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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS HOUSE OF REPRESENTATIVES

EIGHTY-SEVENTH CONGRESS

SECOND SESSION

SUBCOMMITTEE ON PUBLIC WORKS APPROPRIATIONS

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CARSON CULP, *Staff Assistant to the Subcommittee*

PART 6

Atomic Energy Commission

Printed for the use of the Committee on Appropriations

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PUBLIC WORKS APPROPRIATIONS FOR 1963

THURSDAY, MAY 24, 1962.

ATOMIC ENERGY COMMISSION

WITNESSES

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VICTOR CORSO, DEPUTY ASSISTANT CONTROLLER FOR BUDGETS, OFFICE OF CONTROLLER

Operating Expenses

Program and financing

[In thousands of dollars]

	1961 actual	1962 estimate	1963 estimate
Program by activities:			
1. Raw materials	634,604	550,067	512,183
2. Special nuclear materials	560,357	539,060	540,413
3. Weapons	517,671	629,800	742,010
4. Reactor development	424,382	430,596	488,745
5. Physical research	160,998	175,978	216,000
6. Biology and medicine	52,904	61,077	70,353
7. Training, education, and information	13,205	14,255	15,165
8. Civilian applications of—			
Isotopes	4,167	5,884	7,462
Nuclear explosives	7,466	8,900	8,800
9. Communities	9,146	8,583	9,114
10. Program direction and administration	58,899	60,366	61,911
11. Security investigations	6,467	6,036	6,019
12. Cost of work for others	6,528	4,802	4,100
13. Adjustment to prior year costs	1,434		
Total program costs [1]	2,458,228	2,495,344	2,682,275
Change in selected resources [2]	−5,711	38,433	45,213
Total obligations	2,452,517	2,533,777	2,727,488
Financing:			
Unobligated balance brought forward		−154,082	
Advances and reimbursements from non-Federal sources (revenue applied)	−29,495	−27,700	−26,700
Unobligated balance carried forward	154,082		
New obligational authority	2,577,104	2,351,995	2,700,788
New obligational authority:			
Appropriation	2,451,210	2,352,001	2,700,788
Transferred from "Plant acquisition and construction" (74 Stat. 752)	5,000		
Transferred to "Operating expenses, Public Buildings Service," General Services Administration (75 Stat. 353)		−6	
Appropriation (adjusted)	2,456,210	2,351,995	2,700,788
Reappropriation	120,894		

[1] Includes capital outlay for equipment: 1961, $122,770,000; 1962, $122,271,000; 1963, $148,005,000.

[2] Selected resources as of June 30 are as follows:

	1960	1961	1962	1963
Inventories and items on order:				
Inventories	191,097	186,107	183,726	184,458
Unpaid undelivered orders	653,550	642,716	674,795	742,444
Advances	26,436	36,477	45,212	22,044
Collateral funds and other deposits (insurance collateral employee benefit and annuity funds, merchandise deposits with vendors and miscellaneous deposits)	20,185	20,257	20,257	20,257
Total selected resources	891,268	885,557	923,990	969,203

Object classification

[In thousands of dollars]

	1961 actual	1962 estimate	1963 estimate
ATOMIC ENERGY COMMISSION			
11 Personnel compensation:			
Permanent positions	53,489	54,849	56,172
Positions other than permanent	645	559	559
Other personnel compensation	1,802	1,825	1,669
Total, personnel compensation	55,936	57,233	58,400
12 Personnel benefits	4,081	4,161	4,263
21 Travel and transportation of persons	3,280	4,270	4,465
22 Transportation of things	7,605	8,729	8,920
23 Rent, communications, and utilities	215,974	209,062	204,959
24 Printing and reproduction	585	718	748
25 Other services	1,288,846	1,462,195	1,690,824
Services of other agencies	26,090	25,646	26,620
26 Supplies and materials	677,320	599,687	533,500
31 Equipment	137,772	129,891	162,130
41 Grants, subsidies, and contributions	9,004	4,094	4,405
42 Insurance claims and indemnities	64	67	67
Unvouchered		100	100
Total, Atomic Energy Commission	2,426,557	2,505,853	2,699,401
ALLOCATION ACCOUNTS			
11 Personnel compensation:			
Permanent positions	397	458	499
Positions other than permanent	12	7	8
Other personnel compensation	2	1	2
Total, personnel compensation	411	466	509
12 Personnel benefits	31	35	37
21 Travel and transportation of persons	17	18	17
22 Transportation of things	313	355	325
23 Rent, communications, and utilities	4	6	7
25 Other services	513	1,355	1,014
26 Supplies and materials	24,670	25,689	26,178
31 Equipment	1		
Total, allocation accounts	25,960	27,924	28,087
Total, obligations	2,452,517	2,533,777	2,727,488
Obligations are distributed as follows:			
Atomic Energy Commission	2,426,557	2,505,853	2,699,401
Army	25,141	26,199	26,637
Bureau of Mines	331	387	450
Maritime Administration	488	1,338	1,000

Personnel summary

	1961 actual	1962 estimate	1963 estimate
ATOMIC ENERGY COMMISSION			
Total number of permanent positions	7,417	7,187	7,375
Full-time equivalent of other positions	111	89	89
Average number of all employees	6,826	6,838	6,985
Number of employees at end of year	6,846	6,923	7,035
Average grade, grades established by the Atomic Energy Commission	9.0	9.1	9.2
Average salary, grades established by the Atomic Energy Commission	$7,926	$8,075	$8,142
ALLOCATION ACCOUNTS			
Total number of permanent positions	66	77	78
Full-time equivalent of other positions	1	2	2
Average number of all employees	66	72	76
Number of employees at end of year	65	72	77
Average GS grade	7.3	7.5	7.5
Average GS salary	$6,556	$6,651	$6,717

Plant Acquisition and Construction

Program and financing

[In thousands of dollars]

	1961 actual	1962 estimate	1963 estimate
Program by activities:			
Facilities for—			
1. Raw materials	12	61	40
2. Special nuclear materials	76,262	48,590	62,605
3. Weapons	25,376	38,848	36,085
4. Reactor development	84,767	142,557	47,650
5. Physical research	42,588	78,343	132,200
6. Biology and medicine	4,785	3,635	4,810
7. Training, education, and information	52	411	225
8. Civilian applications of isotopes	1,294	171	390
9. Communities	1,532	4,244	1,940
10. Administrative	364	200	100
Total obligations	237,032	317,060	286,045
Financing:			
Unobligated balance brought forward	−182,831	−160,808	
Recovery of prior year obligations	−4,459	−92	
Unobligated balance transferred from "Research, development, test, and evaluation," Air Force (74 Stat. 751)	−6,300		
Unobligated balance transferred to proposed for separate transmittal, "Operating expenses," Atomic Energy Commission		39,200	
Unobligated balance carried forward	160,808		
New obligational authority	204,250	195,360	286,045
New obligational authority:			
Appropriation	212,750	195,360	286,045
Transferred to—			
"Operating expenses," Atomic Energy Commission (54 Stat. 752)	−5,000		
"Other procurement," Navy (74 Stat. 752)	−3,500		
Appropriation (adjusted)	204,250	195,360	286,045

Object classification

[In thousands of dollars]

		1961 actual	1962 estimate	1963 estimate
	ATOMIC ENERGY COMMISSION			
22	Transportation of things	9	5	3
25	Other services	3,005	15,644	17,819
	Services of other agencies	−599	207	
26	Supplies and materials	2,397	3,000	3,000
32	Lands and structures	229,614	295,263	264,293
42	Insurance claims and indemnities	227	420	430
	Total, Atomic Energy Commission	234,653	314,539	285,545
	ALLOCATION ACCOUNTS			
11	Personnel compensation: Permanent positions	3	4	
25	Other services	707	580	500
32	Lands and structures	1,669	1,937	
	Total, allocation accounts	2,379	2,521	500
	Total obligations	237,032	317,060	286,045
	Obligations are distributed as follows:			
	Atomic Energy Commission	234,653	314,539	285,545
	Army	739	930	500
	Maritime Administration	1,545	773	
	Bureau of Public Roads	95	818	

Personnel summary

	1961 actual	1962 estimate	1963 estimate
ALLOCATION ACCOUNTS			
Total number of permanent positions	1	1	
Average number of all employees	1	1	
Number of employees at end of year	0	0	
Average GS grade	6.2	6.3	
Average GS salary	$5,806	$5,830	

ALLOCATIONS RECEIVED FROM OTHER ACCOUNTS

NOTE.—Obligations incurred under allocations from other accounts are included in the schedules of the parent appropriations as follows:
"Research and development," National Aeronautics and Space Administration.
"Construction of facilities," National Aeronautics and Space Administration.
"Research and development," Office of Civil and Defense Mobilization.
"Ship construction," Maritime activities.
"Ships and facilities, Navy."
"Navy management fund."
"Operation and maintenance, Navy."
"Shipbuilding and conversion, Navy."
"Procurement other than aircraft and missiles, Air Force."
"Military construction, Army."
"Research, development, test, and evaluation, Army."
"Operation and maintenance, Army."

[House of Representatives, H. Doc. No. 409, 87th Cong., 2d sess.]

COMMUNICATION FROM THE PRESIDENT OF THE UNITED STATES TRANSMITTING AN AMENDMENT TO THE BUDGET FOR THE FISCAL YEAR 1963 INVOLVING AN INCREASE IN THE AMOUNT OF $210,800,000 FOR THE ATOMIC ENERGY COMMISSION

THE WHITE HOUSE,
Washington, May 21, 1962.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith for the consideration of the Congress an amendment to the budget for the fiscal year 1963 involving an increase in the amount of $210,800,000 for the Atomic Energy Commission.

The details of this amendment, the necessity therefor, and the reasons for its submission at this time are set forth in the attached letter from the Director of the Bureau of the Budget, with whose comments and observations thereon I concur.

Respectfully yours,

JOHN F. KENNEDY.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., May 14, 1962.

THE PRESIDENT,
The White House.

SIR: I have the honor to submit herewith for your consideration an amendment to the budget for the fiscal year 1963 involving an increase in the amount of $210,800,000 for the Atomic Energy Commission, as follows:

ATOMIC ENERGY COMMISSION

Budget appendix page	Heading	Original estimate	Revised estimate	Increase
655	Operating expenses (Delete the paragraph under this heading and insert in lieu thereof the following:) For necessary operating expenses of the Commission in carrying out the purposes of the Atomic Energy Act of 1954, as amended, including the employment of aliens; services authorized by section 15 of the Act of August 2, 1946 (5 U.S.C. 55a); purchase of equipment; purchase, maintenance, and operation of aircraft; publication and dissemination of atomic information; purchase, repair, and cleaning of uniforms; official entertainment expenses (not to exceed $30,000); reimbursement of the General Services Administration for security guard services; purchase (not to exceed [four hundred and thirty-two] *seven hundred and forty*, of which [three hundred and fourteen] *four hundred and ten* are for replacement only) and hire of passenger motor vehicles; [$2,352,001,000] *$2,865,288,000*, and any moneys (except sums received from disposal of property under the Atomic Energy Community Act of 1955 (42 U.S.C. 2301)) received by the Commission, notwithstanding the provisions of section 3617 of the Revised Statutes (31 U.S.C. 484), to remain available until expended: *Provided*, That of such amount $100,000 may be expended for objects of a confidential nature and in any such case the certificate of the Commission as to the amount of the expenditure and that it is deemed inadvisable to specify the nature thereof shall be deemed a sufficient voucher for the sum therein expressed to have been expended: *Provided further*, That from this appropriation transfers of sums may be made to other agencies of the Government for the performance of the work for which this appropriation is made, and in such cases the sums so transferred may be merged with the appropriation to which transferred: *Provided further*, That no part of this appropriation shall be used in connection with the payment of a fixed fee to any contractor or firm of contractors engaged under a cost-plus-a-fixed-fee contract or contracts at any installation of the Commission, where that fee for community management is at a rate in excess of $90,000 per annum, or for the operation of a transportation system where that fee is at a rate in excess of $45,000 per annum.	$2,700,788,000	$2,865,288,000	$164,500,000

The additional funds requested for the "Operating expenses" appropriation include primarily an amount of $120 million to provide necessary restoration of Commission funds currently being used in connection with the weapons testing program. Moreover, significant additional amounts are requested in connection with the production of atomic weapons, for a detailed study into the technical and economic attractiveness of the "seed and blanket" approach to design of civilian atomic power reactors, and for certain other adjustments. These increases are offset in part by various savings, primarily reductions in the estimated cost of uranium ore purchased in Canada. Authority is also sought to purchase additional passenger motor vehicles.

Budget appendix page	Heading	Original estimate	Revised estimate	Increase
659	Plant acquisition and construction (Add the following proviso at the end of the paragraph under this head:) *: Provided, That not to exceed $10,000,000 of this appropriation for carrying out improvements on U.S. Highway 95, Nevada, as authorized in the Commission's 1963 authorization Act, may be transferred to the Bureau of Public Roads, Department of Commerce.*	$286,045,000	$332,345,000	$46,300,000

Additional funds are needed for the "Plant acquisition and construction" appropriation primarily to cover major cost overruns in two large reactor projects (the new production reactor at Hanford and the experimental gas-cooled reactor at Oak Ridge), and to provide for widening and otherwise improving the existing highway from AEC's Nevada Test Site to Las Vegas, Nev., a distance of 58 miles. This improvement is made necessary by the intensification of activity at the Nevada Test Site as a result of the growth in Project Rover (nuclear rocket development) and the resumption of underground weapons testing. In addition, it is proposed to use $20 million of unobligated fiscal year 1962 balances for construction of a prototype organic power and heat industrial reactor under a cooperative arrangement with private industry.

I recommend that the foregoing amendment to the budget for the fiscal year 1963 be transmitted to the Congress.

Respectfully yours,

DAVID E. BELL,
Director of the Bureau of the Budget.

Chairman CANNON. The committee will be in order.

We take up today the budget for the U.S. Atomic Energy Commission. We are glad to have with us Dr. Seaborg, the Chairman of the Commission. We shall insert pages 1 through 12 for operating expenses and pages 412 through 419 for plant acquisition and construction.

(The justification referred to follows:)

GENERAL STATEMENT FOR OPERATING EXPENSES

ESTIMATE OF APPROPRIATION

This book contains the budget estimates for the appropriation "Operating expenses" for fiscal year 1963. The estimates provide for total obligations of $2,891,988,000 to be funded by: (1) a new appropriation of $2,865,288,000, (2) an estimated $26,700,000 to be received as revenues from non-Federal sources during the fiscal year.

ESTIMATES OF COSTS AND OBLIGATIONS

The budget estimates for this appropriation are stated in terms of accrued costs for each of the AEC's operating programs. "Accrued costs" denotes the actual application of labor, materials, equipment, and services to the program during the year, but excludes depreciation of facilities used in the operations. The AEC does, however, maintain accounts for depreciation for the purpose of determining total costs of production and for use in establishing prices for services rendered or products sold to others.

The costs of operation are reconciled to the total obligations to be incurred during the year by estimating the buildup or decrease during the year of the resources that are to be applied to future years' operations. These estimates are included in the section titled, "Increase or Decrease (−) in Selected Resources" and include inventories and undelivered orders.

From total obligations are deducted the revenues estimated to be obtained from non-Federal sources in order to arrive at the amount of appropriations required. These revenues are obtained from AEC-owned community and housing operations, from the sale of products, from services performed for others, and from other miscellaneous sources. These revenues are identified and summarized under the tab "Revenues applied."

The following table summarizes the accrued costs for each program, and the total obligations for fiscal years 1961, 1962, and 1963. The detailed justifications, beginning on page 13, present the programs in the same order as they appear on this summary table.

Summary of accrued operating costs by program reconciled to net obligations

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Accrued costs by program:			
Raw materials	$634,603,883	$538,394,000	$500,585,000
Special nuclear materials	560,356,676	526,819,000	537,300,000
Weapons	517,670,663	749,000,000	786,310,000
Reactor development	424,381,797	429,774,000	503,745,000
Physical research	160,998,302	175,978,000	216,000,000
Biology and medicine	52,904,282	61,077,000	71,353,000
Training, education, and information	13,204,745	14,233,000	15,165,000
Civilian applications of:			
Isotopes	4,166,513	5,884,000	7,462,000
Nuclear explosives	7,466,617	9,650,000	10,050,000
Community	9,146,215	8,583,000	9,114,000
Program direction and administration	58,898,528	60,631,000	64,111,000
Security investigations	6,466,799	7,215,000	6,019,000
Cost of work for others	6,528,457	7,430,000	4,100,000
Adjustment to prior year costs	1,434,600		
Total accrued program costs	2,458,228,077	2,594,668,000	2,731,314,000
Changes in selected resources	−5,711,443	−57,121,521	160,674,000
Total obligations for operating expenses	2,452,516,634	2,537,546,479	2,891,988,000
Less: revenues applied	29,494,924	31,469,000	26,700,000
Net obligations (financed by appropriated funds)	2,423,021,710	2,506,077,479	2,865,288,000

FINANCING OF OBLIGATIONS

The financing of the estimated total obligations of $2,891,988,000 proposed in the budget estimates for fiscal year 1963, together with comparable data for fiscal year 1961 and 1962, is summarized in the following table:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Funds available for obligations:			
Unobligated balance, beginning of year	$120,894,334	$154,082,624	0
Appropriation	2,451,210,000	2,352,001,000	$2,865,288,000
Transfer to "Operating expenses, Public Buildings Services," General Services Administration (75 Stat. 353)	0	−6,145	0
Revenues received from non-Federal sources	29,494,924	31,469,000	26,700,000
Transfer from "Plant acquisition and construction," Atomic Energy Commission (74 Stat. 752)	5,000,000	0	0
Total funds available for obligation	2,606,599,258	2,537,546,479	2,891,988,000
Less: Unobligated balance, end of year	−154,082,624	0	0
Total obligations incurred	2,452,516,634	2,537,546,479	2,891,988,000

EXPENDITURES FOR OPERATING EXPENSES

Expenditures from the "Operating expenses" appropriation for fiscal year 1963 are estimated at $2,635 million, an increase of $85 million over estimated expenditures of $2,550 million in fiscal year 1962. Actual expenditures for operating expenses in fiscal year 1961 totaled $2,411,816,785. The estimated amounts available for expenditure in fiscal years 1961, 1962, and 1963, the expenditures for each year, and the remaining unexpended balances are shown in the following table:

Expenditure analysis

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Funds available for expenditure:			
Unexpended balance, beginning of year:			
Obligated	$847,111,996	$858,316,921	$814,394,400
Unobligated balance	120,894,334	154,082,624	0
New appropriation	2,451,210,000	2,352,001,000	2,865,288,000
Transfer to "Operating expenses, Public Buildings Services," General Services Administration (75 Stat. 353)	0	−6,145	0
Transfer from "Plant acquisition and construction," Atomic Energy Commission (74 Stat. 752)	5,000,000	0	0
Total funds available for expenditure	3,424,216,330	3,364,394,400	3,679,682,400
Less: Expenditures	2,411,816,785	2,550,000,000	2,635,000,000
Unexpended balance, end of year:			
Obligated	858,316,921	814,394,400	1,044,682,400
Unobligated balance	154,082,624	0	
Total unexpended balance	1,012,399,545	814,394,400	1,044,682,400

HIGHLIGHTS OF OPERATING PROGRAMS

There follows a brief description of each of the programs set forth in the summary on page 8.

1. *Raw materials program.*—Operating costs for the raw materials program are estimated at $500.6 million in fiscal year 1963, compared with estimated fiscal year 1962 costs of $538.4 million and actual fiscal year 1961 costs of $634.6 million. The raw materials program provides for procurement of uranium concentrates and ores from foreign and domestic sources. The decrease in quantities of uranium concentrates to be procured in fiscal year 1963 is principally the result of reduced deliveries from domestic and Canadian producers in accordance with the provisions of the respective contracts.

2. *Special nuclear materials program.*—Operating costs for the special nuclear materials program are estimated at $537.3 million in fiscal year 1963, compared with estimated fiscal year 1962 costs of $526.8 million and actual fiscal year 1961 costs of $560.4 million. The production of special nuclear materials begins with the refinement of uranium concentrates for diffusion plants or reactors. The isotope uranium 235 is extracted in gaseous diffusion plants at Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio. Plutonium and related products are produced in the reactors at Hanford, Wash., and Savannah River, S.C. Process development effort is aimed at improving efficiency and product quality, maintaining approved health and safety standards and investigating promising new concepts.

3. *Weapons program.*—Operating costs for the weapons program are estimated at $786.3 million in fiscal year 1963 compared with estimated fiscal year 1962 costs of $749 million and actual fiscal year 1961 costs of $517.7 million. The weapons program includes the production of atomic weapons, the maintenance of stockpiled weapons in a state of constant readiness, the development, design, and testing of new weapon types, and participation with the Department of Defense in experimental programs for detecting nuclear detonations at high altitude and underground.

4. *Reactor development program.*—Operating costs for the reactor development program are estimated at $503.7 million in fiscal year 1963 compared with estimated fiscal year 1962 costs of $429.8 million and actual fiscal year 1961 costs of $424.4 million. Emphasis will continue to be placed on advancing power reactor technology in order to achieve large scale generation of economic electrical energy from atomic reactors. Cooperative endeavors between the Commission and

industrial groups, as well as with the European Atomic Energy Community (Euratom) and Canada, will be continued.

The estimates provide for research and development applicable to advanced systems as well as to many current reactor designs, fuel cycle development, a program of reactor environmental and aerospace nuclear safety, development of separations systems for processing irradiated fuel elements, and a program of high temperature materials research and high performance reactors research.

Work will also be continued on reactors to propel merchant vessels, on reactors to meet military needs for power in remote areas, on reactors to propel naval vessels, rockets, and missiles, and on reactors and radiosotopes to provide electric power and heat for satellites. This research and developmental effort will also provide information useful in the development of civilian power reactors.

Operation of test facilities and experimental reactors will be continued at the National Reactor Testing Station, Idaho, and at other locations.

5. *Physical research program.*—Operating costs for physical research are estimated at $216 million in fiscal year 1963 compared with estimated fiscal year 1962 costs of $176 million and actual fiscal year 1961 costs of $161 million. The physical research program consists of theoretical and experimental investigations required to support the Commission's immediate and long-range objectives for utilizing nuclear energy. Advances achieved in the past can be traced back to similar laboratory investigations. In the atomic energy program, research plays a relatively more important role than in other industrial operations of comparable size. The phenomena dealt with are close to the fringes of scientific knowledge. Unusual materials are employed and their nuclear, as well as their chemical and physical properties, must be determined. The temperatures and radiation densities at which these materials are used are outside the range of previous experience in industrial technology.

6. *Biology and medicine program.*—Operating costs for research in biology and medicine are estimated at $71.4 million for fiscal year 1963, compared with estimated costs of $61.1 million in fiscal year 1962 and actual cost of $52.9 million in fiscal year 1961. Primary emphasis will continue to be placed on the protection of the health and safety of atomic energy plant workers and the general populace from the hazards of atomic energy operations. Research on radioactive fallout problems and related research in the biological hazards of radiation will be expanded with increasing attention given to large scale studies of chronic effects of radiation. Continued emphasis will be placed on research efforts of pertinence in the field of industrial uses of atomic energy. Close liaison will continue to be maintained with other agencies performing functions interrelated with Commission biomedical interests. Research is carried on by Commission laboratories, universities, and other independent institutions.

7. *Training, education, and information program.*—Operating costs for the training, education, and information program are estimated at $15.2 million in fiscal year 1963 compared to estimated fiscal year 1962 costs of $14.2 million and actual fiscal year 1961 costs of $13.2 million. Primary program emphasis will continue to be placed on broadening the base of nuclear technology at home and abroad. Program efforts are directed toward provision of assistance to colleges and universities in establishing nuclear curriculums provision of assistance to States for training in radiation control; operation, through contract, of schools and the conduct of specialized courses; offering of graduate fellowships in the nuclear energy field; presentation of international conferences, studies and exhibits; and development and dissemination of technical information.

8. *Civilian applications of—*

Isotopes: Operating costs for this program are estimated at $7.5 million in fiscal year 1963 compared to estimated fiscal year 1962 costs of $5.9 million and actual fiscal year 1961 costs of $4.2 million. The program consists of research and development activities required to accelerate realization of the potentially vast uses of radioisotopes and radiation technology. The program will provide for expanding the technology and utilization of isotopes with particular attention to civilian applications; and developing, through research and development activities, applications of high level or massive radiation; large scale economic uses of fission product wastes, and methods and technology for preservation of foods by irradiation.

Nuclear explosives: The civilian applications of nuclear explosives (Plowshare) for which costs amount to $10.1 million are estimated for fiscal year 1963 compared to estimated costs of $9.7 million in fiscal year 1962 and actual costs of $7.5 million in 1961, encompasses the development of peaceful uses of nuclear

explosives. The program provides for development of special instrumentation and feasibility studies regarding new applications and devices and for experimental projects directed toward excavation applications and the use of nuclear explosives for scientific purposes such as transplutonium element production.

9. *Community.*—The AEC will continue to operate the community of Los Alamos, N. Mex. under contract and will provide assistance payments for Oak Ridge, Tenn., and Richland, Wash. All houses have been disposed of at Oak Ridge and Richland, and remaining building lots, apartments and commercial properties at Richland are expected to be disposed of during fiscal year 1962. Operating costs of the program are estimated at $9.1 million in fiscal year 1963 compared to estimated fiscal year 1962 costs of $8.6 million and fiscal year 1961 costs of $9.1 million.

10. *Program direction and administration.*—Under the general heading of program direction and administration are grouped together the salary costs and other expenses of Commission personnel engaged in general management, executive direction, and technical supervision of program operations; the negotiation and administration of contracts; other related administrative activities; and the discharge of regulatory functions. The corresponding costs for Commission personnel engaged in nonadministrative and nonregulatory activities directly related to a specific program are included in that program, as for example, personnel safeguarding classified shipments or providing fire protection for a community. Expenses of personnel of other Government agencies, including their travel, doing work for the Commission are treated as contractual services, and are therefore not included in the AEC detail of personal services and travel.

Estimated costs of $64.1 million will be incurred in fiscal year 1963 for program direction and administration compared with estimated fiscal year 1962 costs of $60.6 million and actual fiscal year 1961 costs of $58.9 million. An increase in staff of 222 employees is budgeted for fiscal year 1963 under this program. The increase of $3.5 million is required principally for salaries, travel, and other costs associated with the higher average employment, resulting from the increase in staff. The costs in fiscal year 1963 represent 2.3 percent of the total operating costs, compared with an estimated 2.3 percent in fiscal year 1962 and 2.4 percent in fiscal year 1961.

11. *Security investigations.*—This program covers the costs of investigations performed by the Civil Service Commission and the Federal Bureau of Investigation, at the request of the Commission, of persons to be employed on work involving access to restricted data, under the provisions of the Atomic Energy Act of 1954, as amended. Costs of security investigations in fiscal year 1963 are estimated at $6 million compared with estimated fiscal year 1962 costs of $7.2 million and actual fiscal year 1961 costs of $6.5 million.

12. *Cost of work for others.*—This program includes costs incurred by the Commission in furnishing materials and services to industrial organizations and other private parties apart from those which it provides normally for its own basic program. The costs are incurred only upon the request of others. Charges are made for these materials and services and the revenues derived are included under "Revenues applied." Cost of work for others is estimated to be $4.1 million in fiscal year 1963, compared with $7.4 million in fiscal year 1962 and $6.5 million in fiscal year 1961. The lower estimate in fiscal year 1963 is due principally to an estimated decrease in sales of miscellaneous products and isotopes, together with reduced levels of services rendered to others.

13. *Increase or decrease in selected resources.*—This program includes inventory stocks held by AEC and its contractors, collateral funds, and goods and services on order under contract. The appropriation requirements for these items are based on the changes in balances from the previous fiscal year. Selected resources at the end of fiscal year 1963 are estimated at $989.1 million as compared with $828.4 million in fiscal year 1962 and $885.6 million in fiscal year 1961. The net increase of $160.7 million in fiscal year 1963 results principally from: (1) Increases in goods and services on order related to expanded levels of effort in the weapons, reactor development, and physical research programs; (2) an increase related to procurement of equipment under the physical research program; (3) increases in balances related to the cooperative arrangements program; and (4) decreases in balances related to procurement of Canadian uranium concentrates.

14. *Revenues applied.*—This program includes income from sale and lease of products and from services rendered, revenues from communities, and other miscellaneous income items. These revenues are applied against Atomic Energy Commission appropriation requirements. Revenues are estimated at $26.7 million for fiscal year 1963, compared to an estimate of $31.5 million for fiscal

year 1962. The lower estimate in fiscal year 1963 is due principally to an estimated decrease in sales of various products and reduced levels of services partially offset by increased revenue from charges for SS material consumed and charges for separation of irradiated SS materials. Revenues for fiscal year 1961 were $29.5 million.

JUSTIFICATION FOR PROPOSED LANGUAGE CHANGES—OPERATING EXPENSES

Proposed changes in language are indicated as follows (language enclosed in black brackets indicates proposed deletions; language italicized indicates proposed insertions):

1. "purchase (not to exceed [four hundred and thirty-two] *seven hundred and forty,* of which [three hundred and fourteen] *four hundred and ten* are for replacement only) and hire of passenger motor vehicles".

This change provides for authorization of the procurement in fiscal year 1963 of 740 passenger motor vehicles of which 410 are required for replacement of older vehicles and 330 would be additions to the fleet.

The operation of the General Services Administration Interagency Motor Pool at Livermore, Calif. is to be terminated and 170 passenger vehicles are to be transferred to AEC. Sixty-five of these vehicles, representing the return of vehicles AEC furnished GSA when the motor pool was started in 1957, will be transferred without cost to AEC. The acquisition of the remaining 105 passenger vehicles from GSA requires congressional approval under 5 U.S.C. 78(e). These 105 vehicles are included in the 330 vehicles to be added to the fleet.

Apart from those at Livermore, the additional vehicles requested include 222 automobiles and 3 station wagons. Major requirements are 200 automobiles for the Nevada Test Site to offset a like number of commercial rentals in view of the continuing program at this location, 8 automobiles for the Atomic Bomb Casualty Commission to be substituted for 4-wheel drive truck-type vehicles used for passenger and patient transportation, 10 automobiles for activities at the National Reactor Testing Station in Idaho, and 4 automobiles and 3 station wagons for Brookhaven National Laboratory.

All vehicles to be replaced will meet or exceed the GSA replacement standards.

Contractors are assigned passenger motor vehicles as Government-furnished equipment and operate them in carrying out the Commission's program. The passenger vehicle fleet will number 2,496 at the end of fiscal year 1963.

2. "[$2,352,001,000] *$2,863,288,000,* and any moneys (except sums received from dispoal of property under the Atomic Energy Community Act of 1955 (42 U.S.C. 2301)) received by the Commission, notwithstanding the provisions of section 3617 of the Revised Statutes (31 U.S.C. 484), to remain available until expended."

To reflect the fiscal year 1963 appropriation amount.

JUSTIFICATION FOR PROPOSED LANGUAGE CHANGES—GENERAL PROVISIONS

The proposed change in the language for the administrative provisions is described below. Language enclosed in black brackets indicates proposed deletions; language italicized indicates proposed insertions.

1. "Any appropriation available under this or any other Act to the Atomic Energy Commission may initially be used subject to limitations in this Act during the fiscal year [1962] *1963* to finance the procurement of materials, services, or other costs which are a part of work or activities for which funds have been provided in any other appropriation available to the Commission: * * *"

This change makes the provision applicable to fiscal year 1963.

2. "Not to exceed 5 per centum of appropriations made available for the fiscal year [1962] *1963* for 'Operating expenses' and 'Plant acquisition and construction' may be transferred between such appropriations, but neither such appropriation, except as otherwise provided herein, shall be increased by more than 5 per centum by any such transfers, and any such transfers shall be reported promptly to the Appropriations Committees of the House and Senate" * * *

This change makes the provision applicable to fiscal year 1963.

General Statement for Plant Acquisition and Construction

SUMMARY OF REQUIREMENTS FOR FISCAL YEAR 1963

The budget estimates for the appropriation "Plant acquisition and construction" for the fiscal year 1963 provide for estimated obligations of $359,845,000 to be funded by a new appropriation of $332,345,000 and by utilization of an

unobligated balance of $27,500,000 estimated to be available at the close of fiscal year 1962. Of the estimated total obligations, $201.7 million is requested for projects previously authorized, while the balance $158.1 million, is required for projects for which initial authorization is being requested in the 1963 authorization bill.

A summarization of estimated fiscal year 1963 obligations by program follows:

Estimated fiscal year 1963 obligations

	Funding for projects previously authorized [1]	Funding for projects included in the 1963 authorization act	Total
Raw materials	0	$40,000	$40,000
Special nuclear materials	$52,000,000	33,605,000	85,605,000
Weapons	7,500,000	49,085,000	56,585,000
Reactor development	26,950,000	51,000,000	77,950,000
Physical research	112,000,000	20,200,000	132,200,000
Biology and medicine	3,280,000	1,530,000	4,810,000
Training, education, and information	0	225,000	225,000
Isotopes development	0	390,000	390,000
Community	0	1,940,000	1,940,000
Administrative	0	100,000	100,000
Total obligations	201,730,000	158,115,000	359,845,000
Less unobligated balance brought forward			27,500,000
Appropriation			332,345,000

[1] Includes funds on previously authorized projects for which amended authorization is requested in the 1963 authorization bill.

SUMMARY OF OBLIGATIONS

The following table summarizes the total obligations for each of the construction programs for fiscal years 1961, 1962, and 1963. The detailed justifications, beginning on page 420 present the programs in the same order as they appear on this summary table.

Summary of obligations by program

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Raw materials	$12,448	$61,000	$40,000
Special nuclear materials	76,262,323	47,440,000	85,605,000
Weapons	25,375,646	30,794,000	56,585,000
Reactor development	84,767,131	165,701,769	77,950,000
Physical research	42,588,021	78,343,000	132,200,000
Biology and medicine	4,784,411	3,623,000	4,810,000
Training, education, and information	51,884	411,000	225,000
Isotopes development	1,293,705	171,000	390,000
Community	1,532,056	4,241,000	1,940,000
Administrative	364,333	200,000	100,000
Total obligations	237,031,958	330,985,769	359,845,000

FINANCING OF OBLIGATIONS

The financing of the estimated total obligations of $359,845,000 proposed in the budget estimates for fiscal year 1963, together with comparable data for fiscal years 1961 and 1962, is summarized in the following table:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Funds available:			
Unobligated balance at beginning of year	$182,830,727	$160,807,769	$27,500,000
Recovery of prior year obligations	4,459,000	2,318,000	0
Appropriation	212,750,000	195,360,000	332,345,000
Transfer from "Research, development, test, and evaluation, Air Force" (74 Stat. 751)	6,300,000	0	0
Transfer to "Operating expenses, Atomic Energy Commission" (74 Stat. 752)	−5,000,000	0	0
Transfer to "Other procurement, Navy" (74 Stat. 752)	−3,500,000	0	0
Net amount available for obligations	397,839,727	358,485,769	359,845,000
Unobligated balance at end of year	160,807,769	27,500,000	0
Total obligations	237,031,958	330,985,769	359,845,000

EXPENDITURES FOR PLANT ACQUISITION AND CONSTRUCTION

Expenditures for plant acquisition and construction for fiscal year 1963 are estimated to be $290 million, an increase of $10 million over the estimate of $280 million for fiscal year 1962. Actual expenditures in fiscal year 1961 totaled $299,707,258. Unexpended balances are expected to decrease from $553,718,139 at the beginning of fiscal year 1961 to an estimated $422,265,881 at the end of fiscal year 1963 as shown in the following table:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Unexpended balance, beginning of year	$553,718,139	$464,560,881	$379,920,881
Appropriation	212,750,000	195,360,000	332,345,000
Transfer from "Research, development, test, and evaluation, Air Force" (74 Stat. 751)	6,300,000	0	0
Transfer to "Operating expenses, Atomic Energy Commission" (74 Stat. 752)	−5,000,000	0	0
Transfer to "Other procurement, Navy" (74 Stat. 752)	−3,500,000	0	0
Total funds available	764,268,139	659,920,881	712,265,881
Less expenditures	299,707,258	280,000,000	290,000,000
Unexpended balance, end of year	464,560,881	379,920,881	422,265,881

HIGHLIGHTS OF CONSTRUCTION PROGRAMS

As shown in the table on page 412, estimates are presented on an obligation basis for construction requirements for each of the AEC's functional programs. The highlights of the estimates for new projects and previously authorized projects for which appropriations are required in fiscal year 1963 are as follows:

1. *Raw materials.*—Obligations for raw materials facilities in fiscal year 1963 are estimated at $40,000 to provide for minor modifications and improvements to existing plant or installations of the Grand Junction, Colo., office.

2. *Special nuclear materials.*—Obligations for special nuclear materials facilities in fiscal year 1963 are estimated at $85.6 million and will provide $33.6 million for new projects proposed for authorization in fiscal year 1963, $9 million for increased funding of previously authorized reactor confinement work at Savannah River for which an increased authorization to $12 million is being requested and $43 million for increased costs for the new production reactor at Hanford (now estimated at $195.2 million). The $33.6 million proposed for new projects includes $9.7 million for radioactive waste disposal facilities at Savannah River and Hanford; $7.4 million for projects to improve the health, safety, and efficiency of operations; $5 million for modifications to production and supporting installations; and $11.5 million for general plant projects.

