Mr. ANDREWS. What about the cost increase in shipbuilding and repairing? We were told last year, if I remember correctly, that costs last year were up 25 percent in some areas. What about that area today?

Captain MORGAN. In overall terms the increase has not been as much as 25 percent.

Mr. ANDREWS. I said last year. I am sure costs are still climbing.

Captain MORGAN. Yes, sir; they are.

NUCLEAR SUBMARINE CORES

Mr. ANDREWS. When you overhaul these subs will you put in new cores?

Captain MORGAN. Yes, sir.

Admiral SHIFLEY. For some regular overhauls they would be recored.

Mr. ANDREWS. A new core is contemplated in the *Adams* and the *Clay?*

Captain MORGAN. Yes, sir.

Mr. ANDREWS. What about the cost of cores now?

Captain MORGAN. The cost of cores, themselves, is included in the procurement account. The cost of the installation of the cores is in this budget.

Mr. ANDREWS. Do you know about the cost?

Captain MORGAN. I do not have the accurate figure as to how much the cost of cores has increased between last year and this year. We will have to provide it.

Mr. ANDREWS. What about mileage, do you get more mileage from these new cores?

Admiral SHIFLEY. That is going up, the trend is up. I can get you a statement on that.

Mr. ANDREWS. Put a chart in the record at this point to show what progress has been made over the last 10 years.

(The information follows:)

COMPARISON OF NUCLEAR CORE COST AND PERFORMANCE

Ship type	Initial cores(s)			Present replacement core(s)		
	Cost (millions)	Miles steamed	Dollars (per mile)	Cost millions	Anticipated miles	Dollars per mile
Submarine (1 reactor)	$4.1	62,000	$66	$4.0	400,000	$10
Aircraft carrier (8 reactors)	61.1	207,000	343	80.0	935,000	85
Frigate (2 reactors)	10.2	309,000	33	11.5	700,000	16

Naval nuclear power unit prices have increased by approximately 10 percent in the last year. These increases were due to escalation in the price of special reactor materials as well as increasing labor costs. However, there has been a marked increase in the life of naval nuclear power units in recent years so that, even with the increasing price of power units, the net cost per unit of energy has declined significantly since the beginning of the nuclear power program.

Admiral SHIFLEY. Ideally, Admiral Rickover I believe is working toward being able to provide cores with a new ship that would last the entire life of the ship.

Mr. ANDREWS. He has told us about that. Also, if I remember correctly, the price of the cores has been decreasing from what they were when you first started using them and you get more mileage out of them.

Admiral SHIFLEY. Yes, sir.

Mr. ANDREWS. Therefore, your cost of operation has come down?

Admiral SHIFLEY. That is correct, sir.

COST OF NUCLEAR SUBMARINE VERSUS CONVENTIONAL

Mr. ANDREWS. Has the cost of operating the nuclear-powered submarine gotten closer to the cost of operating a conventional type sub?

Admiral SHIFLEY. It is getting closer but nuclear power is still more expensive than fossil fuel power.

Mr. ANDREWS. And better?

Admiral SHIFLEY. Yes, sir, much better. As a matter of fact, the advantages, particularly in the submarine, to be gained from nuclear power are just so many fold higher than and better than a conventional submarine that it is difficult to make a comparison.

Mr. ANDREWS. I wish you would have some of your men put in the record a statement about the experience you have had operating the nuclear-powered submarines vis-a-vis the conventional type, the overall difference in the cost, and compare present-day statistics with 10 years and 5 years ago.

Admiral SHIFLEY. I will be happy to do that.

Mr. ANDREWS. I have always thought it is much, much cheaper in the long run to have an atomic-powered Navy craft whether under the sea or on the sea.

Admiral SHIFLEY. I will be happy to provide that, sir.

Mr. ANDREWS. You might consult Admiral Rickover.

Admiral SHIFLEY. I will ask him if he wouldn't like to contribute to this.

(The information follows:)

COST OF NUCLEAR POWER VERSUS CONVENTIONAL POWER

There is some difficulty in choosing conventionally powered submarines that are "comparable" to nuclear powered submarines for purposes of an operating cost comparison. Even when such factors as length, weight, crew composition, electronics and weapon characteristics can be reasonably matched, the contrasts dominate. Every conventional submarine must return to the atmosphere after relatively short submerged periods in order to continue operating whereas the submerged endurance of nuclear powered submarines is limited only by the endurance of its crew. The conventional submarine is severely limited in speed when either totally submerged or snorkeling as compared to top speed on the surface whereas the submerged speed of a nuclear powered submarine equals or exceeds the top surface speed of a conventional submarine. In addition, the conventional submarine is fuel limited to a maximum cruising radius measured in thousands of miles. In essence, we are comparing two weapons systems with completely different tactical and strategic capabilities regardless of the "match" in size, armament or electronics.

Nevertheless, during the last decade, the average cost of operating nuclear powered submarines has decreased relative to the average cost of operating the most similar diesel electric submarines. The table below shows the reduction in the ratio of operating costs for nuclear powered submarines compared to the operating costs of diesel electric submarines. The average operating costs are based primarily upon overhaul costs, alteration costs, nuclear core costs and core reprocessing costs. The cost of fossil fuel, supplies and equipage, and unscheduled repairs was considered in the analysis but the overall impact

on the ratio was relatively minor. Personnel costs were excluded since the crew allowance for the nuclear and conventional submarines in these classes is virtually identical. The following comparisons were made:

The SS 563 fast attack class with the SSN 478 *Skate* class and the SS 580 fast attack class with the SSN 585 *Skipjack* class.

RATIO OF AVERAGE ANNUAL OPERATING COSTS

1. Submarine being compared: *Skate* SSN class (SSN 578, 579, 583, 584) to the fast attack SS class (SS 563, 564, 565, 566, 567, 568).

Average nuclear cost as a percentage of average diesel cost

Fiscal year:	*Percent*
1961	356
1965	205
1970	196

2. Submarines being compared: *Skipjack* SSN class (SSN 585, 590, 591, 592) to the fast attack SS class (SS 580, 581, 582).

Average nuclear cost as a percentage of average diesel cost

Fiscal year:	*Percent*
1962	219
1965	237
1970	197

COST INCREASE OF SHIP OVERHAULS

Mr. ANDREWS. How much has the original cost estimate increased for the 197 ships now scheduled to be overhauled in 1969? What is your original estimate and the most accurate cost as the most recent date? Do you have those figures?

Captain MORGAN. Yes, sir. In July 1969 when we formulated the final program we expected to be able to overhaul those 197 ships for $430 million.

Mr. ANDREWS. That is your original estimate?

Captain MORGAN. Yes, sir, Now, there have been increases and decreases; some of the ships have gone up, in some cases they have gone down; but at this point we expect to overhaul the ships of the fleet within that budget.

Mr. ANDREWS. $430 million?

Captain MORGAN. $430 million. It is possible we may have to add $5 million or $10 million to it at the end of the year.

Mr. ANDREWS. The increased costs have not been as high this year as they were last year?

Captain MORGAN. I think, sir, it is not the increase in cost has been any less, it is just that we were able to estimate more accurately at the beginning of this year what it was going to be.

ADVANCED PLANNING AND CHANGE ORDERS

Mr. ANDREWS. Included in the $430,663,000 revised estimate for regular overhauls for fiscal year 1969 is an amount of $24,649,000 for advanced planning and change orders. How much of this amount is for advanced planning and how much for the change orders? Do you have those figures?

Captain MORGAN. Yes, sir.

Mr. ANDREWS. Put them in the record.