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RESEARCH AID

COST OF CONSTRUCTION OF THE SOVIET W-CLASS SUBMARINE

CIA/RR RA 59-19
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CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

SECRET

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FOREWORD

This research aid on the cost of construction of the Soviet W-class submarine was undertaken to fill a continuing need for placing a value on the Soviet effort in naval shipbuilding in order to assess the relative importance and the role of this effort in the Soviet economy. Specifically, the purpose of this research aid is to provide, as an aid for economic studies of Soviet naval shipbuilding, a means of pricing, in rubles, naval ships constructed in Soviet shipyards.

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Appendixes

25X1

Chart

COST OF CONSTRUCTION OF THE SOVIET W-CLASS SUBMARINE*

Summary

Extensive calculations on the cost of construction of the Soviet W-class submarine indicate an estimated cost of 41 million rubles in the USSR and an estimated cost of $10 million in the US.** The ruble-dollar ratio thus derived is 4.1 rubles to $1. A categorization of the cost into general categories is shown in the chart.***

The estimated cost of the 244 W-class submarines constructed in the USSR during 1950-57 was $2.4 billion, or 10 billion rubles. This estimate was obtained by using the values developed in this research aid and the latest estimate of the weight of the W-class submarine, 750 tons light ship displacement.**** 1/†

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1. Introduction

W-class submarines are the most numerous of any class in the Soviet submarine fleet, which, in turn, is larger than the combined submarine fleets of all the rest of the world. Of 295 long-range submarines in

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* The estimates and conclusions in this research aid represent the best judgment of this Office as of 15 November 1959.

** Ruble values are given in 1 July 1955 rubles, and dollar values are given in 1955 US dollars throughout this research aid. Except for labor costs, all computed monetary values have been rounded to two significant digits.

*** Following p. 2.

**** Tonnages are given in long tons (2,240 pounds) lightship displacement throughout this research aid. Light ship displacement is the weight of a vessel complete, ready for service in every respect, including ballast and liquids in the machinery at operating levels but excluding the crew and their effects and all items of consumable or variable load such as stores, fuel, and cargo.

25X1

the Soviet fleet, 2/ more than 80 percent are W-class ships, which thus constitute the largest single class of submarine in the world. These ships were constructed between 1950 and 1957 and served, more than any other naval construction, to elevate the USSR to the status of a first-class naval power. 25X1

The interest in the economic drain on Soviet resources of the program for construction of the W-class submarine is obvious, and this research aid represents an attempt to measure this drain by estimating the cost of the program in rubles and dollars. The research aid sets forth the evaluation accomplished and its methodology.

The calculation of the ruble and dollar values was accomplished through the following series of steps: allocation of the tonnage of the W-class submarine into weight groups according to the weight classification system used by the US Navy, determination of the cost of construction of a W-class submarine in the US in terms of 1955 dollars, conversion of the estimated dollar costs into rubles, and calculation of a ruble-dollar ratio. The problems encountered and their resolution are discussed below.