3. *Weapons.*—Obligations for weapons facilities in fiscal year 1963 are estimated at $56.6 million to provide $49.1 million for new projects proposed for authorization in fiscal year 1963, including $29.1 million for additional production, development, and supporting facilities; $10 million for improvement of U.S. Highway 95 between Las Vegas, Nev., and the Nevada test site; and $10 million for general plant projects; and increased funding of $7.5 million for a previously authorized project for which an increase in authorization is being requested.

4. *Reactor development.*—Obligations for reactor development facilities in fiscal year 1963 are estimated at $78 million which will provide $51 million for new projects to be authorized and $27 million for funding on previously authorized projects. The new projects provide $20 million for an organic power and heat industrial reactor; $10 million for research and development test plants for Project Rover; $5 million for housing of the lithium-cooled reactor experiment; $5 million for modifications to reactors; $1.4 million for modification and additions to CANEL facilities at Middletown, Conn.; $1.5 million for a cafeteria at Argonne National Laboratory; and $8.1 million for general plant projects. The funding on previously authorized projects provides $13.5 million for the advanced test reactor (on which total cost is increased from $40 to $47 million); $11 million for the flexible experimental gas-cooled reactor (on which total cost is increased from $40 to $51 million); and $2.5 million for modifications to the sodium graphite reactor experiment for increased operating performance.

5. *Physical research.*—Obligations for physical research facilities in fiscal year 1963 are estimated at $132.2 million, consisting of $20.2 million for new projects to be authorized including $5 million for a building addition for physics and mathematics, $2.5 million for an inorganic materials laboratory, $2.3 million for a mathematics and computer building, and $3.4 million for general plant projects; $7.5 million for a transuranium processing plant for which increased authorization is being requested in fiscal year 1963; and $104.5 million for additional funding on previously authorized projects including $95 million for a linear electron accelerator.

6. *Biology and medicine.*—Obligations for biology and medicine facilities in fiscal year 1963 are estimated at $4.8 million, consisting of $1.5 million for new projects to be authorized including $0.9 million for support of biomedical research projects in atomic energy and $0.6 million for general plant projects; $2.8 million for a controlled environment laboratory and an animal bioradiological laboratory for which increased authorization is being requested in fiscal year 1963; and $0.5 million to complete the funding on the laboratory for mixed fission product inhalation studies authorized in fiscal year 1962.

7. *Training, education, and information.*—Obligations for training, education, and information facilities in fiscal year 1963 are estimated at $225,000 to provide for general plant construction at the Nuclear Training Center at Puerto Rico.

8. *Isotopes development.*—Obligations for isotopes development facilities in fiscal year 1963 are estimated at $390,000 for an isotopes technology laboratory.

9. *Community.*—Obligations for community facilities in fiscal year 1963 are estimated at $1.9 million to provide for the following at Los Alamos: $0.6 million for an additional elementary school; $0.7 million for real estate development and a new water well; and $0.6 million for general plant projects.

10. *Administrative.*—Obligations for administrative facilities in fiscal year 1963 are estimated at $100,000 for general plant projects at headquarters.

EXPLANATION OF PROPOSED LANGUAGE CHANGES—PLANT ACQUISITION AND CONSTRUCTION

Proposed changes in language are indicated as follows: Language enclosed in black brackets indicates proposed deletions, and italicized indicates proposed insertion of new language.

1. "[$195,360,000] *$332,345,000,* to remain available until expended"

To delete the amount appropriated in fiscal year 1962 and to insert the amount of the fiscal year 1963 appropriation request.

2. "Provided, That not to exceed $10,000,000 of the funds herein provided may be transferred to the Bureau of Public Roads, Department of Commerce, for carrying out improvements on U.S. Highway 95, Nevada as authorized in the Commission's 1963 authorization Act"

To permit the Commission to transfer not to exceed $10 million to the Bureau of Public Roads, Department of Commerce, to be used for improvement of U.S. Highway 95 between Las Vegas, Nev., and the Nevada Test Site in accordance with the authorization in the Commission's proposed 1963 authorization act.

Mr. CANNON. The appropriation for the current year, for fiscal year 1962, aggregated $2,352,001,000. The amount requested for the coming year, fiscal year 1963, is a half billion dollars in excess of that amount and totals $2,865,288,000.

This provides for what is unquestionably one of the most important activities of our day and time. It is of the greatest importance both in peace and in war.

We have with us Dr. Seaborg, Chairman of the Commission. We shall be glad to have any statement he cares to make at this time. Dr. Seaborg.

GENERAL STATEMENT

Dr. SEABORG. Thank you, Mr. Chairman and members of the Appropriations Committee.

The Commissioners and members of the AEC staff welcome this opportunity to present the budget estimates of the Atomic Energy Commission for fiscal year 1963.

I would propose, Mr. Chairman, to follow the procedure of other years, in which we include in our presentation to the committee whatever sensitive, classified information is necessary to convey an adequate picture of our program. For example, certain classified information is contained in my general statement, and other classified information may be offered in response to your questions. Subsequent to the hearing, with your permission, we would indicate the amendments and deletions necessary to be made in the transcript in order to assure that the printed record be an unclassified account of the proceedings, but nevertheless present as complete and faithful a record as this circumstance will permit.

The estimates we will discuss today include the amendments transmitted by the President's letter of May 21. Atomic Energy Commission funds are provided in two appropriations, one covering operating expenses and the other covering plant acquisition and construction. Our requested appropriations for fiscal year 1963, then, are $2,865,288,000 for "Operating expenses," and $332,345,000 for "Plant acquisition and construction." These total $3,197,633,000.

The requested appropriation for "Operating expenses" is $513,287,000 greater than the 1962 appropriation of $2,352,001,000. Of this increase $120 million represents a deferment to 1963 of amounts which normally would have been obligated in fiscal year 1962 but have been applied to the requirements resulting from the resumption of weapons tests. As you will recall, the 1962 budget estimates of the Commission did not include any funds for the resumption of tests in this year. With the announcement of the President on September 5, 1961, that weapons tests would be undertaken, your committee added $30 million to the 1962 estimates then under consideration. Those funds enabled us to get started without delay. During the year we have applied to the fund requirements for weapons testing all possible savings from other programs. Since the total requirement could not be fully met from such savings, the operating expense appropriation was exempted from the apportionment requirements of the Anti-Deficiency Act on January 17, 1962, under the confidentiality clause of that act.

Under the weapons program I will review more fully the funding adjustments necessary to meet the weapons testing requirements, Mr.

Chairman, and also, I will tell you about some of the results of the tests.

In the event this appropriation bill is enacted prior to June 30 next, we would hope that this amount of $120 million could be made immediately available so that these deferred obligations might be met in this fiscal year. If that does not appear probable, we would then need to have authority under a continuing resolution to incur such obligations at the beginning of the new fiscal year.

A comparison of our estimated program costs for 1962 and 1963 will help to clarify the true relationship between the two years. Our program costs in 1962 are expected to be approximately $2,594,000,000. The estimate for 1963 is $2,731,000,000, or an increase of $137 million in the operating costs expected to be incurred.

The largest program increase in 1963 occurs in reactor development, where we have stepped up our efforts to provide nuclear power for space propulsion and operation of satellite instruments. A major increase is also estimated for the physical research program. The remaining increases in several of the other programs are in large part offset by the decrease in raw materials costs projected for 1963.

For plant acquisition and construction, our requested appropriation of $332,345,000 for fiscal year 1963 is $136,985,000 greater than the amount appropriated for 1962. The appropriation requested, together with unobligated balances of $27,500,000 to be carried over from fiscal year 1962, would provide for estimated obligations of $359,845,000 in fiscal year 1963. This amount is about $29 million more than our estimated 1962 obligations of $330,985,769.

The amount for plant obligations in 1963 consists, first of all, of $158,115,000 of new projects proposed for authorization. Hearings before the Joint Committee on Atomic Energy on our requested legislation to authorize these projects were completed only last Monday, May 21. The remaining $201,730,000 is required for projects which were not fully funded in the year they were authorized, and for projects on which the cost estimates have increased.

The two projects requiring the greatest amounts are both prior-year projects. Our request of $95 million for the linear electron accelerator being constructed at Stanford University would bring the total amount appropriated to $114 million, the amount for which the project was authorized last year and its estimated cost today. The next largest requirement is $43 million for the new production reactor at Hanford. This amount, I regret to say, is the increase which has occurred during the past year in the estimated cost to complete the construction of this project.

The largest requirements for construction funds, apart from these two large projects, are for the reactor development program and the weapons program, with somewhat smaller amounts provided for the special nuclear materials and physical research programs.

In turning now to our several budget programs, I propose for the moment to depart from the usual order of presentation. My purpose is to direct attention to two programs for which our estimated costs are relatively small. It is my sincere belief that the importance of these programs has not been adequately stressed and that it is in the national interest to provide greater support for them in the years ahead. The first of these programs is training, education, and information; the second is civilian application of isotopes.

TRAINING, EDUCATION, AND INFORMATION

The training, education, and information program covers Commission activities directed toward broadening the base of nuclear knowledge at home and abroad. There is an urgent national need to see that nuclear science is incorporated in the curriculums of our educational institutions from high school through the university postdoctoral level, in the life sciences, the physical sciences, and engineering. Nothing less will assure an adequate supply of trained manpower for the tasks which challenge our society in the nuclear era into which we have now moved. The assistance AEC provides is of critical importance in encouraging and accelerating the steps our educational institutions must take to fulfill this responsibility.

Our assistance takes a number of forms, of which I will mention some of the most significant. Graduate fellowships are offered in nuclear energy fields. Training opportunities are provided to university-level faculty members at AEC laboratories. Grants are made to colleges and universities to acquire nuclear equipment for teaching. Summer courses are offered to high school teachers. Special schools are operated, which are also open to a limited number of qualified foreign citizens.

The program also includes training for State and local government personnel who will be engaged in radiological health and radiation control activities. The program covers limited support of international scientific conferences, and the presentation of atomic energy exhibits in this country and abroad. The final activity I will mention is the basic task of organizing and disseminating the technical information developed by our contractors.

The estimated cost in fiscal year 1963 for all the activities making up the training, education, and information program is approximately $15 million.

CIVILIAN APPLICATION OF ISOTOPES

The second small program, which has already paid dividends many times its cost, is civilian application of isotopes. Our estimated costs for this program in 1963 are $7.5 million. This work is directed at extending and speeding up the development and adoption of techniques employing radioisotopes and high intensity radiation in such pursuits as engineering, agriculture, medicine, and research. I would like to mention a few areas where we hope to demonstrate new beneficial applications of radioisotopes and radiation.

We are developing a radioisotope quality control technique which gives promise of dimishing many costly failures in the electronic systems of missiles.

A method for measuring underground storage capacity for ground water has been used successfully in New Mexico.

In the area of crime prevention, we recently developed a nuclear activation analysis technique which may serve to identify the geographic origin of narcotics smuggled into this country.

A possible ally in our battle against smog is an isotopic device which continuously measures atmospheric contamination. This device, which is undergoing field tests by the California State Department of Health, can detect atmospheric concentration of sulfur dioxide down to 1 part in 10 million.

An impressive result in the beneficial processing of materials is the development of wood plastic alloys, produced by irradiation, which have substantially greater toughness, elasticity, and dimensional stability than the original wood.

Research and development is underway in many other areas, aimed at the successful application of radioisotope technology to innumerable practical problems in governmental operations, public benefit areas, technology and science.

I might depart from the text and mention a rather amusing application. Through the radioactivation analysis technique it has recently been possible to draw the inference that Napoleon did not die from cancer at all. He died from arsenic poisoning. These techniques are so sensitive, and this illustrates the point. They took some of the hair that had been preserved from his head. By neutron activation analysis—bombarding it with neutrons in order to induce a radioactivity in it—they could measure substantially larger concentrations of arsenic in it than is normal.

Chairman CANNON. Off the record.

(Discussion off the record.)

Dr. SEABORG. A major activity is the development and production of isotopic fuels and fuel forms for power sources used in SNAP devices. A primary task in 1963 will be provision of curium 242 fuel for the SNAP 11 devices which will power equipment in the SURVEYOR satellite units with which NASA will attempt the first soft lunar landings.

This, of course, is an example of an additional use of these transuranium isotopes that many of us are so much interested in.

We are also taking steps to increase the availability of the long-lived fission products, especially strontium 90 and cesium 137, which are very suitable for isotopic power devices. In the development of radiation pasteurization of foods, contracts for experimentation with seafood and fruit products will be continued at about the same level as in 1962.

RAW MATERIALS

The first program which appears in our budget justifications is the raw materials program. The quantities of uranium concentrates to be procured will decline from an estimated 29,325 tons in fiscal year 1962 to 28,400 tons in 1963. The total 1963 cost of the program is estimated at $501 million, about $36 million less than the estimated cost in 1962, and $125 million less than the costs incurred in 1961.

The projected purchases of 17,300 tons of domestically produced U^{308} are at approximately the same level as the 17,200 tons we estimate for 1962. After 1963 receipts of domestic uranium are expected to decline moderately to about 16,000 tons in 1965 and 1966. Receipts from foreign sources will show a sharp decrease after 1963.

The Commission's commitments to procure uranium result from both contracts and public announcements, and none extends beyond December 31, 1966. Domestic purchases through 1966 are based on a program announced in May 1956 and later modified by an announcement of November 24, 1958. Under this program the Commission is obligated to purchase uranium concentrates produced in the United States at $8 per pound of contained U^{308} during the period April 1962 through December 1966. The Commission's obligation is limited,

however, to an appropriate quantity of uranium derived from ores developed as of November 1958.

Milling contracts now generally extend through December 31, 1966, except for several which terminate earlier because of insufficient eligible ore.

Although tonnage receipts in 1963 decline only about 3 percent, the dollar cost for the entire program is estimated to be nearly 7 percent less than in 1962. The reason is that a greater proportion of the total is being purchased from lower cost domestic sources. The overall average cost per pound of U^{308} drops from $9.18 in 1962 to $8.84 in 1963.

The Commission's total commitments under foreign and domestic contracts and domestic public announcements for the 4½-year period extending from July 1, 1962, to December 31, 1966, are estimated to cover purchase of 98,700 tons of U^{308} at an estimated cost of $1.7 billion. About 74,200 tons, or 75 percent, will come from U.S. suppliers and the remainder from Australia, Canada, and South Africa. These quantities are believed adequate to meet projected requirements at least through 1966.

SPECIAL NUCLEAR MATERIAL

Special nuclear materials is the next item in our budget presentation. This program is estimated to cost $537 million in 1963, an increase of approximately $10 million over our anticipated 1962 cost. This increase is primarily attributable to increased costs at Hanford, where large-scale retubing of the reactors is necessary and preparation of fuel for the new production reactor will begin. Receipts of uranium concentrates will continue to decrease from the peak level of fiscal year 1960. The cascade feed (UF–6) preparation plants at Oak Ridge and Portsmouth have been shut down and all cascade feed will be supplied from the Paducah plant and from the privately owned facility operated by Allied Chemical.

The 1963 production of reactor products, enriched uranium 235, and other products will be primarily for weapons and other military requirements.

For the first time next year, we expect to incur costs for procurement of plutonium from domestic power reactors. The Commission is obligated by law to pay a fair price for all plutonium produced and delivered by domestic reactor operators. Facilities are being provided at Savannah River for the receipt of spent irradiated material of low uranium 235 enrichment, and we have facilities at Idaho which can be used to store and process highly enriched material. Plant modifications for processing the material of low enrichment have been held in abeyance because of industry interest in providing the processing services. We are presently negotiating a basis of arrangement with Davison Chemical Co., who propose to build a privately financed plant to accomplish the processing of the spent fuel elements discharged from such reactors.

Construction obligations for the special nuclear materials program in 1963 are estimated at approximately $86 million. The largest requirement relates to completing the construction of the new production reactor at Hanford. Technical difficulties encountered during the past year have seriously delayed construction progress. We now

estimate that the reactor will have a total cost of $195,200,000, which is $43 million more than the estimate in our budget last year.

Other projects requiring obligation in 1963 relate to improved safety, to provision of storage for radioactive materials, and to provision for more efficient manufacturing procedures in feed material preparation.

WEAPONS

For the weapons program, our estimated costs in 1963 are $786 million. The increase over our estimated costs for 1962 is $37 million.

This comparison, however, gives little indication of the striking changes which have taken place in this program since it was last discussed with your committee a year ago. The estimate presented to the committee for weapons program costs was $561 million, about $188 million less than the present estimate for 1962.

The estimates provided at that time included only $4 million for weapon tests, an amount just sufficient to maintain a skeleton force at the Nevada test site should weapon tests again become necessary. Following resumption of testing by the Soviet Union, your committee took action to make available for AEC tests an amount of $30 million from estimated unobligated 1961 funds. These funds were of crucial importance in making it possible for us to proceed without delay with the preparation and conduct of the initial underground tests which followed.

As plans developed for underground testing at the Nevada test site, and for the limited series of atmospheric tests being conducted in the Pacific, the 1962 funding requirements for weapons testing have grown to $223,400,000. Of this amount, $203,400,000 is the estimate of costs to be incurred by June 30 and $20 million is required for obligations which will not be liquidated until fiscal year 1963.

These funds have been provided as follows: In addition to the $4 million in the original estimate and the $30 million designated for this purpose by your committee from unobligated funds, it developed that an additional $7.1 million of unobligated funds from 1961 were available. Savings in the raw materials and special nuclear materials programs provided $51 million, and $11.3 million became available through reprograming of funds within the weapons program originally intended for test detection studies under Project VELA. Still required was an additional $120 million. You will recall that the President's budget in January contemplated a supplemental request for appropriation to meet this situation. It was subsequently agreed that a more desirable course would be to defer $120 million of obligations planned for 1962 until the beginning of fiscal year 1963. The necessary amounts were obtained by using $19.8 million available for the cooperative power demonstration program and $100.2 million for the prefinancing of certain integrated contractors. Enactment of our 1963 appropriation request would restore these funds.

The resumption of underground testing at Nevada on September 15 followed a moratorium of nearly 3 years. Weapons research and development had proceeded during this period by extrapolation of earlier test results, with heavy reliance on theoretical analysis and computational methods.

To advance our weapons technology the tests currently being conducted fall generally into four categories. First, we are exploring

numerous advanced concepts, aimed at major improvements in reducing warhead weights for desired yields, at developing new weapon design principles and techniques, and at reducing the vulnerability of missile warheads to countermeasures.

Second, we are verifying the performance of weapon designs which are essentially extrapolations from previously tested configurations, both to provide a more certain basis from which to develop still more advanced designs and to verify designs of weapons for stockpile.

Third, we are conducting tests designed to provide critically needed information on the effects of nuclear explosions on systems and objects of military interest.

Finally, systems tests are being performed in which the Department of Defense proves out a complete weapons system, such as POLARIS.

Weapons research and development will be moderately expanded to take full advantage of test results to design new systems. Areas on which particular attention will be focused include:

1. Improvement of yield-to-weight ratios;
2. Increasing fusion yield with reduction of fission yield;
3. Reducing vulnerability of nuclear weapons to countermeasures;
4. Providing increased reliability and safety; and
5. Achievement of greater simplicity and ruggedness of design.

Investigation of techniques to detect detonations will continue under Project VELA in cooperation with the Department of Defense. Seismic information is being obtained from the Nevada underground tests, in lieu of the separate experiments originally planned. We will continue development work on instrumentation to be carried in space satellities to detect high altitude detonations.

Estimated construction obligations for the weapons program in fiscal year 1963 are about $57 million. Two of the projects are related to the need to improve conditions affecting our underground testing activities at the Nevada test site. Urgently needed support facilities at the site will be undertaken at a cost of $7,500,000 as soon as authorizing legislation is enacted. We have also requested $10 million for improving the highway from Las Vegas to the site, a project to be carried out through the Bureau of Public Roads and the State of Nevada.

Some of the remaining 16 plant projects are related to the increasing complexity of nuclear weapons systems. The stringent manufacturing tolerances now being imposed can be achieved only under carefully controlled plant conditions. Additional plant capacity is also needed, to produce specialized types of certain components and to increase the output of certain materials required in a high degree of purity.

Several of the projects are in support of weapons development activity. Future designs must meet the varied and severe environmental conditions encountered with advanced delivery systems. Also, we continue to explore new theories of weapon design.

The weapon projects proposed for obligation in 1963 are essential to keep pace with advances being made in nuclear weapons technology.

I might say that the weapons tests in the Pacific have gone very well so far. The results have yielded much needed and very useful new information.

Mr. CANNON. Off the record at that point.

(Discussion off the record.)

Mr. CANNON. On the record.

REACTOR DEVELOPMENT

Dr. SEABORG. The purpose of our reactor development program is to develop reactors for military and space use, for propulsion, and for central station power. Included in our objectives are improved reactor efficiency, reduction of cost, improved safety and reliability, and a greater understanding of nuclear engineering and technology.

Our estimated operating costs of reactor development for fiscal year 1963 are about $504 million, an increase of about $74 million over the estimate for 1962. The two major areas of increase are for the nuclear rocket effort (Project ROVER) and for compact power sources for satellite and other applications (Project SNAP). Closely related is an increase for nuclear safety, principally to permit proof-testing and securing safe performance of nuclear systems during flight and in reentry. These additions reflect the high national priority assigned to space exploration and defense.

CIVILIAN POWER

In the past year substantial progress has been made toward the primary goals of our civilian power program. Included in these goals are the objectives to reduce nuclear power costs so that by 1968 utilities in the high fuel cost areas of the Nation may choose on the basis of economics alone to build nuclear powerplants, and to improve our reactor technology so that benefits from nuclear power may be extended to wider geographic areas.

At the President's request we recently began a study to reassess the role of nuclear power in the Nation's economy. Our instructions are "identify the objectives, scope, and content of a nuclear development program in the light of the Nation's prospective energy needs and resources * * *." The President also called for the study to "recommend appropriate steps to assure the proper timing of development and construction of nuclear power projects, including the construction of necessary prototypes." This study, which is to be coordinated with other interested Government agencies and industrial groups, is to be completed by September 1.

We are today in a more favorable position to perform such a study realistically than perhaps has been the case in the past. This is because there are now three large nuclear powerplants generating electric power and providing operating data and experience. These are the 60,000-kilowatt Shippingport reactor, the 185,000-kilowatt Dresden Nuclear Power Station, and the 141,000-kilowatt Yankee Nuclear Power Station. Each has generated more than a billion kilowatt hours of electricity.

There also have been disappointments and delays. The causes range from the problems of finding locations for nuclear powerplants which are suitable both from safety and economic aspects to the technical problems normally associated with such large research and development efforts.

In the civilian power program the AEC effort is directed toward the development of several promising reactor concepts. These are the water cooled, organic cooled, gas cooled, and liquid metal cooled concepts. In addition, work is being carried forward on advanced

systems research and development. The estimated cost of the AEC civilian power reactor effort for fiscal 1963 is $84.1 million, about the same level as for fiscal year 1962.

The AEC now has in operation or under modification eight reactors to explore these major concepts. Three other reactors will begin operation before the end of fiscal year 1963. Construction continues on one reactor and on the development work on two others scheduled for operation in fiscal year 1964. Development on another is underway with operation scheduled for fiscal year 1965.

(The following data were referred to above:)

AEC experimental reactors and reactor experiments

Reactor and type	Capacity (thermal kilowatts — kw(t); electrical kilowatts, net — kw(e))	Criticality date
Experimental breeder reactor No. 1 (ERB–1), fast breeder, NRTS, Idaho.	1,400 kw(t); no electrical	August 1951.
Experimental boiling water reactor (EBWR), Lemont, Ill.	100,000 kw(t); 4,500 kw(e)	December 1956.
Sodium reactor experiment (SRE), sodium graphite, Santa Susana, Calif.	20,000 kw(t); 6,000 kw(e)	April 1957.
Organic moderated reactor experiment (OMRE), NRTS, Idaho.	16,000 kw(t); no electrical	September 1957.
Shippingport atomic powerplant, pressurized water, Shippingport, Pa.	231,000 kw(t); 60,000 kw(e)	December 1957.
Plutonium recycle test reactor (PRTR), heavy-water moderated and cooled, Hanford, Wash.	70,000 kw(t); no electrical	November 1960.
Los Alamos plutonium reactor experiment (LAMPRE), fast molten plutonium fueled, sodium cooled, Los Alamos, N. Mex.	1,000 kw(t); no electrical	April 1961.
Heavy-water components test reactor (HWCTR), pressurized heavy water, Savannah River, S.C.	61,000 kw(t); no electrical	March 1962.
Boiling reactor experiment No. 5 (BORAX–5), boiling water, internal nuclear superheat NRTS, Idaho.	20,000 kw(t); no electrical	May–June 1962.
Experimental breeder reactor No. 2 (EBR–2), fast breeder, NRTS, Idaho.	62,500 kw(t); 16,500 kw(e)	September 1962.
Experimental organic cooled reactor (EOCR), organic moderated and cooled, NRTS, Idaho.	40,000 kw(t); no electrical	March 1963.
Molten salt reactor experiment (MSRE), fluid fuel, molten salt, single region, graphite moderated, Oak Ridge, Tenn.	5,000–10,000 kw(t); no electrical.	January 1964.
Experimental beryllium oxide reactor (EBOR), gas cooled, beryllium oxide moderated, NRTS, Idaho.	10,000 kw(t); no electrical	March 1964.
Experimental gas-cooled reactor (ECGR), helium cooled, graphite moderated, Oak Ridge, Tenn.	84,300 kw(t); 22,300 kw(e)	May 1964.
Ultra-high-temperature reactor experiment (UHTREX), helium cooled, Los Alamos, N. Mex.	3,000 kw(t); no electrical	September 1964.

Dr. SEABORG. Completion of one of these reactors, the experimental gas-cooled reactor, has been delayed because of problems revealed during the detailed reactor design, and in the fabrication and delivery of components. These difficulties have resulted in an increase in the estimated total cost from $40 million to $51 million. The additional $11 million is a part of our request for construction funds.

The largest of the AEC-owned power reactors is the Shippingport plant, which has operated successfully and reliably since its startup in December 1957. Operation of the Shippingport plant with the seed and blanket core has shown the desirability of further exploring this concept for larger central station plants. Consequently, in fiscal years 1963 and 1964 development and design effort will be conducted to determine the potential of the seed and blanket core concept for plants of about 500,000 electrical kilowatts.

COOPERATIVE POWER DEMONSTRATION PROGRAM

For those concepts which have proved technically feasible and appear economically promising, the next step is to build and operate a prototype reactor. For the construction of prototype reactor plants the Commission seeks the participation of utilities in a power demonstration program. Arrangements with private utilities provide for the AEC to perform stipulated research and development and to waive use charges for fuel and heavy water for a period of 5 years. Arrangements with cooperatively or publicly owned utilities provide for the AEC to own the reactor while the utility furnishes the conventional facilities. The Commission may also receive unsolicited proposals from utilities for a reactor project and consider granting appropriate assistance.

Operating expenses for the cooperative power demonstration program shows a decrease of about $1 million to $9,416,000 estimated for fiscal year 1963. The decrease is primarily because of the completion of construction of reactors and the related research and development authorized in prior years.

At the present time there are 10 nuclear power cooperative projects. The total electrical capacity of these plants is 922,700 kilowatts. Of these plants one is in operation, seven are to achieve criticality before the end of fiscal year 1963, and two more in fiscal years 1964 and 1965. These 10 plants range in size from 11,400 to 141,000 kilowatts. Represented in these reactors are the pressurized water, boiling water, nuclear superheat, organic cooled, sodium cooled, gas cooled, and heavy water cooled reactor systems.

(The projects referred to above are as follows:)

Cooperative arrangement projects

Reactor plant, location, type, and proposer	Capacity (thermal kilowatts, kw(t); electrical kilowatts, net, kw(e))	Criticality date
Yankee nuclear power station, Rowe, Mass., pressurized water, Yankee Atomic Electric Co.	485,000 kw(t), 141,000 kw(e)	August 1960.
Hallam nuclear power facility, Hallam, Nebr., sodium graphite, Consumers Public Power District of Nebraska.	240,000 kw(t), 76,000 kw(e)	June 1962.
Elk River reactor, Elk River, Minn., boiling water, Rural Cooperative Power Association.	73,000 kw(t) (including 14,800 from conventional superheater), 22,000 kw(e).	June–July 1962.
Piqua nuclear power facility, Piqua, Ohio, organic cooled and moderated, city of Piqua, Ohio.	45,500 kw(t), 11,409 kw(e)	Do.
Big Rock Point plant, Big Rock Point, Mich., boiling water, Consumers Power Co. and General Electric Co.	157,000 kw(t), 47,800 kw(e)	August 1962.
Carolinas-Virginia tube reactor (CVTR), Parr, S.C., pressure tube, heavy water, Carolinas-Virginia Nuclear Power Associates, Inc.	60,500 kw(t), 16,900 kw(e)	September 1962.
Pathfinder atomic power plant, Sioux Falls, S. Dak., boiling water, integral nuclear superheat, Northern States Power Co.	200,000 kw(t), 62,000 kw(e)	November 1962.
Enrico Fermi atomic powerplant, Lagoona Beach, Mich., fast breeder, sodium cooled, Power Reactor Development Co.	200,000 kw(t), 60,000 kw(e)	Do.
Boiling reactor nuclear superheat (BONUS) Punta Hignera, P.R., boiling water, integral nuclear superheat, Puerto Rico Water Resources Authority.	50,000 kw(t), 16,000 kw(e)	July 1963.
High temperature gas-cooled reactor (HTGR), Peach Bottom, Pa., helium cooled, graphite moderated, Philadelphia Electric Co., and General Dynamics Corp.	115,000 kw(t), 40,000 kw(e)	September 1964.

Dr. SEABORG. Arrangements are pending for two unsolicited projects. Negotiations are completed for one of these, the 50,000 electrical kilowatt boiling water reactor of the Dairyland Power Cooperative at La Crosse, Wis. Negotiations of arrangements with the Southern California Edison Co., for a 355,000 electrical kilowatt pressurized water reactor are in abeyance until problems related to site selection are resolved.

In our proposed authorization bill, we have included language to modify the third-round arrangements by making available assistance to support engineering design effort in addition to research and development assistance and the waiver of use charges for fuel and heavy water. Under third-round arrangements the utility constructs, owns, and operates the reactor as well as the conventional facilities. We believe that making financial support available for the design effort will make it more attractive for industry to participate in arrangements for first of a kind, large commercial nuclear powerplants.

For such plants design costs are likely to be substantial, but extensive research and development assistance would be less necessary.

The design assistance would be available for types and power levels of nuclear powerplants set forth in a Commission invitation. Under the criteria recently submitted to the Joint Committee on Atomic Energy, assistance could be provided to support the design of the nuclear steam supply system and the architect-engineer design of the steam utilization and power conversion system of the plant. The design assistance would not be available for reactor projects already under construction or previously approved under a cooperative arrangement.

Our proposed authorization legislation would permit similar design assistance for an unsolicited proposal for a boiling water reactor which will provide both electricity and process steam. The project is of interest because it will explore a potential economic application for small size reactor plants.

We have also requested authorization to enter into a cooperative arrangement for an organic power and heat industrial reactor. The Packaging Corp. of America has expressed interest in participating in a cooperative project in which they would provide a site at Filer, Mich., and the facilities to utilize the steam and to generate electricity for its own use from the reactor built and owned by the Commission. The project is important for several reasons.

Studies have indicated that organic reactors offer a potential of competitive nuclear power in the high cost areas of the Nation in the near future. The size of the proposed project is sufficient to serve as a prototype for a 300,000-electrical-kilowatt organic powerplant. From its operation we shall be better able to evaluate the potential of this reactor concept for central station use. Furthermore, the project will demonstrate the capabilities of an organic power reactor to provide industrial heat.

INDUSTRIAL REACTOR PROJECTS

In addition to the Government's nuclear power program, private industry has several nuclear powerplants in which the Government has no financial participation. One of these, a 185,000-kilowatt boiling-water reactor plant, is in routine operation. Construction of

two others, with a total installed capacity of 303,500 electrical kilowatts, including 104,000 kilowatts from oil-fire superheat, are to be completed this summer. The California Public Utilities Commission has received an application for a 313,000-kilowatt boiling-water reactor plant. Industry also has two small experimental plants in operation. A third to be used in the development of nuclear superheat is under construction.

(The following data were submitted for the record:)

Industrial reactor projects

Reactor plant, location, type, and owner	Capacity (thermal kilowatts — kw(t); electrical kilowatts, net — kw(e))	Criticality date
Dresden Nuclear Power Station, Morris, Ill., boiling water, Commonwealth Edison Co.	629,000 kw(t), 185,000 kw(e)	October 1959.
Consolidated Edison thorium reactor, Indian Point, N.Y., pressurized water, Consolidated Edison Co. of New York.	795,000 kw(t), 255,000 kw(e) (includes 104,000 kw as oil-fired superheat).	Summer 1962.
Humboldt Bay Powerplant near Eureka, Calif., boiling water, Pacific Gas & Electric Co.	165,000 kw(t), 48,500 kw(e)	August 1962.
Bodega Bay Atomic Park, Bodega Bay, Calif., boiling water, Pacific Gas & Electric Co.	1,000,000 kw(t), 313,000 kw(e)	Fall 1965.
Vallecitos boiling water reactor (VBWR), Pleasanton, Calif., boiling water, General Electric Co. and Pacific Gas & Electric Co.	50,000 kw(t), 10,000 kw(e)	August 1957.
Saxton nuclear experimental reactor project, Saxton, Pa., pressurized water, Saxton Nuclear Experimental Corp.	20,000 kw(t), 3,000 kw(e)	April 1962.
ESADA Vallecitos experimental superheat reactor (EVESR), Pleasanton, Calif., light water moderated, nuclear superheat, Empire State Atomic Development Associates and General Electric Co.	12,500 kw(t), no electrical	January 1963.

COOPERATION WITH EURATOM

Dr. SEABORG. Our cooperative program on civilian power reactor projects has continued with EURATOM. Operation is expected by the end of 1962 of a 150,000-electrical kilowatt boiling water reactor plant in Italy, the only project being constructed under the first United States-EURATOM invitation. On September 21, 1961, the United States and EURATOM issued a second invitation for not more than two large-scale reactors to be completed by the end of 1965. A proposal was received in October 1961 for a 210,000-kilowatt pressurized water reactor plant. An additional proposal has recently been received for the 165,000-electrical kilowatt pressurized water reactor already under construction in Italy. The eligibility of this reactor is under review. It is hoped that additional proposals may be forthcoming.

The joint United States-EURATOM research and development program has been primarily concerned with the boiling water reactor concept, since the only reactor proposal accepted to date is of this type. If other reactor proposals are accepted, the research and development work will be expanded to include work related to those reactor projects and to those reactor concepts.

MARITIME REACTORS

The NS *Savannah* successfully completed initial sea trials and on May 1 the Maritime Administration accepted the vessel from her builder, the New York Shipbuilding Co. The ship will be operated

out of Yorktown, Va., for an interim period before engaging in domestic and foreign runs.

Research and development work will be continued on water and other promising systems applicable to merchant marine usage.

ARMY REACTORS

Army power reactors are being developed for our military services for use in remote locations, for major military installations requiring substantial blocks of power independent of conventional fuel supply, and for direct support of military field operations.

During fiscal year 1962 three pressurized water reactor plants attained criticality. These are located at Fort Greely, Alaska; Sundance, Wyo.; and McMurdo Sound in the Antarctic.

Work has been initiated on a second plant for the Antarctic to be located at Byrd Station. Our schedule calls for shipment of the plant from this country in the fall of 1963. A contract for the project was awarded in October 1961 to Alco Products for the concept selection, design, fabrication, field assembly, and test operation of the plant. On March 29, 1962, Alco Products announced its decision to discontinue nuclear operations. The Commission has been seeking means whereby the Byrd Station project could be completed by another contractor. Alco Products has recommended Allis Chalmers Manufacturing Co. which has given assurance that it would assume the work at its present stage and carry it to conclusion on the present schedule. Negotiations with these companies are presently underway.

The greater part of the Army reactor effort for fiscal year 1963 will be directed to the gas-cooled reactor concept, which offers the possibility of militarily useful mobile reactors for the support of field operations. At Idaho, a mobile gas-cooled reactor will be operated to demonstrate safety aspects and procedures related to plant relocation.

Last December the Department of Defense reaffirmed its requirement for a military compact reactor. Detailed studies and experiments will be performed for a liquid metal reactor plant of minimum weight and volume and with a high degree of mobility.

In addition, research and development work will continue on improved pressurized water reactor cores.

NAVAL PROPULSION REACTORS

The objectives of the naval reactors program is to develop nuclear propulsion plants and reactor cores for Navy submarines and combatant surface ships. These propulsion plants range in size from a single reactor to the eight-reactor plant of the carrier *Enterprise*.

Of the 61 nuclear-powered submarines now authorized, 26 are in operation. Included are 29 POLARIS missile submarines authorized, of which 9 are in operation. For the surface fleet, an aircraft carrier, guided missile cruiser, and two destroyer leaders (frigates) have been authorized. The carrier and the cruiser are in operation and sea trials of the first destroyer are planned for fiscal year 1963.

The effort to develop improved cores with significantly longer lifetimes is continuing.

Improved cores will result in fewer refueling periods, greater reduction in fuel costs, and more continuous availability of the ships. This

development effort is also making significant contributions to the advancement of reactor technology for both civilian and other military applications.

During fiscal year 1963, construction in Idaho will continue on the natural circulation reactor, a land-based prototype for submarine application. Construction of this prototype plant is scheduled for completion in fiscal year 1964. The natural circulation concept offers significant gains in simplicity, reliability, and inherent safety, along with the important advantage of quieter operation.

