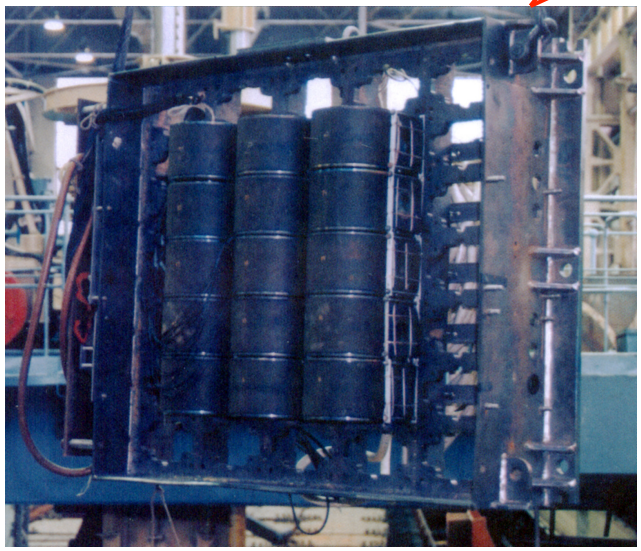
Pr.885 SEVERODVINSK Class

(Yasen Class) SSGN

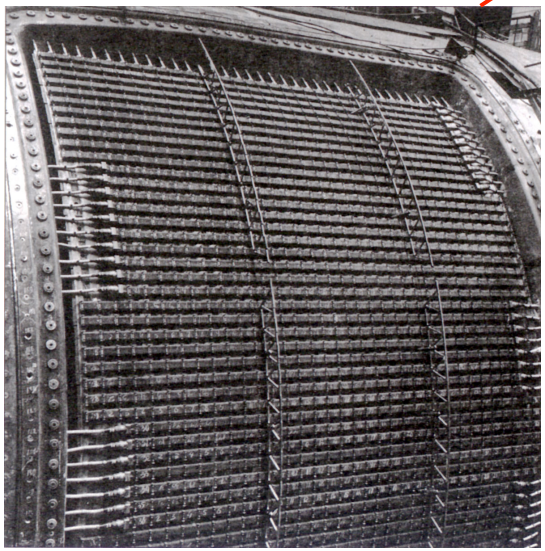
350 meter long passive towed array

MG-35M Shtil-3
Underwater communications array

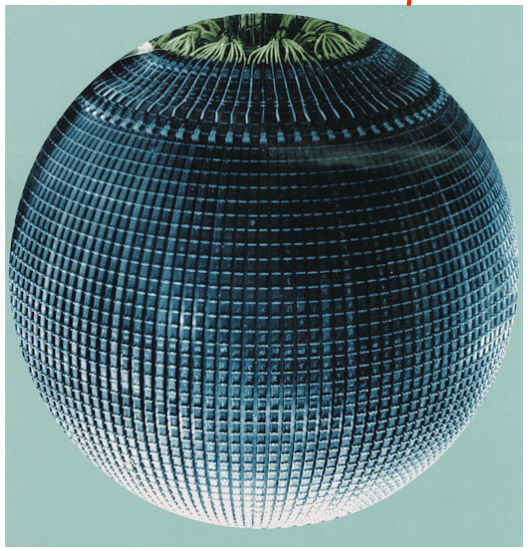
Active planar arrays
3 total – sail, port, stbd