2. Estimated Allocation of Tonnage to Weight Groups

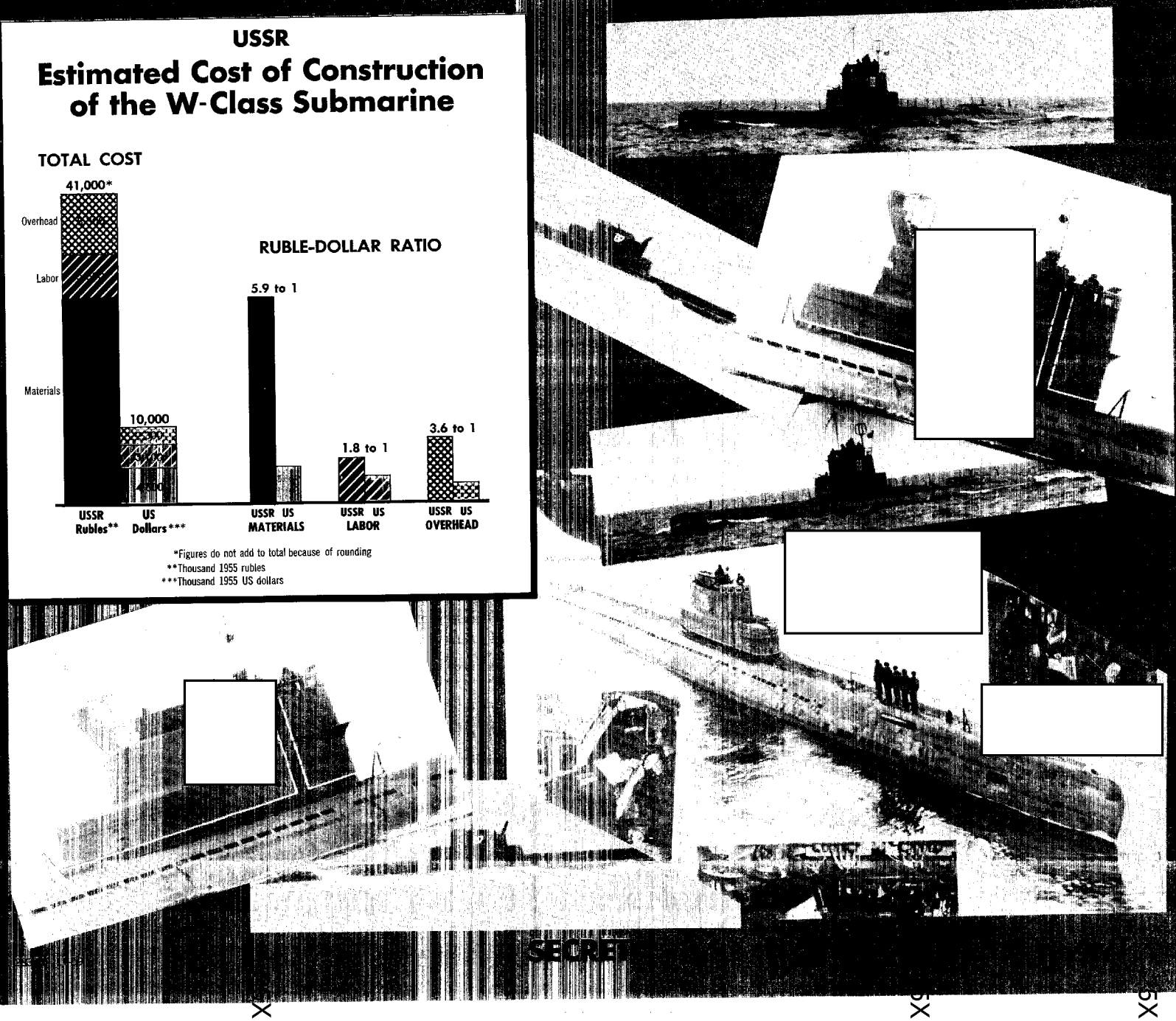
The allocation of the tonnage of the Soviet W-class submarine to weight groups was estimated by analogy with US submarines in accordance with the system of weight classification used by the US Navy. 3/ To find a submarine of approximately the same size as the W-class submarine, it was necessary to go back to 1942, when the SS 205 submarine, the USS Marlin, was completed. This submarine displaced 733 tons, whereas the W-class submarine displaces 750 tons. All US submarines of the fleet type that were constructed after the Marlin were at least twice the weight of the USS Marlin.*

* Between 1950 and 1952, three small attack submarines, SSK 1-3 (900 tons), were built, but the analogy with the W-class submarine is not appropriate. Therefore, no use was made of these submarines in this research aid.