Development work will continue on a single-reactor propulsion system for destroyer-type ships. This effort represents a second generation in nuclear propulsion systems for surface ships.

No land-based prototype is planned. During fiscal year 1963 development and test programs will continue and a reference design for the first core will be developed.

PROJECT ROVER

Project ROVER is the project for the development of nuclear rocket propulsion systems for space missions. The project is administered by the AEC and NASA through their joint office, the Space Nuclear Propulsion Office. In recognition of the unique potential of nuclear rocket systems for transporting large payloads to the moon and planets, we will continue to pursue this effort on a high-priority basis. The AEC is responsible for conducting research and development on the nuclear reactors and nuclear components required for space missions assigned by the NASA, and the NASA is responsible for research and development on rocket engines and subsystems, other than reactor components, and integration of the reactors into total propulsion systems.

Objectives of the project are (1) to develop a nuclear propulsion system designated "NERVA" for flight demonstration in the 1966–67 period; and (2) to advance the technology of reactors which will provide for such improvements as higher exhaust temperatures, and higher power levels that are required for more sophisticated space missions in the years ahead. The advanced effort has been designated "Phoebus" and the work is being performed by the Los Alamos Scientific Laboratory.

Efforts toward the first objective include the development and testing by the Los Alamos Scientific Laboratory, of two series of nonflyable reactors designated KIWI–A and KIWI–B. The KIWI–A series, and the first test of the KIWI–B series, using gaseous hydrogen as propellant, were completed last year at the Nuclear Rocket Development Station in Nevada. Additional KIWI–B tests will be conducted at Nevada in fiscal year 1963 utilizing improved core designs and liquid hydrogen as the propellant. Slippages have occurred in the schedule for KIWI–B tests, principally as the result of delays in construction and checkout of test facilities and technical problems which have come about in the preparation of reactors for test. We are hopeful that actions already taken, aimed toward strengthening the onsite management of the construction and testing efforts, will prevent any further delays. Last July, the Space Nuclear Propulsion Office entered into a contract with Aerojet-General Corp. to develop the NERVA engine. Westinghouse Electric Corp. is the

principal subcontractor to Aerojet for nuclear systems in the engine. We hope to designate, sometime in fiscal year 1963, the particular reactor design for development and adaptation into the NERVA engine.

Subsequent tests will be required to establish performance and safety characteristics of the reactor design selected.

To further the second objective, the development of advanced rocket reactor technology, the design and fabrication of reactors for the PHOEBUS tests will begin in fiscal year 1963. In addition, a significant portion of the efforts at Los Alamos in the ROVER program will be devoted to research and studies related to advanced nuclear rocket reactors

The scheduled fabrication of fuel elements and reactors for the KIWI–B, NERVA, and PHOEBUS tests accounts for much of the estimated cost increase for the ROVER project.

Our plant acquisition and construction budget includes a $10 million project for research and development test plants for Project ROVER. The scope of facilities to be included in this project cannot be fully determined at this time, since detailed requirements will only become known as the research and test efforts progress. However, since availability of development and test facilities may well be a pacing factor, it is important that the necessary funding be available as soon as the facility needs develop.

MISSILE PROPULSION

The objective of Project PLUTO has been expanded from demonstration of the feasibility of a nuclear ramjet engine for strategic missiles operating at high speed, low altitude, and extended ranges, to the development of a nuclear reactor which can be incorporated into such a weapon system.

As you know the Tory IIA–1 reactor was successfully operated in a series of tests last fall. Success of these tests permitted us to drop the Tory IIA–2 tests from our schedule, and to proceed directly to the Tory IIC. Tory IIC is designed to bridge the gap between the engineering test device and a flyable powerplant. Testing will begin in 1963. Design power, operating temperature, and size of the reactor approximate the requirements for a propulsion system needed for flight at sea level.

The Department of Defense has stated an interest in continuing with a ground test follow-on program after successful demonstration of Tory IIC. Proposals will be invited for participation in the follow-on program, which will include development of reactors for ground test and, when required, for flight test.

The varied and interrelated functions of the follow-on program, including the development of an airframe and reactor and propulsion systems, will require close coordination among the participants. We are working with the Air Force to determine the type of management organization which will be best suited to accomplish the program.

Also the Deputy Chief of Naval Operations for Development has requested the AEC to undertake studies of nuclear ramjet engines compatible with vehicles which are capable of launch from existing POLARIS submarines or from other seaborne launch configurations.

Cost increases for the PLUTO project are largely for fabrication and test operation of the TORY IIC, and for initiation of the follow-on program.

SATELLITES AND SMALL POWER SOURCES

The operating costs of the satellite and small power source effort, often called the SNAP program, increase $22.4 million for fiscal year 1963 over the preceding year. The objective of the SNAP program is to develop long-lived, lightweight, compact nuclear electric power sources for satellites, space vehicles, and other applications. The major parts of the SNAP program are the development of radioisotope power sources, compact reactors, and advanced space systems. The effort on compact reactors and advanced space systems accounts for the increase in estimated operating costs.

During fiscal year 1962 radioisotope units were used to power automatic weather stations in the Arctic and the Antarctic, a floating light buoy in Chesapeake Bay and, along with solar batteries, two of the Navy's TRANSIT navigational satellites. The use with TRANSIT marks the first application of nuclear energy in space, and the TRANSIT units continue to operate satisfactorily. Later this year, a higher powered radioisotope unit will be delivered for use in the operational prototype TRANSIT satellite, for which it will supply power for the entire payload. The radioisotope unit will have a design operational lifetime of 5 years. By the end of fiscal year 1963 fabrication of a unit will be nearly completed for SURVEYOR, a soft lunar landing mission specified by the National Aeronautics and Space Administration.

An important milestone in the SNAP reactor program is Project SNAPSHOT, the joint AEC-Air Force effort to test reactor power systems in orbit. Two systems using essentially similar reactors are under development for SNAPSHOT. One system provides 3,000 watts of electrical power, and uses a rotating mercury vapor turboelectric power conversion system; the other provides 500 watts of electrical power and uses a static thermoelectric power converter. The launch date for the turboelectric system has recently been postponed from fiscal year 1964 to fiscal year 1965, following tests which which indicated that a turboelectric converter which would fully meet the performance specifications could not be furnished by the earlier date. Design improvements and extensive development testing of the converter are underway. The launch date for the thermoelectric system is scheduled for early in fiscal year 1964.

Other SNAP reactor projects are also under development. In fiscal year 1963 engineering and component development will continue for a larger SNAP reactor to be used for power in orbital test of experimental electrical propulsion devices. The reactor which will have the thermal capability to run one or two turboelectric units of 30 electrical kilowatt capacity, is scheduled to be delivered to NASA in fiscal year 1965. Component development will continue for a reactor for a Navy underwater application.

Advanced space power systems is a new part of the SNAP program and was initiated to provide large nuclear-electric space plants in the megawatt range. Such nuclear space plants could serve as large sources of power for communications, television, and radar satellites, and for electric or ion propulsion of space vehicles. SNAP 50 is the primary effort in the advanced space power system.

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SNAP 50 will require advanced technology in materials and reactor coolants. Work in this technology, essential for high performance reactors, was continued following the termination of the aircraft nuclear propulsion program. To explore the severe technical problems of SNAP 50, operation of a lithium cooled reactor experiment in 1965 is planned. During fiscal year 1963 procurement will begin of long leadtime items and fabrication of fuel elements will be initiated.

Two projects in support of the SNAP 50 effort are included in the budget for plant acquisition and construction. A project for $5 million provides for facilities at the National Reactor Testing Station in Idaho necessary to assemble, disassemble, and test the lithium cooled reactor experiment. A $1.4 million project is included for modification of the facilities at Middletown, Conn., to permit fabrication of large columbium components for the reactor experiment.

NUCLEAR SAFETY

For nuclear safety, greater emphasis is being given in fiscal year 1963 to safety tests of various nuclear devices planned for aerospace application. Included in this effort are ground tests to investigate such effects as vibration and impact upon the devices, and flight tests to determine reentry burnup and radioactive dispersion characteristics.

GENERAL NUCLEAR TECHNOLOGY

The effort in general nuclear technology consists of research and development to advance the technology applicable to reactors of all types—civilian, military, and space. The work includes reactor physics, development of fuels, materials, and components, and chemical separations.

A key facility for the development of reactor components and materials for advanced concepts is the advanced test reactor now under construction at the National Reactor Testing Station. Results of design effort to date indicate that the total cost estimate must be increased from $40 million to $47 million. The 1963 construction estimates include $13,450,000 to complete the funding required under this revised estimate.

PHYSICAL RESEARCH

The research supported by the Atomic Energy Commission in the physical sciences is directed toward gaining a basic understanding of phenomena related to the development, use, and control of nuclear energy. Our investigations fall into the categories of physics and mathematics, chemistry, metallurgy, and materials, and controlled thermonuclear research.

We project a $40 million increase in the physical research program from $176 million in 1962 to $216 million in 1963.

Nearly half of the increase is allocated to support for high-energy physics. The continued growth of this support is directly related to the operation of recently completed accelerators and the development efforts required for others still under construction, such as the linear electron accelerator approved by your Committee last year for construction at Stanford University. The consideration given to that

project brought general recognition that progress in high-energy physics research requires us to provide increasingly complex and elaborate equipment.

While the equipment needs of high-energy physics are particularly dramatic, other types of research have similar needs. We find with each passing year that the cost of all types of research continues to mount, both because more and more of the easily accomplished research has been completed and because the degree of sophistication and complexity of present-day research requires the development of experimental apparatus and techniques not dreamed of a few years ago.

Last year, I expressed concern that the growth in our support for high-energy physics not be at the expense of other progress equally vital. I wish to reiterate this view and again emphasize my conviction that this Nation can ill afford not to press forward in the other fields of scientific research supported by the Commission. The increases proposed for 1963 in low-energy physics, chemistry, and metallurgy and materials, even though modest, indicate recognition of this need.

The area of low-energy physics, for example, deals with the nuclear reactions which underlie AEC's major development programs in weapons and nuclear reactors. In our support of research undertakings in low-energy physics, we have selected only a few of the highly meritorious proposals submitted for our consideration. We can anticipate receiving over the next few years a much larger number of proposals for the construction and operation of varied types of low-energy accelerators. It will be necessary to expand sharply our support for low-energy work in future years if we are not to lose fine opportunities to fill gaps in our knowledge.

For the several areas of chemistry research, we propose to increase our support by $8 million to an estimated 1963 level of $48 million. Many of the materials used in our present programs and of potential interest for the future are substances which were unknown a few years ago. The attainment of fundamental understanding of the chemical properties of all materials of interest to our advanced efforts in reactor, weapons, and space technology is the only certain way to reduce the risks of delay and failure, and to reduce the cost of success. It is ignorance and guesswork which multiply the costs of technical developments.

These same considerations prompt our efforts to speed up research on metallurgy and materials. We aim to improve our understanding of materials having immediate or potential importance for nuclear applications, and to understand the behavior of materials under various conditions, including exposure to irradiation, and to refine the theories which can provide a dependable explanation of this behavior.

The quest for controlled production of power from thermonuclear reactions is to be continued at about the same level. Most of this effort is being conducted at four laboratories—at Los Alamos, Oak Ridge, Livermore, and Princeton. Results continue to be encouraging. There have been significant achievements in confinement time and plasma temperature. We should all realize that the possibility of attaining the ultimate objective is still many years away.

Mr. JENSEN. You have some universities that are producing more than others, don't you?

Dr. SEABORG. Certainly.

Mr. JENSEN. You have others, I assume, that are not producing anything of value in any consequential amount. I think there is where a lot of money is wasted the way it was wasted for several years in the saline water program until we stopped it. I hope too much of that is not going on under your management, Mr. Seaborg.

Dr. SEABORG. I hope not, too. I agree with you in the field of saline water research where much money has been appropriated in many States, including my own State, that we can find instances where it was not well used. It was just available, and it seemed necessary to spend it, but it was not always spent on sound approaches.

Mr. JENSEN. Don't you have some instances where you feel some money is being wasted in these research programs?

Dr. SEABORG. There must be some. It would be very unusual.

Mr. JENSEN. Can't you put your finger on it?

Dr. SEABORG. I think that when we have a program where this seems to be the case, we do make adjustments. We keep a continuous review. We have our Division of Research. I think we probably have as close a supervision, through the competent people we have in our organization, as anybody in the Government.

Mr. JENSEN. I am sure of that.

Dr. SEABORG. And we are continuously conscious of this.

Dr. WILSON. We have told the Advisory Committee that if they feel some project should be discontinued, we want their recommendations.

Mr. JENSEN. Do they make a monthly report or quarterly report?

Dr. WILSON. No.

Mr. JENSEN. How do they bring it to your attention, this Advisory Committee?

Dr. WILSON. They are just concentrating on thermonuclear reaction.

Mr. CANNON. In the last day or two from a very authoritative source, we have had criticism that there is no penalty for failure. A man can fail and will be shifted to something else. There is no record of failure. It never catches up with him. There was no penalty for failure. It would seem, along with the line the gentleman from Iowa suggests, that there should be some pattern and some definite facility for screening these men when they first come in and then checking them as they go along. Some men have a habit of success. Some men have the habit of failure. They are good fellows but they never quite make it. We hope you will give this some attention, Doctor.

Dr. SEABORG. We are very conscious of this.

Mr. PILLION. Mr. Chairman, I want to say there is some substance to the chairman's remarks here concerning the research expenditures. I know I have found it in other departments where we have had the same wastage. I wonder if it is not a question of screening for a desirable or practical objective before you allocate and spend these moneys. For example, I am not particularly impressed, even though it may be dramatic, that we have found a system by which we can tell in what country the opium was grown. I am not impressed by that. Or that Napoleon died of arsenic poisoning. That has no

practical or useful knowledge as of now. We had the same thing last year where they came in and made a great deal of hullabaloo about the fact you had an irradiated needle. That has been known for years. I see no great need for expenditures on that particular item. I do think it is a question, Mr. Chairman, of determining the objective that you are trying to reach, determining the money value of them and set up guidelines whether or not they are practical. I know there is a difference between pure research and the engineering and the applied research. I think that is where the Commission might set up guidelines and standards to make sure that you get either a usable pure research objective or a good practical objective.

Dr. SEABORG. I can't say that our system can't be improved, but we have a system where the research proposals are submitted to the criticism of scientists that are experts in the field. The proposals must pass this test. As a result of this, a large number of the new proposals that we are asked to support are ruled out, perhaps half of them. I don't know the statistics, something of that order. I think we have a rather stringent screening procedure.

Mr. JENSEN. For both private and public institutions?

Dr. SEABORG. Yes. We don't draw any particular distinction there. It is on the basis of the competence of the man and on the validity of the proposal. In determining those two things we rely on scientists who are in the position to make, I believe, the best decision.

Mr. JENSEN. Of course, Doctor, I am sure you are well aware that we expect almost the impossible of the Atomic Energy Commission. You have gathered around you a wonderful group of men, there is no question about it. They are dedicated men. They are well versed in their profession. And because of the great importance the job that you and all of your employees have, we of course are very anxious and give great concern to your efficiency and the outcome of everything you do which is so important to the American people and the free world. So we have you set up on a high pedestal, higher than possibly any other agency of Government. That of course is the main reason why we are so anxious that you maintain a high standard of efficiency in work that is so important to the welfare of our country and the free world.

Mr. GRAHAM. May I make some friendly colloquy with the distinguished Congressman over on the far end, Mr. Pillion. We well know each other and are good friends.

In connection with this opium, Mr. Chairman, I used to be Assistant Secretary of the Treasury, and had charge of customs, and did a lot of work with the investigative agencies. This question of the origin of opium was always very disturbing to us, and I think I had better leave this off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

Dr. SEABORG. I would like to make this comment regarding Mr. Jensen's statement. There is value and sometimes great value in supporting the research at some of these smaller colleges even though it is not the most advanced and the most sophisticated, because it increases their capability and, more importantly, increases the source of scientists that we need who due to one reason or another are taking their work at small colleges. I think this is a strong argument for

carrying on, not bad research, but research that is not strictly in the frontline. It adds to our source of scientists, it increases our whole national capacity to carry on research. Of course, we have to carry it on and supervise it in a way to assure that research that is not good, efficient, and worth while is not carried on.

Mr. CANNON. Thank you, Doctor. You may proceed on the record.

Dr. SEABORG. About $166 million of the total operating costs of physical research are incurred for work at AEC laboratories. The remaining $50 million supports contract research arrangements with about 150 independent organizations, principally colleges and universities.

In addition to the $95 million requested to complete the funding of the linear electron accelerator approved last year at a total estimated cost of $114 million, the estimates for construction include $37,200,000 for 15 other physical research projects. A revised cost estimate of $47 million requires us to request $3 million for the zero gradient synchrotron at Argonne National Laboratory. Our estimates include an additional $7,500,000 for the transuranium processing plant at Oak Ridge to supplement the $1,200,000 previously appropriated for this project. The scope of our program to produce significant research quantities of such heavy elements as americium, curium, berkelium, and californium has been sharply expanded. As a result, a more extensive facility is required to cope with the intense radioactivity which will be encountered in the chemical processing of materials irradiated in the high flux isotope reactor, now under construction at Oak Ridge.

Several projects are for improvements and additions to major pieces of existing research equipment, mainly high energy accelerators. Additional laboratory space is also planned for four AEC research centers, as well as essential support facilities.

BIOLOGY AND MEDICINE

Our biology and medicine program is primarily concerned with research necessary to complete understanding of the radiation hazard of atomic energy activities. Information developed under this program is essential to assure the health and safety of the population at large as well as of persons engaged in atomic energy activities. Costs for the program are estimated at $71 million, an increase of $10 million over fiscal year 1962.

To keep pace with expanding activities in the fields of nuclear reactors, high-energy physics, nuclear technology, and the Nation's space program, the reorientation and expansion of our biomedical program was begun in 1962. The 1963 estimate has been developed with full understanding of the responsibilities, needs, and planned programs of the other agencies of Government concerned with radiation health problems and basic research in the life sciences.

Certain important programs aimed at defining long-range effects of human exposures to low levels of irradiation, which were begun in 1962, will begin to approach full operational levels as facilities being constructed at our national laboratories are completed. The large-scale project on the effects of inhaled radioactive materials is developing rapidly. The facilities for this project at the Air Force base at

Sandia, N. Mex., will be completed late in fiscal year 1963. Our expanded radiation genetics facilities at Oak Ridge will be fully utilized by next winter, and our program in oceanography and marine biology will increase with the Nation's planned expansion of this area of science. Our programs in this area are directly related to our needs for long-range information as to hazards from nuclear propelled ships, and from the developing uses of nuclear devices in the oceans and in space vehicles. Studies in terrestrial and fresh water environments are also being expanded as our needs increase for information about the movement of radioactive materials, and the effects of both high-and low-level radiation.

The renewal of large-scale atmospheric weapons testing demanded an expanded effort in our fallout studies program, and offered an opportunity to fill important gaps in our knowledge of the behavior of radioactive material in the stratosphere. These studies will not only contribute to a better appraisal of the public hazard of atmospheric testing, but will also permit a firmer understanding of the potential hazards of nuclear components in rockets and other space devices. Other aspects of our program include medical treatment of radiation injury, cancer research, and selected beneficial uses of nuclear energy in the life sciences, including food pasteurization and health physics.

While the largest part of our biomedical research costs will be incurred at 15 AEC laboratories, of which 6 are on university campuses. well over one-third of the total will be incurred through contracts at 225 State and private educational institutions throughout the country.

Estimated construction obligations for biomedical facilities are about $4,800,000. These funds will provide laboratory additions at Oak Ridge, Berkeley, and Brookhaven, and complete the funding of the laboratory under construction at Sandia Base in New Mexico for the study of inhaled radioactive fission products.

CIVILIAN APPLICATIONS OF NUCLEAR EXPLOSIVES

Our program is directed to developing ways to use nuclear explosives for peaceful purposes. We call this our Plowshare program. The Commission believes there are several immediately promising peaceful uses for nuclear explosives. For some cases the promise is economic; for others it is scientific. Our 1963 estimate of $10.1 million will permit a project relating to economic promise to be executed early in fiscal year 1963 and a project of scientific promise to be undertaken later in that year.

The project relating to economic promises is called Sedan and is an excavation experiment to be conducted in alluvium at the Nevada Test Site to provide data concerning the cratering effects of a nuclear detonation. The detonation would be of higher yield and at a greater depth than the low-yield detonations used in earlier cratering experiments. Preparations will also be made during 1963 for the next excavation experiment, now planned for fiscal year 1964.

The scientific project is called Coach and would be designed to produce very heavy elements for research purposes, possibly elements heavier than any yet discovered. The results would also shed some light on the fundamental scientific theory underlying these reactions.

The feasibility of producing certain isotopes not available in desired quantities from other sources would also be investigated.

In addition, we will continue our general study of other applications—in mining, water resource development, petroleum recovery, and so forth, and expand our basic understanding of phenomena associated with nuclear explosives. We will also complete the preliminary work essential to making a decision on the future of Project CHARIOT, the excavation experiment being considered for a location in Alaska.

COMMUNITY

The estimate for the community program has essentially two components. The first consists of assistance payments totaling about $2,300,000 to the communities of Oak Ridge, Tenn., and Richland, Wash. These payments are in line with earlier years and in accord with the criteria established by the Atomic Energy Community Act of 1955. The other component is for the operating expenses of the Los Alamos community. These exceed by $1 million the revenues collected for rentals, utility charges, and so forth.

Looking to future years, members of the committee may have noted that legislation has recently been introduced which would provide for the disposal of Los Alamos under essentially the same provisions which served so well for the transfer of Oak Ridge and Richland to private ownership. Following enactment of such legislation, extensive preparations would be required for accomplishing the transfer. The steps to be taken would have no significant impact on our community operating costs in 1963.

PROGRAM DIRECTION AND ADMINISTRATION

The final program I will mention is "Program Direction and Administration," the heading under which we provide for the salaries and other costs of AEC personnel engaged in general direction and administration of the Commission's activities. These include the Government officials and employees who are responsible for determining policy, for supervising and reviewing the efforts of contractors, and for regulating the licensed activities of reactor operators and users of radioisotopes to protect the public health and safety. Our estimates provide for increasing yearend full-time employment by 222 positions to 5,314 at the end of fiscal year 1963.

AEC staffing has not kept pace with the increased complexity of our research and development program, nor with the increase in workload. The reactor development program in particular requires considerably more supervisory and technical capability as the state of the art advances and as additional reactors go into operation. Increased attention to safety and to more effective project control are our objectives in this program.

To assure appropriate administration and technical surveillance of contractor efforts, an additional 136 employees will be needed. These employees are required for overseeing the intensified efforts in the development of our various SNAP reactor and isotope projects; for administration of our civilian power reactor projects; for assignment to field offices of the joint Space Nuclear Propulsion Office maintained by the AEC and NASA; for the expanded scope of the nuclear

safety program projected for our own AEC installations; for field experiments planned for the PLOWSHARE program; and for administration of the projected scope of research in the physical and life sciences.

Responsibility and workload are also growing in every portion of our regulatory activity, and we propose to add 44 regulatory personnel.

A substantial change was made in the alinement of AEC field office responsibilities a few weeks ago when we established the Nevada Operations Office at Las Vegas, Nev., in recognition of the expanded scope and continuous character of the activities now projected for the Nevada test site. These activities include not only the underground testing of weapons, but also the testing of large-scale experimental reactors for PLUTO and ROVER. Separate areas of the test site are maintained and equipped to test these advanced reactors at the very high power levels desired for propulsion of missiles and space vehicles. The personnel strength being assigned to the Nevada Operations Office is 220. Most of this number is being obtained by transferring 149 positions from the Albuquerque Operations Office, which was formerly responsible for supervising activities at the Nevada site. The remaining 71 positions would be provided from the employment increase shown in our 1963 estimate.

The changes just cited identify all proposed personnel increases except 15 employees required to handle workload developments in a number of nontechnical activities. Offsetting these increases in part is a reduction of 44 employees now engaged in activities related to the raw materials program.

In the course of these hearings we would like to discuss with your committee the matter of establishing salaries for our hearing examiners on the same basis as those of other Commission employees. Commissioner Olson will be here tomorrow and will be prepared to speak on this matter.

This brings us to the end of my general statement, Mr. Chairman. I shall try to respond to any questions you or the committee may wish to ask me. If there are no immediate questions, the General Manager is prepared to review the budget program in greater detail.

PRODUCTION OF UF–6

Chairman CANNON. I would like to ask, Doctor, in reference to the UF–6 plants at Oak Ridge and Portsmouth which have been closed down, what is your relative cost of production at Paducah versus that of the private plant?

Dr. SEABORG. This is the production of the UF–6, the feed material for the gaseous diffusion plant where we separate the isotopes. The gaseous diffusion plants are still operating at all three places. This is just the feed material.

Dr. WILSON. We are still producing the bulk of it in the Government-owned plant, at Paducah.

Mr. CANNON. Are you producing as cheaply as they produce at the Allied plant?

Dr. SEABORG. By concentrating in two places rather than three or four.

Mr. QUINN. The material flows through the UF–6 operation, Mr. Chairman, have been decreasing as the raw material procurement

has decreased. We have three AEC facilities to produce UF–6, one at each of our three diffusion plant sites, Oak Ridge, Paducah, and Portsmouth. We also entered into a 5-year contract for UF–6 production with Allied Chemical Corp. The present contract term extends to 1964. Since the time when we entered into this contract our raw material procurement has dropped off and there is not now need for the full capacity of all these facilities. Consequently, we have reduced the operation in our plants; we have continued the operation at Paducah and at the Allied facility as provided in our contract.

Now, as far as the relative costs are concerned, the Allied contract price includes amortization of their capital investment. The price for UF–6 production there is approximately $1.20 per pound of uranium. Now, the Allied plant performs the operation of converting uranium from the form of ore concentrates to UF–6. Therefore it performs more than is done at our Paducah plant or was done previously at Oak Ridge and Portsmouth; the AEC plants use as feed purified material from the refining operations that we presently carry out at Weldon Springs, Mo., and Cincinnati, Ohio. Thus, a mere comparison of the operating costs at Paducah with the Allied contract price would not be meaningful.

We have in the past made analyses of the comparison between our costs for producing UF–6 and the price in the Allied contract. When allowances are made for the more rapid writeoff of the plant facilities, which was necessitated in the case of Allied by the short duration of the contract, and making other allowances for the costs included by industry but not included in Government costs, our conclusion was that the costs were generally comparable. In terms of our actual out-of-pocket cost, the unit price in the Allied contract is greater than costs at the Government facilities.

Dr. WILSON. On the other hand, that kept us from having to build a plant ourselves, putting in the capital equipment ourselves, at the time.

Mr. CANNON. What we would like to have, and I wish you would put it in the record, the unit cost of production at Oak Ridge and Portsmouth and the unit cost at Allied Chemical. Please put in the record the relative unit cost at the three plants.

(Data of a classified nature is being furnished separately.)

NEW PRODUCTION REACTOR AT HANFORD

Mr. CANNON. Then I would like to ask you, Doctor, are any of the additional costs on the new Hanford reactor attributable to cost conversion features for electric power generation? Why has the cost increased $43 million?

Dr. SEABORG. I would like to call on Mr. Quinn again.

Mr. QUINN. The Hanford reactor which is now being built represents a substantial departure in technology from our other Hanford reactors. It is, by the authorization bill, a convertible reactor and, as such, is designed to operate at much higher temperatures and pressures than the other facilities at Hanford with which we have had experience. Consequently, in entering into this project there was a considerable amount of new technology to be developed. The magnitude of the technical problems was not adequately recognized when

the initial cost estimates were formulated. In addition, in the course of the construction program we encountered very serious technical problems in the production of acceptable pipe for the primary coolant loop. This has become the controlling factor in the delay of the schedule for the reactor and is the largest single element in the increase in cost.

Mr. CANNON. One of the complaints made, which we were just discussing previously here, is that there is no penalty for failure and there is no fixing of responsibility. Where is the responsibility for this increased cost running up $43 million?

Mr. QUINN. Certainly our present figure is our best estimate of the cost of building the reactor which was authorized to be built. The initial cost estimate, against which this increase is measured was prepared in connection with project 58–b–8 of Public Law 85–162 which provided that AEC submit to the Joint Committee on Atomic Energy a study on a large scale single or dual purpose reactor. We were allowed 1 year to make this study.

Mr. CANNON. Was that ample time, 1 year?

Mr. QUINN. Considering the extent of departure from previous production reactor technology, events have proved that that was not an adequate time to develop a more realistic cost estimate. There was not sufficient appreciation of the magnitude of the problems to be solved.

Mr. CANNON. How much time should you have had?

Mr. QUINN. In view of the design changes which developed during the first year after authorization of construction, an additional year's time would have resulted in a firmer design scope on which to base a cost estimate.

Dr. WILSON. You see, Mr. Cannon, the original recommendation of the Atomic Energy Commission was not for a convertible reactor. The Joint Committee wanted us to put in a convertible reactor that could be used for making power and in essence gave us a year to design it. That was before my time, but I believe it is the fact.

Mr. CANNON. Still we seem to be short $43 million. Why and who is responsible for the additional cost of this $43 million?

Mr. QUINN. I would say, Mr. Chairman, that the original cost estimates were certainly overoptimistic.

Mr. CANNON. Would you say the cost estimate was erroneous?

Mr. QUINN. I think it was the best estimate that our engineers were able to produce at the end of the 1 year study time. It has proved to be erroneous in considerable extent due to the difficulties that we have encountered. But as of the time when construction was started, although there was only a small contingency in the estimate, our engineers believed they could accomplish the job within the estimate. As construction proceeded, as more refined cost estimates became available, we made certain changes in the design in an effort to hold the cost within this original estimate. We were not able to do this completely and are now faced with this significant overrun.

Mr. CANNON. Looking back at it now, you do not see where this $43 million could have been saved?

Mr. QUINN. I think if we had had more time to perform design and development work before initiating construction, a portion of this money could have been saved. We were attempting to construct the reactor on a very tight time schedule, considering the new technology that was involved in it.

Mr. PILLION. Mr. Chairman, on the question of the Hanford reactor, I wonder if wastage is the right word that we are using here. Actually the modification that is required here and is, I assume, the great part of this $43 million additional, isn't that due to the high temperatures and the high pressures that you will need for the production of steam for that convertible use for electrical energy production?

Mr. QUINN. I think it is quite true that some portion of that increase is the result of the higher temperatures and pressures.

Mr. PILLION. Would you say that the original plan that you had was sufficient for the production of plutonium, would have been sufficient and was adequate for the production of plutonium as initially planned?

Mr. QUINN. Initially, at the time the project was authorized the convertible reactor was estimated at $145 million. A reactor that would have the same plutonium production rate but without the convertible features was estimated at $120 million so that initially there appeared to be a $25 million differential assignable to convertibility. Since that time we have been faced with the increase in the cost of the convertible reactor. Of course, we did not go through and build the so-called single-purpose reactor; it could also have exceeded the estimates. I think it is fair to say that the departure from our previous experience and technology was not adequately reflected in the original cost estimates with the result this delay and overrun.

Mr. PILLION. Could you answer this question? Would you estimate the amount of the $43 million additional that could be assignable to the fact that this plant will be used for a dual purpose? Would you say half or could you estimate it?

Mr. QUINN. That is difficult to pin down, Mr. Pillion. Certainly, as we see it today, the high pressure pipe is the controlling element in the schedule. If that were not present it would be some other element that was controlling, and whether that element would be related to convertibility is difficult to say.

ECONOMIC NUCLEAR POWER

Mr. EVINS. I would like to make an observation at this point. The gentleman refers to the fact that the Joint Committee had set a time limitation of 1 year to try to speed this matter up and the Atomic Energy Commission is pleading always for more time. This committee has been trying over the years to speed this development up, the art and the science. I recall they testified earlier that in a period of 10 or 15 years commercial-type power would be available to the public. Later on the testimony said it would be 25 years. A former chairman testified before leaving the Commission that it would be in another generation. So always AEC is appealing for more and more time, and the Joint Committee and this committee are trying to speed the matter up. There is the difficulty between the committees of the Congress and the AEC. I can see very well why they would want to speed up the process when the Commission is always appealing for more time.

Dr. WILSON. I want to differ with that a little bit. We had a very thorough study of the time when we would have economic power in high fuel cost areas in this country in 1958. That was the first

real study that we made comprehensively. We came up with the proposition that we could have economic power in high fuel cost areas in 10 years. We still believe that is a good estimate. In other words, 1968 is about the time. I don't think the Atomic Energy Commission ever said—some individuals, some enthusiasts may have—away back then that we would have economic power in 10 or 12 years or 15 years. It is true that the Congress has been anxious to speed it up but we have seen too many of the obstacles in the way of it to give such optimistic estimates.

Dr. SEABORG. I would like to make a comment, also, referring to both points. This overrun on the new production reactor and the optimistic estimates on when we may have economic civilian power.

NEW PRODUCTION REACTOR

I do not know who we can blame other than nature, itself, primarily, for this overrun on the new production reactor. I don't believe we can blame the Joint Committee for setting the 1-year time limit. This is a very difficult job technically. It is really advanced technology and we have found that out as we have proceeded. I think that better plans might have reduced the total cost, probably would have reduced it, but basically trying to build something for the first time is just a very difficult technological thing to do.

ECONOMIC NUCLEAR POWER

Now, with respect to the optimistic predictions as to the earlier advent of economic civilian nuclear power, there are many of us, including me, who feel that civilian nuclear power is just about on schedule. I made estimates 10 years ago, I made them on the record in writing, and we are just about following that schedule now. I saw the technical difficulties at that time. Many of my friends did. Commissioner Haworth did. I don't know whether Commissioner Wilson did.

Dr. WILSON. Yes, I am on record.

Dr. SEABORG. We saw the difficulties. We envisaged the final attainment of economic civilian nuclear power and most of us envisaged it on or about the time scale that it is coming.

Mr. EVINS. In view of the various delays, in view of the time necessary I think the Joint Committee is to be commended for putting a target date for you to achieve production.

Dr. SEABORG. That is an additional spur.

Mr. EVINS. You certainly developed the atomic bomb on a speed schedule.

Dr. SEABORG. Yes. Economics did not enter there. We have civilian nuclear power. We can build reactors that will give us electricity. The difference here is that it must be economically competitive if it is going to be adopted over the conventional sources.

Dr. WILSON. You also have the fact that the cost of conventional fuels has not taken the course which most people thought they were going to. They had been going up steadily for a period of years. With nuclear power coming into the picture, and I think partly because of that, for the last 6 years there has been practically no change or a slight decrease in the cost of conventional fuels.

Mr. CANNON. In this connection when we were in Turkey shortly after the death of Mustafa Kemel, Pasha Attaturk——

(Discussion off the record.)

Mr. CANNON. On the record.

He called in some of the most eminent American educators and said, "Gentlemen, how can we improve our system of education?" After study, they reported, "Your Majesty, the Turkish alphabet is too long. It consists of over a hundred letters. You must reduce it to 20 or 25 characters." Accordingly he called in the heads of the Turkish educational system and said, "Gentlemen, we now propose to reduce the Turkish alphabet to 20 or 25 characters. How long will it take you to make that effective?"

After some consultation they said, "Ten years." He said, "That is all right, gentlemen. Let us say we will take 10 years. But remember that 9½ years have already passed, so you have only a half year left." So in a half year they produced an entirely new alphabet and it is in use in Turkey today.

We might take a lesson from Mustafa Kemel.

UNOBLIGATED BALANCE, JUNE 30, 1961

I notice that on page 3 of the justifications you show an unobligated balance carried into the fiscal year 1962 of $154,082,624. Last year on page 1035 of the hearings you estimated this would be $66,943,000. That means that you have had for use this current year $87,139,624 more than you expected. We shall appreciate it if when the transcript comes to you, you will include a tabulation showing in what activities the underruns occurred in the fiscal year 1961. And will you also show where you are applying the excess in the current year.

(The information referred to follows:)

Analysis of additional unobligated balances, fiscal year 1961 operating expenses appropriation

	Millions
Total actual unobligated balance at June 30, 1961	$154. 1
Estimated amount shown in fiscal year 1962 budget submission to Congress	67. 0
Estimate of additional amount of unobligated funds identified in August 1962 (Appropriations Committee informally advised of this amount and applied it to increase weapons program for tests)	30. 0
Subtotal	97. 0
Difference	57. 1
Analysis of difference:	
Additional free unobligated amount (from underruns in 1961 costs)	7. 1
Cooperative power reactor demonstration program	31. 3
Cooperation with Euratom	4. 0
Project ROVER [1]	7. 0
Beryllium research and development (gas-cooled reactor program) [1]	2. 0
Purchase of stretch computor for Lawrence Radiation Laboratory	5. 7
Total	57. 1

[1] See pp. 1015 and 1016 of hearings before the subcommittee of the Committee on Appropriations, House of Representatives public works appropriations for 1962.

FINANCING TEST PROGRAM

Mr. CANNON. You are estimating no unobligated balance going into fiscal year 1963. We take that to mean that you have financed a heavy weapons testing program and you have had to scrape up every possible dollar to do it. Will you please put into the record a table showing from what programs you took this money? And in what amounts?