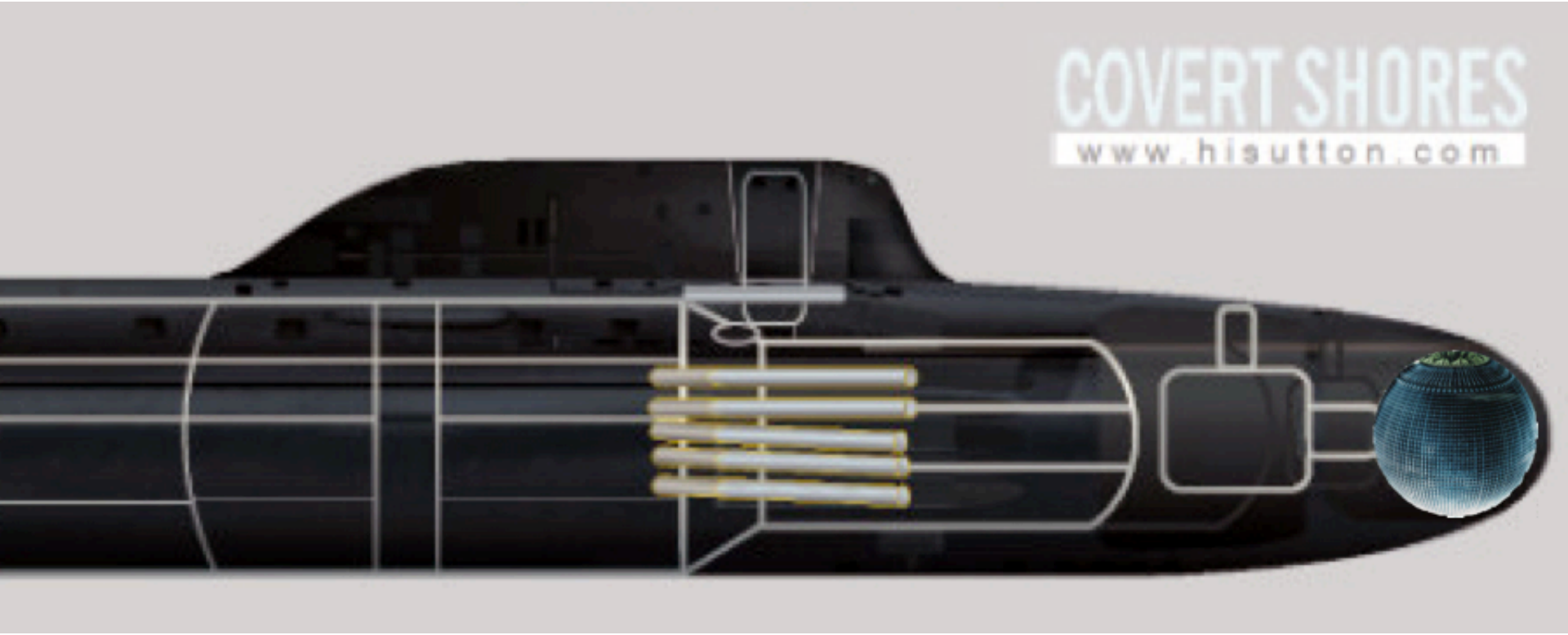
Large passive flank arrays
2 total – port, stbd