USSR

Estimated Cost of Construction of the W-Class Submarine

*Figures do not add to total because of rounding
**Thousand 1955 rubles
***Thousand 1955 US dollars



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The allocation of weights of the USS Marlin was used as the basis for estimating the allocation of weights of the W-class submarine. Some adjustments were necessary, however, and they are explained in detail in Appendix A. The estimated allocation of weights of the W-class submarine that is used in this research aid is shown in Table 1.

Table 1

Estimated Allocation of Tonnage to Weight Groups of the Soviet W-Class Submarine

Weight Group	Long Tons Light Ship Displacement	Percent of Total
Hull structure	315	41.9
Propulsion machinery	237	31.6
Electric plant	17	2.3
Equipment for communication and control	30	4.0
Auxiliary systems	101	13.5
Outfit and furnishings	21	2.8
Armament	29	3.9
Total	750	100.0

3. Estimated Cost of Construction in the US

Once the allocation of weights was estimated for the Soviet W-class submarine, the estimation of costs was accomplished by analogy with the SS 580, the USS Barbel (1,733 tons), for which complete costs and accompanying weights were obtained through the US Navy from the Portsmouth Naval Shipyard in New Hampshire, where the ship was constructed. The general method used was to attribute the cost per ton of construction of the USS Barbel to the W-class submarine, by weight group. In practice, materials, direct labor, and overhead were considered separately.

Throughout the analysis the assumption was made that it would take as many man-hours to build the submarine in the US as in the USSR. Although recent studies based on Soviet publications 4/ indicate that for comparable situations the USSR would use one-fourth to one-third

more man-hours, it is considered that because the USS Barbel was not constructed in series and the Soviet W-class submarine was, the Soviet gains in productivity offset the basically greater productivity in the US. A summary of the costs so obtained is shown in Table 2, and the details of the dollar calculations are discussed below.

Table 2

Estimated Cost of What the Construction Would Be of the Soviet W-Class Submarine in the US

Cost Group	Thousand 1955 US $	Long Tons Light Ship Displacement
Hull structure	1,200	315
Propulsion machinery	1,300	237
Electric plant	780	17
Equipment for communication and control	2,600	30
Auxiliary systems	1,900	101
Outfit and furnishings	370	21
Armament	620	29
Engineering services a/	380	Not applicable
Construction services a/	520	Not applicable
Postdelivery costs b/	290	Not applicable
Total	10,000	750

a. This category is a cost group only and does not affect the calculation of the weight of the submarine. The first seven groups (hull structure through armament) are both cost groups and weight groups.
b. Costs of changes and adjustments, which usually are made after delivery of the submarine, for which the contractor is not responsible under the contract.

To obtain the estimated cost of construction of the hull structure of the Soviet W-class submarine in the US, costs and direct labor hours per ton were obtained for the USS Barbel for 14 cost subgroups included in the cost of the hull structure. The allocation of weights to these subgroups, however, was accomplished by analogy with the SS 563, the USS Tang. This procedure was followed because the USS Tang, like the

W-class submarine, has a conventional hull shape, whereas the USS Barbel has an "Albacore" (whale-shaped) hull. Direct labor was priced at $2.25 per man-hour, and overhead was figured as 79 percent of direct labor, as was done at the Portsmouth Naval Shipyard in 1955.* The resulting costs of the hull structure are as follows: materials, $220,000; direct labor, $525,000; overhead, $420,000; total, $1.2 million.

The average cost of materials per ton of the USS Barbel for propulsion machinery was $3,282, with an average labor time of 563 man-hours per ton. The cost of the 237 tons of propulsion machinery of the W-class submarine, therefore, was as follows: materials, $780,000; direct labor, $300,000; overhead, $240,000; total, $1.3 million. The calculations for electric plant, equipment for communication and control, auxiliary systems, outfit and furnishings, and armament were accomplished in the same way as those for propulsion machinery, with the results shown in Table 3.