(The information referred to follows:)

Analysis of funding in fiscal year 1962 for weapons test program obligations in fiscal year 1962

Total test costs in fiscal year 1962	$203.4
GSO increase related to costs	20.0
Total 1962 test funding	223.4
Funded as follows:	
1962 NTS standby costs in base budget	4.0
Additional unobligated carryover from 1961 earmarked by Appropriations Committee	30.0
Additional 1961 carryover	7.1
Savings in raw materials program	21.0
Savings in special nuclear program	30.0
Reprograming of weapons VELA funds to tests	11.3
Total savings and reprograming	103.4
Deferral of obligations to fiscal year 1963	120.0
Total savings, reprograming and deferrals	223.4

CONTRACT WITH UNIVERSITY OF CHICAGO

Mr. CANNON. The attention of the committee has been called to a report in the New York Times of January 21, 1962, that you are making new contractual arrangements with universities which may provide these nonprofit institutions with a profit for operating your national laboratories. Will you please explain what this is all about, and how it may be affecting your budget request this year, and subsequent budget requests. I believe you can tell us now perhaps what this story in the New York Times is all about, and how it is affecting your budget requests this year.

Dr. SEABORG. That refers to the University of Chicago management allowance.

Mr. CANNON. I hand the article to you now.

Dr. SEABORG. The university felt that their management allowance was not adequate. It had been, I believe, $600,000 or $500,000.

Dr. WILSON. It was $500,000.

Dr. SEABORG. They felt in view of the magnitude of the contract, their responsibilities, their contributions, their administrative expenses, and so forth, that it should be raised to $1,600,000. We felt that this was too high, but that perhaps some adjustment, some raising of the fee was called for, and we compromised on a negotiated intermediate figure of $1,200,000.

Mr. CANNON. Of course it is a nonprofit operation.

Dr. SEABORG. This is a nonprofit university.

The University of Chicago does not regard this as a profit. The university argues forcibly that the compromised figure we are paying

does not fully compensate them for central administrative expenses incurred under the contract. I should say, apart from our contractual arrangement, however, that even though an institution like the University of Chicago is a nonprofit organization overall, this does not mean that there are not parts of its operation where profit accrues. So this is consistent with its being a nonprofit organization, which it qualifies to be and which it is. Even if there were, according to some people's definition, a profit here, it would be very difficult to define what is a profit. We regard what a university like the University of Chicago is giving us in leadership, outstanding people and prestige, as very difficult to measure in terms of money. From our point of view, what they can give to the operation of the laboratory is a great deal and is commensurate with such a fee.

Mr. CANNON. In response to what Dr. Seaborg has said, this committee has put a 15-percent limit on overhead costs on research grants on two of its appropriations bills. What would that do if applied to contracts with Chicago and similar projects?

Dr. SEABORG. This $1.2 million is away below that of course.

Mr. CANNON. Below 15 percent?

Dr. SEABORG. Yes. That would be five or six times as high.

Dr. WILSON. It is not strictly comparable, though, because we do pay a good share of the overhead expense as a direct expense in this kind of contract where it is operated as our facility.

Mr. CANNON. Now let us make it comparable. We are saying 15 percent of all indirect expenses. What will be the effect of that on the Chicago contract?

Dr. WILSON. Yes. Fifteen percent of the total contract is much greater than the $1.2 million. I don't know what it would be but I would think it would still be——

Mr. MCCARTHY. I don't know, we don't have the figures here, Mr. Chairman. We can supply them, how much of the indirect expense is included.

Mr. CANNON. We would like to have a complete breakdown on indirect expenses.

(The information follows:)

The estimated operating cost of the Argonne National Laboratory for fiscal year 1962 for the scope of work to be conducted by the Laboratory is $48.8 million. In addition, the contract also provides for payment in fiscal year 1962 of $1.2 million allowance in lieu of all University of Chicago overhead, other indirect expense and management compensation.

INSTALLATION OF ELECTRIC POWER GENERATING FACILITIES AT NPR

Mr. CANNON. Now as to the electric power generating proposal at Hanford, we would be glad if you would put in the record a copy of the most recent proposal at this stage of negotiations, and with that any legal opinion that you would have to support the contention that authority exists in law for you to enter into any contracts such as are under discussion. Also, if you will, give us some detail of your expected revenues from the sale of steam to meet those costs.

Dr. WILSON. I would like to make clear that it is premature to answer that now.

Mr. CANNON. In this recovery of steam, would you seek to recover the full investment? What would be the point at which you are aiming?

Dr. SEABORG. The full——

Mr. CANNON. The full Federal investment of the conversion features which have produced this steam as a byproduct.

Dr. SEABORG. There has been no agreement yet.

Mr. CANNON. What is your objective?

Dr. SEABORG. The AEC proposal would contemplate recovering this under certain conditions of operation, depending on how long it operated.

Mr. CANNON. You see, Doctor, you will be making this contract before we see you again next year. It will be a year before we will have an opportunity to review this again. That will be too late. We would like to know when you return the transcript just what contract you are going to make. At least we would like to know what your objective is, what you expect to secure.

Dr. SEABORG. We might serve that purpose by submitting for the record the letter that I have written to Mr. Hurd.

Mr. CANNON. Let us know what you expect to secure and how you propose to do it.

(The material referred to follows:)

MEMORANDUM

MAY 31, 1962.

To: A. R. Luedecke, General Manager.
From: Edwin E. Ferguson, Acting General Counsel.
Subject: Legal basis for proposed arrangement between the Atomic Energy Commission and the Washington Public Power Supply System to permit utilization of steam produced during operation of the new production reactor, Hanford, Wash.

The Washington Public Power Supply System (WPPSS), an organization consisting of 16 public utility districts in the State of Washington, submitted a proposal to the Atomic Energy Commission (AEC) and the Bonneville Power Administration (BPA) under the terms of which steam produced in the course of operating the new production reactor (NPR), now under construction at Hanford, Wash., would be utilized for power generation. (See letter to AEC Chairman Glenn T. Seaborg and BPA Administrator Charles F. Luce dated November 28, 1961, from WPPSS Managing Director Owen W. Hurd.) The essential features of this proposal bearing on the arrangement with AEC are:

(1) Lease to WPPSS, for a period commensurate with that of the revenue bonds, of a small parcel of land adjacent to the NPR on which power generating facilities would be constructed by WPPSS;

(2) Sale of steam by AEC to WPPSS during periods when the NPR is being operated by AEC;

(3) Generation of power by WPPSS in the generating facilities to be constructed and operated by WPPSS utilizing steam delivered by AEC;

(4) Lease of the NPR by AEC to WPPSS during periods when it is not required for AEC purposes.

In a letter to WPPSS dated April 6, 1962, AEC stated certain modifications and qualifications of the WPPSS proposal that it would consider necessary to the negotiation of an acceptable arrangement. The purpose of this memorandum is to analyze the legal authority of AEC to enter into the proposed arrangements, as modified by AEC's letter of April 6, 1962.

This proposal has been developed and submitted as a result of the fact that AEC is constructing a reactor with a capability of producing large quantities of steam which can be utilized for the production of significant quantities of electric power. The proposal has been examined very carefully by AEC within the framework of the Commission's statutory responsibilities and authority and for its economic implications.

In order to make a proper evaluation of the WPPSS proposal, it is essential to consider it within the context of its overall objective and to keep this ultimate objective in mind in analyzing each separate but interdependent part of the proposed arrangement. Thus, inability to perform any essential part would, of necessity, make the entire proposal infeasible. It is with this basic concept in mind that the legal aspects of the WPPSS proposal are identified and discussed in the following three sections:

1. Authority of AEC to sell to WPPSS energy (steam) produced during the course of operation of the NPR by AEC

Section 44 of the Atomic Energy Act of 1954, as amended, provides:

"If energy is produced at production facilities of the Commission or is produced in experimental utilization facilities of the Commission, such energy may be used by the Commission, or transferred to other Government agencies, or sold to publicly, cooperatively, or privately owned utilities or users at reasonable and nondiscriminatory prices. If the energy produced is electric energy, the price shall be subject to regulation by the appropriate agency having jurisdiction. In contracting for the disposal of such energy, the Commission shall give preference and priority to public bodies and cooperatives or to privately owned utilities providing electric utility services to high cost areas not being served by public bodies or cooperatives. Nothing in this act shall be construed to authorize the Commission to engage in the sale or distribution of energy for commercial use except such energy as may be produced by the Commission incident to the operation of research and development facilities of the Commission, or of production facilities of the Commission."

The NPR is a production facility as defined in section 11 t. of the Atomic Energy Act of 1954, as amended, and in 10 C.F.R. 50. Under the proposal, AEC would be selling steam energy produced at a production facility of the Commission to a group of publicly owned utilities. Such steam production by AEC would be "incident to the operation of * * * [a production facility] of the Commission," as required by the last sentence of section 44. WPPSS is an operating agency and a municipal corporation organized under the statutes of the State of Washington, revised code of Washington (1957 Supp.) chapter 43.52 (ch. 29, Laws of Washington, 1957) and a municipality within the meaning of "municipality" of section 3(7) of the Federal Power Act, and thus, the preference requirement of section 44 is satisfied.

Section 44 further provides that a "reasonable and nondiscriminatory" charge shall be made for the energy sold pursuant to this section. The legislative history of section 44 does not provide any guidance on the criteria which should be considered in reaching a determination on a reasonable price. The Commission has exercised this authority on two previous occasions [1] and has reached a determination, with the advice of the Federal Power Commission, on a reasonable price under the particular circumstances. Essentially, the criterion used was the cost of fuel which would be required to produce power in comparable quantities and qualities or, in other words, the value of the steam to the utility represented by the savings in fuel cost accruing to the utility. The Commission has determined, in connection with the WPPSS proposal, that a reasonable price would be based on the value of the steam for its intended use, giving appropriate recognition to the uncertainty in the duration of the period during which AEC will be operating the NPR and providing steam. The advice of the Federal Power Commission is again being obtained in arriving at a specific price.

It is my opinion that AEC has legal authority to dispose of steam energy produced in the NPR in accordance with the proposed arrangements.

2. Authority of AEC to lease to WPPSS approximately 13 acres of land adjacent to NPR on which WPPSS would construct generating facilities

Article IV, section 3, clause 2, of the U.S. Constitution provides that "The Congress shall have power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States; * * *".

In *U.S.* v. *Gratiot* (14 Pet. 526, 539 (1840)), the Supreme Court held that the power of Congress over the public lands extended to, and included, the leasing of such property, and that the words "dispose of" found in article IV of the Constitution quoted above are not limited to sale. The Court held further that disposal of public lands is in the discretion of the Congress.

The courts, comptrollers general and attorneys general have held consistently through the years that specific legislative authority must be established by Congress before any particular Federal agency may dispose of Federal property. Congress has passed legislation from time to time granting to particular agencies special authority to take certain types of action with respect to Federal property.

[1] In the sale of steam produced in the operation of the sodium reactor experiment reactor at Santa Susana, Calif., and in the sale of power from the submarine intermediate reactor at West Milton, N.Y.

Specific legislation has been enacted by the Congress granting to AEC authority "to * * * lease * * * real and personal property as provided in this Act" (sec. 12(a)(7) of the Atomic Energy Act of 1946 and sec. 161 g. of the Atomic Energy Act of 1954, as amended). The Office of the General Counsel of AEC has consistently interpreted the words "as provided in this Act" not to mean "as expressly provided in this Act," but rather as intended to effectuate the policies and purposes specified elsewhere in the act. To have interpreted these words under the 1946 act as meaning "as expressly provided in this Act" would have rendered the words meaningless inasmuch as no such provisions were contained in the act. Although the 1954 act, as amended, contains certain special provisions concerning lease of materials or particular land,[2] the language of section 12(a)(7) of the 1946 act was retained in section 161 g. of the 1954 act and, in the legislative history of the 1954 act there is no indication of congressional intent to narrow the scope of the authority conferred by section 12(a)(7) of the 1946 act.

AEC has actually implemented the authority granted under these two sections, as interpreted above, in numerous instances since enactment of the 1946 act. Leases of land under AEC jurisdiction have been made for a variety of purposes in furtherance of the responsibilities of the Commission, as set forth in both acts. Examples of such leases are:

(*a*) Lease of land at Oak Ridge, Hanford, and Los Alamos for commercial purposes, e.g., lease of land at Oak Ridge to Abbot Laboratories as a site for a commercial isotope processing facility;

(*b*) Lease of a quarry site at Oak Ridge;

(*c*) Lease of land at Oak Ridge and Hanford for housing purposes;

(*d*) Lease of land for church sites at Oak Ridge.

The Congress has been informed of AEC leasing activities and policies by virtue of direct communications from the Commission to the Joint Committee on Atomic Energy (JCAE) concerning particular leasing actions and as a result of hearings which the JCAE has held in connection with specific leasing activities, (see hearings before a subcommittee of the Joint Committee on Atomic Energy, 81st Cong., 2d sess., on "Department Store Lease at Oak Ridge, Tenn.," 3/13 and 14/50). Furthermore, the Congress has specifically recognized the leasing activity of AEC in the enactment of the AEC Community Act of 1955 (secs. 36 a., 42 e. and 52 c.) and in the enactment of an amendment to section 161 e. of the 1954 act in 1956 (Public Law 84–722) to clarify a certain aspect of the leasing policy which AEC was pursuing in order to eliminate potential inequities under leases the Commission had already executed.

What policies and purposes of the Commission set forth in the Atomic Energy Act of 1954, as amended, would be furthered by a lease of land under AEC jurisdiction to WPPSS on which WPPSS would construct and operate generating facilities in conjunction with the operation of the NPR?

Lease to WPPSS of approximately 13 acres of land adjacent to the NPR must be considered in the context of the integrated proposal under which conversion of the NPR would permit utilization of excess steam for electric power generation purposes. For technical reasons, in order to maximize the effective use of the steam, it is necessary to have the generating facilities immediately adjacent to the reactor facility.

The Congress, in enacting the Atomic Energy Act of 1954, as amended, set forth (1) certain policies of the United States in the field of atomic energy and (2) certain methods by which these policies could be effectuated. Thus:

1. Section 1 of the act declares the policy of the United States to be that—

"a. the development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security; and

"b. the development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the the standard of living, and strengthen free competition in private enterprise."

2. Section 3 of the act states that—

"[I]t is the purpose of this act to effectuate the policies set forth above by providing for—

"a. a program of conducting, assisting, and fostering research and development in order to encourage maximum scientific and industrial progress;

"b. a program for the dissemination of unclassified scientific and technical information * * * so as to encourage scientific and industrial progress; * * *

[2] Secs. 67, 81, 161 e.

"d. a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security and with the health and safety of the public; * * *."

3. Section 31 a. of the act provides that in connection with the Commission's responsibility "to insure the continued conduct of research and development and training activities * * * by private or public institutions or persons, and to assist in the acquisition of an ever-expanding fund of theoretical and practical knowledge, * * * the Commission is authorized and directed to make arrangements (including contracts, agreements, and loans) for the conduct of research and development activities relating to—

"(4) * * * the demonstration of the practical value of utilization or production facilities for industrial or commercial purposes * * *."

The Congress, by including the sections of the act quoted above, was establishing certain functions and responsibilities which the Federal Government should carry out. The Commission was given the responsibility to accomplish these objectives. Making the energy generated in the NPR available for electric power production would be in furtherance of the Commission's responsibility to promote the development and utilization of atomic energy for peaceful purposes and the demonstration of the practical value of a production facility for industrial or commercial purposes. The lease of land to WPPSS is an essential aspect of adapting the NPR to electric power production inasmuch as the Commission controls the land on which generating facilities must be constructed.

Specifically, operation of the NPR for the dual purposes of plutonium and power production would permit experience to be obtained with respect to the utilization of a large plutonium production reactor for the additional purpose of electric power generation. Information obtained from operating the NPR in such a manner would be useful in the general field of reactor technology development. The potentiality of the use of the NPR for electric power generation was contemplated by the Congress when an additional $25 million was authorized and appropriated for the inclusion of certain technical features in the NPR which would permit the use of its excess steam production for power generation.

It is my opinion that AEC has legal authority to lease to WPPSS a parcel of land adjacent to the NPR as a site for generating facilities to be constructed by WPPSS in accordance with the proposed arrangements.

3. Authority of AEC to lease the NPR to WPPSS during periods when the NPR is not being operated by AEC

The same considerations are pertinent here as those presented in section 2. above concerning the programmatic responsibilities of the Commission set forth in the Atomic Energy Act of 1954, as amended. However, it seems appropriate to reiterate that it is essential for the WPPSS proposal to be viewed in its entirety. The total project becomes economically feasible only if the NPR is available as a source of steam over a reasonably long period of time sufficient to permit amortization of the cost of construction of the generating facilities. The Commission will operate the NPR only as long as required to meet AEC production requirements. Therefore, if the Commission is to accomplish the programmatic objectives described in section 2. above, it would be necessary to lease the NPR to WPPSS in order to permit its continued operation by WPPSS for steam production.

Under any arrangement developed in connection with the WPPSS proposal, AEC does not propose to commit itself to the expenditure of any Government funds. All actions for which funds might be necessary will be financed by WPPSS. Thus, the provisions of 31 U.S.C. 665, prohibiting an officer or employee of the Government from involving the Government in a contract or other obligation for the payment of money for any purpose in advance of appropriations made for such purpose unless such contract or obligation is authorized by law, will not have a bearing in this situation.

In preliminary discussions among AEC, BPA, and WPPSS, consideration has been given to a provision which would be included in the AEC and BPA contracts with WPPSS respectively giving the Government an option to acquire the generating and related facilities under certain conditions. Such an option would be included in a contract between AEC and WPPSS solely on the basis that it would be advantageous to the Government to have it and its inclusion would not reflect any present intention on the part of AEC to exercise the option. AEC does not have existing authority to exercise such an option and, therefore, would need to obtain necessary authorization and appropriations from the Congress before the option could be exercised.

Another consideration which should be borne in mind in evaluating the WPPSS proposal is that substantial economic benefits could result from the sale of steam which would otherwise be wasted. Although primary reliance should by no means be placed on the potential economic benefits to be achieved through arrangements with WPPSS as programmatic justification for such arrangements, nevertheless, these potential economic benefits should not be ignored.

In summary, from the analysis presented above, I conclude that AEC has adequate, existing legal authority to enter into the arrangements with WPPSS pursuant to its proposal to AEC and BPA, as modified by the letter of April 6, 1962 from Chairman Seaborg to Owen Hurd.

THE PRICING OF STEAM TO BE MADE AVAILABLE TO THE WPPSS FOR THE GENERATION FOR ELECTRIC POWER AT THE HANFORD NEW PRODUCTION REACTOR

As noted in AEC's reply to the Washington Public Power Supply System (WPPSS) proposal, both reproduced above, during periods when the NPR is being operated by the AEC, AEC would provide to WPPSS excess steam energy produced at the NPR under the authority set forth in section 44 of the Atomic Energy Act of 1954, as amended. Section 44 requires, in part, that such energy be sold at "reasonable and nondiscriminatory prices." The reasonable and nondiscriminatory price at which AEC plans to make steam available to the WPPSS will be based upon the value of the steam for its intended use, giving appropriate recognition to the uncertainty in the duration of the period during which AEC would operate NPR and make such steam available to WPPSS.

The value of the steam will be based upon the differences between estimates of the values of the power that would be produced at NPR and the costs of making power from NPR steam. The underlying concept is based on the principle that total estimated NPR power costs, including payments to AEC, not exceed the estimated power values, when both are considered over the entire anticipated useful life of the NPR project.

The values of power are currently being estimated for the AEC by the Federal Power Commission. These estimates are not yet available.

The costs of making power from NPR steam will be based upon estimates now being made by the AEC, the Bonneville Power Administration, and the WPPSS. These estimates are also not yet available.

Should the studies indicate that total power costs would exceed power values during the later years, when WPPSS would operate the reactor under lease, considerations of overall feasibility may make it necessary to accumulate a trust fund from steam payments in the early years of operation of the powerplant. The size of the fund accumulated and its disposition would be influenced by the duration of the period when the NPR would be operated by AEC for AEC purposes.

Regardless of the results of the estimates upon which the price of steam will be based, AEC will be reimbursed, in addition to the steam price, for its full costs which would be brought about by the design, construction, and operation by WPPSS of electric power generating facilities at the NPR.

APRIL 6, 1962.

Mr. OWEN W. HURD,
Managing Director, Washington Public Power Supply System,
Kennewick, Wash.

DEAR MR. HURD: The Commission has completed its review of the proposal which you submitted to Mr. Luce and me on November 28, 1961, and amended by your letter of February 2, 1962, concerning conversion of AEC's new production reactor, now being constructed at Hanford, for electric power recovery. I am pleased to report that we consider your proposal, as modified by our comments below, to be a satisfactory basis for negotiation of appropriate agreements to accomplish the conversion project.

We have analyzed the preliminary statement attached to your letter, in particular the basic criteria and proposed terms and conditions relating to the proposed agreements between AEC and WPPSS, and would like to make certain observations concerning those parts of the preliminary statement which need to be modified in certain respects in order to establish a satisfactory basis for negotiation. The comments which follow are general in nature and are not intended to express the full, detailed position of the Commission with respect to any particular aspect of the proposal.

LEASE OF LAND

The AEC is prepared to lease the necessary land upon which WPPSS would construct the generating plant and related facilities. In addition, the AEC would also make certain land or easements available for transmission lines to either WPPSS or BPA. We have not determined what the specific charges would be, but we will be prepared to discuss this point during negotiations.

GENERATING FACILITIES

The AEC would expect WPPSS to undertake the responsibility for designing and constructing the generating facilities. Subject to deletion of certain classified information not related to the proposed powerplant, we would make available, to the extent desired, plans, studies, designs, and related information at our disposal. We would plan to review and approve all features of the powerplant design and operations in order to assure that the facilities would be designed, built, and operated on a basis entirely compatible with safe and effective operation of the reactor.

ADDITIONS, MODIFICATIONS OR REPLACEMENTS OF EQUIPMENT IN REACTOR

With respect to any additions, modifications, or replacements in the NPR itself which may be desired by WPPSS in connection with the conversion project, AEC would expect to perform the necessary design and construction work itself with funds advanced by the WPPSS. The types of changes in the reactor which are contemplated are such as to make it essential that the AEC have complete control over the resulting equipment. Thus, the AEC should receive title to such equipment. AEC has no basis, however, for contributing to the financing of these modifications.

SUPPLY OF STEAM TO WPPSS BY AEC

The AEC is prepared to provide any excess steam produced during periods when the NPR is being operated by the AEC. With respect to the price at which such steam will be sold, AEC would have to arrive at a reasonable and nondiscriminatory price, as required by section 44 of the Atomic Energy Act of 1954, as amended. We believe that such a price would be based on the value of the steam for its intended use, giving appropriate recognition to the uncertainty in the duration of the dual-purpose period of operation. We will be prepared, of course, to discuss this matter during negotiations.

LEASE OF THE NPR TO WPPSS

During periods when NPR is not operated by AEC, we are prepared to lease it to the WPPSS under appropriate conditions. Among these conditions would be the right of the AEC to recapture the reactor at any time for its own purposes. Furthermore, we would expect the reactor to be operated and maintained in such a manner as to permit its continued and effective operation by AEC should the recapture clause be exercised. We will be prepared, during negotiations, to discuss appropriate charges for lease of the reactor.

LICENSES

While your letter of February 2, 1962, requested elimination at this time of your earlier request for assurances that all necessary licenses would be granted, the following information may be useful in your planning:

During the dual-purpose period, no AEC licenses would be required by WPPSS for operation of the generating facilities. The NPR would be operated by the AEC during the dual-purpose period only after a careful review of all aspects of its design, construction, and proposed program of operation resulted in a finding that it could be operated without constituting an undue risk to the public health and safety.

During any period of NPR operation by WPPSS or another non-AEC organization, the normal licensing procedures in effect at the time would be expected to be followed. While AEC cannot assure that all necessary licenses will be granted in the future, the Commission, prior to consummation of an agreement with WPPSS, will have to determine whether on the basis of available information there is any reason to believe that the NPR could not be operated in the future as a licensed power reactor at the Hanford site without undue risk to the public health and safety.

SUPPLY OF FUEL

During any periods that the WPPSS is operating the NPR, the WPPSS would be expected to obtain nuclear fuel in the same manner as other non-Government operators of nuclear power reactors. The AEC is prepared to provide to WPPSS special nuclear material for fuel use and would perform fuel cycle services to the extent and under the same conditions that it would provide such materials and services to other licensees.

IDEMNITY AND INSURANCE

During the dual-purpose period, WPPSS will have the protection afforded to "persons indemnified" by the indemnity provision contained in the AEC contract with the operator of the reactor. This indemnity has been granted pursuant to Section 170 of the Atomic Energy Act of 1954.

WPPSS would be responsible during both the dual-purpose and single-purpose periods for obtaining appropriate nonnuclear insurance.

During the single-purpose period of operation, when the reactor would be leased to WPPSS and operated under license, WPPSS would be subject to the same indemnity and insurance responsibilities as other licensees. In addition, during this period we would expect WPPSS to secure adequate property insurance on the reactor.

In connection with our review of your proposal, the Commission believes that no additional congressional authorization would be required for the Commission to negotiate and undertake appropriate agreements with WPPSS along the lines of your proposal, as modified by our comments above.

The modifications which we have proposed are based, to a considerable extent, on very fruitful preliminary discussions which have been held with you and your associates and with the Bonneville Power Administration. We have attempted, within the framework of our existing statutory authority and policies, to meet the general lines of your proposal.

We sincerely hope that you will be able to accept our comments, and that a satisfactory basis now exists to proceed with negotiations and development of appropriate agreements to implement this project. If you have any questions concerning any of our comments, I suggest that you communicate with Mr. Travis at Hanford, whom we have asked to conduct whatever negotiations are necessary.

Sincerely yours,

GLENN T. SEABORG, *Chairman.*

WASHINGTON PUBLIC POWER SUPPLY SYSTEM,
February 2, 1962.

BONNEVILLE POWER ADMINISTRATION,
The Department of the Interior,
Portland, Oreg.
(Attention: Mr. Charles F. Luce, Administrator.)
Dr. GLENN T. SEABORG,
Chairman, Atomic Energy Commission,
Washington, D.C.

DEAR MR. LUCE AND DR. SEABORG: Since submission of our "preliminary statement of basic criteria and proposed terms and conditions of agreement for WPPSS construction of NPR power facilities" with our letter to you dated November 28, 1961, it has been determined that paragraph 6 of the preliminary statement relating to licenses and permits, may be eliminated at this time and we, therefore, request that this be done.

Our thought on this topic is that provision with respect to any specific permit or license that may be required can be better formulated after further conferences with your staff and dealt with later by appropriate agreement or procedure.

Very truly yours,

OWEN W. HURD, *Managing Director.*

WASHINGTON PUBLIC POWER SUPPLY SYSTEM,
Kennewick, Wash., November 28, 1961.

Dr. GLENN T. SEABORG,
Chairman, Atomic Energy Commission,
Washington, D.C.
Mr. CHARLES F. LUCE,
Administrator, Bonneville Power Administration,
The Department of Interior, Portland, Oreg.

DEAR DR. SEABORG AND MR. LUCE: By our letters to Mr. Luce and Mr. J. E. Travis dated November 9, 1961, and copies of a resolution adopted by the Washington Public Power Supply System (WPPSS) on October 20, 1961, we have indicated the concurrence of WPPSS in the action by Mr. Earl Coe, director of the Washington State Department of Conservation initiating consideration of the non-Federal financing of electric power facilities to utilize heat from the Hanford new production reactor (NPR) as set forth in Mr. Coe's letters to Dr. Seaborg dated October 27 and November 22, 1961. For your reference copies of these letters are attached. In addition, these letters advised of the desire of WPPSS to cooperate in this matter and, if economically and otherwise feasible, to serve as the non-Federal entity for this purpose.

It is the purpose of this letter to submit a proposal and request to enter into negotiations jointly with the Atomic Energy Commission (AEC) and the Bonneville Power Administration (BPA) leading to the execution of necessary contracts and agreements which could result in the financing, construction, and operation by WPPSS of power production and associated facilities utilizing heat from the Hanford NPR.

The interest and incentive of WPPSS to undertake the financing, construction, and operation of NPR power facilities by WPPSS is based on the following circumstances:

(1) Analyses and studies of available information by WPPSS consultants (R. W. Beck & Associates) indicate that the production of electric power from waste heat during the period of expected dual-purpose operation of the NPR (8 years) and thereafter under assumed conditions and integrated with existing Federal hydro resources and marketed by BPA would be economically feasible and provide a source of low-cost power which could become available at a time of expected regional power deficiency.

(2) The action of Congress during the last session in refusing to appropriate funds for the Atomic Energy Commission to complete the construction of the NPR power facilities suggests that a plan for non-Federal financing and construction of such power facilities is desirable. During the last session of Congress, WPPSS endorsed the President's program for Federal financing and construction of the Hanford power facilities, and is prepared to support this program if it is resubmitted to the Congress.

(3) The principal objective of the WPPSS is to do those things necessary within its powers, including the construction of hydro and thermal generating plants best adapted to an integrated and comprehensive regional power supply, which will insure members and the region with a supply of electric power at the lowest possible costs. It is in the interest of the achievement of this objective that this proposal is being made.

(4) WPPSS is an operating agency and a municipal corporation organized under the statutes of the States of Washington, revised code of Washington (1957 Supp.) chapter 43.52 (ch. 29 laws of Washington 1957) and a municipality within the meaning of "municipality" of section 3(7) of the Federal Power Act. WPPSS has the authority by law, among other things, "to generate, produce, transmit, deliver, exchange, purchase, or sell electric energy and to enter into contracts for any or all such purposes"; also "to negotiate and enter into contracts with the United States or any of its agencies, with any State or its agencies, with Canada or its agencies, or with any district or city of this State, for the lease, purchase, construction, extension, betterment, acquisition, operation, and maintenance of all or any part of any electric generating and transmission plants and reservoirs, works and facilities, or rights necessary thereto, either within or without the State of Washington and for the marketing of the energy produced therefrom." It is the declared policy of the law under which WPPSS exists that "the authority granted in this chapter shall apply equally to the generating of electricity by waterpower, by steampower, by atomic power, or by any other means whatsoever."

(5) WPPSS is presently composed of 16 public utility districts of the State of Washington serving 223,389 rural, domestic, commercial, and industrial customers in the State of Washington with a combined present peak power requirement of 997,757 kilowatts and annual consumption of 4,792,654,000 kilowatt-hours during 1960. The total plant value of power generating and distribution facilities owned and operated by WPPSS member districts is approximately $600 million. Twelve of the WPPSS members presently purchase their entire power requirements from BPA. Four members own generating facilities, but obtain the major part of their power requirements from BPA.

(6) The WPPSS has obtained an FPC license for the construction of the Packwood hydroelectric project (26,000 kilowatts) in Lewis County, Wash. (FPC project No. 2244). Bids have been received for project construction and equipment, and construction is expected to begin in 1962 and be completed in 1964.

The WPPSS presently has an application pending before FPC for the Nez Perce project (2 million kilowatts, FPC project No. 2273) on the Snake River for which a competing application for the mutually exclusive High Mountain Sheep project by the Pacific Northwest Power Co. is also pending.

Other hydro projects currently being investigated are the Hoh Bow project (60,000 kilowatts, FPC project No. 2257) located in Jefferson County, Wash., for which a preliminary permit has been received from the Federal Power Commission and the Ben Franklin project on the Columbia River near Richland, Wash. (252,000 kilowatts).

It is the desire of the WPPSS that the installation of the electrical power production facilities at the NPR by a non-Federal agency shall accomplish the objectives envisaged by AEC and BPA in support of the legislation for Federal construction of these facilities.

The WPPSS has recognized that operating conditions and requirements of the NPR are such that substantial reserves of capacity and energy are required which are available only from the U.S. Columbia River power system to make possible the use of energy from the NPR as a firm power source. It has also recognized that the marketing of additional firm power made available by the integration of the NPR energy source with the Columbia River system can best be accomplished by such integration and marketing.

This letter, with the attached statement of basic contract terms and conditions, embodies our present concept of arrangements that would make possible the financing, construction, and operation by WPPSS of power facilities required for optimum commercial power production from heat produced by the NPR.

We are hopeful that the response by AEC and BPA to this proposal and request will (1) advise of existing statutory authority of both agencies to enter into such contracts and agreements with WPPSS as considered necessary to accomplish the intended purpose of this proposal; (2) advise of additional congressional authorizations, if any, needed by each agency to accomplish this purpose; (3) advise as to the acceptability, concurrence, and appropriateness of the basic terms and conditions proposed; (4) advise of the interest, willingness, and merit of proceeding with negotiations and discussions along the lines of this proposal; and (5) advise of any alternate proposals which may be considered to be desirable and appropriate to accomplish the intent of this proposal.

Very truly yours,

OWEN W. HURD, *Managing Director.*

PRELIMINARY STATEMENT OF BASIC CRITERIA AND PROPOSED TERMS AND CONDITIONS OF AGREEMENT FOR WPPSS CONSTRUCTION OF NPR POWER FACILITIES

As a result of recent conferences with staff representatives of AEC and BPA and based upon our present knowledge and understandings of factors pertinent to the installation by WPPSS of the electrical generating and associated facilities at the NPR, we have set forth hereinafter an outline of proposed terms and contitions which could provide the basis for negotiation of agreements between the WPPSS and AEC and BPA for the proposed installation.

The proposed terms and conditions have been divided into two parts, (I) those which would be pertinent to the arrangements relating more specifically to AEC, and (II) those pertinent to the arrangements relating more specifically to BPA.

I. PROPOSED TERMS AND CONDITIONS RELATING TO AGREEMENT BETWEEN AEC AND WPPSS

A. Construction

(1) AEC will lease, or otherwise make available at nominal rental, to WPPSS on a long-term basis, adequate land adjacent to the NPR for the construction and operation of the electrical generating and associated facilities, including ingress and egress thereto, and including rights-of-way for the construction and operation of transmission lines from said facilities to a satisfactory point of interconnection with the BPA transmission system.

(2) AEC will make available to WPPSS, without cost, all studies, designs, plans, specifications, and related material and information which are available to it and are pertinent and necessary for the design, construction, and operation of the proposed power facilities.

(3) AEC or WPPSS will prepare, or cause to be prepared, all necessary designs, plans, specifications, and related documents and, upon approval thereof by the other party, will construct, or cause to be constructed, the electrical generating and associated facilities to, but not including the switchyard adjacent to the generating plant. If AEC designs and constructs said facilities, WPPSS will advance or reimburse AEC periodically at mutually agreeable times for all costs and expenses incurred on its behalf subsequent to the effective date of the proposed agreement for the design and construction of the said facilities less an amount which shall represent the value to AEC of the "sixth cooling loop" and the additional instrumentation of the reactor previously contemplated by AEC in its plans for conversion of the reactor to dual-purpose operation.

(4) AEC shall have full and exclusive right and control in all respects to the "sixth cooling loop" and the additional instrumentation.

(5) WPPSS will construct, or cause to be constructed, the switchyard and transmission facilities required to deliver the project output to the BPA transmission system.

(6) WPPSS will undertake to sell WPPSS revenue bonds in an amount sufficient to advance or repay all costs incurred by AEC as may be required by (3) above and such additional amounts as are determined by AEC, BPA, and WPPSS as necessary for other capital costs, including transmission facilities, reserves, working capital and other financial requirements for the successful construction and operation of the proposed project.

B. Operation

(1) Upon satisfactory completion of construction and testing of the proposed facilities by WPPSS or AEC, WPPSS shall assume full responsibility for the operation and maintenance of all of the proposed facilities except the "sixth cooling loop" and the additional instrumentation which shall be operated and maintained by AEC as an integral part of the NPR.

(2) AEC will make available to WPPSS byproduct steam for power production during the period(s) that the NPR is operated for the production of plutonium.

(3) AEC will lease, or otherwise make the NPR available, to WPPSS without cost other than direct costs incurred by AEC in connection therewith during the period when the NPR is not actually used and operated by AEC for plutonium production.

(4) During periods when the NPR is operated by WPPSS for power production, AEC shall have and retain all rights to reactivate and utilize the NPR at any time upon appropriate notice for the primary purpose of plutonium production.

(5) WPPSS will at all times operate the electrical generating facilities in accordance with procedures, practices, and schedules as prescribed and agreed upon by AEC and BPA, and in a manner consistent with the operation of the NPR for its primary purpose of plutonium production as determined by AEC to be in the national interest.

(6) WPPSS will take all steps to qualify and AEC will grant all necessary licenses and permits that may now, or hereafter, be required for the operation of the electrical generating facilities and the NPR.

(7) During any and all periods when the NPR is operated by WPPSS, AEC will guarantee an uninterrupted supply of nuclear fuel for the NPR at costs not to exceed the cost to the Government for such fuel.

(8) AEC will indemnify WPPSS from all claim or damage resulting from the operation of the NPR or associated facilities or will provide insurance therefor to WPPSS at reasonable cost.

(9) The term of the agreement between AEC and WPPSS shall be for a period not less than that necessary to amortize any and all revenue bonds or other obligations sold or incurred by WPPSS for the purpose of financing the construction of the proposed facilities.

(10) Upon expiration of the agreement or when all bonds or other obligations incurred by the WPPSS have been retired, whichever is earlier, the Government, at its option and at no cost, may acquire the ownership of the electrical generating and associated facilities.

(11) The Government, at its option and after proper notice, may acquire the ownership of the facilities at any time during the life of the contract upon payment to WPPSS of an amount sufficient to amortize all outstanding bonds and other obligations incurred by WPPSS properly related to the project.

II. PROPOSED TERMS AND CONDITIONS RELATING TO AGREEMENT BETWEEN BPA AND WPPSS

A. Upon completion of construction, WPPSS will operate the electrical generating facilities, including associated transmission facilities, constructed by it in accordance with schedules and in a manner satisfactory to BPA and AEC, and will deliver the project electrical output to BPA at a mutually agreeable delivery point.