Large passive spherical array

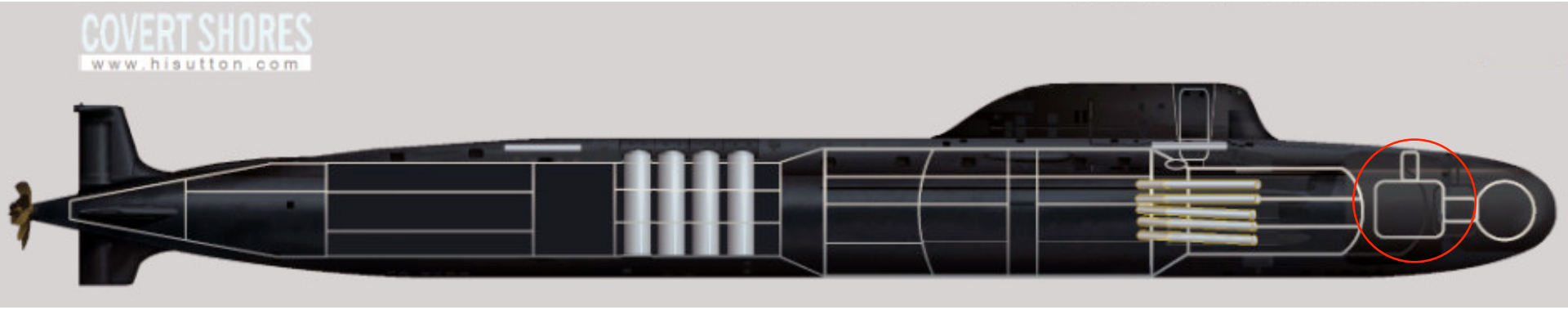


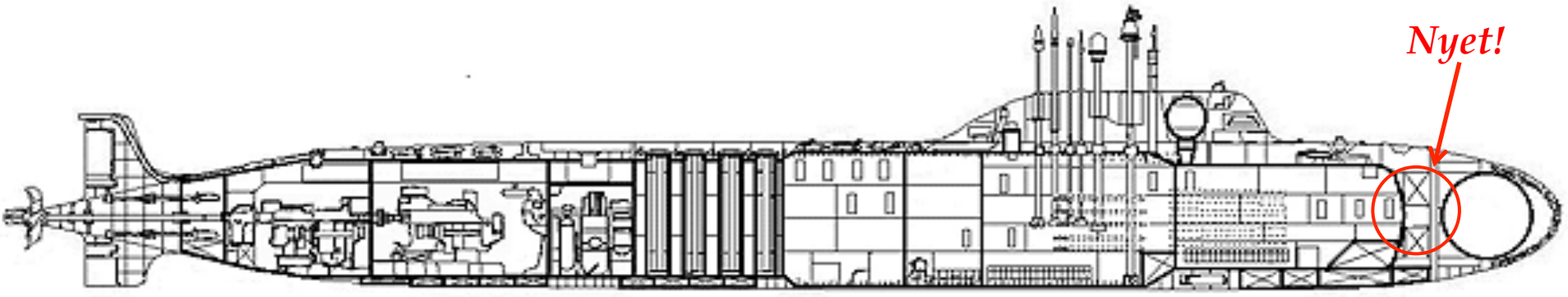
MGK-600 Irtysh Amphora Sonar Suite



The driving issue for space forward would be the large passive spherical array. The big flank arrays are housed in the outer hull structure and can be easily repositioned. The spherical array is another matter due to its massive size. Many drawings and models suggest this array could be as large as 8 meters in diameter – the same size as the MGK-540 SKAT-3 cylindrical hull array on Project 971 Akula SSNs. In addition, Russian digital sonar designs have a large, full depth rated capsule (cylindrical arrays have it as the center of the structure) that contains much of the array's beam forming and signal processing components, as well as physically supporting the array itself. Some articles that discuss the development of the Irtysh Amphora system describe it as having a capsule separate from the spherical array.

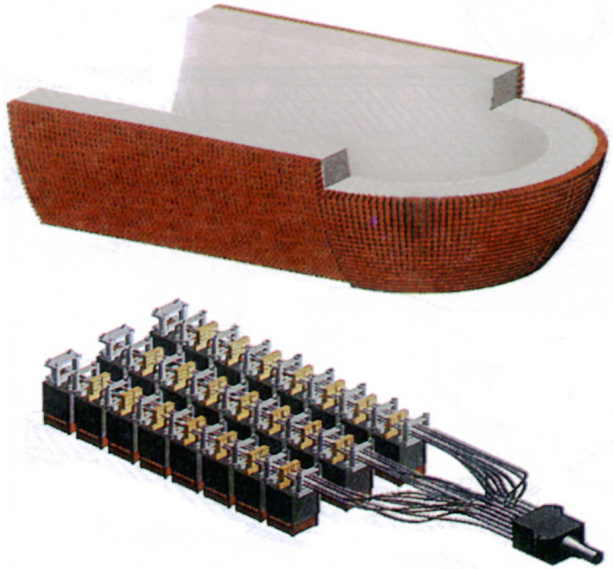
MGK-600 Irtysh Amphora Sonar Suite





Alternatively, some drawings suggest an American-style access tunnel that connects the pressure hull to the spherical array. Such a design is doubtful as it represents a weak point in the pressure hull and is not consistent with Russian survivability requirements – if the Russians do anything really well, it's building tough boats. Regardless, both of the possible design options would be badly affected by a net loss of 4.5 meters in length forward. This then begs the question, how could an even larger array be installed if the largest sonar array in the Russian inventory wouldn't fit? The answer lies in spreading things out.