Table 3

Estimated Cost of Construction of Electric Plant, Equipment for Communication and Control, Auxiliary Systems, Outfit and Furnishings, and Armament of the Soviet W-Class Submarine

Thousand 1955 US $

Cost Group	Materials	Direct Labor	Overhead	Total
Electric plant	370	230	180	780
Equipment for communication and control	2,200	220	180	2,600
Auxiliary systems	620	710	560	1,900
Outfit and furnishings	59	170	140	370
Armament	120	280	220	620

Design and engineering charges constitute a cost group only and not a weight group. It was estimated that there would be no significant diminution in the cost of these services for a smaller submarine, and so the costs were allocated on the basis of a 1-to-1 ratio, with results as follows: materials, $9,000; direct labor, $206,000; overhead, $160,000; total, $380,000.

* The same figures for labor and overhead were used for all cost groups that follow.

Construction services also constitute a cost group only and do not enter into calculations of the weight of the submarine. This group consists of six subgroups, the first three of which (staging, scaffoldings, and cribbing; launching; and trials and docking) would not be affected greatly by differences in the size of the ship. Therefore, these subgroups were attributed to the W-class submarine in a 1-to-1 ratio. The remaining groups (temporary utilities and services; preservation, rigging, and handling materials; and cleaning ship services) were estimated to vary directly with the weight of the ship. The resulting costs are as follows: materials, $36,000; direct labor, $271,000; overhead, $210,000; total, $520,000.

Postdelivery costs (US $290,000) were estimated to vary directly with the weight of the ship and to be 50 percent of this cost in direct labor and 50 percent in materials.

4. Estimated Cost of Construction in the USSR

The estimation of the cost of construction of the Soviet W-class submarine in terms of rubles generally involved the application of appropriate ruble-dollar ratios to the dollar estimates given in the previous section. It was found convenient to consider all the materials that were used in all cost groups first, then to estimate the cost of direct labor, and finally to estimate overhead. A summary of the results of the calculations is shown in Table 4,* and additional details on these calculations are given below.

a. Materials

A ruble-dollar ratio of 6.5 to 1 for high-tensile steel plates and shapes was used for subgroups consisting of plating and framing in the hull structure. 5/ For lead ballast a ratio of 13.3 to 1 was used on the basis of a price for lead of 7,150 rubles per ton, 6/ and for the remaining subgroups the ratio of 5.7 to 1 for steel shapes was used. 7/ The results are shown in Table 5.**

A ruble-dollar ratio of 9.6 to 1 was used for the submarine batteries and for the main diesel plant for propulsion machinery because it was estimated that the ratios for marine diesels and for storage batteries were almost identical, the ratio for marine diesels being 9.6 to 1.*** For the other subgroups of the propulsion machinery group the ratio of 6.2 to 1 for seamless steel pipe was used. 9/ The results are shown in Table 6.****

* Table 4 follows on p. 7.
** Table 5 follows on p. 7.
*** Based on source 8/.
**** Table 6 follows on p. 8.

Table 4

Estimated Cost of Construction of the Soviet W-Class Submarine

Cost Category and Group	Thousand 1955 Rubles	Ruble-Dollar Ratio
Materials		
Hull structure	1,500	6.8 to 1
Propulsion machinery	7,200	9.2 to 1
Electric plant	1,100	3.0 to 1
Equipment for communication and control	13,000	6.0 to 1
Auxiliary systems	2,200	3.5 to 1
Outfit and furnishings	270	4.5 to 1
Armament	400	3.4 to 1
Engineering services	41	4.5 to 1
Construction services	160	4.5 to 1
Postdelivery costs	860	5.9 to 1
Subtotal	27,000	5.9 to 1
Direct labor	5,600	1.8 to 1
Overhead	8,300	3.6 to 1
Total	41,000	4.1 to 1

Table 5

Estimated Cost of Construction
of the Hull Structure of the Soviet W-Class Submarine

Cost Subgroup	Thousand 1955 US $	Thousand 1955 Rubles	Ruble-Dollar Ratio
Shell plating and framing	110	710	6.5 to 1
Lead ballast	21	280	13.3 to 1
Other	91	520	5.7 to 1
Total	220	1,500	6.8 to 1