B. BPA will assume full responsibility for the delivery and sale of all project output at established and uniform rates reflecting the integration of the NPR power with other BPA resources.

C. BPA will reimburse WPPSS, or otherwise make provisions therefor, for all costs and expenses incurred by WPPSS during each year of the term of the agreement for the operation of the proposed facilities, including, without limitation, interest and amortization of any and all debt obligations incurred by WPPSS in connection with said project; the establishment of necessary reserves: renewals and replacements, operation and maintenance; and administrative and general expenses: taxes or payments in lieu thereof, insurance and other costs or expenses incurred by WPPSS for the successful operation of the project facilities.

D. The term of the agreement shall be coextensive with the agreement between WPPSS and AEC.

E. In the event WPPSS shall continue to operate the electrical generating facilities, including the NPR, after all revenue bonds or other obligations issued by WPPSS have been retired, WPPSS shall sell, or otherwise make available, to BPA at its actual cost the power output from the project as long as WPPSS shall continue to operate the facilities.

WASHINGTON PUBLIC POWER SUPPLY SYSTEM,
Kennewick, Wash., November 9, 1961.

Mr. CHARLES F. LUCE,
Administrator, Bonneville Power Administration,
Portland, Oreg.

DEAR MR. LUCE: This is to confirm information previously given to you during recent conversations regarding the action taken by the executive committee of the Washington Public Power Supply System endorsing consideration and studies leading to the non-Federal financing of the power features of the Hanford NPR and our desire to aid and assist in bringing about an early decision as to the desirability of non-Federal participation in the financing of the NPR power features and, if determined economically feasible, to serve as a non-Federal entity for this purpose. Enclosed is a copy of the resolution adopted by the WPPSS Executive Committee related to this matter.

Considerations to date have indicated the desirability of the full integration and coordination of the NPR electrical output with the BPA system and its marketing by BPA. We would therefore like to initiate and carry forward, as promptly as possible, discussions and other actions necessary to bring about and implement early decisions as to the arrangements which would be necessary between BPA, AEC, and WPPSS in order to develop a plan of non-Federal financing, construction, and operation of the NPR power features in the event that such arrangements are economically feasible.

We have greatly appreciated the cooperation and interest already expressed by yourself and members of your staff in this matter and stand ready to proceed as expeditiously as circumstances permit.

Very truly yours,

OWEN W. HURD, *Managing Director.*

WASHINGTON PUBLIC POWER SUPPLY SYSTEM,
Kennewick, Wash., November 9, 1961.

Mr. J. E. TRAVIS,
Manager, Hanford Operations Office,
Atomic Energy Commission,
Richland, Wash.

DEAR MR. TRAVIS: As you know, the Washington Public Power Supply System has had a continuing interest in the proposals for the addition of electric power facilities to the NPR to utilize the waste heat during the period of plutonium production and for power purposes only thereafter. The WPPSS Executive Committee, at a meeting on October 20, 1961, adopted the enclosed resolution endorsing the action of the director of the Washington State Department of Conservation for initiating consideration by BPA and AEC of ways and means for non-Federal participation in the fianancing of the NPR power features and to assist in bringing about an early decision as to the desirability of non-Federal participation in the financing of the NPR power features and, if determined to be economically feasible, to serve as the non-Federal entity for this purpose.

It is the purpose of this letter to advise you of the action taken and to express our desire and interest to cooperate in every way possible to bring about early decisions on matters pertaining to the arrangements necessary between BPA-AEC-WPPSS for the non-Federal financing, construction and operation of the NPR power production facilities and, if economically feasible to serve as the non-Federal entity for this purpose.

We are aware of Mr. Coe's letter of October 27, 1961, to Mr. Seaborg relative to problems related to non-Federal financing of the NPR power features and concur with the viewpoints expressed as well as recognize the importance of obtaining answers to the specific questions raised in his letter. At an appropriate time, we will appreciate the opportunity to participate in discussions with your staff regarding the specific steps that need to be taken to consummate the necessary arrangements with AEC, BPA, and WPPSS for the non-Federal financing of the NPR power features.

Very truly yours,

OWEN W. HURD, *Managing Director.*

WASHINGTON PUBLIC POWER SUPPLY SYSTEM EXECUTIVE COMMITTEE
RESOLUTION 12

A resolution relating to investigation of non-Federal participation in Hanford NPR power facilities, adopted by WPPSS Executive Committee, regular monthly meeting, October 20, 1961, Wenatchee, Wash.

Whereas Congress has rejected proposed plans and appropriations for the addition of power facilities to the Hanford new plutonium production reactor (NPR) now under construction making it desirable to consider ways and means for financing of said power facilities; and

Whereas WPPSS has recognized the need for supplementing Northwest hydro resources with thermal power including the utilization of Cle Elum coal deposits when economically feasible; and

Whereas WPPSS has had a continuing interest in the economic utilization of the waste heat from the Hanford NPR by conversions to electric power and its integration with power produced at Northwest hydro projects and marketed by the Bonneville Power Administration; and

Whereas the economic utilization of waste heat at the NPR during the period of expected plutonium production and the use of the facilities thereafter for power production purposes would aid in meeting expected Northwest power shortages beginning 1964–65 and make available power for Northwest industrial expansion as well as benefit to the Nation otherwise: Now, therefore, be it

Resolved, That WPPSS commend Earl Coe, director of the Washington Department of Conservation in the actions he has taken in initiating consideration by BPA and AEC of ways and means for non-Federal participation in the financing of the NPR power feature, and continuing studies of the economic utilization of Cle Elum coal as a source of low-cost power; and be it further

Resolved, That the managing director is instructed to advise the department of conservation, BPA, and AEC of its desire to aid and assist in bringing about an early decision as to the desirability of non-Federal participation in the financing of the NPR power features and if determined to be economically feasible to serve as the non-Federal entity for this purpose.

DEPARTMENT OF CONSERVATION,
Olympia, October 27, 1961.

GLENN T. SEABORG,
Chairman, Atomic Energy Commission,
Washington, D.C.

DEAR SIR: The recent congressional action refusing appropriations for the construction of electrical generating facilities at the new production reactor now under construction at Hanford, Wash., suggests the possibility of the State of Washington undertaking construction of the generating facilities.

The authority of the State of Washington to construct such a project through the Office of the Director of Conservation of the State of Washington has been preliminarily analyzed in the enclosed memorandum dated October 4, 1961, prepared by the Office of the Attorney General of the State of Washington.

As you are aware, the economic feasibility of the project probably cannot be demonstrated if the project is delayed much longer. Thus, the economics of the electrical generating facility at Hanford are directly related to—

The period of operation of the new production reactor during which steam would be available as a byproduct.

The earliest possible release of energy reserves held by the Bonneville Power Administration in anticipation of 1965–66 power requirements. (Release of this energy reserve can be accomplished only if alternative energy becomes available.)

We believe that the participation of the State of Washington in this project along the lines indicated in the enclosed memorandum may provide the means for avoiding delays which could be fatal to the project.

We wish to emphasize that we do not offer the proposed course of action as a substitute for Federal construction of the facility. Our proposal is, rather, an alternative to Federal construction if, and only if, it becomes apparent that the congressional approval of Federal construction with appropriations cannot be obtained to assure construction within the time in which economic feasibility can be demonstrated.

The State of Washington has consistently and energetically supported Federal authorization and construction of the generating facilities at Hanford. The State is still of the opinion that Federal construction, if commenced in 1962, would be the most desirable approach.

In the event that Federal construction is found to be improbable and State participation is found to be prima facie acceptable, a number of problems must be resolved.

We have had the pleasure of the cooperation of personnel at Hanford and representatives of the Bonneville Power Administration. In our discussions, a few of the problems with which we would be faced in the event the State participation were defined. However, it will be necessary for us to further explore, in concert with the Bonneville Power Administration, Department of Interior and congressional committee staffs, such problems as—

(1) Considerations involved in "leasing" the site of construction with the view of meeting requirements of revenue bond financing.

(2) The period of time in which the Commission can agree to provide steam energy as a byproduct to the primary purpose of the NPR.

(3) In the event of termination of curtailment of plutonium production for military purposes, the terms and conditions for operation of the reactor for steam generation only for the State of Washington would require definition and mutual agreement with the view of satisfying necessary covenants of revenue bonds.

We realize that many additional problems must be defined, analyzed, and provided for before the final analysis of the feasibility of participation by the State of Washington can be determined. We also realize that additional conferences with your staff will be necessary. However, we are confident that these problems, as complicated as they may be from a legal viewpoint, can be resolved.

We hope and believe that our offices and other agencies of the State of Washington will prove to be the catalyst which will enable construction of this important facility with its resultant contribution to the technology and economic strength of our Nation. Accordingly, it is hereby requested that we be favored with your general observations concerning the foregoing and such other problems that you foresee under the plan of participation discussed above.

Very truly yours,

EARL COE,
Director, Department of Conservation.

STATE OF WASHINGTON,
DEPARTMENT OF CONSERVATION AND DEVELOPMENT,
Olympia, November 22, 1961.

GLENN T. SEABORG,
Chairman, Atomic Energy Commission,
Washington, D.C.

DEAR SIR: Since we submitted our letter of October 27 relative to construction of the generating facilities at the Hanford new production reactor by the State of Washington, and your acknowledgment of November 13, the Washington Public Power Supply System, a municipal corporation of the State of Washington consisting of 16 public utility districts, has declared its desire to construct the facilities and is submitting to you an outline of its proposal for undertaking the project.

We request that you defer action on our letter of October 27, and, instead, respond first to the specific proposal submitted by WPPSS. However, we request that the State of Washington be included, in any future discussions for the construction of the facilities by WPPSS, so that in the event WPPSS is unable, for some unforseen reason, to undertake the project, the State will be in a position to proceed with the project as a State-owned facility.

We appreciate the cooperation you and your staff have given us.

Sincerely yours,

EARL COE, *Director.*

Mr. JENSEN. There is another contract that has a bearing on the situation that will need to be negotiated in conjunction with the proposed contract between AEC and the Washington Public Power Supply System, and that is the contract between Bonneville and the Washington Public Power Supply System. It would be well to have a copy of that contract; would it not? The clerk advises me we have already put that in the record.

I may ask to put in a statement later on relative to these proposed contracts.

Now, off the record.

(Discussion off the record.)

Chairman CANNON. Thank you, Mr. Chairman.

The committee will stand adjourned. You will be notified when we resume. In the morning the committee will meet to hear Admiral Rickover at 10 o'clock.

Thank you, gentlemen.

FRIDAY, MAY 25, 1962.

NAVAL NUCLEAR PROGRAM

WITNESS

VICE ADM. H. G. RICKOVER, MANAGER, NAVAL REACTORS, DIVISION OF REACTOR DEVELOPMENT, ATOMIC ENERGY COMMISSION

Mr. CANNON. The committee will be in order.

We are privileged to have with us this morning not only one of the most distinguished men of the Nation, but one of the most eminent of our times, a man who has influenced world history. Without the result and the products of Admiral Rickover's genius, the Nation would not be safe today. Our strongest defense is the nuclear submarine, capable of delivering a warhead anywhere on the face of the world.

We very much appreciate having you with us, Admiral Rickover, and we would be glad to have a statement from you at this time.

Admiral RICKOVER. Thank you for your kind words, Mr. Chairman. I have no prepared statement, sir. I suggest, if it is agreeable to you, that I talk about what we are doing in the naval program and the Shippingport station program, and describe how we are getting along.

Mr. CANNON. That is one of the most important subjects before the committee and the Congress today. You deal not only with weaponry but also with the national economy. We shall be glad to hear you at this time.

NUCLEAR NAVY

Admiral RICKOVER. We have currently in operation 26 nuclear submarines. Of these, nine are POLARIS; the others are attack-type submarines. Two to three more should become operational this year, so we should have a total of about 28 by the end of the year.

With the submarines that have been authorized, together with those in this year's appropriation measure, there will be a total of 75 nuclear submarines, of which 35 will be POLARIS type, the remainder being attack submarines.

There are also in commission the nuclear-powered guided-missile cruiser *Long Beach* and the aircraft carrier *Enterprise*. The *Long Beach* went into operation last year, the *Enterprise* this year. The *Enterprise* was started a year after one recent conventional aircraft carrier and 2 years after another, yet she is more ready for war than either of the others. This demonstrates you can build nuclear-powered surface ships just as fast as conventional ones.

We expect the *Bainbridge*, our first nuclear-powered destroyer leader, to go to sea this year. She will have a cruising radius of about 150,000 miles continuously at full power, whereas the conventionally powered destroyer carries oil sufficient for only 2,000 miles at full power.

When the *Bainbridge* becomes operational she will introduce a new element into naval surface warfare. She will be able to fire missiles and she will be able to sink submarines. She will constitute, by herself, a fast, single-ship task force capable of remaining at sea for long periods of time. She may well become the capital ship of the future.

Dr. WILSON. Will you give the speeds of the carrier and the destroyer?

Admiral RICKOVER. Off the record.

(Discussion off the record.)

Admiral RICKOVER. Because of her somewhat greater displacement, the destroyer's speed is a little less than what conventional destroyers make.

The Navy claims that nuclear surface ships are too expensive. For this reason they are not interested in building additional ones. The cost of a nuclear surface ship over a 20-year life, taking building and operating costs into account, comes out to be about 1½ times as much as for a conventional ship. This is given as the main reason for not going sooner to nuclear surface ships. It is stated that when cost is reduced more will be built.

While an increase of 50 percent is considered a reason for not going to such naval ships, I have not heard any naval aviators advocating

that we should not use naval aircraft even though their cost has gone up about 2,500 percent. Actually, almost everything has gone up in cost. As I testified recently, even the cost of having babies has gone up. I believe it is now about 1.7 times what it was in 1950. On that basis, we should stop having babies, but I see no visible evidence of this. I believe that ultimately the Navy will come around to nuclear surface ships.

My ultimate objective is to develop nuclear cores that, once installed, will last the 20-year life of the ship. If we are permitted to keep on with our development work, we should achieve this. It means you would install the nuclear core while the ship is being built, and you would never have to replace it during the life of the ship.

If we were to build a nuclear-powered aircraft carrier today, we would have to replace the nuclear fuel only once during the 20-year life of the ship. This gives you some idea of the tremendous potential in nuclear power for the Navy.

(Discussion off the record.)

Mr. JENSEN. What accounts for this?

Admiral RICKOVER. In order to take advantage of the high speed and long endurance inherent in nuclear power we have designed all the propulsion machinery to be more rugged and more reliable. Therefore, it lasts longer without overhaul. As you know, Mr. Jensen, we have a very intensive training program through which we put officers and men. The people we train must have outstanding potential to be capable of completing the course and operating the plants properly and safely. As you are aware, there are dangers inherent in nuclear power, and we must see to it that public health and safety is always taken into account in the operation of our ships. We train the sailors in college courses and the officers in graduate courses; in addition they all get much practical training. These men all become more competent than average officers and men, and due to their thorough knowledge of their nuclear propulsion plants, they are able to maintain them in generally excellent condition.

Dr. WILSON. The absence of a boiler reduces maintenance time.

Admiral RICKOVER. That is true. Further, as Dr. Wilson well knows, the considerable work required to constantly clean boilers. On a nuclear-powered aircraft carrier, in particular, the absence of stack gasses permits the ship and the airplanes to remain clean.

Mr. PILLION. Is the space, Admiral, for the nuclear machinery much less than the conventional machinery plus the storage space for the fuel required? Do you get additional ship space by reason of the nuclear installation?

Admiral RICKOVER. On a submarine, sir, you cannot make a practicable comparison. There is no other way known of getting the power and speed that atomic power affords a submarine. As you know, the conventional submarine of the last war could go submerged at a speed of about 10 miles for only 1 hour. Some of the later submarines were able to make about 18 miles for 1 hour. The nuclear part of the propulsion plant uses only a small part of the entire space in a submarine. The propulsion machinery, the electrical generating machinery and its controls, and the other auxiliaries necessary for the operation of the ship take a great deal of space, but these are essential if the ship is to carry out her functions, regardless of whether she is nuclear or conventionally powered.

On an aircraft carrier, though, we are able to carry about 60 percent more aviation fuel because, being nuclear powered, the ship does not have to carry fuel oil. She can use the tanks to carry additional aviation fuel; the practically unlimited cruising radius and the additional jet fuel makes her a better military unit; she can perform her mission better. Whether or not you agree with the need for additional aircraft carriers, there is no question the nuclear powered one is better from a military standpoint.

Mr. CANNON. You may proceed.

(Discussion off the record.)

SHIPPINGPORT NUCLEAR POWERPLANT

Admiral RICKOVER. If there are no more questions about the naval nuclear program, I should like to discuss the Shippingport Station reactor, as well as the new project for a 500,000-kilowatt central station reactor, if I may.

Mr. CANNON. You may proceed.

Admiral RICKOVER. We broke ground for the Shippingport Atomic Power Station in 1954. Actual operation of the plant started in 1957. This was the first atomic power central station in the United States. The plant has operated satisfactorily since that time, and if we wished, I believe we could keep it running for several years more on its first load of natural uranium fuel. The reactor core is of the seed-blanket type; it contains about 14 tons of natural uranium in the blanket and about 90 kilograms of U^{235} in the seed. We replace the seed about every 12 to 18 months, but the natural uranium fuel remains in place. The reactor is at present operating with its third seed and its original natural uranium blanket. We expect to replace the third seed with a fourth one later this year. By the end of the fourth seed, the burnup in the natural uranium blanket will have reached an average of about 9,000 megawatt-days per ton. This natural uranium fuel has now been operating in the reactor for over 4 years. Based on examination of the fuel elements when we last had the reactor down, we believe the natural uranium could last for still another 4 years.

What we are trying to prove is that it is best from an overall standpoint to obtain as much energy as possible from the natural uranium in place in the reactor. This energy is produced from the seven-tenths of 1 percent of U^{235} which is inherent in natural uranium; from the fast fissioning of U^{238}; and from the plutonium which is formed in the natural uranium.

Another advantage of this reactor concept is that it minimizes the use of enriched uranium. Further, the economics of the seed-blanket reactor concept is less dependent on the cost of chemical processing or on the price of plutonium than is the case for other types of reactors.

Upon depletion of the fourth seed at Shippingport, we will increase the capacity of the plant to 150,000 kilowatts of electricity. The present capacity is 60,000 kilowatts. To achieve this higher capacity we have designed and we are now building a new core, also of the seed-blanket type. So, in a relatively short period of time we will be obtaining out of the same pressure vessel 2½ times the power and 5½ times the energy the first core was designed to produce.

NEW SEED-BLANKET REACTOR

The very encouraging results we have obtained from Shippingport have led us to consider a much larger nuclear power station using the seed-blanket core concept. The initial phase of this new work has been approved by the Atomic Energy Commission and has been discussed with the Joint Committee on Atomic Energy. It is my conviction that the future use of atomic power for central stations will be in large stations, in the range of 400,000 to 600,000 kilowatts or more. These stations would be placed in a network around the country and they would be interconnected. In my opinion they would be a very valuable national asset, particularly in wartime. If an atomic holocaust were to occur, the availability of large nuclear reactor plants would free us of one major problem—the problem of having to transport coal to our electric power stations. Of course, you would have to repair transmission lines, but you could keep on operating after repairing the transmission lines. That is one of the advantages of atomic power.

Accordingly there is being requested in the current appropriation measure $7.5 million to start work on a 500,000-kilowatt electrical reactor plant utilizing the seed-blanket core concept. I estimate that it will take 4 years or so to fully design and develop the reactor; the total research and development costs would amount to about $95 million, and the construction of the first plant would be about $100 million. I believe our present understanding of reactors is such that considerable advancement can be made through a concentrated research and development effort. If you really want to make progress, you start off with a sound idea; you get experienced and knowledgeable scientists and engineers working on it, and they will come up with new ideas which will throw out many of the present ones. We found this time and again during the development of the Shippingport Atomic Power Station, as well as of our naval reactors.

If I were given the job to build a 500,000-kilowatt reactor plant in the shortest possible time I could of course build one based on the technology we already have. But it would not be a plant from which much could be learned. I recommend that we develop an advanced reactor from which a great deal could be learned so that a significant contribution will be made to the reactor art. Otherwise, I fear it would be wasteful of time and money.

That is all I have to say on that subject, sir.

Mr. CANNON. Admiral Rickover, we are all aware of the advances made in civilian atomic power as a result of the Shippingport program which has been under outstanding stewardship from the beginning. As you have indicated, you are now undertaking the design and development of a 500,000-electrical kilowatt central station atomic plant which will utilize the same fundamental reactor concept used at Shippingport, that is to say, a seed-blanket core which minimizes the amount of enriched uranium required for light water reactors and furnishes large amounts of power from natural uranium, and reduces chemical processing.

This development is of the greatest importance to the Nation and to civilization, and to the civilian atomic power program since it has as main objectives the conservation of natural resources and the advancement of reactor technology.

If we are really to develop atomic power, and certainly that should be one of our major objectives, we can do no better than to assign the research and development of these plants to you.

I would like to ask you if everything is being provided and if every condition is being met necessary to give you a free hand in this very important work. Is there anything the committee can do to supplement what you already have and to make it possible for you to proceed on an uninterrupted development of this program?

Admiral RICKOVER. Mr. Chairman, the Commission is backing this proposal and they have recommended to you the appropriation of $7.5 million to start work. I hope it would be the intent of Congress to authorize completion of this development and construction of the plant if promising results are obtained during the initial phase of this work. Obviously, there can be no blanket authorization of funds; we must come back every year to Congress and ask for funds.

Today what is being asked for of Congress is adequate for the initial phase of this development. The $7.5 million that has been requested will cover about an 18-month program and should give us a good start.

I would like to assure this committee that if at any time during this development it appeared the project was not worthwhile, I shall be the first to come and tell you. I have many things that need doing, and I would not desire to continue with the development of a project which did not appear to have promise. I would inform your committee, as I have on previous occasions, that the project should be terminated.

Insofar as money for the Shippingport plant, for this new development project, and for the naval program is concerned, if you grant us the money that is being asked, we are amply taken care of. We need no more funds than that.

This committee has always been most generous to me, sir.

Mr. CANNON. I am very glad that is true, Admiral Rickover. Of course, it is always impossible to foresee developments and situations which are constantly changing. If at any time there is development about which you think you need the cooperation of the committee, I hope you will feel free to let us know individually and collectively. I believe I express the sentiment and opinion of every member of the committee seated at the table.

Mr. JENSEN. I am sure you do, Mr. Chairman. I am sure you are expressing the opinion of members of the committee.

Mr. CANNON. We also know that you have in training a thoroughly competent group of scientists and engineers, men who have demonstrated their capacity, and we trust that with their cooperation you will be in a position where you can exercise your judgment both as to objectives and as to the methods of achieving those objectives. We are glad that you are in charge. No one is better able to proceed, and we want you and we want them to understand that, and we are here to help you.

Admiral RICKOVER. Thank you very much. May I thank Mr. Jensen, too.

Mr. CANNON. We know you would turn back any appropriation funds you can not use effectively, so contrary to custom we always perfer to give you a little too much rather than risk not providing enough. We know we can depend on you to turn back what you do not need and cannot use effectively.

May I ask how much have you turned back in the last 2 years?

Admiral RICKOVER. About $5 million last year and $12 million the year before.

SELECTION AND TRAINING OF MILITARY PERSONNEL

Mr. CANNON. Returning to the Navy, is the Navy making any improvements in the education of officers? We are spending a great deal of money. When I looked into that matter the other day, I was surprised at the amount of money we are spending in the education of officers.

We do not begrudge the money. We don't begrudge any amount spent for military purposes, if we know it is being effectively administered. Have you any ideas how we might be certain that we are getting our money's worth when we provide money for this purpose?

Admiral RICKOVER. That is an appropriate question at this time, because yesterday the Secretary of the Navy announced he was making certain basic changes at the Naval Academy. One of these changes is the installation of a civilian dean who will have charge of that part of the curriculum that does not pertain to the strictly military aspects of midshipmen's training.

Another change will require that only civilian instructors be used for academic subjects, leaving officers to teach the strictly military subjects.

Still another change will reduce the maximum permissible age of entry by 1 year—from 22 to 21; there is also to be a toughening of entrance requirements. These changes will, I think, have their effect on West Point and the Air Force Academy, too. Of course, there will be the usual protestations from them that everything they are doing is just fine—that no change is necessary—but ultimately they will quietly adopt these ideas, too. With your permission sir, I would like to insert the Secretary of the Navy, Mr. Korth's announcement of the change.

Mr. CANNON. It is so ordered.

(The announcement referred to above follows:)

[News release, Department of Defense, Office of Public Affairs, May 24, 1962]

NAVY ANNOUNCES ACADEMIC CHANGES AT NAVAL ACADEMY

Secretary of the Navy Fred Korth announced today a policy which will result in a gradual replacement of officer instructors at the U.S. Naval Academy, in all but the Naval Science Division, by civilian professors. Naval Science includes seamanship, navigation, command, leadership, and weapons courses.

In addition, he announced that a civilian dean of academics will be established to assist the Superintendent. This civilian will be an educator of national stature and will be selected by the Secretary based upon recommendations by the Chief of Naval Personnel.

These changes resulted primarily from a review of the Naval Academy education program initiated by former Secretary of the Navy John B. Connally. In directing this review, Mr. Connally expressed the need for accelerated improvement, particularly in the fields of mathematics, science, and engineering, in order that the Navy keep pace with the present rapid technological advancement.

In announcing these planned changes, Secretary Korth pointed out that there would be no reduction in the present emphasis on basic naval indoctrination, discipline, leadership, and motivation to command at sea.

(Text of the Secretary of the Navy's letter attached.)

MAY 21, 1962.

From: Secretary of the Navy.
To: Under Secretary of the Navy, Chief of Naval Personnel.
Subject: Education at the Naval Academy.

1. On December 20, 1961, Secretary Connally, in a letter to the Chief of Naval Personnel, requested the submission of a plan by which accelerated improvement of education at the Naval Academy in the field of mathematics, science, and engineering could be achieved. This letter resulted in very extensive correspondence from various sources, containing recommendations and comments, which I have carefully reviewed. I have also considered the report of the Board of Visitors of 1961, and the report of the Special Advisory Commission on Future Development of Academic Facilities (Moreell report) insofar as it deals with faculty and curriculum.

2. I am impressed favorably by the improvements which have been made at the Academy. Significant progress has been achieved. I am convinced, however, that more rapid improvement is possible and necessary. To aid in the furtherance of this aim, I approve the proposal of the Manager, Naval Reactors Branch, AEC, concurred in by the Chief of Naval Personnel and the Under Secretary of the Navy, that a civilian educator of national rank be appointed to report to and assist the Superintendent of the Naval Academy as his dean of academics. The Chief of Naval Personnel is requested to recommend to me for appointment to this position an individual possessing the requisite competence and stature.

3. Recognized by all who have evaluated education at the Naval Academy during this unprecedented period of technological advancement, has been the serious problem of providing as instructors naval officers who possess adequate educational qualifications and teaching experience. This problem has been primarily one of timing, brought on by the incompatability between the rapid move into a more complex technology and the longer time required to achieve advanced education and teaching experience in these new areas. To correct this deficiency as rapidly as is practicable, I desire that the Chief of Naval Personnel initiate action to replace, on a phased basis, the officer instructors in all but the Naval Science Division of the academic organization with qualified civilian professors. In this regard I do not intend that assignments of officers now under orders to the Naval Academy be canceled, or that those now serving be short toured. Nor does this replacement policy preclude the future assignment of naval officers to the Naval Academy faculty in those instances where such officers possess the educational and teaching qualifications to be required of civilian professors. I do intend that where such assignments are made, they are made on the basis of educational and teaching qualifications, and not on the basis of possession of officer status. I further desire that the present efforts of the Chief of Naval Personnel to increase the number of prospective officer instructors who receive a year of postgraduate training prior to their tours as instructors be continued and intensified as to officers ordered to duty in the Naval Science Division. Such efforts should, of course, also be continued with regard to officers ordered to the Divisions of Science and Engineering, and Social Science and Humanities until the phased replacement of officers by civilian professors is accomplished.

4. The Under Secretary of the Navy is requested to initiate the steps necessary to lower the maximum age for admission of midshipment to 21 vice the present 22 years, as recommended by the Board of Visitors; to raise the Academy entrance requirements to the maximum practicable extent; and to conduct an analysis of the fiscal aspects of the above policy decisions.

5. It is not my intent to reduce in any way the present emphasis on basic Naval indoctrination, discipline, leadership, and motivation to command at sea. Officers ordered to duty at the Naval Academy must continue to exhibit outstanding traits of character, dedication and professional competence so as to motivate midshipmen to a successful and rewarding career of Naval service to this Nation.

FRED KORTH.

Admiral RICKOVER. However, the real problem with the training of officers is this: Just as water cannot rise above its level, the highest level that can possibly be attained today in military competence depends on the kind of boys who enter the service academies, their potential, and the kind of education and training they get. This is

not the case in other occupations, whether it be in Congress, in the executive branch of the Government, in business, in industry, or in the professions. In all these occupations there is a constant inflow of new people at all levels. If the people who entered these organizations at the bottom are not the best for the jobs at the top, other, outside men can step in. Not so in the military. Once you set the standards of entrance to the military, right then and there you automatically and permanently set the top ability level you can ever get out of the military. They are thus self-limited. Therefore, if you want to make a long-range improvement in our military institutions, this must start at the service academies, in their selection system, and in the education they give.

Perhaps we should consider placing highly competent civilians into the top reaches of the military structure. This certainly could be considered for many of the scientific, engineering, logistics, material, and management functions.

Let us take the case of a successful company. If they see an outstanding man on the outside, they will bring him in and place him in the hierarchy; if they see a young capable man within the organization, they will advance him over his seniors.

Wars now are fast, powerful, and destructive. The consequence of individual action is far greater than it has ever been. Therefore, unless you have a system where the best people available anywhere can be put into important jobs, you sure are in trouble.

Mr. CANNON. I would like to interrupt you there to say that for the last 2 or 3 years or so I have been expressing my concern over the selection process under which we take boys from the cornfields, from the workshops, from the streets, anywhere we find them, while they are still in their teens and before they have demonstrated their capacity, their mental caliber, their temperament, or other factors that contribute toward success or result in failure. All we ask of them is that they pass the entrance requirements to the academies.

Then when they are graduated, they are promoted automatically. It is merely a question of time. We are limited thereby, in the men to whom we entrust the safety of this Nation, the men who will command our military forces. We are limited in the selection of men who are responsible for national defense, the safety of the Nation in times of stress; to those few men whom we have picked up here and there and yonder in the cornfields and in the factory from whom this selection can be made.

Now, it would seem we are starting at the wrong end. We should wait—and this is an important factor—until these men have on their own initiative entered a standard college and completed an approved course of study. Then after they have demonstrated their capacity, we should make our selection and take men of proven ability, of proven talent and send them to an intensive military school. Apparently we are selecting these boys at least 4 years too soon.

Mr. JENSEN. Mr. Chairman.

Mr. CANNON. The gentleman from Iowa.

Mr. JENSEN. I have given many examinations and I have only had one failure at the Naval Academy. I am often appalled when I see the grades made by some college students. It is almost unbelievable. The high school senior will generally get a better grade than a college man. Have you noticed that? It is difficult to account for.

Admiral RICKOVER. May I interrupt, please?

Mr. CANNON. Admiral Rickover.

Admiral RICKOVER. Dr. Bestor has shown from "Educational Measurement" published by the American Council on Education that nearly 10 percent of college seniors had achievement scores below the average high school senior. It was also found that if the graduating class had been selected from the entire student body on the basis of achievement test scores alone only 28 percent of the senior class would have graduated; the remainder would have been made up of 21 percent juniors, 19 percent sophormores, 15 percent freshmen.

These figures point up what you are saying, sir.

Mr. JENSEN. Another peculiar thing, my first appointment to Annapolis was a boy from a little town, Farragut, Iowa. His name is Vance Cox. He was made the skipper of the first missile ship which was commissioned in Boston Harbor last fall. He was a high school graduate. He was from a small town, I think of about 400 people, and he passed a civil service examination with an average of 94 and a fraction percent.

Admiral RICKOVER. He was lucky to come from a small town or a farming area. He probably did much better than if he had gone to some of the city schools.

Mr. JENSEN. It is a most unusual thing to analyze those grades that these boys make, and you can imagine in 24 years I have given a lot of examinations. It is the most difficult thing in the world to forecast in advance by any degree just what kind of a grade these boys were going to make.

Admiral RICKOVER. This is because there is no standard for the high school diploma. In the United States there are about 33,000 school districts, and each school in each district decides on its own what a high school diploma means so you cannot relate any one high school diploma to any other. You can have a boy graduating with excellent grades from a high school, yet in college he may not do well at all. The more rigorous college curriculum immediately shows up the excellence or lack of excellence of a particular high school. About 60 percent of those who enter college fail to finish.

I interview young men who are just about to graduate from the Naval Academy. I interviewed over 100 this year. I also interviewed about the same number of young men who are in our college Naval Reserve Officers Training Corps. I find that on the average the young men in the NROTC are scholastically a year or more ahead of those at the Naval Academy.

This, I believe is the point Mr. Cannon was making. He was maintaining that we are not getting the best boys into the service academies. If you want to compare their scholastic achievements with those of European students I can give you some basis for such a comparison. I don't believe that the average graduate of our service academies has been much better equipped intellectually than the graduates of the higher secondary schools of Continental Europe. If you look at the examination questions that must be passed by the 18- to 19-year-old boys and girls on completing the course at the better secondary schools in Europe you will see that many of the graduates of our service academies would have a hard time passing them. In general the children abroad are about 3 years or so ahead of ours scholastically at the time they finish secondary school.

Mr. JENSEN. I listened to you years ago, Admiral, when you talked about the educational system of Russia. The other day you talked about the educational system of England. I think there is one thing you forget, and that is this, that our children have a broader base in education than any other country in the world in this respect. We do not put great emphasis in our high schools on any particular subject. We give them a smattering so to speak, and to some degree a good education in many parts of their curriculum, so that when a child or a pupil leaves the high school, he has, I am quite sure, a better concept of the many things in business life or social life, and even in military life on a broader base, and are better informed on many subjects than the school children of foreign countries, to the end that when they do graduate from high school or college, they have pretty well decided by that time what they want to do in their lifetime, whether they want to be a doctor, a businessman, a military man, a scientist or what not. I think our liberal arts in college is a great determining factor in keeping our country on more or less of an even keel economically, in business, science and professions. We don't spend a greater share of our time teaching the sciences as do possibly other countries but I believe that is one point you have failed to recognize in our educational system, Admiral. We teach these children so many different things in our schools and colleges that fits them for their life's vocation and we do it in the most voluntary manner. We do not pick out a certain group and say now we are going to put great emphasis on you and we are going to spend a lot of money on you. It is up to you to make yourself, and to do the best you can for yourself. If you can do good for yourself under our system of government, you do good for your country. After all, our country is built around the individual, our Constitution is, and I am not going to throw our educational system in the ash can. Of course, it can be improved, but the facts are that we have built here the finest, the greatest, the strongest Nation in the world, and we have to give much credit to our educational system.

Admiral RICKOVER. Recently I sent you a copy of the book I recently published "Swiss Schools and Ours—Why Theirs are Better." I think you will find in it some points of interest. You will find they no longer have "class" education in Europe; you will find they are short of unskilled workers while we are short on skilled workers.

Look at the problem we have right now with retraining unskilled workers—workers whose education was faulty, and so made it impossible for them to cope with the requirements of a modern industrial society. Western Europe does not have that problem. In England, for example, 52 percent of the work force is skilled. Switzerland imports a quarter of a million unskilled workers. Sweden, Denmark, and other European countries also import unskilled workers. Their shortage is in unskilled labor; our shortage is in skilled workers.

Mr. JENSEN. Excuse me. But we are getting away from the subject.

Admiral RICKOVER. Mr. Jensen, I do agree about the great importance of education.

Mr. JENSEN. But we have never disagreed on your profession. I have stayed with you through thick and thin on the thing that you do best.

Admiral RICKOVER. Why, you are just as qualified as I am. You are not a schoolteacher, neither am I. We are both in the same boat.

Mr. CANNON. I was reminded when I read the newspapers this morning of a conversation I had with the president of Missouri University at a time when these GI boys were coming back from service and matriculating at school again. I said:

> Mr. President, I should think that these boys after 2 or more years in the service, coming back to an academic atmosphere, would be greatly handicapped by the long hiatus since their last college work; that they would be rusty, and would have difficulty reorienting themselves, and would be at a disadvantage starting so late in life finishing their college course.

He said:

> I must confess that I had the same attitude. For that reason, our faculty has kept a very careful check on all of the different categories of students. We find that the GI, when he comes back, takes a little time to get into the groove again, but at the end of the year, the usual GI who is returning after an absence of some years, has a general average better than the man who comes from high school and goes straight through.

I thought that was very interesting. He said:

> We find not only is the general average of the men returning from the Army higher than that of the men who have never had service and enjoyed an uninterrupted course, but we find that the GI men who are married make a better general average than the GI men who are not married.

It goes further than that.

> We find that the married GI men who have children have a better general average than the GI men who are married and without children.

In other words, the man who has returned after a number of years of service in the Army is a better student or at least gets better results or has better capacity than the man who has come straight up from high school. The man who is married has a still better average, and the married man who is with children has the highest average of all.

I noted in this morning's newspaper that Astronaut Carpenter had flunked out in college, but that he had later on realized his mistake, had gone back, and had completed his college course.

I would like to ask, Admiral Rickover, how do you account for the fact that the man with military service has a better average than the man without it, and that the married man has a still better average, and especially that the man married and with children has the highest average of all?