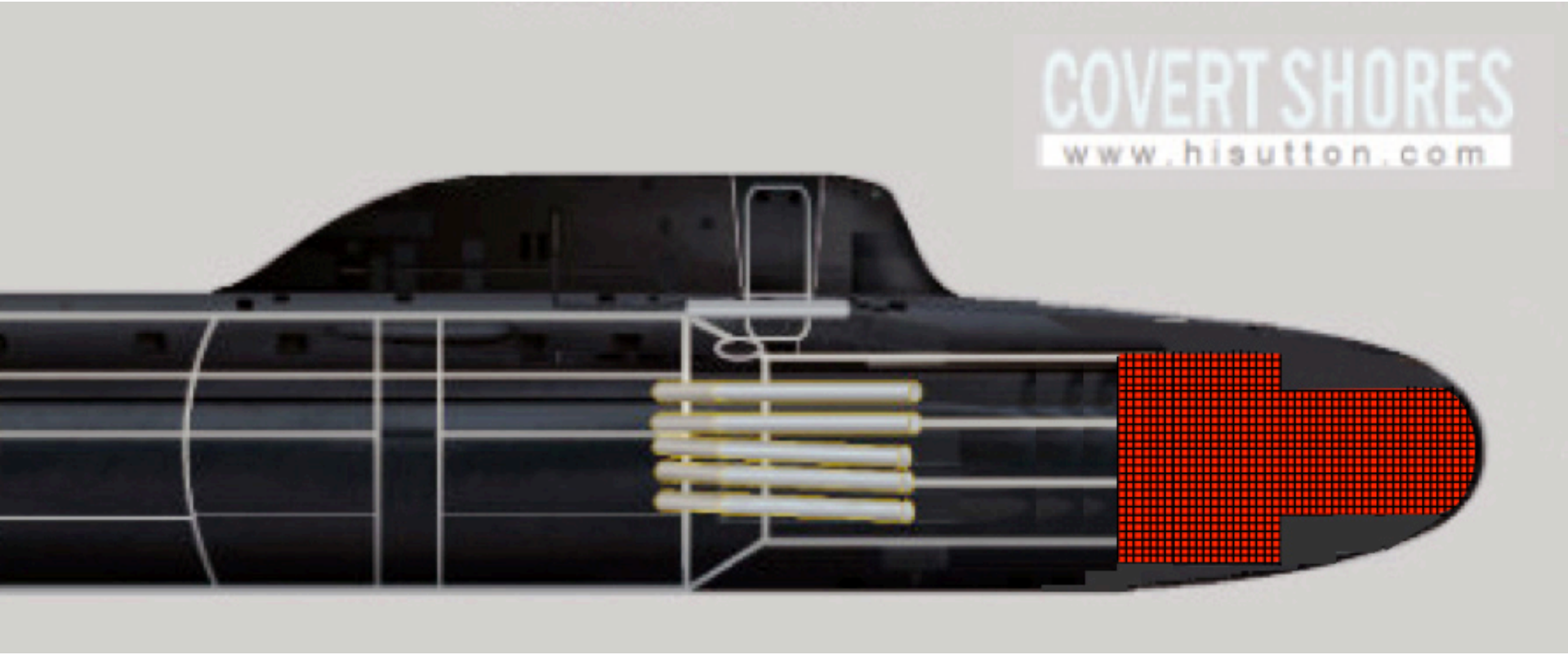
Project 677 Lada Class – Lira Sonar Suite



The Project 677 Lada, Russia's problematic 4th generation conventional submarine, has a huge "quasiconformal" main hull array that is much larger than the MGK-400 Rubikon cone-shaped main hull array (4.5 meter diameter x 3 meter tall) on the Project 636 Kilo class submarines. The Rubikon main array is the largest sonar ever fielded on a non-nuclear submarine and rivals the U.S. AN/ BQQ-5 sphere in size. Despite the Lada being 25% smaller than a Project 636 Kilo, the Lira sonar suite has more area in the integrated conformal and flank array arrangement.

The Lira sonar suite has experienced problems during its long development, but these difficulties have been described as software issues that affected the quality of the data transferred between the Lira sonar system and the Litiy (Lithium) combat system. Reportedly the software glitches were resolved in late 2011.