Table 6

Estimated Cost of Construction
of Propulsion Machinery of the Soviet W-Class Submarine

Cost Subgroup	Thousand 1955 US $	Thousand 1955 Rubles	Ruble-Dollar Ratio
Main propulsion plant	696	6,700	9.6 to 1
Other	82	510	6.2 to 1
Total	778	7,200	9.2 to 1

The ratio of 3.0 to 1 used for electric plant is based on general electrical equipment, including generators and similar items. 10/ The ratio of 6.0 to 1 used for equipment for communication and control is that attributable to military electronics. 11/ The ratio for auxiliary systems is based on prices for pumps, compressors, and similar items and is estimated at 3.5 to 1. 12/ Attributed to outfit and furnishings, engineering services, and construction services was a ratio of 4.5 to 1, which represents the general category of machinery and equipment. 13/ The ratio of 3.4 to 1* used for armament is the ratio for tanks. The results of the application of these ratios are shown in Table 7.

Table 7

Estimated Cost of Materials for Selected Cost Groups
for Construction of the Soviet W-Class Submarine

Cost Group	Thousand 1955 US $	Thousand 1955 Rubles	Ruble-Dollar Ratio
Electric plant	366	1,100	3.0 to 1
Equipment for communication and control	2,210	13,000	6.0 to 1
Auxiliary systems	617	2,200	3.5 to 1
Outfit and furnishings	59	270	4.5 to 1
Armament	118	400	3.4 to 1
Engineering services	9	41	4.5 to 1
Construction services	36	160	4.5 to 1

* Based on source 14/.

Applied to that part of postdelivery costs allocated to materials was a ratio of 5.9 to 1, the average ratio for the cost of all other materials. Thus the $145,000 worth of materials in postdelivery costs is equivalent to 860,000 rubles.

b. Direct Labor and Overhead

The labor rate in Soviet shipyards was taken as 4.0 rubles per hour [redacted] 25X1

25X1 [redacted] The rate at the Portsmouth Naval Shipyard was $2.25 per hour, which yielded a ruble-dollar ratio of 1.8 to 1 for labor. Application of this ratio to the $3.1 million estimated to have been expended on direct labor in construction of the W-class submarine resulted in a ruble value of 5.6 million.

Overhead was counted as one-third labor and two-thirds materials. The ruble-dollar ratio for labor was 1.8 to 1, and the ratio for materials was 4.5 to 1, which is the ratio used previously for machinery and equipment. Application of these ratios, weighted as indicated, to the total overhead cost of $2.3 million yielded a cost in the USSR of 8.3 million rubles and an average ratio of 3.6 to 1 for overhead.

5. Estimated Cost and Volume of the Program for the W-Class Submarine

The ruble-dollar ratio developed in this research aid and the recent reevaluation of the size of the Soviet W-class submarine 16/ permit a more accurate estimate of the cost of the program for construction of W-class submarines.

The program, which spanned the years 1950-57, resulted in construction of 244 ships totaling 183,000 tons. The value of the program is $2.4 billion, or 10 billion rubles. Detailed data, by individual year, are shown in Table 8.*

* Table 8 follows on p. 10.

Table 8

Estimated Cost and Volume of the Program for Construction
of the Soviet W-Class Submarine
1950-57

Year	Number of Submarines	Long Tons Light Ship Displacement	Cost	
			Thousand 1955 US $	Thousand 1955 Rubles
1950	1	750	10,000	41,000
1951	6	4,500	60,000	250,000
1952	16	12,000	160,000	660,000
1953	23	17,250	230,000	940,000
1954	46	34,500	460,000	1,900,000
1955	68	51,000	680,000	2,800,000
1956	66	49,500	660,000	2,700,000
1957	18	13,500	180,000	740,000
Total	244	183,000	2,400,000	10,000,000

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