Admiral RICKOVER. I think the obvious answer is motivation. For example, polls conducted in England with their national servicemen which corresponds to our draftees, showed that about 50 percent quit school as soon as they reached the age of 15. There is compulsory 10 years of schooling in England which starts at age 5 and ends at age 15. Many of these national servicemen said that if they had to do it over again they would have stayed on at school. This happens in the United States too—many of the boys and girls leave school as soon as they can. I am certain that the most important factor is motivation.

The man who had the children had a greater responsibility; his family motivated him and he went back to school and he did his work better. But he is also older and more mature than he was before he entered the service. No doubt during his military service

he saw that the road to advancement was through learning. But I must add to that that when these young men go back to college they can generally make a respectable mark in an ordinary college despite their previous lack of a good basic education.

Mr. EVINS. What you said about motivation reminds me of a small college in my State from which Cordell Hull is the most distinguished graduate. Poverty and motivation determine their desire to get ahead.

I think the admiral is making a great contribution in the field of education, not only in the nuclear science field.

Mr. CANNON. If the gentleman will permit me to interrupt him?

Mr. EVINS. Yes, sir.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. EVINS. I was impressed at what the admiral said in a recent appearance before our committee when he said that at one time he thought money was the answer, but he more recently had decided the appropriation of money is not the full answer, and this is what I believe very strongly. We want to provide you with adequate appropriations, but motivation and resolve and determination and these other things are essential, not only in this program, but in others.

Admiral RICKOVER. I am not saying we don't need money. But we are not going to solve atomic problems, missile problems, space problems, educational problems, or any other problems by money alone. I would like to repeat the statement I have made many times I think this committee of Congress is the most generous group of men who have ever lived insofar as money is concerned. If there is inadequate progress in the United States in fields on which you legislate, whether it is in atomic power or in education or whatnot, the fault cannot in my opinion be laid to Congress.

NEW SEED—BLANKET REACTOR

Mr. EVINS. On this central station reactor, you say it may cost $95 million to $100 million.

Admiral RICKOVER. Yes, sir, to develop it.

REACTOR DEVELOPMENT PROGRAM

Mr. EVINS. You testified earlier that you did not like to engage in something unless you had the money and funds to go forward with it, but the men on this side of the table are rather practical minded men, at least we think we are, and we would like to know we are getting results. We know that your contributions in nuclear power are tremendous and we applaud you for it. We know that we have developed the atomic bomb which ended the war and got the world into its present stage. We wish we had it exclusively for our own, but we have given out the art until others have it. But how much money have we spent in the development of nuclear power? Can you tell us?

Admiral RICKOVER. I suggest you address that question to Dr. Pittman, who is the Director of Reactor Development, sir.

Mr. EVINS. He is an excellent man and a graduate of Vanderbilt University.

How much have we spent in atomic reactor development?

Dr. PITTMAN. The total for the civilian power program since we started it in 1948 is $525 million. This is just for the civilian program.

Mr. EVINS. I was asking the overall figure.

Dr. PITTMAN. About $3.2 billion for the reactor development division program which includes the military and space reactor programs. This does not include weapons or production. This is the reactor development division program since it started, roughly in 1948.

Mr. EVINS. How much for the civilian?

Dr. PITTMAN. About $525 million for the civilian power program itself.

Mr. EVINS. Who is getting the greater benefit of that? Is it the consumer, the public, or is it the private utility companies that have had contracts with the Atomic Energy Commission? Who is receiving the lion's share of the benefit from this money being appropriated?

Dr. PITTMAN. Eventually it will go to the public.

Dr. WILSON. No private utility has made any money out of it so you can rest safe on that.

Mr. EVINS. Many of us have been interested in seeing nuclear or atomic power developed for the benefit of the people as soon as possible. We are back of you, we are enccuraging you and we are trying to help you, but we wonder when it is going to be achieved?

Dr. PITTMAN. It can only happen when it is going to become competitive. We have the goal that it will be competitive in high cost areas in 1968. We are convinced we will meet that goal and we are further convinced as time goes on into the 1970's the competitive will expand quite rapidly throughout the United States, and the number of people who will be able to take advantage of this expenditure will be increased tremendously.

Mr. EVINS. I have a feeling that the coal interests, the electric power people, and others are doing everything within their power to slow down the process, and not to speed it up. We have developed the bomb and we have developed it rapidly and we have developed nuclear submarine power rapidly, but we do not seem to be able to develop rapidly electric power from nuclear sources.

Mr. MAGNUSON. Will the world ever run out of uranium, Admiral?

Admiral RICKOVER. Yes, the world will run out of all minerals, including uranium at some time. But to give you a practical answer, the energy reserves in uranium are greater than in coal or oil. That is the real reason for learning how to use uranium for energy, because coal and oil are too valuable just to burn. There is only a finite amount of energy in the earth—coal, oil, uranium and thorium. From an intrinsic standpoint they are worth more than gold, because you can do things with coal and oil you cannot do with gold. It is only a question of time before we will run out of coal and oil. The real reason for working on atomic energy for peaceful purposes is that no modern industrial society can be viable without large energy resources. We must have these large energy resources. That is the major reason for working on civilian atomic power.

I am not anywhere near as sanguine as Dr. Pittman as to when atomic energy will be competitive with energy from coal or oil. He may be off 10 years, but what difference does it make? If we must have it, we must, and it makes no difference whether it becomes com-

petitive in 1968 as Dr. Pittman believes, or in 1978 or 1988. There is no shortage of coal or oil today, but sooner or later there will be. So we must work on developing atomic energy now. Because if we do not work at it now we will not have it when we need it.

I believe it is fruitless to keep on arguing about the exact year atomic power is going to be competitive with coal or oil. I think the people who are urging appropriations for their projects in Congress might be better off if they did not get so thoroughly involved in predicting the exact date we are going to have competitive atomic power; the exact cost to one-hundredth of a mill; things generally don't work out that way. This committee surely knows that many people come to you and ask for money and make promises on costs, time, and so on, that seldom bear out. That is part of the game. If atomic power is worthwhile it should be pursued on its merits and supported financially on that basis. This is my view.

Dr. WILSON. There is one addition that should be made to the statement of how long our uranium will last. The uranium 235 which is only 0.7 of a percent of natural uranium, is the main thing we are burning in reactors today. We get some additions from something like the seed and blanket, but these very large resources of energy are only true if you can use substantially all of the uranium which means breeder reactors, and things of that type. The seed and blanket is a step in that direction but it does not go very far.

Admiral RICKOVER. It is a long tough problem to develop atomic power, but we cannot, as I have said, run an industrial society without energy resources. The cost of electricity today is about 1 percent of the total manufacturing costs, so from a cost standpoint it is really not too significant. Yet if we did not have electricity, we could not have our modern industry.

So it does not make too much difference whether it is going to cost 2, 3, or even 4 or 5 percent of total cost of manufacture. You still must have it. If we sitting around this table are concerned with the welfare of our future citizens we must insure that they also will have energy resources. We must incur these expenditures for the benefit of our children and their children. As far as the coal interests are concerned, I think they are needlessly concerned about atomic power reducing the use of coal. Actually, the atomic energy industry has been the cause of using more coal rather than less. From that point of view, they should be urging the development of atomic power. Coal and oil are simply too valuable a natural resource to burn for obtaining energy alone. There are other far more valuable uses for them, as in petrochemicals.

Mr. EVINS. The Joint Committee put a time limit of 1 year to develop the Hanford reactor. Now we have been advised that they were not able to do it in the 1 year and it will cost $43 million more. So we must be concerned with time.

Admiral RICKOVER. There is a gestation period for developments as well as for humans. You cannot force developments too fast. If you already knew what you are going to do then it would no longer be a development. When you call something research and development, you are getting into the area of the unknown. You just don't know how it will turn out, how long it will take, or how much it will cost. You have to trust the people doing the development; that is why judgment of the people who will be in charge is the most important factor in authorizing research and development.

Mr. EVINS. We do trust you and we admire you; but we want more to be like Admiral Rickover and push things along rather than become comfortable and complacent in your programs and not become too bureaucratic.

Mr. CANNON. Mr. Jensen.

EDUCATION OF MILITARY PERSONNEL

Mr. JENSEN. A number of years ago I was on the visiting committee to Annapolis. Every year, as you know, Admiral, there is a committee of three members from each body appointed by the Speaker and the Vice President, to visit Annapolis and West Point, and I presume now the Air Force Academy at Colorado Springs. They spend a week going into every function of those academies.

When I was made a member of that committee, we worked constantly 5 days morning till night, and then had meetings in the evenings also with the Commandant and his staff. I discovered at that time that they did not each have courses in business administration nor did they have in their curriculum an instructor in procurement. Then I began to realize why the military had gotten into a lot of trouble in their purchasing of these billions of dollars worth of defense materials.

The last day when we had a meeting with the Commandant and the entire officer personnel of Annapolis, I asked this question of the Commandant: "Why don't you give some good lessons in business administration and in purchasing?" He said, "Well, I guess we figured it was not in our line of endeavor." I said, "Your people graduate from here and they finally get into the Pentagon, and they buy billions of dollars worth of stuff and they never have had 1 minute of training in business administration and purchasing."

I said, "Don't you think it is about time you teach these boys a little business administration and the art of purchasing?"

He thought it was.

I said that I was going to insist when you start the next class that you give instructions in business administration and purchasing and I understand they did.

Do you know, Admiral, to what degree they are instructing in business administration and purchasing at Annapolis and West Point?

Admiral RICKOVER. I think they possibly do have elective courses that would touch on business administration. You realize, sir, that the time available is greatly limited for all the basic subjects that must be taught. That is why they must refrain from devoting too much time to specialties. These can be studied after graduation. This is one reason why we have a Supply Corps in the Navy—why we have other special branches in the military.

I agree that any officer who becomes involved in handling material, particularly procurement, inevitably gets involved with money and how to spend it. He has to acquire some understanding of financial matters but a good deal of this a man can pick up on his own without necessarily getting formal courses of study. It is just like a woman learning how to make an apple pie. She does not have to go to school to do it. There are some things you can pick up by yourself. If you start in teaching things like business administration and law and accounting at the Naval Academy, there would be no time left for

teaching the fundamental subjects, such as mathematics, physics, chemistry, engineering, science, history as well as the purely naval subjects required. That is why the Naval Academy cannot go too much into the teaching of specialties. There simply is not the time.

Mr. JENSEN. If no one is taught the area of business administration and purchasing at the Academy, then we should make very sure that they do not have the authority to buy even a common pin for the public, because certainly it has been a disgraceful record that has been made by many in the military who do the purchasing. I hope that we can have an end to that. So much for that.

(Discussion off the record.)

NUCLEAR NAVY

Mr. CANNON. Admiral Rickover, would you supply us with information concerning your testimony of 3 or 4 years ago when you asked that we step up production of nuclear submarines.

Admiral RICKOVER. Yes, sir, 3 years ago I told this committee I thought the Navy should be building more nuclear attack submarines. If you like, I will find that statement for the record. I still think we should be building more attack submarines. The Russians have missile-carrying submarines which can operate off our coasts. We urgently need more nuclear attack submarines because they are the best weapons we have to counter this threat.

Representative Van Zandt introduced a bill in 1958 and again in 1960 to authorize construction of 100 nuclear attack submarines at a rate of 20 per year. The Navy did not support this bill. A total of only eight attack submarines have been authorized in the last 3 years—eight are being requested this year.

(The statement referred to above follows:)

STATEMENT OF VICE ADM. H. G. RICKOVER IN TESTIMONY BEFORE THE SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS, HOUSE OF REPRESENTATIVES, 86TH CONGRESS, 1ST SESSION, MONDAY, APRIL 27, 1959

I believe our submarine program is adequate for the POLARIS type. It is not at all adequate for attack submarines * * * I do not believe we are building enough attack submarines. Today it is the best weapon that we have for destroying enemy submarines. There is no better weapon * * * We have the capacity right now, with the number of submarine building yards, to build about 10 more nuclear attack submarines a year.

Mr. JENSEN. You have already told us in an off-the-record discussion the number of atomic powered submarines that we have, and the number which are POLARIS equipped. What was that number?

Admiral RICKOVER. The number in operation now is nine POLARIS. The number which will have been authorized when the current appropriations bill is finished will be 35 POLARIS submarines.

Mr. JENSEN. How many atomic powered alone?

Admiral RICKOVER. In addition to these 35 POLARIS there will be 40 atomic powered attack submarines. Thus if Congress approves the fiscal 1963 appropriation measure, there will be a total of 75 nuclear submarines either in operation, being built, or authorized.

Mr. JENSEN. How many conventional submarines do you have?

Admiral RICKOVER. We have 113 conventional submarines in commission.

Mr. JENSEN. We have a considerable quantity of enriched uranium, do we not?

Admiral RICKOVER. That again is a question which other people here are more competent to answer.

Dr. WILSON. Off the record.

(Discussion off the record.)

REACTOR DEVELOPMENT PROGRAM

Mr. JENSEN. Is plutonium a substitute for enriched uranium?

Dr. WILSON. For certain purposes. It is not a substitute in power reactors now but eventually it will be. Certain weapons are designed to use enriched uranium and certain weapons are designed to use plutonium.

Mr. JENSEN. About 3 years ago our great friend and colleague, who has passed to his great reward, Mr. Rabaut, and I were sent to England to look at their atomic reactor program. We went to Dunreay and took a look at the reactor that they were building up there. This was known as the breeder concept. Mr. Culp was with us. They claimed at that time that it was 85 percent complete, and that it would produce a lot of plutonium which they said they needed very badly, because they had very little enriched uranium.

We also inspected the other atomic reactor plants in different parts of England. They were very cooperative with us. They were wonderful. We have worked very closely with England and they have worked very closely with us on this atomic matter. Has that reactor at Dunreay been completed?

Dr. WILSON. It has been completed and it is operating at low power. It is not up to full power.

Mr. JENSEN. Is it doing what they expected it to do, and that is that it would be a little bit like perpetual motion?

Dr. WILSON. That is what we are striving for and must get if we are going to have a reserve of uranium in the future but they are very far from economical today.

Mr. JENSEN. Are we making some progress?

Dr. WILSON. In a sense we have breeder reactors at Savannah River and Hanford. They are making plutonium from uranium, but our first breeder power reactor of a large scale is the one at Detroit which is due to come in this year.

Mr. JENSEN. It will come in this year?

Dr. WILSON. Yes; it is scheduled to come in this year. They have had some difficulties in construction.

Mr. JENSEN. We visited the Detroit plant and learned something about their hope and their program.

What in your opinion, Dr. Wilson, is the reactor concept that is showing the most promise?

Dr. WILSON. It depends on whether you are talking about a long-range promise or immediate promise. Immediate promise of economic power will probably be achieved by the water-type reactor.

Mr. JENSEN. Boiling water?

Dr. WILSON. Boiling water or pressurized. They are very closely competitive.

Mr. JENSEN. I have tried to differentiate between those two concepts. What is the difference?

Dr. WILSON. There is not a great deal of difference. One of them actually boils the water in the reactor itself. It generates its steam in the reactor itself. The other keeps enough pressure on so that there is no boiling in the reactor itself, and it goes over into a heat exchanger where you transfer the heat from the pressurized water to water at a lower pressure which does the boiling.

Mr. JENSEN. The plant in Nebraska is sodium graphite?

Dr. WILSON. Yes.

Mr. JENSEN. Is that plant ready to go on the line?

Dr. WILSON. Yes; that is scheduled for this year also.

Mr. JENSEN. The reactor is underground. Is it not much cheaper to build them underground?

Dr. WILSON. It is cheaper to build them above ground with the containment vessel.

Mr. JENSEN. That is hard to understand. Digging dirt out of the ground is done fast and pouring concrete is done very fast, and economically.

Dr. WILSON. Building steel vessels can be done very rapidly and economically, too. After all, there are many problems that you have when you go down as deep in the ground as you must for this, and you must have something that will hold the ground away, and you have in essence a containment vessel of some sort to keep the ground out, so the net result is that it is not more economical to build underground than above.

Mr. JENSEN. Go ahead with your different concepts that you feel show the best promise for the short range, and the long range.

Dr. WILSON. The other one that may come into the short range is the organic cooled, where they use an organic coolant instead of water. The main trouble with that has been the fouling of the main cooling system. The organic coolant is not as stable as might be wished and you do get some difficulty, but we believe we have pretty well licked the problem. It can only be proven by longtime operation, but we are going to go into that. One of the things on the appropriation this year is an organic-cooled reactor.

For the longer range, what we must go to is breeder reactors, fast breeders probably, of which there a number of different designs, and at this stage you cannot tell which will be the most effective. Some of them breed from uranium to make plutonium and some of them breed from thorium to make uranium 233, but we are not ready to build many large prototypes yet, because there are tremendous problems in making a breeder reactor economical and safe.

Mr. JENSEN. What type is used now?

Admiral RICKOVER. Pressurized water, sir.

Mr. JENSEN. And you do that because you have plenty of water?

Dr. WILSON. You need fresh water.

Admiral RICKOVER. There is far more experience with water than there is with any other cooling medium. Further, we can make fresh water from sea water. Our ships have evaporators. If we lose some of the fresh water, we can make it right on board ship.

Mr. JENSEN. Right on the ship?

Admiral RICKOVER. Yes, sir.

Mr. JENSEN. Do you have to carry fresh water or do you make it?

Admiral RICKOVER. We make it. There are tanks on the ship in which we store the fresh water we make. We must have fresh water,

of course, for drinking, cooking, and other purposes also. If you were young and had the opportunity you might consider serving in a nuclear submarine rather than coming to Congress. It is comfortable and you would not be subjected to as many pressures, sir.

Mr. JENSEN. We have more boys in the Navy per capita from Iowa, Nebraska, and Missouri than any other States in the Union.

Admiral RICKOVER. They are running away from the farms. You would not be as harassed on a submarine as you are in Congress. You would get no mail, telephone calls, or visits.

I respectfully suggest you go out on one of these nuclear submarines for a 1-day cruise. I know it will be very interesting and instructive.

Mr. JENSEN. I would like to.

Mr. CANNON. Mr. Pillion.

MISSILE DETERRENTS

Mr. PILLION. I have been somewhat concerned about our missile bases being stationary, and that a lot of our firepower could be destroyed. If you had 50 or 60 submarines lying off our east, west, and south coasts, and they surfaced and threw their missiles at one of our industrial areas around the coast, the destructive power of those Russian submarines would be just as great as that of a POLARIS, would it not?

Admiral RICKOVER. Yes, sir; assuming they have the same type warhead.

Mr. PILLION. Let us assume they have the same power in their warheads as we would have in ours. Therefore, to assume that the POLARIS missile in itself is a deterrent—an absolute deterrent—would be a mistake, would it not?

Admiral RICKOVER. That is correct, sir.

Mr. PILLION. As to what is or is not a deterrent is actually a psychological problem of what Khrushchev and his Politburo think. So for us to think that the POLARIS is an absolute deterrent would be a mistake also. We must look into the minds of the people who are going to make the decision in the Kremlin and in that area.

Admiral RICKOVER. We believe we think logically, and we have to assume where the life of his nation is concerned the other man is thinking logically, too. Otherwise, all bets are off. People who think logically cannot have meaningful dealings with others who think illogically. But I don't believe anyone has accused the Politburo of not thinking logically. They may not think the way we would like, but we cannot say they do not think logically.

Mr. PILLION. I believe in more mobile missile dispersement, and I do not think the fact that a submarine submerges and then shoots its missiles is necessarily something that gives us a decided or immediate advantage or complete advantage.

Is there some practicality to the idea that perhaps we ought to have more mobile intermediate- and long-range missiles for Navy ships which are mobile rather than a stationary target upon which they can fix in the event of a first strike? A first strike after all is almost 70 or 80 percent of the battle if it comes. I wonder if there is any practicality, even if they are surface ships, to the mere fact that they are movable would mean they could not knock them out in the first strike.

Admiral RICKOVER. This idea has been proposed to the Secretary of Defense, but he has the problem of having to look at the Defense Establishment and the money available to him as a whole. In his wisdom, and I am sure with the advice of his military advisers, he has decided not to do this. For mobility of missiles on land he has authorized development and procurement of MINUTEMAN missiles by the Air Force. You are getting into questions that have been very thoroughly studied by the Secretary of Defense and I am sure he has done the best he could under the circumstances. If he had unlimited funds, he could do many other things, but he doesn't have that freedom. Pretty soon you could wreck the country if you granted all the funds the military and others ask for. With a national budget of more than $80 billion you are being quite generous.

Mr. JENSEN. Actually it is a $100 billion budget in round figures.

Mr. CANNON. Mr. Pillion.

ATOMIC POWERPLANT PROGRAM

Mr. PILLION. Would you say the attempt to push the construction of numerous large atomic powerplants is premature at this time because of the tremendous problems yet to be solved in order to achieve economic power?

Admiral RICKOVER. I am not sure we can achieve competitive atomic electric power with the knowledge we have today. In my opinion, no plant that you will build today will actually be competitive. Therefore, the money you spend on building civilian atomic plants should be on prototypes—for the primary purpose of developing the art, for learning for the future.

Mr. PILLION. And don't make two or three of the same type?

Admiral RICKOVER. That is right, sir. I think this is what the program of the Atomic Energy Commission essentially is. The AEC is not proposing that we build large numbers of civilian atomic powerplants with Federal funds. If industry wants to do so they can do it with their own money: the program of the Atomic Energy Commission is not to build large numbers of such plants.

Mr. PILLION. That concludes my questioning.

Mr. CANNON. Thank you, Admiral Rickover. We much appreciate having you with us today.

Mr. PILLION. It is always educational and instructive.

Mr. CANNON. The committee and the country appreciates what you and your associates are accomplishing.

Mr. JENSEN. I would like to say it is always very gratifying and enlightening to hear Admiral Rickover testify. I know he is one of the most efficient and learned men in the world, and I thank God that you are an American.

Mr. CANNON. I am sure Mr. Jensen speaks for all members of the committee.

Admiral RICKOVER. Mr. Jensen and Mr. Cannon and the other members of this committee, you have touched me very deeply by what you have said. I do appreciate your confidence, and I can only tell you I will try to do the best I can. As I look back over my years, I probably have sinned both against God and my fellow men because I have not done as much as I could or should have.

Mr. JENSEN. I am sure if you have sinned, the good Lord will forgive you for all the good things you have done, and I don't think

your sin has been so great—in fact, I doubt that you have sinned at all. It has been wonderful to have you with us.

Mr. CANNON. The committee stands adjourned until 10 o'clock Monday morning.

MONDAY, MAY 28, 1962.

Mr. CANNON. The committee will be in order.

RAW MATERIALS

We take up this morning the budget proper, and the first item is $500,585,000 for raw materials. The stenographer will insert pages 13 through 17, and the associated construction pages.

(The justification follows:)

RAW MATERIALS PROGRAM—OPERATING EXPENSES

Program statement

Estimate, fiscal year 1963	$500, 585, 000
Estimate, fiscal year 1962	538, 394, 000
Decrease	37, 809, 000

Raw materials program budget requirements for fiscal year 1963 consist entirely of costs directly related to the procurement of uranium concentrates. Uranium concentrate purchases in fiscal year 1963 are currently forecast at 28,400 tons compared with estimated fiscal year 1962 procurement of 29,325 tons, a decrease of 925 tons. The average price per pound will decrease in fiscal year 1963 to $8.84 from an average price of $9.18 in fiscal year 1962. The decrease in average unit price is principally due to the larger proportion of lower cost domestic receipts in fiscal year 1963 and a devaluation of Canadian currency.

The overall decrease of 3.2 percent in concentrate tonnage is principally the result of a decrease in estimated receipts from Canada in accordance with the schedule of deliveries under the current contract. Too, final deliveries under the Combined Development Agency agreement with Portugal and Australia (Radium Hill) will be completed in fiscal year 1962 and deliveries under the Australia (Rum Jungle) agreement will be completed by mid-fiscal year 1963. No provision is made in the fiscal year 1963 estimate for the purchase of uranium ores inasmuch as the Commission's guaranteed market for domestic uranium ores terminated March 31, 1962, with the expiration of "Domestic Uranium Circular 5, Revised." Costs related to personnel which were formerly budgeted in the raw materials program under the category "Resource evaluation" are now reflected in the administrative section of the Commission's budget estimate inasmuch as these activities are now considered to be of an administrative nature.

The breakdown of the estimate by category and explanations thereof follow:

Summary of estimates by category

	Fiscal year 1961 actual	Fiscal year 1962 estimate	Fiscal year 1963 estimate
1. Procurement of uranium concentrates and oxides [1]	$625, 589, 297	$536, 938, 000	$500, 519, 000
2. Procurement of uranium ores	6, 038, 588	1, 336, 000	0
3. Other procurement	2, 975, 998	0	0
4. Capital equipment not included in construction projects	0	120, 000	66, 000
Total, raw materials program	634, 603, 883	538, 394, 000	500, 585, 000

[1] Excludes comparability adjustment of $1,814,994 in fiscal year 1961 and $1,706,000 in fiscal year 1962 for costs associated with personnel budgeted under "Program direction and administration" in fiscal year 1963, but budgeted and costed in prior years under the raw materials program.

1. Procurement of uranium concentrates and oxides

Fiscal year 1961	$625, 589, 297
Fiscal year 1962	536, 938, 000
Fiscal year 1963	500, 519, 000

Procurement of uranium concentrates is required for production of special nuclear materials for military application and peaceful uses of atomic energy. The estimate for such procurement provides for deliveries to the Commission of uranium concentrates from the principal sources represented by contracts with (1) individual private processing mill operators in the United States, (2) the Canadian Government, and (3) the South African Government. A small quantity will be purchased from Australia during the first half of fiscal year 1963 through the Combined Development Agency; deliveries from Portugal will be completed in fiscal year 1962. The breakdown of procurement by principal source is set forth in the following tabulation:

[Cost in thousands]

	Fiscal year 1961			Fiscal year 1962			Fiscal year 1963		
	Tons U^{308}	Price per pound	Cost	Tons U^{308}	Price per pound	Cost	Tons U^{308}	Price per pound	Cost
United States	17, 758	$8. 54	$303, 163	17, 210	$8. 19	$282, 016	17, 300	$7. 87	$272, 468
Canada	10, 251	10. 91	223, 651	7, 740	10. 02	155, 173	6, 900	9. 74	134, 360
Overseas	4, 251	11. 78	100, 165	4, 375	11. 54	100, 945	4, 200	11. 36	95, 404
Total, uranium concentrates	32, 260	9. 72	626, 979	29, 325	9. 18	538, 134	28, 400	8. 84	502, 232
Add: Refining costs, upgrading U^{308} to U^{30}			2, 938			2, 898			3, 237
Deduct: Sales of uranium ores to processing mills			4, 328			4, 094			4, 950
Total, uranium concentrates (net)			625, 589			536, 938			500, 519

Procurement contracts with domestic producers as well as with the Canadian Government and the South Africa Atomic Energy Board provide for the purchase of specified total quantities of U^{308} as well as for limitations on maximum annual deliveries.

The following discussions of U^{308} deliveries by major source is based on estimated total deliveries of 28,400 tons in fiscal year 1963.

United States

The estimate of domestic receipts in fiscal year 1963 is 17,300 tons, all of which is to be received from 25 mills in the Western United States. The estimate is based on contracts presently in effect and takes into consideration proposed and anticipated revisions to such contracts for those producers who qualify under the Commission's announcements of April 2, 1958, and November 24, 1958.

Canada

The Commission's commitments as revised, to purchase uranium concentrates from Canada in the 1960–66 period was announced in November 1959. The revised agreement did not change total quantity or costs under previous agreements and had as its principal feature the deferral until after March 1962, of approximately 9,300 tons originally scheduled for delivery during the 1960–1962 period. The fiscal year 1963 estimate of 6,900 tons includes approximately 4,450 tons of previously deferred material and the remaining 2,450 tons was scheduled for delivery in fiscal year 1963 under the earlier contracts. The portion of expenditures for Canadian material payable in Canadian currency is reflected in the fiscal year 1963 budget estimate at the recently announced exchange rate of $0.925 United States to $1 Canadian.

Overseas

Total U^{308} procurement in fiscal year 1963 is expected to be at a slightly lower level than in fiscal year 1962 mainly as a result of the completion in fiscal year 1962 of deliveries from Portugal and from one of the Australian contracts—

Radium Hill. Final deliveries under the remaining Australian contract– Rum Jungle will be made in fiscal year 1963 leaving South Africa as the only overseas supplier of uranium concentrate to the United States after fiscal year 1963. Procurement from South Africa will continue through December 1966.

2. Procurement of uranium ores

Fiscal year 1961	$6,038,588
Fiscal year 1962	1,336,000
Fiscal year 1963	0

No uranium ore purchases are budgeted for fiscal year 1963. The Commission's obligation to purchase uranium ore terminated March 31, 1962, with the expiration on that date of Circular 5 (revised).

	Fiscal year 1961			Fiscal year 1962			Fiscal year 1963		
	Tons	Price per ton	Cost	Tons	Price per ton	Cost	Tons	Price per ton	Cost
Ore	221,431	$27.27	$6,039,000	30,038	$44.48	$1,336,000	0	0	0

3. Other procurement

Fiscal year 1961	$2,975,998
Fiscal year 1962	0
Fiscal year 1963	0

All contracts under this category expired in fiscal year 1961.

4. Equipment not included in construction projects, $66,000

Replacement and new equipment will be required in fiscal year 1963 in connection with the handling, sampling, and assaying functions of the concentrate procurement activity at Grand Junction.

PLANT ACQUISITION AND CONSTRUCTION

RAW MATERIALS PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations, fiscal year 1963	$40,000
Estimated obligations, fiscal year 1962	61,000
Actual obligations, fiscal year 1961	12,448

Obligations for the raw materials program for fiscal year 1963 are estimated at $40,000 for the project listed below:

Project No		Estimated cost	Funded through fiscal year 1962	Estimated obligations, fiscal year 1963
63–1	General plant projects	$40,000	0	$40,000

EXPLANATION OF PROJECTS ABOVE

1. Project 63–1—General plant project, $40,000

This project provides for minor capital improvements, alterations, additions, engineering, retirement, and minor new construction which are required to maintain the Commission's raw materials facilities in a safe and efficient operating condition.

Mr. CANNON. Dr. Johnson, we are glad to have you with us this morning.

Mr. JOHNSON. Thank you, Mr. Chairman.

Mr. CANNON. We are pleased to note a further decrease of $37,809,000 in this program.

We would appreciate it if you would review briefly the provisions of those contracts, if any, that you renegotiated or revised this last year and which have made this situation possible.

Mr. JOHNSON. Mr. Chairman, we have about completed now the actions that were initiated in 1958, to limit domestic uranium purchases under publicly announced programs, and to arrange stretchouts where possible with domestic and foreign suppliers. I think that from now on under the present program our estimates should be reasonably firm.

There will continue to be some element of uncertainty in the domestic procurement, but within a narrow range, I believe, because of the possibility that some of the producers may not be able to make the deliveries to the fullest extent of our commitments due to failure of ore reserves or economic conditions.

With respect to the current estimate, our budget of $500,585,000, I believe, is within plus or minus 1 percent. I would think that might be the range. Our fiscal 1962 expenditures of $538,394,000 are approximately $24 million less than the amount that Congress appropriated last year. The reasons for the expenditure being less are several.

An important factor has been the drop in the Canadian exchange from 103 to 92.5. For several years Canadian exchange has been at a premium, but during the past year the Canadian Government has seen fit by foreign exchange operations to gradually reduce the foreign exchange, and I think our average for the year will be 95 to 96 as compared to 103 when we prepared our 1962 budget.

For our 1963 budget we are using a figure of 92.5 which is the official rate established within the past month or so by the Canadian Government in consultation with the International Monetary Fund. In view of the fact that this is an official rate, I would anticipate that it is more likely for it to hold steady, rather than like during the past year when there was no officially announced objective of the Canadian operations.

So in our fiscal 1963, we have used the figure of 92.5 which is the official rate. The drop in the exchange in fiscal 1962 resulted in a saving of approximately $10 million. That accounts for a little over $10 million of the $24 million reduction in our expenditures, compared with the appropriation.

In addition there was a further stretchout in Canadian deliveries of about $1,700,000. The balance of the fallaway to $24 million, of about $12 million, is the result of certain fallaways in our domestic deliveries. These also are permanent. There was about $7 million in such fallaways. These cannot be made up.

On the other hand there was a reduction of a couple of million dollars as a result of a 2 months strike at one of the important mills. The milling contractor has the right of making that up over the period of the contract.

Mr. CANNON. We lose nothing but time.

Mr. JOHNSON. On that part, yes. On the $10 million foreign exchange, on about $7 million fallaway, this is a permanent reduction in our expenditures.

STOCKPILE

Mr. EVINS. Dr. Johnson, how large is our stockpile of uranium and raw materials required by the Atomic Energy Commission? We are looking into the stockpile situation. Do we have to keep on purchasing from Africa and all over the world?

Mr. JOHNSON. Our foreign purchases are dropping off rapidly. In fiscal 1963, about 61 percent of our purchases will be from domestic sources, 24 percent from Canada, and 15 from overseas, mainly Africa. In 1964, there will be 73 percent from domestic sources, 10 percent from Canada, and about 17 percent from Africa. Our 1964 expenditures will be down somewhat over a hundred million from our 1963.

With respect to our foreign contracts, our small Portuguese contract under the CDA, Combined Development Agency, in which the British are interested, has terminated. We are in the closeout arrangements now.

The last of our two Australian contracts which were held jointly with the British will expire in January of 1963, leaving only the Canadian and the South African. Our Canadian contracts would have expired by March 31, 1963, except for the negotiation of a stretchout in 1959 by which we reduced in the pre-1963 period our Canadian purchases by about $200 million, and we will pick them up later.

As for stockpile, I will leave the General Manager speak to that, because I believe all of the material that is coming in from the raw materials is being processed in our production plants.

General LUEDECKE. We have no stockpile as such at present. Some of the tailings have not been stripped down.

Mr. EVINS. Does this mean we are running close to the supply or keeping ahead? I would think we would have some reserve of stockpile available.

General LUEDECKE. The stockpile in the tailings will be fed back as the purchases of new ore go down in order to hold the production from the plants up to an economic level.

Mr. EVINS. We have a rather substantial stockpile of weapons, haven't we?

General LUEDECKE. In that sense, we have a stockpile. The future requirements for ore for that and other purposes is something that is under consideration continuously. Guidance at this point is not adequate to project beyond the present contract.

(Discussion off the record.)

ESTABLISHMENT OF FIXED PRICES ON URANIUM CONCENTRATES

Mr. CANNON. Resuming the discussion we had last year, it is to be noted that the Comptroller General continues to criticize you for your policy in establishing fixed prices in advance on uranium concentrates. I believe that you have established a price of $8 per pound for the period 1962 to 1966. We would be glad if you would bring us up to date as to your thinking on the period after 1966, particularly with reference to a periodic price redetermination as part of your contract terms. Do your present contracts provide for redetermination.

Mr. JOHNSON. Our contracts do not provide for redeterminations. A fixed price was established on the $8 price through 1966. This was

done by decision in May of 1956 when we were approaching the period at the end of the then announced program of March 31, 1962. There was need in order to meet requirements of encouraging long-range exploration. We were short of material at the time. In fiscal 1956 the average price that was paid for domestic concentrates was between $11 and $12 a pound. We reviewed the cost of production and set the $8 price as a target for industry to reduce costs and lower prices. When we established the price there was quite a protest on the part of industry as to the lowness of the price. However, improvements in technology, the discovery of large deposits, has made it possible for industry to reduce costs by a substantial amount. However, if we include in our cost the cost of finding ore, the cost of building mills, opening new mines, it is my opinion that a price on the order of $7 to $8, and possibly more, will be required in the future. However, as long as we have developed ore reserves with amortized plants and facilities, it would be possible to purchase uranium at substantially lower prices than the $8 price.

This would be living off the bank account of the past with respect to development, exploration and facilities which have been paid for. This is true both in the United States and abroad.

The General Accounting Office is looking at costs somewhat as they might a project to go to the moon. After the cost of developing the project, and following various approaches that have to be abandoned are paid for, we will probably arrive at an ability to construct the vehicles to go to the moon at relatively small cost. But in the meantime it has been necessary to pay for all of the approaches running up the dead ends.

There has been a tremendous amount of effort gone into the development and domestic exploration work. It was by individuals and by companies. There are companies who have failed to develop ore reserves or have developed ore that has been uneconomic. I know of individual losses that range from $500,000 to possibly $5 million. So the risks are high, and I think that the price that was established in 1956 was reasonable under the conditions. It did bring out the production.

In 1956, for example, our ore reserves then were 70,000 tons of uranium oxide. Exploration development was about to cease because it would no longer be possible to develop ore and get a market and return on capital by March 31, 1962.

Mr. EVINS. What is the status of production by our domestic industry?

DOMESTIC PRODUCTION

Mr. JOHNSON. Our domestic industry is being maintained at approximately the top level. Our production of domestic ore in fiscal 1963, estimated at 17,300 tons, is about the top figure. We expect it to continue at that rate or at a rate near that, dropping down to about 16,000 tons. We have not made any foreign contracts since 1955 when our domestic industry improved. As I was about to say, since 1956 when we established this $8 price, there have been developed in this country 192,000 tons of U^{308}. The ore reserves that we had in 1956, if there had been no more exploration, would have not supported the production we had from 1956 to 1962. 87,000 tons of uranium oxide were produced in this country between January 1, 1956,

and January 1, 1962, as compared with ore reserves of 70,000 tons at that period. We now have ore reserves in this country of about 175,000 tons. We estimate production to the end of 1966 at 82,000 tons. So there will be reserves at the end of 1966 of about 93,000 tons.