Modified Irtysh Amphora Sonar Suite



Replacing the separate sphere and flank arrays with an integrated conformal/flank array design allows the Russians to reduce the size of the bow while at the same time increasing the the effective area of the main hull arrays.

In addition, if the hydrophone arrays are fitted in a similar fashion as on the Project 677 Lada, then the installation would be easier and would likely have lower construction costs compared to the the original Irtysh Amphora arrays.

Modified Irtysh Amphora Sonar Suite

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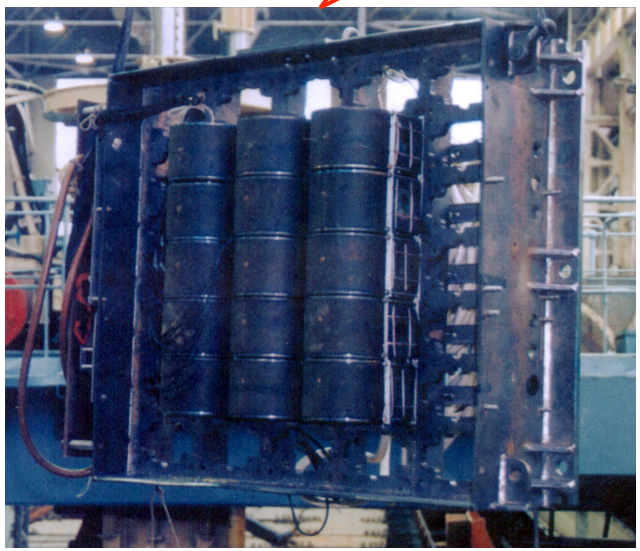
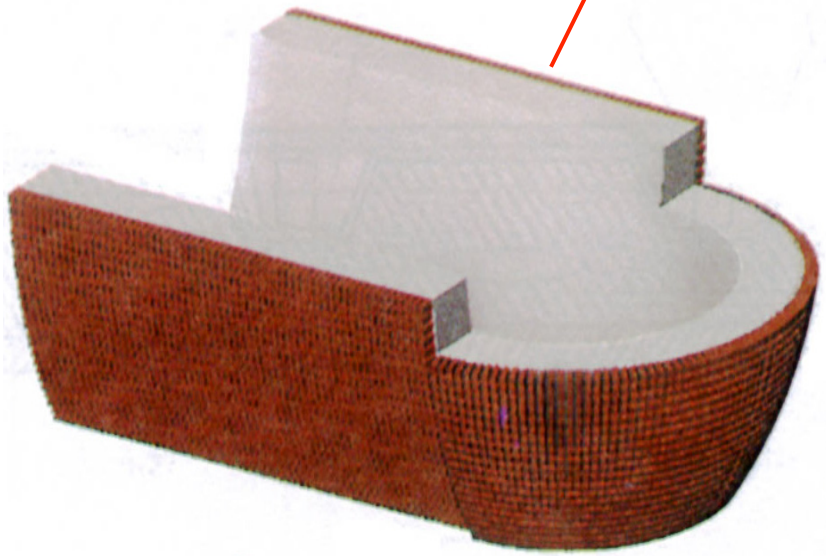
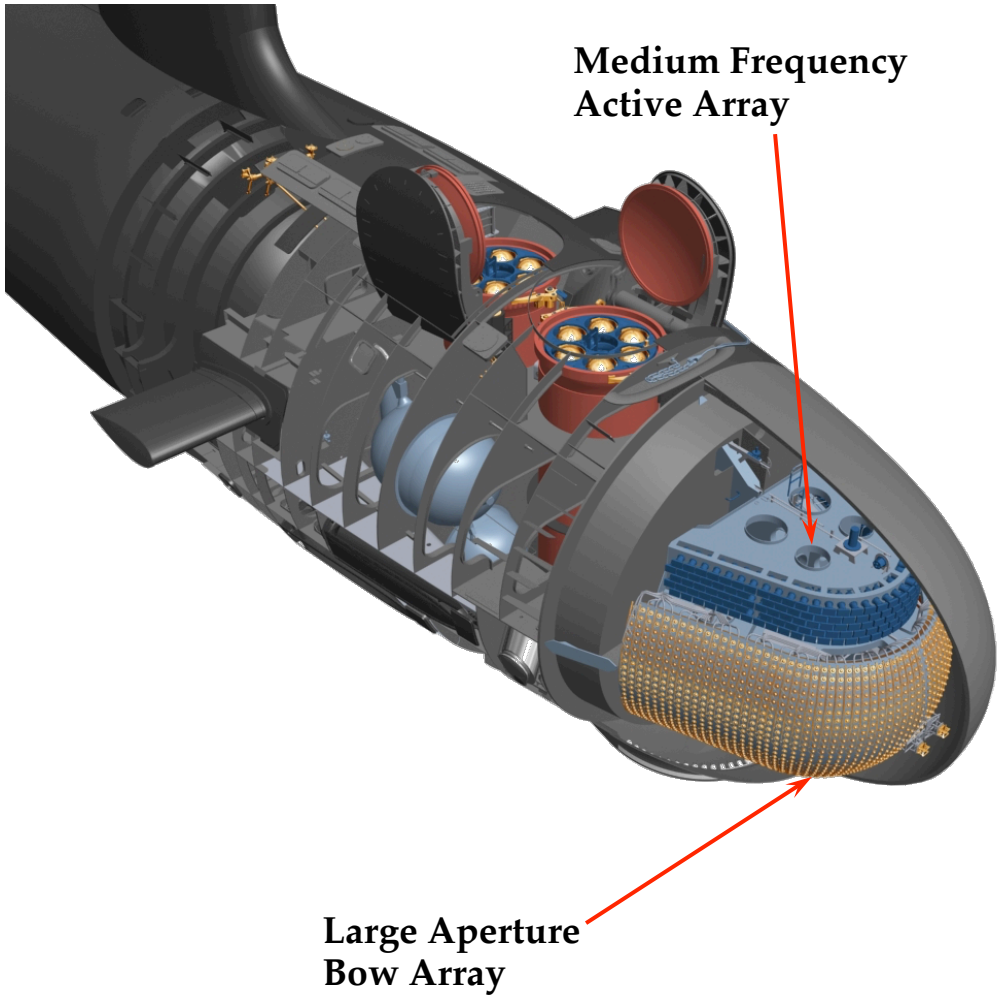