Mr. EVINS. You also have some secondary reserves, too, do you not, of uranium in this country?

Mr. JOHNSON. We have large low-grade resources in shales, phosphates. The phosphate reserves will probably have to come out as a byproduct in the processing of commercial phosphate fertilizers. If we move into the shales, we have done considerable work there during the early period when it looked as though we would have to go to any source at all to get uranium for the program, and the cost will be from $30 to $50 a pound.

These are the reserves that Admiral Rickover was talking about when he said that the uranium resources contain more energy than coal. The low-grade resources that will become available economically when reactor technology has been developed so that practically all of the latent energy in the uranium can be recovered in breeder reactors. However, during the immediate future, the next 20 to 30 years probably, competitive nuclear power undoubtedly will depend upon the availability of lower cost uranium, uranium in the category ofpresent prices.

Mr. EVINS. I would not write off the guideline suggestions of the General Accounting Office. They might have some beneficial suggestions.

Mr. JOHNSON. I do not, either. I have a high regard for the General Accounting Office and for the necessity of taking a critical look at all programs.

ESTABLISHMENT OF FIXED PRICES ON URANIUM CONCENTRATES

Mr. CANNON. This serves to emphasize the contingency we had hoped to anticipate. We were somewhat taken by surprise when suddenly without notice you announced $8 running until 1966 with no possibility, regardless of what renegotiation, if any took place in the meantime. We are not criticizing the rate of $8 which appears to be a reasonable figure, we would hope, however, in reference to the period beyond 1966, that you will not again reestablish a fixed rate without notice, and that you will provide in the contracts for renegotiation. With the scientific progress now being made in the development of these concentrates, you never can tell when we might have a breakthrough that would materially change the bases on which the rates are determined. This committee would appreciate it if the contracts for the period after 1966 include provision for renegotiation.

Mr. JENSEN. Mr. Chairman.

Mr. CANNON. The gentleman from Iowa.

Mr. JENSEN. I presume you fixed the price at $8 a pound until 1966 because you felt that by so doing a producer would know that he would be safe in spending his capital for producing uranium over that period of years. He would feel more safe in his capital investment. Was that the reason, and in order to get sufficient supply of uranium?

Mr. JOHNSON. I think the primary reason for fixing long-term prices was the fact that we were not in a position to go out and contract with

producers for the uranium. The uranium had to be found in order to meet the program. As a matter of fact, when the program started in 1948, there were only 2,000 to 3,000 tons of known reserves in this country. We were getting 95 percent from our foreign suppliers overseas. It was necessary to see if we could not find uranium in this country.

The cost of exploration by either the individual prospector or the company is a risky business. Many of them have failed to find anything. But in order to have an incentive to find they had to know what they could get for material if they found it. There had to be a sufficient time to allow for exploration and development, opening up mines, and a production period.

We figured on about a 5-year production period and a 2- to 3-year exploration and development period as being the minimum leadtime. With supplies developed, as we have today, I think that it would be sound Government policy to limit forward commitments by the Government to the very minimum, and if you have an industry in being, to purchase the material on a competitive basis.

There are some other considerations that will have to be considered. One is that of having an operating base from which to get increased production on a competitive bidding basis. If we could have our industry at some minimum economic operating level, with the capacity to expand to meet any military requirements that might develop, or we might reasonably develop, I think that we would have an opportunity to get material at the lowest price by competitive bidding and with relatively short leadtime. In other words, for example, invitations for bid could be issued now for delivery in 1964. However, if you don't have an industry in being, if you have to open up mines this would not work. Also there is the possibility with competitive bidding of having one or two companies have the lowest bid. There would have to be some way of distributing the purchases. It might be that the low bids would come from companies who were trying to deplete the reserves, and get out of business, and when the next bids would come up, the bidders would have to base their bids on reopening mines. That would be uneconomic.

Mr. JENSEN. Your $8 per pound price has produced the desired results in that you have gotten production in an amount that is possibly beyond your expectations?

Mr. JOHNSON. That is correct. There was more rapid expansion of reserves than we had reason to expect.

Mr. JENSEN. When the contracts run out in 1966, is it anticipated that you will have a sufficient stockpile which then will permit you to accept the lowest responsible bidder for this material?

General LUEDECKE. I think, Mr. Jensen, this is a question to which major consideration must be given during this fiscal year.

Mr. JENSEN. During this fiscal year?

General LUEDECKE. You appreciate the arrangements we can make will be dependent in great part on what the overall requirements for U308 will be. At least in the next few years, after 1966, it will be dependent in major part on what the military requirements are.

Mr. JENSEN. So you must anticipate at least 3 years ahead.

General LUEDECKE. At least that far. The position that the Government would be in with respect to further procurement and pricing will depend in great part on how much it is.

Mr. JENSEN. Then let me ask this question. At the going rate of $8, have the producers made reasonable profit, or have some of them fallen by the wayside and others gone forward? What is the record?

Mr. JOHNSON. It is the same as in copper mining or gold mining. There is a wide range of costs. Some companies fail, some have marginal profits, and others make large profits. The principal factor in the profit margin is the type of deposit, and that is controlled by nature. I presume in farming you have a wide variation in cost of production as well. In mining you certainly have a very wide range of costs. It is never known until a deposit is found and developed as to what the costs are going to be.

Mr. JENSEN. Generally speaking, what has been the production cost? Do you have any record on that?

Mr. JOHNSON. The production costs without exploration or development today on an average of our domestic production might be on the order of approximately $6 a pound. This is with amortized facilities and does not take into account the cost of finding.

Mr. JENSEN. Taking the overall, those that have made a go of it, and those that have fallen aside——

Mr. JOHNSON. Not those that have not made a go of it, but those that are in operation. It does not take into account the losses that have been incurred by those who opened up ore that was uneconomic nor the cost of finding ore in exploring, and the preproduction cost of development.

Mr. JENSEN. The $6 a pound does not take into account the exploration and development?

Mr. JOHNSON. And those that have spent money and got no production.

Mr. JENSEN. The $6 a pound does not take into consideration those that fell into the wayside.

Mr. JOHNSON. That is right, and that is part of the cost. One statistic that gives some indication of the risk of finding ore. As the committee knows, because it was mentioned on several occasions, we had an initial production bonus program that paid a special bonus for the first 10,000 pounds delivered by any producer. It was necessary to make a delivery in order to be certified. We certified over 1,200 producers for the 10,000-pound bonus. Of that number, only 350 were able to deliver the full 10,000 pounds. The rest of them, 850, produced less than 10,000 pounds before they ceased operations.

This illustrates to some extent the problem of finding the material, and there is no record of the expenditures of those who did not ship.

Mr. JENSEN. What was the cost to the Federal Government on those wo did not make a go of it?

Mr. JOHNSON. None. That is private loss.

Mr. JENSEN. That is all, Mr. Chairman.

RENEGOTIATION PROVISIONS IN CONTRACTS

Mr. CANNON. You have not yet given us a statement about your position as to including in future contracts a provision for renogotiation.

Mr. JOHNSON. It will be the Commission's position, sir. My own position is that we should buy material, as far as possible, on a competitive bid basis, and if so, on an annual basis, to keep the Govern-

ment's long-term procurement at a minimum. If we were to try to maintain the industry at some base, depending on what kind of a program is set up, certainly serious consideration should be given to price redetermination. Price redetermination, however, would not have been satisfactory for the kind of a program we have had in the past. But when we are dealing with deposits that have been developed and are open and are not attempting to encourage exploration, I think that price redetermination would be the method if we make long-term contracts.

Mr. CANNON. Your policy on long-term contracts would be to provide for renegotiation.

Mr. JOHNSON. If we were going on a fixed price basis, yes. Otherwise, competitive bidding.

REDUCTION IN 1962 ESTIMATE

Mr. CANNON. Last year on page 1044 of the hearings, you estimated you would purchase in fiscal year 1962, 29,975 tons of concentrate at a cost of $560,976,000.

However, you now indicate that you will acquire only 29,325 tons at a cost of $538,134,000. Does this mean you overestimated the figure you would acquire and, therefore might also be overestimating your 1963 requirements or does this represent a delay in the delivery to pick up funds for the weapons testing program? I realize the weapons testing program was wholly unexpected, and you had to reach here and there for every available dollar in order to meet the unanticipated cost.

Mr. JOHNSON. Mr. Chairman, of the $24 million, approximately a $10 million reduction came as a result of Canadian foreign exchange. There was another stretchout, a small Canadian stretchout of $1,700,000. Then within our domestic program there were several fallaways due to failure of the producers to fulfill the total amount of material they could have delivered under our contracts. There was no relation between the reduction in our purchases or the reduction in the cost and requirements for funds for the weapons tests.

Mr. CANNON. And no change in your program.

Mr. JOHNSON. No change in the program. As I mentioned earlier, I believe that our 1963 budget is probably within a plus or minus of 1 percent. We still have the question of possible fallaways on domestic products for failure of ore reserves or failure to produce for economic reasons. Our expenditures might fall $5 or $6 million less than the figure. It might go a few million dollars over. That is about as close as we can safely estimate.

DOMESTIC PRODUCTION

Mr. CANNON. Last year you indicated that domestic production would come from 27 mills. Now there seems to be only 25 mills according to your statement on page 16. What happened to the other two, and how many tons of concentrate are you taking from the other two this year?

Mr. JOHNSON. Two of the mills have closed because of lack of ore.

Mr. CANNON. Not because of price considerations?

Mr. JOHNSON. Not because of price considerations, no. There has been a third mill closed as a result of the consolidation of two mills into one operation.

Mr. CANNON. That does not reduce the amount available.

Mr. JOHNSON. No. There was some stretchout involved in that.

Mr. CANNON. These two having closed, how much are you buying from them this year?

Mr. JOHNSON. In fiscal 1962?

Mr. CANNON. Yes, the current year.

Mr. JOHNSON. In fiscal 1962, there was $1,781,000 budgeted for one of the mills, the one at Gunnison, Colo. The Lakeview, Oreg., mill failed to produce any in fiscal 1962.

Mr. CANNON. You bought none from it for the current year?

Mr. JOHNSON. We bought none, that is correct, sir. I believe our fiscal 1962 budget shows a reduction of $969,000 as a result of the early closing of the Gunnison mill. We did not have anything in our 1962 budget for the Lakeview mill which was closed at the time we submitted our 1962 budget.

Mr. CANNON. You have lost 3 of the 27 mills through closure. Is there any prospect of such development from the other 24?

Mr. JOHNSON. No. I think the other 24 mills will operate in fiscal 1963 under our present program.

Mr. CANNON. And produce the amount you are now anticipating?

Mr. JOHNSON. Yes. Subject to some variation in the delivery of ores from independent producers and other mines. I say there will be a slight variation. We think it is reasonably firm now.

REFINING COSTS

Mr. CANNON. For the current year, 1962, you show a total cost of $2,898,000 for upgrading U 308 to U 03. You are estimating $3,237,000 for 1963. Why this increase? How much more will be upgraded?

Mr. JOHNSON. This is a refining cost in Canada under a contract with Canada under which a certain portion of the material we purchase from Canada is in a refined product. The amount that is upgraded, I haven't the exact figures, has been running around 3.300 tons of oxide a year, I believe. The estimate for 1963 covers a slightly larger quantity. I don't seem to have the exact quantity that is involved there.

Mr. CANNON. Will you insert the quantity in the record?

Mr. JOHNSON. Yes, sir.

(Information referred to follows:)

EXPLANATION OF INCREASE IN CANADIAN REFINING COSTS, FISCAL YEAR 1963 OVER FISCAL YEAR 1962

The increase in delivery of refined oxide in fiscal year 1963 to 4,300 tons as compared with the fiscal year 1962 estimate of 3,722 tons is the result of an arrangement negotiated in connection with the stretchout which allows the refinery to complete deliveries in advance of completing mill concentrate deliveries. Under the stretchout, deliveries of mill concentrate drop in later years below the economic operating rate for the refinery. There has been no change in the contract quantity to be refined.

The contract price for refining is $0.396 (Canadian currency) per pound. The estimate of costs shown in the fiscal year 1962 column of the 1963 budget is based upon an average cost of $0.389 per pound in U.S. funds including an estimated freight cost of 1 cent per pound. The fiscal year 1963 budget is based upon a unit cost of $0.376 including freight. The unit cost difference is due to using an exchange rate of $0.960 for the Canadian dollar in fiscal year 1962 and $0.925 in fiscal year 1963.

Mr. CANNON. In view of the fact that you expect to refine more, why shouldn't the cost come down?

Mr. JOHNSON. In the Canadian contract?

Mr. CANNON. Yes, you have shown quite an increase here.

Mr. JOHNSON. In the refining.

Mr. CANNON. Wouldn't that naturally result in a lower price?

Mr. JOHNSON. There has been no change in the total quantity of material that would be refined in Canada under the contract that was negotiated, I think, in 1956. Had we not entered into a stretchout with Canada, the entire quantity of Canadian material would have been purchased and our Canadian contracts, including the refinery contract, would have been completed in this coming fiscal year. There was a stretchout. The stretchout also involved the Canadian refined products. I can't speak without getting the figures as to the variation in 1962 and 1963. But it does not represent any increase in the total quantity to be refined under the contract. It merely shifts the relationship between a couple of years.

Mr. CANNON. But the dollar is down. Why shouldn't the total price be down?

Mr. JOHNSON. It will be down on the basis of unit cost.

Mr. CANNON. Will it reflect the decrease in the exchange?

Mr. JOHNSON. In the exchange. The exchange rate applies to the refining as well as to the purchase of mill concentrate. The unit cost will be less definitely, both the cost of refining and the cost of material.

Mr. CANNON. You really are refining more?

Mr. JOHNSON. Yes, sir.

Mr. JENSEN. Mr. Chairman.

Mr. CANNON. The gentleman from Iowa.

EFFECT OF CHANGE IN VALUATION OF THE CANADIAN DOLLAR

Mr. JENSEN. What effect will the stabilization of the dollar that Canada just put into effect of 92.5 cents to 1 U.S. dollar? Won't that have some effect on the price of anything we buy from Canada, including the uranium concentrates and oxides?

Mr. JOHNSON. Yes, sir.

Mr. JENSEN. What will the effect actually be dollarwise?

Mr. JOHNSON. The effect in fiscal year 1962 was a reduction in our dollar cost by a little over $10 million as compared with the amount we would have paid had the Canadian exchange remained at 103, which was the figure used in our fiscal 1962 budget. So we have a saving in our fiscal 1962 as a result of the drop in the Canadian exchange.

Mr. JENSEN. You are sure it works that way?

Mr. JOHNSON. Yes, sir. That is responsible for the $10 million of the $24 million savings we show in our fiscal 1962 costs as compared with our estimated costs.

General LUEDECKE. Our 1963 budget is computed on the basis of the new exchange.

Mr. JENSEN. We just pay them 92.5 cents for every one of their bills that shows so much in Canadian dollars?

Mr. JOHNSON. Yes.

Mr. JENSEN. So if you had a bill of a million dollars, you would only pay them $925,000?

Mr. JOHNSON. Yes, sir. In our fiscal 1963 budget, a change of 1 cent in the Canadian exchange amounts close to a million dollars savings.

Mr. JENSEN. In all our trade relations with Canada, do you mean that the action which Canada took at stabilizing the dollar at 92.5 cents, that we gain both in imports or exports or do we lose on exports?

Mr. JOHNSON. Canada pays more in Canadian dollars for material we export into Canada. In other words, if we sell Canada material of $1 in American money, it costs them about $1.07 Canadian money for it.

Mr. JENSEN. I can't see where Canada made any gains by stabilizing their dollar at 92.5 cents.

Mr. JOHNSON. It does improve their export business. It is creating quite a stir in this country in some areas like my home State of Washington, because it improves the competitive position of Canadian lumber coming into this country. It is equivalent to a reduction in price.

Mr. JENSEN. Lumber is one of the main export businesses of Canada.

Mr. JOHNSON. Lumber and grain. It has the effect of reducing the Canadian price in the export market. It gives them an advantage in the export market.

Mr. JENSEN. So in the overall picture, the action of the Canadian Government in stabilizing the dollar at 92.5 cents has been of advantage to the Government of Canada.

Mr. JOHNSON. It has been an advantage to their foreign trade, I would say. Also I think the policy was to discourage imports so that they have improved the balance of trade.

Mr. JENSEN. And to possibly ward off further reduction in the value of their dollar.

Mr. JOHNSON. I am not familiar with all of the details of the Canadian monetary policy.

Mr. JENSEN. That is all.

Mr. CANNON. Mr. Pillion.

OVERSEA PROCUREMENT

Mr. PILLION. I note that the cost for the oversea concentrates is $11.36 for 1963 as against $7.87 for domestic ore and $9.74 for Canadian concentrates. Why should the oversea ore cost that much? Is it because of the poorer grade of ore or higher cost of refining or what?

Mr. JOHNSON. The grade of ore is lower. The contracts were all made earlier. We made firm contracts.

Mr. PILLION. Lasting until 1966?

Mr. JOHNSON. The only oversea contracts until 1966 are the South African contracts which were negotiated back in 1951 and 1952, except for some of the Canadian material that was to be delivered by March 31, 1962, or March 31, 1963. We negotiated with Canada a stretchout so that some of our Canadian purchases will now be coming in after 1963. Our Canadian purchases drop sharply from now on. We will be buying 6,900 tons in fiscal 1963. In fiscal 1964, 2,275 tons. Fiscal 1965, 1,540 tons. Fiscal 1966, 500 tons.

Mr. PILLION. What I am trying to get at is if the average cost of your concentrate in this country is $6 a pound, to be paying $11.36,

as you are paying this year, for oversea concentrates is a rather high price, isn't it?

Mr. JOHNSON. It is.

Mr. PILLION. What action are you taking to bring this price more in line with realistic cost?

Mr. JOHNSON. We have firm contracts and we are not in a position to do anything about it. But let me say with regard to the Canadian contracts, in 1959 when we negotiated a stretchout with Canada, about half of the Canadian companies that were engaged in producing uranium concentrates would have only been able to pay off their bonds with little available for the stockholders. Some of them would not have done this.

Some of them were in more prosperous condition because of better ore. The stretchout was negotiated for our benefit as well as for the international relations with Canada. When we had decided that we would not exercise our options to buy material in the post 1962 period, the Canadian uranium industry would have been faced with a drastic and sharp drop in 1962. We wanted to extend the delivery period. So under the stretchout arrangement that was negotiated, the lower cost companies acquired some of the production contracts from the higher cost companies, and in this way production in Canada has been concentrated in the lower cost operations which have a higher volume of business now. We did not buy any more material in return for getting a deferment of our purchases. There is a considerable saving in interest, if we want to calculate it, by deferring the material to a later date when we did not need it at the earlier date.

PRICE OF URANIUM CONCENTRATE

Mr. PILLION. You are not buying any ore, I notice, in 1963, and you are limiting yourself to buying concentrates, is that right?

Mr. JOHNSON. Yes, sir.

Mr. PILLION. The U.S. Government has no reducing or refining mills itself?

Mr. JOHNSON. No, sir.

Mr. PILLION. It buys everything in a concentrate form?

Mr. JOHNSON. Yes, sir.

Mr. PILLION. U^{308}.

Mr. JOHNSON. Yes, sir.

Mr. PILLION. You are paying a set price of $8 per pound for these concentrates in the United States, is that correct?

Mr. JOHNSON. That is correct.

Mr. PILLION. That is regardless of whether the cost to the manufacturer is $6 or $6.50 or $7 or $4.

Mr. JOHNSON. That is correct.

Mr. PILLION. And you have no renegotiation clause by which to recapture any profits that may be deemed excessive?

Mr. JOHNSON. That is correct.

Mr. PILLION. You need roughly around 32,000 tons of concentrate a year. Why wouldn't it be possible to have your Commission announce that it would buy, say, one-half of the 32,000 that you need annually—say 16,000 tons of concentrates—inviting bids, at $6. So that you have the low cost producing companies coming in and saying that it costs us $4 a ton to refine this and we are being offered

$6 and pick up 16,000 tons of bids then at that price. Then after you have picked up the 16,000 tons say to the more marginal mills, "We realize that your costs may be a little bit higher and we will offer you $6.50 a ton," and get as much as you can at $6.50, and then as much as you can at $7. Why wouldn't that be the normal business-like way of attacking this problem, instead of giving everyone a set $8 figure?

Mr. JOHNSON. As we discussed earlier, and I think that might be the way to do it with an industry in operation.

Mr. CANNON. However, you have a fixed price until 1966. You can't take action until 1966.

Mr. JOHNSON. That is correct.

Mr. CANNON. That is the very thing we are asking you to do after 1966.

Mr. JOHNSON. That is right.

Mr. PILLION. That is right. I am just getting around to that to try to get the mechanics of the theory you are expounding. The gentleman is on the right track.

Mr. JENSEN. You had to have a 3-year lead period we are told here.

Mr. PILLION. That is the question that arises. They must make a decision this year to provide for concentrates in 1965, 1966, and 1967, and from then on. Now, what I would like to know is, who makes this decision as to what method of procedure you will use? Is that made by the Commission under a law that is broad enough to permit the Atomic Energy Commission to make these decisions, or does it depend upon further authorization to be recommended by the Joint Committee on Atomic Energy, or does it depend upon this committee to write into the law some restrictions or limitations as to how you will purchase? Where is the delegation of authority as to what method you are going to use?

Mr. JOHNSON. The Atomic Energy Act provides that the Commission may fix prices for all source materials to be delivered to it over a specified time. That was the basic authority for long term contracts. As we mentioned earlier at the time we put in the $8 price, there were not companies that we could go to that had sufficient ore in order to fulfill the requirements. This was based upon encouraging exploration and development. Today we have the reserves necessary—our domestic reserves and our production capability—to probably take care of any foreseeable military requirements for possibly the next 10 years. While we are operating under a condition of that kind, we can make our purchases—additional purchases—on a competitive bid basis to the extent that it would not have the effect of concentrating production in the hands of one or two low cost producers, which I think would be bad. This is one of the questions that will have to be considered for the post-1966 period, and the suggestion you made might be an approach to providing for a broader base than by simply taking the lowest bid.

Mr. PILLION. Then as I understand it, the Atomic Energy Commission still has, and will have, over the next 2 or 3 years, sufficient authority under present law to make the determination as to what method you will use for the pricing and the purchase of uranium.

General LUEDECKE. That is correct.

Mr. PILLION. So the only recourse this committee has to require a policy in line with the chairman's suggestion, is either to ask you to do what the chairman has suggested, or put a limitation in the law.

Mr. CANNON. Yes. We would be glad if you would notify us by letter in advance of any proposed action in this regard.

SALE OF URANIUM ORES

May I ask one question at this point. Last year you indicated you received only $2,764,000 from the sale in 1961 of uranium ores to processing mills, but I note on page 15 of the justifications you report that instead of $2,764,000, you have actually realized $4,328,000. May we assume that your estimates for 1962 and 1963 are similarly too low?

Mr. JOHNSON. I don't think so, sir. They are the best estimates we made. I think our 1963 estimates will be borne out.

Mr. CANNON. You have taken that into consideration?

Mr. JOHNSON. Yes, sir.

Mr. CANNON. Why was that not taken into consideration in making 1961 estimates?

Mr. JOHNSON. Are you speaking of 1961 or 1962?

Mr. CANNON. 1961. That is where we were in error. It was nearly double the amount estimated with respect to the actual receipts.

Mr. JOHNSON. We had an opportunity to sell more ore. That is the answer, sir.

Mr. CANNON. Isn't it quite likely that you will have the same opportunity in 1963?

Mr. JOHNSON. No, I think not. Our 1963 figure I think represents the best estimate that we can make today. We have taken everything into consideration that we can foresee. Of course, our stockpile of ore is greatly decreased. I would not anticipate that there would be more sales. We could make more sales of some of the stockpile but it would add to the amount of concentrate we would buy. I think there is an advantage in withholding the sales of ores and spreading them out if it would result in increasing our concentrate purchases when we can afford to defer the purchase of the additional concentrates.

STOCKPILE

Mr. CANNON. What part of the stockpile does this represent?

Mr. JOHNSON. The sales?

Mr. CANNON. Yes, you sold $4,950,000 worth. What part of the stockpile does that represent?

Mr. JOHNSON. The total stockpile we now have represents $19 million in value, and 395,000 tons of ore. At one time we had over a million tons. Of the $19 million, $4,950,000 represents about 25 percent.

Mr. CANNON. What will be the status of the stockpile in 1963 and after?

Mr. JOHNSON. Our fiscal 1963 estimate represents the sale of about 25 percent of our remaining stockpile. We are not buying any more. So as we go along before we reach 1966, we will have sold off all our stockpile of ore.

Mr. CANNON. You do expect to add to that after 1966?

Mr. JOHNSON. No.

Mr. CANNON. There is no possibility or likelihood?

Mr. JOHNSON. We see no likelihood of buying any additional ore. We will liquidate the ore we now have.

Mr. CANNON. What is the actual revenue for the current year to date on the sale of uranium ore to the processing mills?

Mr. JOHNSON. We have sold at April 30, 87 percent of our anticipated quantity.

Mr. MCCARTHY. As of the end of April the actual sales were $3,558,000.

SPECIAL NUCLEAR MATERIALS

Mr. EVINS (presiding). We will now take up special nuclear materials. Mr. Reporter, place in the record pages 18 and 19 and the associated construction pages.

(The justification follows:)

OPERATING EXPENSES

SPECIAL NUCLEAR MATERIALS PROGRAM—OPERATING COSTS

Program statement

Estimate, fiscal year 1963	$537, 300, 000
Estimate, fiscal year 1962	526, 819, 000
Increase	10, 481, 000

Summary of estimates by category

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Procurement and production and related capital equipment	$509, 622, 224	$483, 981, 000	$494, 619, 000
2. Process development and related capital equipment	38, 295, 160	37, 638, 000	37, 000, 000
3. Other capital equipment	12, 439, 292	5, 200, 000	5, 681, 000
Total, special nuclear materials program	560, 356, 676	526, 819, 000	537, 300, 000

JUSTIFICATION OF CATEGORIES

1. Procurement and production and related capital equipment, $494,619,000

These funds provide for the operation of Government facilities for the production of special nuclear and other special materials required for use in weapons manufacture, research, and development and in the peaceful applications of atomic energy. Also included in this estimate are funds to cover UF_6 purchases from Allied Chemical and the procurement of plutonium from domestic reactor operators and AECL. The major units of the AEC production complex are located at Oak Ridge, Tenn.; Paducah, Ky.; Portsmouth, Ohio; Hanford, Wash.; Savannah River, S.C.; Fernald, Ohio; and Weldon Spring, Mo.

2. Process development and related capital equipment, $37,000,000

These funds provide for technical plant support to assure continuity and safety of operations, and for development and improvement of processes and equipment used in producing and processing feed materials, U^{235}, plutonium and other special products. The development program also assures attainment of production levels required to meet current AEC commitments at the lowest possible cost of operation. Development effort varies at each site in accordance with the production requirements.

3. Other capital equipment, $5,681,000

These funds provide for those items of capital equipment which cannot be identified with a specific procurement and production or process development category, or which will be acquired for multipurpose or general-purpose use in support of the overall special nuclear materials program.

PLANT ACQUISITION AND CONSTRUCTION

Special Nuclear Materials Program—Construction Obligations

Program statement

Estimated obligations fiscal year 1963	$85, 605, 000
Estimated obligations fiscal year 1962	47, 440, 000
Actual obligations fiscal year 1961	76, 262, 323

Obligations for the special nuclear materials program for fiscal year 1963 are estimated at $85,605,000 for the projects listed below:

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations fiscal year 1963
63-a-1	Modifications to production and supporting installations.	$5, 000, 000	0	$5, 000, 000
63-a-2	Modifications to facilities for conversion of UNH to UF_4.	1, 450, 000	0	1, 450, 000
63-a-3	Radioactive waste disposal facility, Hanford, Wash.	3, 700, 000	0	3, 700, 000
63-b-1	Consolidated service facility, Hanford, Wash.	955, 000	0	955, 000
63-b-2	Additional high level waste storage tanks, Savannah River, S.C.	6, 000, 000	0	6, 000, 000
63-b-3	Health physics headquarters addition, Savannah River, S.C.	1, 000, 000	0	1, 000, 000
63-b-4	Emergency duty personnel shelters, various sites	4, 000, 000	0	4, 000, 000
63-1	General plant projects	11, 500 000	0	11, 500, 000
62-a-5	Additional reactor confinement, Savannah River, S.C.	12, 000, 000	$3, 000, 000	9, 000, 000
59-a-5	Production reactor facility for special nuclear materials, conversion type, Hanford, Wash.	195, 200, 000	152, 200, 000	43, 000, 000
	Total	240, 805, 000	155, 200, 000	85, 605, 000

EXPLANATION OF PROJECTS

1. Project 63-a-1—Modifications to production and supporting installations, $5,000,000

This project provides for the design, procurement, fabrication, and installation of equipment, together with the necessary plant modifications to existing facilities and/or construction of new facilities necessary to guarantee the continuity of operation, to incorporate technological advances, to increase safety of operations, and to assure the most economical operation of the special nuclear materials production and supporting facilities under the administration of the Hanford, Savannah River, Idaho and Oak Ridge operations offices. Items to be performed under this project cannot be identified specifically in advance since their need is generally predicated on the progress of process development effort, changes in program requirements and new findings which may require additional safety precautions.

2. Project 63-a-2—Modifications to facilities for conversion of UNH to UF_4, $1,450,000

This project provides for modifications and additions to existing facilities at either Weldon Spring or Fernald sites for production improvement in the conversion of uranly nitrate to uranium trioxide and uranium tetrafluoride.

Adaptation of the fluid bed process to an AEC feed materials plant involves replacing the existing batch denitration pots and the reactors in the uraniumtetrafluoride process with fluid bed denitrators, and with fluid bed reduction and hydrofluorination reactors. Denitration and reduction-hydrofluorination could be installed in existing buildings at one site with necessary structural alterations but no major building additions. The processing steps accomplished in these reactors would be:

1. Denitration of purified uranyl nitrate hexahydrate (UNH) to uranium trioxide (UO_3).
2. Reduction of UO_3 to uranium dioxide (UO).
3. Conversion of UO_2 to uranium tetrafluoride (UF_4).

Fluid bed reactors are simple, sealed vessels capable of continuous production. These units have excellent heat and mass transfer characteristics which give high unit processing capacities and more uniform product quality with lower mainte-

nance costs. The justification for this project is based on reduction in labor, materials, maintenance, utilities, and overhead costs totaling an estimated $740,000 annually.

3. Project 63–a–3—Radioactive waste disposal facilities, Hanford, Wash., $3,700,000

This project provides for construction and installation of facilities to provide necessary additional waste tank storage capacity at a cost of $2,700,000. Also included in this project at $1 million is an underground tunnel for storing indefinitely extra large contaminated items of equipment.

4. Project 63–b–1—Consolidated service facility, Hanford, Wash., $955,000

This project provides for a central service facility in the fuels production and development area. The proposed facility is 38,800 square feet in area and will house analytical control laboratories, maintenance facilities, and material handling facilities all of which are in direct support of fuel element production at Hanford. Construction will be primarily of structural steel and reinforced concrete framework with installed metal siding. Facilities include steam heating and air conditioning. Electric, water, air, steam, sanitary sewerage and processing services will be provided from existing main services in the area.

Existing facilities which now include 12 buildings in scattered locations and a part of another facility are obsolete and inadequate. The 12 buildings would be removed. Removal cost is estimated to approximate the salvage value of the buildings. A significant factor in justifying this project is the fact that it will provide a means for more efficient use of personnel, equipment, and facilities. This will permit a reduction of 29 employees who would otherwise be required for the production effort at the end of fiscal year 1963.

If this new facility were not built, it would be necessary to perform some modernization of existing facilities at an estimated cost of $210,000. Estimated annual savings of $404,000 through use of the new consolidated facility would amortize the net additional capital investment of $745,000 in less than 2 years.

5. Project 63–b–2—Additional high-level waste storage tanks, Savannah River, S.C., $6 million.

This project provides for the construction and underground installation of additional waste storage facilities which will be necessary to meet anticipated increases in waste storage volume.

6. Project 63–b–3—Health physics headquarters addition, Savannah River, S.C., $1 million

This project provides for the construction of an additional wing in the health physics headquarters building of approximately 4,800 square feet. The addition will house eight additional laboratories, two offices, one instrument and balance room and one laboratory sample and waste storage room. A service floor of 4,800 square feet under the addition will house equipment and provide general storage space. The service floor portion of the building will be reinforced concrete including interior columns. The building above grade will be structural steel with flat cement asbestos board siding and steel roof deck. Laboratory equipment includes hoods, cabinets, benches, and shelving.

The existing building, designed on the basis of Hanford operating experience, was initially occupied in 1953. Until approximately a year ago there was adequate flexibility in the original building to accommodate programmatic changes. Program changes in the last year and new analytical procedures and instrumentation changes necessitated numerous building modifications and created a shortage of laboratory space for support of radioassay of local foodstuff, biology, and for radioactive waste disposal and waste methods.

There is now a shortage of laboratory space in four phases of this program, radioassay of local foodstuffs, biology, waste disposal, and chemistry methods. This shortage was brought about by a number of factors including the following: (1) There is increased emphasis on monitoring the radioactivity in locally produced foodstuff. (2) Increased releases of long-lived radionuclides to the effluent streams and the Savannah River have necessitated a biology program. (3) There is urgent need for developing improved methods of ground disposal for the ever increasing inventory of radioactive wastes. (4) The decrease in the recommended radioactivity concentration guides for large populations has resulted in a pressing need to develop new analytical methods which will allow the detection of small percentages of public zone limits. (5) Expanding interest and concern by the public and governmental organizations make it imperative that adequate reporting data be available and that the methods of environmental radioactivity surveillance

be the best and most thorough possible. The addition of the proposed wing is considered to be the most practicable means for efficiently performing work objectives.

7. Project 63–b–4—Emergency duty personnel shelters, various sites, $4,000,000

This project provides for construction of emergency duty personnel shelters at appropriate locations in the AEC complex. The proposed work is necessary to provide for the protection of emergency duty production and security personnel required for orderly plant shutdown and surveillance in the event of a national emergency requiring evacuation of plant areas. This project does not provide for instrumentation and remote controls which may be required to observe plant conditions, and observe critical operations in essential plants such as powerhouses in the reactor areas. The shelters would be buried, constructed of reinforced concrete, designed for 50 pounds per square inch blast side-on overpressure and sufficiently shielded to protect against initial and residual fallout radiation.

The shelters will be located in close proximity to important nuclear reactor, Uranium 235 production, and weapons facilities to provide maximum accessibility for the personnel who must perform shutdown and security activities. Annex I of the national plan for civil defense and defense mobilization includes AEC production facilities among the listings of assumed targets. Therefore, for reasons involving safety of the public in surrounding areas, security protection and preservation of plants to permit AEC to maintain or resume essential operations, it is necessary that some personnel remain on duty at many plants to provide orderly shutdown and security protection while all others are evacuated.

Provision of such shelters will not require an increase in operating funds for the plants involved. However, nominal maintenance funds will be required to sustain the shelters in a state of readiness.

8. Project 63–1—General plant projects, $11,500,000

This project provides for the accomplishment of numerous miscellaneous changes and additions to production processing and supporting facilities of the Oak Ridge, Hanford, and Savannah River Operations Offices. This type of work is required on a continuing basis to adapt the facilities to new production requirements and process improvements, to assure continuity of operations, to reduce maintenance and operating cost, and to reduce or eliminate health or safety hazards.

The cost estimate for fiscal year 1963 is based on experience in prior years. Obligations in fiscal year 1962 will be approximately $11,500,000 for general plant construction. The estimate in fiscal year 1963 is less than 1 percent of the capital value of all special nuclear materials plants under the jurisdiction of the Oak Ridge, Hanford, and Savannah River Operations Offices.

The amount estimated for each office is as follows:

Operations Office:	*Amount*
Oak Ridge	$7, 800, 000
Hanford	2, 600, 000
Savannah River	1, 100, 000
Total	11, 500, 000

9. Project 62–a–5—Additional reactor confinement, Savannah River, S.C., $9 million

Public Law 87–315 authorized at a total estimated cost of $3 million the provision of additional means of minimizing the effects of possible incidents in the Savannah River reactors which would otherwise result in the release of highly radioactive particulate matter. This project was intended to supplement the confinement facilities being provided under project 60–a–4, reactor air filters, Savannah River, S.C., and was requested by AEC on the basis of a recommendation by the Advisory Committee on Reactor Safeguards resulting from a review of limited confinement studies in connection with 60–a–4.

Since the project was authorized, a need for expanded scope of confinement has been evolved from intensified analyses of accidents and confinement needs. The necessary confinement facilities cannot be provided within allowable funds or authority approved for this project by Public Law 87–315.

It is currently estimated that it will cost $12 million to provide the necessary facilities required for increased reliability of reactor cooling, better sealing and ventilation, emergency power for critical equipment, additional instrumentation and remote control and monitoring, larger basins for storing contaminated water, and other miscellaneous items.

Fiscal year 1963 obligations of $9 million are necessary to cover the increased scope and cost of project 62–a–5 (from $3 million to $12 million) and provide the required confinement at the earliest practicable date.