Integrated passive conformal
and flank arrays



Anyone Else Gone this Route?



The Royal Navy has never used anything *but* conformal arrays on their nuclear submarines (Type 2001, 2020, 2043, 2074, 2076).

Up until 2012, the U.S. Navy used a 15-foot sphere as the main hull array. However, beginning with the *Virginia* class Block III SSNs the sphere was replaced by two conformal arrays. The bottom one is passive only and has more area than the old sphere. The upper conformal is a separate active array.

The U.S. Navy went this route to get rid of the access tunnel – to allow the installation of the two large payload tubes forward and reduce the number of pressure hull penetrations – and to improve sensor performance (a larger passive array) while at the same time reducing construction costs.

Conclusions

Analysis of the Project 885M submarine *Kazan* indicates that she is shorter than the earlier Project 885 *Severodvinsk* by 8.3 – 9.1 meters above the waterline, depending on how many frames were removed in the engineering spaces. Another 1 meter reduction would be in the sonar dome, under the waterline, based on the rate of curvature of the bow.

***Kazan*'s overall length would thus be trimmed by a total of <u>9.3 – 10.1 meters</u>, which is consistent with Russian news reporting.**

- **4.0 meters (5 frames) in the berthing compartment**
- **0.8 or 1.6 meters (one or two frames) likely in the reactor compartment**
- **3.5 meters above the waterline in the bow, plus an additional 1.0 meter below**

The significant shortening of the sonar dome length would very likely require the Russians to abandon the large spherical array of the original MGK-600 Irtysh Amphora sonar suite and replace it, and the two separate large flank arrays, with an integrated conformal/flank array design similar to that on the Project 677 Lada class submarines.

The sheer size of an integrated conformal/flank array, when paired with modern electronics, would improve *Kazan*'s detection capability against very quiet targets – more so against noisier ones. When combined with the probable reduction in construction costs, this would be a rare success story for the troubled Russian submarine production base.