The revised estimate, therefore, provides for the design and construction of facilities to (1) seal the reactor building, above and below grade, to contain initially all accidents except those that cause excessive damage to the reactor building, (2) filter all gases exhausted from process areas to remove most of the particulate and halogen activity, (3) modify the emergency H_2O addition facilities to insure reliable operation and control of the reactor in the event of high radiation levels or building flooding, (4) provide for outside open basins for storage of large volumes of contaminated water removed from the reactor buildings, (5) provide for remote facilities to control ventilation and emergency cooling systems and develop information regarding possible reentry of vital facilities or evacuation of the surrounding territory.

10. Project 59–a–5—Production reactor facility for special nuclear materials, convertible type, Hanford, Wash., $43,000,000

The initial authorization for this reactor project was $145 million. In fiscal year 1962, the estimate was increased $7,200,000 to a total of $152,200,000 to provide for supporting facilities. This estimate increases the project total by $43 million to a new total of $195,200,000.

The basic reason for the $43 million cost increase can be stated generally as starting the project on the basis of incomplete design and the difficulty in obtaining primary pipe which will meet the A–E's specifications. These have occasioned numerous change orders which increased costs and caused delays which also added to the total cost.

Mr. EVINS. The total request is decreased from $560,356,676 to $537 million.

PROCUREMENT AND PRODUCTION

In the procurement and production and related capital equipment, catetory, will you explain the basis for the reductions.

General LUEDECKE. Mr. Chairman, Mr. Baranowski will answer.

Mr. BARANOWSKI. In 1962 we reduced our power utilization in the cascades for the production of enriched uranium. In addition, we reduced, during 1962, the amount of plant improvements to the U^{235} gaseous diffusion plants. Further projecting the manpower requirements for the production of U^{235}, we made some major manpower reductions in our three large diffusion plants during 1962. The total reduction over the period of 1962 was around 1,300 people. This reflects one major reduction in 1962.

PROCESS DEVELOPMENT

Mr. EVINS. On the second item, process development and related capital investment, $37 million, these funds provide for technical plant support to assure continuity and safety of operations. Please explain this item.

Mr. BARANOWSKI. The primary purpose of the $37 million is to do work in the area of improving plant performance. In addition we have a couple of new products on which we have been doing development work—plutonoium 238 is used as a heat source in auxiliary power units in space vehicles, and in addition we have initiated a program of recovering fission products from our separation plant waste streams, for use as heat source in various devices for the production of electric power.

We also have a major effort at Hanford on reducing radioactivity discharges to the Columbia River. We were successful last year in reducing radioactivity discharges to the Columbia River by a factor of about two.

Also, we have a number of projects which were instituted last year which reduced our cost of operations.

Mr. EVINS. What are you going to spend out of this $37 million for the space program?

Mr. BARANOWSKI. From the production standpoint, we produce and recover from our radioactive waste streams strontium 90, which is not used in the space program, but has been used to supply electrical energy for a remote prototype weather station. As far as the space program is concerned, we recover neptunium 237 from our separation plants, which is then fabricated into targets, reirradiated in production reactors to produce plutonium 238. The plutonium 238 is the heat source for the production of electrical power in the auxiliary power units for space application.

OTHER CAPITAL EQUIPMENT

Mr. EVINS. You have $5½ million for other capital equipment for special nuclear materials. What is the purpose of this fund?

Mr. BARANOWSKI. These are general equipment items that cannot be identified with a particular program at a site.

They are for general applications at a particular site, such as mobile vehicles.

Mr. EVINS. Will you supply for the record a breakdown of what these funds are for?

Mr. BARANOWSKI. Yes, sir.

(The information follows:)

EXAMPLES OF OTHER CAPITAL EQUIPMENT ITEMS

These funds cover equipment that cannot be identified with a specific budget and reporting classification or that is acquired for multipurpose or general purpose use. Examples of such items in fiscal year 1963 include: Motor pool passenger cars and pickups, road graders, a maintenance shop crane, toolmakers lathe, a firetruck and fire pumper, three IBM 1401 computers, microfilm equipment, coal-handling equipment, towing tractors, dump trucks, forklifts, central air compressors, dust-control equipment, nitrogen-handling equipment, replacements for onsite electrical and water distribution systems, and centralized office furnishings.

REDUCTION IN 1962 ESTIMATE

Mr. EVINS. Last year you estimated a cost of $557 million for the current year. You are now showing an underrun of $31.6 million for the current year.

Mr. BARANOWSKI. In the previous 1962 estimate.

Mr. EVINS. $557 million showing a reduction of $31.6 million. Is this hurting your program in any respect?

Mr. BARANOWSKI. No; it is not.

INCREASED REQUIREMENTS IN 1963

Mr. EVINS. In view of the underrun what real need is there for a $10 million increase as requested for 1963?

Mr. BARANOWSKI. In taking a look at the 1963 budget, we took into account all of the cost reductions which we effected in 1962. In the reactor products category, a number of increases will occur. NPR costs of $3.3 million will be incurred in 1963 for production of fuel elements. We had included a cost for NPR fuel element fabrication

in 1962. This has been deferred to 1963. In addition, we expect a $3 million increase in the rate of installation of zirconium tubes in Hanford reactors. There are, of course, other miscellaneous increases, some of which are offset by miscellaneous decreases.

GAS CENTRIFUGE

Mr. EVINS. Last year we discussed the prospect of the gas centrifuge method of separation. Are the prospects of achieving success with this any better? How much money is going into this program in 1963 over 1962 and what do you now estimate will be the total cost of the program?

Mr. BARANOWSKI. The 1963 cost will run at a level of about $2.3 million which is approximately $100,000 less than 1962 costs. We are currently obtaining engineering data on the process. We hope to make by the end of calendar year 1963 a realistic appraisal of the process for the separation of uranium isotopes. A number of significant things have been achieved in the past year.

(Discussion off the record.)

Mr. BARANOWSKI. In addition we have made substantial progress toward the development of a centrifuge machine with higher performance than was available when we started the program. However, a significant amount of additional work has to be done before we can make a realistic appraisal of the process.

PROCESS DEVELOPMENT

Mr. EVINS. In connection with this $37 million process development, what contracts are supported with these funds? Specifically what have we gotten from this program in tangible measurable savings in the past year? You can supply that for the record.

Mr. BARANOWSKI. Yes, sir.

(The information follows:)

Process development funds are used by the principal production contractors at the various production sites. Following are some examples of the benefits obtained through process development effort during the past year:

1. NPR studies at Hanford have eliminated the large mixing headers permitting an estimated savings of $230,000.

2. Several improvements in reactor hydraulic systems at Hanford are in place which resulted in improved operating efficiency and estimated annual economic benefits of $200,000 during the past year.

3. Progress has been made for the development of a process to demonstrate the feasibility of purifying inpile gas at Hanford. A reduction in helium consumption and an annual reduction of $200,000 in operating cost is expected.

4. A study to establish a method at Savannah River for handling enriched fuel tubes in the disassembly basins resulted in establishing procedures for rapid and critically safe storing and bundling of the fuel tubes in a double-tiered arrangement in special racks. The unique handling scheme eliminated the need for approximately $200,000 that would have been required for investments to handle the tubes by conventional methods.

5. Similar work was completed on a tritium element at Savannah River having a potential savings of $700,000 per reactor year due to lower reactor component and target and fuel fabrication cost.

6. In the gaseous diffusion and feed materials complex a two-stage stirred fluid bed hydrofluorination system has been placed on an operational basis at the Paducah feed plant. Onstream performance indicates that anticipated savings of $100,000 per year due to better conversion of Hanford oxide and decreased man-years per ton of production will be realized.

7. A method for fluorine cell electrolyte recovery has been developed which will save $100,000 per year in material cost at Oak Ridge and Paducah.

8. Development studies have established the feasibility of reusing certain portions of process equipment scheduled for removal under the Cascade improvement program. Savings will approximate $3 million.

9. Use of lithium at Oak Ridge as a reducing agent in UF_4 to U metal production has eliminated the use of iodine and reduced salvage and maintenance costs for total direct savings of $300,000 per year.

10. Tooling development on cutting edge materials, cutting speed angles, and regrinding cycles has reduced the total tooling cost for machining at Fernald from $700,000 to about $200,000 a year.

11. Chemical recycle development directed toward recovery in the refinery of U from Mg F2 slag has led to a minor equipment modification which indicates savings of $300,000 to $600,000 per year in recovery costs beginning in October 1962.

12. Development effort at Hanford has reduced the quantities of radioisotopes discharged from reactor effluent streams into the Columbia River to about half of the previous year's concentration through adoption of improved water treatment processes.

13. Technology was also developed and demonstrated at Hanford for the isolation and recovery of large quantities of cerium 137 from the waste supernates stored in underground tanks. In addition, a solvent extraction process was developed and demonstrated, utilizing equipment available at the hot semiworks, for the purification of strontium 90 and cerium 144.

14. In the preparation of samples for counting by extraction techniques at Savannah River, the Vortex mixer reduced the time of equilibrium by a factor of 10. This device effected a savings of about 870 man-days per year at Savannah River.

15. The development and successful installation of a modification in the enriched uranium recovery process at Savannah River recovered most of the neptunium as a separate stream, eliminating the need for much more extensive modifications and major capital expenditures.

16. An instrument which rapidly detects release of airborne uranium dust has been developed, tested, and installed in the diffusion plants. This instrument reduces from hours to minutes the time required to detect and obtain accurate readings of airborne contamination.

In addition to the foregoing examples we have also furnished several classified examples of progress in process development during the last year.

PROCESSING USED FUEL

Mr. EVINS. You have been negotiating with the Davison Chemical Co. on a plan for processing used fuel. Bring us up to date on this plan and tell us the full extent to which the Federal Government will have to subsidize this operation to get it going and for how long.

Mr. BARANOWSKI. At the current time we are negotiating with the Davison Chemical Co. the basis of arrangements for processing irradiated fuels from private industry. The only commitment which has been approved by the Commission for consideration in this negotiation is the offer of a base load of fuels for a period of 5 years. The assumed startup date of the Davison plant is in 1965. This has been the only commitment that we have considered so far in the negotiation with the Davison Co.

Mr. EVINS. How much will this be represented by a subsidy and for how long?

Mr. BARANOWSKI. It would depend on the terms and conditions of the final contract. We are receiving from Davison a more complete estimate of the cost of processing fuels in their plant which would be compared with processing the same fuels in our plant. At this time we are unable to make a firm statement on what the difference in cost would be between processing in our plant and processing fuels in the Davison plant.

Mr. EVINS. Do you expect to have a firm contract this year?

Mr. BARANOWSKI. We hope to complete the negotiations if possible some time during this calendar year; yes, sir.

Mr. EVINS. How long have these contract negotiations been underway? Tell us about your plans.

Mr. BARANOWSKI. The contract discussions have only been underway approximately the last 2 months. The Davison Co. over a period of a couple of years has been developing the technology and type of plant they would build for the processing of the power fuels. They have talked to the Commission and the Commission staff a number of times, discussing their preliminary plans for the processing of these fuels. They envision the construction of a processing plant with a capacity on the order of 1 ton of uranium per day which is sufficient to take care of all of the power fuels which are currently on board. To make the plant an economical undertaking Davison requested a baseload from the Commission which is estimated at this time to be of the order of a hundred days' processing. Tentatively they have established a daily processing charge of approximately $22,000 for the basic plant. For 100 days' processing, this amounts to approximately $2,200,000 per year.

Mr. EVINS. Mr. Pillion.

Mr. PILLION. On the Davison contract, is that the contract that the New York State atomic energy group is interested in?

Mr. BARANOWSKI. This is one of the States that the Davison Chemical Co. is considering for the location of their chemical processing plant.

Mr. PILLION. You don't seem to spend very much money up in New York State out of all these millions of dollars. What is the purpose of this contract?

Mr. BARANOWSKI. The Commission has announced in 1957 that it would accept fuels from the various power operators for processing since no private facilities existed. The Commission is quite interested in having a private industry built in this particular area of the complete fuel cycle. At the present time the industry does provide for the fabrication of the fuel elements and for the construction of the reactors. There is a gap in the fuel cycle which is for the recovery of enriched uranium and plutonium from the irradiated fuels discharged from power reactors.

Mr. PILLION. Who does it now?

Mr. BARANOWSKI. The Commission has a commitment to accept these fuels and provide for the processing. No power fuels have been shipped to the Commission for processing as yet. Fuels discharged from power reactors will be ready to ship during fiscal year 1963.

Mr. PILLION. The process would recover the usable plutonium and uranium for further use.

General LUEDECKE. The purpose of this recovery process is to take the fuel from the reactors after they have been burned down to a point where they are no longer operating economically, to run them through a chemical processing plant, to recover the plutonium either for future use or for return to the Government, and to recover the uranium and such other waste products as might be indicated. The Commission has not constructed processing facilities to handle the commercial market, because it was our hope that available process technology would permit an industrial concern to evaluate the entire process, establish their own plants and handle the processing

outside of the Government plants. The processing company would make its arrangements direct with the power companies.

Mr. PILLION. We are getting reports around Buffalo that the State of New York has purchased an area south of Buffalo about 50 miles in the Allegheny Mountains area for burying waste recovered materials. Is this all part of this Davison contract?

General LUEDECKE. I am not completely familiar with the details of it. I think it is all part of a proposition to have a number of nuclear energy industries locate at this site. It is their hope that the Davison Chemical Co.'s processing plant would be one of the industries. They have also given consideration to burial of low-level waste, such as the Commission now does in Tennessee and Idaho. I am not aware of any specific commitments that have been made as yet.

Mr. PILLION. The chairman raised a question of subsidies. Could the Commission do it any cheaper than the contract that you would probably make with respect to this operation?

General LUEDECKE. We are not sure at this point for two reasons. We don't know quite what it will cost us and we don't know what they are going to charge because they have not developed it. Any subsidy that would be involved would be a recognized difference between our costs and their charges. We cannot determine whether it is a subsidy or not.

Mr. PILLION. So subsidy may not be the right word to use here?

General LUEDECKE. Yes, sir. We don't know what it will cost. We had to develop a theoretical plant and base our estimates on the cost of this theoretical plant. They feel that their costs are going to be comparable to the charges on the theoretical plant basis. It could conceivably be that it would end up the opposite of a subsidy. It would relieve the Government of a cost.

BEN FRANKLIN DAM

Mr. EVINS. Mr. Baranowski, the Corps of Engineers is continuing to spend funds in the Ben Franklin project. Are you participating in this study and what do you estimate it will cost in total and how long it will take?

Mr. BARANOWSKI. We have talked with the Corps of Engineers but I do not know the current status.

Mr. EVINS. Will you supply information on this for the record?

Mr. BARANOWSKI. Yes, sir.

(The information follows:)

REGARDING BEN FRANKLIN DAM FEASIBILITY STUDY

AEC is not participating in a feasibility study on the Ben Franklin Dam which we understand is being undertaken by the Corps of Engineers.

CHANGE IN WORKLOAD AT WELDON SPRING, MO.

Mr. EVINS. You are making some changes in work and personnel at the Weldon Spring, Mo., installation. We will place in the record your letter of April 30, and ask you to elaborate on the reasons for this change and these reductions.

(The information follows:)

U.S. Atomic Energy Commission,
Washington, D.C., April 30, 1962.

Hon. Clarence Cannon,
House of Representatives.

Dear Mr. Cannon: On or about July 1, 1962, the AEC plans to make significant changes in the operation of the feed materials plants at Weldon Spring, Mo., and Fernald, Ohio. It is planned to consolidate all of the uranium concentrate refining in the Weldon Spring plant and all of the production reactor fuel element machining operations in the Fernald plant. Currently both plants are refining uranium concentrates as well as machining fuel elements.

The scheduled deliveries of ore concentrates are decreasing and the Weldon Spring refinery, which is the newer and more efficient of the two refineries, has ample capacity to process all of the available refinery feeds after July 1, 1962. Coincident with the changes in refinery operations, Fernald will start up new uranium machining equipment which will produce fully machined fuel elements from blank slugs in a series of automatic operations. Most of the fuel element machining operations are now being performed at Fernald, and ample capacity exists at that site to meet currently projected requirements. As a result of these major operating program changes, personnel reductions at both Fernald and Weldon Spring will be made.

At Fernald, it is estimated that the number of employees will be reduced by about 340 (including 86 salaried) from the present level of 2,195. At Weldon Spring, the reduction will amount to 35 persons (including 5 salaried) out of a total employment of 797.

Sincerely yours,

F. P. Baranowski,
Director, Division of Production.

Mr. Baranowski. The Commission operates refineries for converting the ore concentrates to uranyl nitrate. We have refineries at Weldon Springs and at Fernald. In projecting our refinery load it was determined that we could process the refinery load at the one site, the more efficient site, Weldon Spring. We also took a look at the finished machining of uranium slugs at both Fernald and Weldon Spring. It was determined that the complete machining of the final slugs would be done at Fernald. We plan closing out the finishing operations at Weldon Spring. We are concentrating our refinery load at Weldon Spring, and plan to shutdown the refinery at Fernald beginning July of this year.

SPECIAL NUCLEAR MATERIALS PROGRAM CONSTRUCTIONS

Mr. Evins. I notice you have some 10 construction projects. Would you please give us a brief rundown of what you propose to do and why these funds are required?

MODIFICATIONS TO PRODUCTION AND SUPPORTING INSTALLATIONS

Mr. Baranowski. Starting with the first project, modification of production and supporting facilities.

Mr. Evins. You are asking for $5 million.

Mr. Baranowski. Yes. To cover items of the emergency type which we cannot schedule in advance. These are programs which turn out to be essential and which we cannot now identify as a line item, as we have done for the projects which follow.

MODIFICATION TO FACILITIES FOR CONVERSION OF UNH TO UF_4

Mr. EVINS. No. 2.

Mr. BARANOWSKI. This project is for the conversion of the uranyl nitrate from the refinery operation to UF_4, by a new technique which will replace pot operations and screw-type reactors.

RADIOACTIVE WASTE DISPOSAL FACILITIES, HANFORD, WASH.

Mr. EVINS. No. 3.

Mr. BARANOWSKI. In the operation of our separations plants we discharge highly radioactive waste materials. Periodically we have to add to our waste storage system additional storage tanks to handle the radioactive waste which is discharged from the separation plant. This is a continuing item. We estimate that the installation of these tanks at Hanford will be adequate to about 1967.

Mr. EVINS. None of these items have had any funds for 1962. They are all new for 1963?

Mr. BARANOWSKI. New 1963 items, yes, sir.

CONSOLIDATED SERVICE FACILITY, HANFORD, WASH.

Mr. EVINS. B–1.

Mr. BARANOWSKI. B–1 is consolidation of a number of services which were being done in the fuel element canning operation at Hanford. We were using 12 buildings in the operation, and we plan to consolidate the activities in one building. We need the new consolidated facility to assist in meeting the more stringent requirements on fuel elements at Hanford.

Mr. EVINS. What is this consolidated service facility?

Mr. BARANOWSKI. This facility consolidates our maintenance, handling, and analytical operations in one centralized location.

ADDITIONAL HIGH LEVEL WASTE STORAGE TANKS, SAVANNAH RIVER, S.C.

Mr. EVINS. No. 2, you have an item of $6 million.

Mr. BARANOWSKI. That is a similar type project to the previous $3.7 million facility for Hanford, the construction of waste tanks to handle highly radioactive waste discharged from separation plants.

Mr. EVINS. Your A–3 is $3.7 million for waste disposal and your B–2 is $6 million for the same purpose.

Mr. BARANOWSKI. The same purpose except that the type of tanks to be constructed at Savannah River are more expensive than at Hanford.

EMERGENCY DUTY PERSONNEL SHELTERS

Mr. EVINS. What about your B–4, emergency duty personnel shelters?

Mr. BARANOWSKI. Mr. Derry will talk to that item.

Mr. DERRY. Those are really emergency operational facilities to provide protection for the workers that would stay behind after our disaster plan has required evacuation of all other personnel from the plants in the event of an attack alert.

Mr. EVINS. This is a super bombshelter for the employees?

Mr. DERRY. No, this is not a fallout shelter. This is for the operational shutdown personnel that need a super bombshelter. It is a blastshelter. We have to provide protection, we feel, for the people we are asking to stay behind to perform the operational mission of cooling the reactors and performing other similar emergency functions.

Mr. EVINS. What are you going to have in this shelter? Is this a recreational center?

Mr. DERRY. No, sir. This is just a place to protect the personnel so they will survive either a near-miss or, in case the plant is not hit, to take measures to prevent the plant from becoming a hazard by self-destruction.

Mr. EVINS. If the plant is unfortunately struck by a bomb, how will they be able to work? It will be destroyed.

Mr. DERRY. Yes, sir. These are needed in case the plant is not hit. We recognize that all our production plants are primary targets.

Mr. EVINS. How large is this personnel shelter? How many employees will it accommodate?

Mr. DERRY. From 15 to 30 people.

(Discussion off the record.)

Mr. EVINS. Will the shelter be on Government property?

Mr. DERRY. They will be on Government property.

Mr. PILLION. How much will the maintenance cost be?

Mr. DERRY. These will be lump-sum competitively bid. They will be fairly low maintenance, and will add only a small incremental amount to each one of the operating plants.

GENERAL PLANT PROJECTS

Mr. EVINS. Please explain 63–1, your general plant projects, for which $11.5 million is budgeted.

Mr. BARANOWSKI. These are the type of small projects that you have to do each year in an operating plant. An item of this type would continue each year as long as you have a large operating complex as we have in the production of special nuclear materials. The estimate is based on past experience.

Mr. EVINS. All right.

Mr. PILLION. How much did you have in 1961–62 for this purpose?

Mr. MCCARTHY. $11.5 million in 1962. In 1961, under this program, it was $11.1 million. In 1960 it was $10 million.

These are minor capital additions and improvements, modifications. No project would be in excess of $500,000. In the authorization bill there is a limitation on the amount that we may spend for each project.

Mr. EVINS. Supply a breakdown for the record.

Mr. MCCARTHY. Yes, sir. May we furnish examples of the subprojects we actually initiated under the 1961 project?

(The information follows:)

GENERAL PLANT PROJECTS

Special nuclear material program, fiscal year 1961

Description and location of project	*Total estimated cost*
Hanford Operations Office: Hanford Works, Richland, Wash.:	
Electrical system expansion, 300 area, increasing the effective capacity of the 351 substation by 9,000 kilovolt-amperes, construction of approximately 5,500 feet of 13.8-kilovolt lines and approximately 900 feet of 2.4-kilovolt secondary distribution lines, and a secondary substation of 3,000 to 4,000 kilovolt-amperes capacity	$253,000
Secondary containment, dissolver off-gases, Redox plant—to provide a secondary or backup filter system, external to Redox, to provide a filter capability in the event of a fire, or explosion which could damage the primary filter system	195,000
Waste treatment pilot plant	155,000
Relocation of warehousing facilities, 1100 area	141,000
Radioecology facility—fencing approximately 800 acres in the Rattlesnake Springs region and providing necessary facilities for experimental ecological studies of terrestrial and aquatic ecological systems	90,000
Oak Ridge Operations Office:	
Paducah, Ky.: Installation of additional boiler, C–600 steamplant	230,000
St. Louis, Mo.: Roll straightener facilities, building 301	118,000
Fernald, Ohio:	
Addition to plant 8 and equipment to convert scrap plant products to green salt more economically (Winlo process)	477,500
Mechanical shop and office addition, mechanical shop and storeroom, FMPC	99,000
Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn.:	
Radiation alarm system, K–25 plant	405,000
Radiation alarm system, K–26, K–29, K–1401, and K–1420	382,000
Radiation alarm system, K–31, K–33, and laboratory administrative areas	331,000
Telemetering system, pumphouse	130,000
Addition to building K–1004J to house gas centrifuge facilities	91,000
Y–12, Oak Ridge, Tenn.:	
Fire protection improvements	460,000
Furnace and other supporting facilities for production of materials	425,000
Fire protection improvements, group II	381,000
Maintenance facilities, building 9720–6	325,000
Steam system improvements	133,000
Vacuum annealing facility, building 9204–4	130,000
Analytical development facility, building 9203	118,000
Conversion of building 9723–14 to office space	115,000
Mechanical development facilities, building 9203	114,000
Argon storage and distribution system	95,000
Miscellaneous, Oak Ridge, Tenn.:	
Surface improvements, Bear Creek Road	135,000
Modifications to building 1916–T–1, Office of Technical Information Extension	134,500
Savannah River Operations Office: Savannah River plant, South Carolina:	
Fire detection and protection equipment in production and service buildings	290,000
Land management program	200,000
Relocate controls for reactor cooling water pumps to central reactor area control rooms	190,000
Building alterations and utilities for installation of a computer in the laboratory	160,000

Mr. EVINS. Mr. Jensen.

NEW PRODUCTION REACTOR, HANFORD, WASH.

Mr. JENSEN. Referring to 59–a–5, there has been a tremendous increase in the estimated cost of the new production reactor at Hanford, and I believe additional information is needed as to the cause of this increase and what phase of the NPR facilities it is properly chargeable to. On page 103 of the Joint Committee print of March 1961 is a letter from Chairman McCone of the AEC to the chairman of the Joint Committee on Atomic Energy, which contains the following reference to the estimated cost of the NPR which reads as follows:

> The Commission as a group visited Hanford on August 6 and 7 at which time a considerable portion of the visit was devoted to a review of NPR matters. I know you will be pleased to learn, as we were, that current estimates still show that the reactor can be completed within the $145 million estimate developed by General Electric over 2 years ago. As the committee was previously informed, however, the $145 million estimate did not include other Hanford supporting facilities which are still estimated to cost about $7 million. We were also pleased to learn that although it is a tight schedule, turnover to operations is still expected to be accomplished in October 1962. The heavy phase of the construction is progressing rapidly and some 60 percent of the critical equipment is on order.

It is difficult to understand how the Commission staff and the Hanford people could be so positive at that time about the total cost of NPR and the progress on its construction, only to find a year and a half later that the cost would be 30 percent or $43 million higher and that the time of completion would be delayed at least a year.

I think we need to know just what elements of the project are responsible for the increased cost and to which phase of the NPR these increases are properly chargeable. To that end I submit the following questions and ask that answers be submitted for the record.

Mr. EVINS. Those questions may be included and let the gentleman supply the answers for the record.

(The questions and answers referred to may be found beginning on p. 113.)

Mr. JENSEN. I think those questions need to be properly answered, so I hope you will take your time to at least try to answer them to our satisfaction.

INSTALLATION OF ELECTRIC POWER GENERATING FACILITIES AT NPR

Also, Mr. Chairman, during the hearings on Thursday, May 7, 1962, some discussions were had relative to the WPPSS proposal to construct electric generating facilities at NPR at Hanford, and to purchase steam from AEC to operate these electric generating facilities.

The proposal also contemplated that all the power produced which would be nonfirm power would be delivered to Bonneville Power Administration and BPA would in turn deliver an unknown amount of firm power to the Washington Public Power Supply System participants in this proposal. Such delivery of firm power could easily be two or three times the amount of nonfirm power produced by NPR. If all proper NPR power production costs are included, that is. Under the proposed contract, BPA would be the de facto guarantor of security for the WPPSS bonds. Mr. Luce, the BPA Administrator, in effect admitted this in testimony before this committee when he stated that under terms of the change arrangements would take the full output of the Hanford generator, and in turn would deliver power to the

participating utilities of a value equal to the operating expenses and amortization, interest, and so on, each year until the plant is paid for. In that sense, the terms of the contract would be security for the revenue bonds which would be issued to finance the plant.

In addition, the Federal Government could take or might be required to take title to and be obligated to pay up to $135 million or more for power facilities Congress has said the Federal Government cannot build or operate. The contracts would also provide for AEC to lease the new plutonium reactor to WPPSS if AEC operation for plutonium production should cease before the WPPSS bonds were paid off.

I and other minority members have this question, and I am not sure that some of the majority members seriously question whether AEC and BPA have legal authority to obligate the Federal Government in the manner contemplated in the proposed contracts or to use appropriated funds to effectuate these contracts.

In this connection, Mr. Taber has requested a ruling from the Comptroller General of these matters. It is our contention that WPPSS proposal is a patent subterfuge to circumvent the expressed will of Congress. Certainly WPPSS tacitly admits this in its letter of November 28, 1961, to AEC and BPA, where it was stated:

> It is the desire of the WPPSS that the installation of electric power generating facilities at NPR by a non-Federal agency shall accomplish the objective envisioned by AEC and BPA in support of the legislation for Federal construction of these facilities.

We do not believe it proper for any two agencies of the Government to be parties to such an attempt. If the existing laws are so loosely written that these Federal agencies can contend they have legal authority to achieve such circumvention then it is time to close such loopholes in the basic law. It is also fully evident that under the proposed contract the taxpayers of the Nation would be called upon to contribute untold millions of dollars in further subsidy of low-priced power for the Pacific Northwest.

The proposers of this scheme are trying to circumvent the will of Congress and try to tell us that power can be produced at a cost less than Bonneville's present rate. The only way that can be done is on paper by writing off a large part of the various costs and charges that are properly to be leveled against the NPR power. If these costs are included, then BPA would have to deliver two or three times as much firm power as it receives nonfirm power. In either case, the taxpayers of the Nation will provide a high subsidy.

We think the time is overdue for the Pacific Northwest to provide and pay for needed increases in the future supply without further Federal subsidy.

Mr. EVINS. I believe similar questions have been propounded to the Commission in writing maybe from Mr. Taber and if so, that letter and the responses may be included in the record.

General LUEDECKE. Pursuant to an earlier request by the chairman we will submit for the record the basis of our arrangements.

Mr. JENSEN. This is my statement.

Mr. EVINS. The answers may be included in the record.

(The information referred to follows:)

INFORMATION FOR INCLUSION IN RECORD OF HEARINGS ON FISCAL YEAR 1963 AEC BUDGET BEFORE PUBLIC WORKS SUBCOMMITTEE OF HOUSE APPROPRIATIONS COMMITTEE

The following is provided in answer to the nine questions posed by Congressman Jensen regarding the new production reactor.

1. Question. What temperatures and what pressures were contemplated for the coolant water in the plutonium-only reactor that was estimated to cost $120 million?

2. Question. What temperatures and what pressures were contemplated in the coolant water in the convertible reactor estimated to cost $145 million?

Information on questions 1 and 2 is being furnished on a classified basis.

3. Question. Was the indicated major development problem of the fuel element of the NPR referred to in Mr. McCone's letter of September 14, 1960, caused by or related to the increase in pressure and temperatures over that required for a plutonium-only reactor?

Answer. The problems associated with fuel element development for the NPR were probably made somewhat more difficult by its higher temperatures relative to those contemplated for the single-purpose reactor. The degree of the difference, however, is impossible to measure.

4. Question. What critical equipment was on order in September 1960 when the $145 million estimate was again validated?

Answer. The following critical equipment was on order as of September 1, 1960:

Item	*Approximate value*
Graphite	$2, 700, 000
Ball 3X equipment	100, 000
Inlet connector valves	600, 000
Outlet connector valves	990, 000
Zirconium tubes graphite cooling	165, 000
Gas system	210, 000
Biological shield crates	650, 000
Heavy aggregate	50, 000
Process tubes:	
Pilot order	3, 000, 000
Production order	7, 200, 000
Elevators	1, 159, 000
Transformers, motor control centers	60, 000
Fuel element conveyors	850, 000
Graphite cooling heat exchanger pumps	210, 000
Primary pumps	750, 000
Heat exchangers	4, 600, 000
Pressurizer	230, 000
Valves, primary loop	450, 000
Secondary valves	110, 000
Dump condensers and pumps	820, 000
Drive turbines	1, 170, 000
Condensers	215, 000
230-kilovolt substation and 13.8-kilovolt electrical switchgear	586, 000
Demineralizer equipment	867, 000
Electric motors, circulating pumps	450, 000
Circulating pumps	475, 000
Filter plant equipment	407, 000
Boiler	550, 000
Turbine generator	897, 000
Total	30, 521, 000

5. Question. What total dollars were obligated at that time?

Answer. As of September 1, 1960, approximately $56 million had been committed for the NPR construction program, of which approximately $16 million had been spent.

6. Question. What equipment or construction feature is primarily responsible for the $43 million increased cost and when did this tremedous increase in cost become apparent? What was the total dollar obligation at that time?

Answer. The following table contains a breakdown by functional elements of the $43 million increased cost of the NPR project:

	Millions
Piping	$11. 4
Instrumentation	3. 1
Miscellaneous	6. 3
Estimated change order allowance	7. 0
Indirect construction costs	5. 9
Engineering costs	5. 5
Project startup costs	2. 0
Contingency	1. 8
Total	43. 0

Revised cost estimates approved in September 1961 indicated an approximate $20 million increase in the cost of the NPR project. By February 1962 further difficulties, mainly associated with the primary system piping, indicated additional cost increases of approximately $23 million. The cost and obligations as of these dates were as follows:

[In millions of dollars]

Date	Obligations	Costs
September 1961	116. 5	78. 8
February 1962	132. 2	107. 2

7. Question. On what basis is this NPR project being built? Cost plus or how?

Answer. Design and engineering of the NPR and its auxiliary facilities are being conducted on a cost-plus-fixed-fee basis. Construction management is also being performed on a cost-plus-fixed-fee basis. The cost-plus-fixed-fee construction contractor is undertaking to accomplish a large part of the construction work by fixed price subcontracts.

8. Question. It is evident that the original $25 million convertibility figure was arrived at by subtracting the $120 million estimated cost of the plutonium-only reactor from the $145 million estimated cost of the convertible reactor. Does it not follow that this same method must be used in arriving at the actual ultimate cost of convertibility? In other words, to take the total ultimate cost of the MPR and subtract the $120 million estimated cost of the plutonium-only reactor? What possible justification can you have for using any other method?

Answer. The actual capital cost of NPR convertibility cannot be determined by subtracting $120 million (the cost, estimated in 1958, of a single-purpose reactor) from the ultimate cost of the convertible NPR. To do this would presume a degree of accuracy in the $120 million estimate which obviously cannot be attributed to the initial $145 million estimate for the convertible reactor. As the single-purpose reactor was not built and as its design concept was also very different from existing Hanford production reactors, it is impossible to determine what difficulties would have been encountered in its design and construction, and the effect of such difficulties on the ultimate cost of the reactor.

9. Question. I believe it has been indicated in the past that the NPR would have to be shut down to make the conversion from plutonium-only production to dual-purpose operation. If this is still true, how long will the conversion take? What facilities are to be constructed now and what conversion changes or additional facilities will have to be constructed later, in order to make the NPR facilities capable of producing the quality and reliability of steam needed to operate a generating plant?

Answer. It is currently expected that the NPR will have to be shut down for approximately 6 weeks to tie in a powerplant. This would be accomplished at the end of the plant construction period which would last approximately 3 years.

The NPR as now designed and being built will produce steam suitable for use in turbine generators. Previous studies have indicated, however, that it would be worthwhile to install additional facilities to improve the quality and reliability of NPR steam for use in the generation for electric power. These improvements, however, are not absolutely necessary; rather, their costs have been shown in previous studies to be a worthwhile investment only should power recovery be undertaken. The major components of the facilities in question are a sixth primary coolant loop to increase steam pressure and an additional standby boiler

and turbine generator, as well as certain improvements in instrumentation, the latter two related to increased reliability of the steam supply.

HOUSE OF REPRESENTATIVES,
Washington, D.C., April 18, 1962.

Dr. GLENN T. SEABORG,
Chairman, Atomic Energy Commission,
Washington, D.C.

DEAR DR. SEABORG: The Bonneville Power Administration budget request for fiscal year 1963 is currently being heard before the Public Works Subcommittee of the House Appropriations Committee. In this connection, Bonneville has presented a proposal relative to construction by the Washington Public Power Supply System of a powerplant at the new production reactor at Hanford, Wash.

In the WPPSS proposal the claim is made that that non-Federal agency can construct the powerplant in question on Federal property by agreement with AEC without requiring additional or amendatory AEC legislation. With this hypothesis we cannot agree.

Congress, by the vote in the House of Representatives, rejected in no uncertain terms the proposal for constructing the powerplant at Hanford. For AEC now to become a party to an attempted subterfuge to negate congressional action is unthinkable. Furthermore, the proposal as presented raises several questions other than the one of lack of legal authority to enter into proposed contracts.

The convertibility feature of the new production reactor was sold to the Congress on the primary basis that it provide for reducing the cost of producing plutonium by 30 to 40 percent over that from a plutonium only reactor. Under the present proposal, the cost of plutonium would not be reduced, nor would there by any recovery of the capital cost of the convertibility features, nor would there be provisions for repayment of any portion of the capital cost of the reactor itself.

Under the proposed contract as drafted the Bonneville Power Administrator could, either through collusion or on his own determination, commit the Federal Government to take over and pay for the proposed electric generating plant at Hanford. To agree that BPA or AEC has authority to make contracts which would make this possible is unbelievable.

There are many other adverse factors relative to this Hanford deal that should in themselves have precluded any consideration whatsoever of the proposal presented.

The undersigned reiterate that neither AEC nor Bonneville has any authority to enter into the proposed Hanford power contracts, and we request AEC to refrain from execution of any such contracts until this matter can be gone into at length by the Congress.

Sincerely yours,

BEN F. JENSEN.
JOHN TABER.
IVOR D. FENTON.
JOHN R. PILLION.

MAY 4, 1962.

Hon. BEN F. JENSEN,
House of Representatives.

DEAR MR. JENSEN: Reference is made to the letter of April 18, cosigned by you, regarding the proposal to the AEC and the Bonneville Power Administration (BPA) submitted by the Washington Public Power Supply System (WPPSS) to finance, construct, and operate electric power recovery facilities in association with the new production reactor (NPR) now under construction at AEC's Hanford Works in the State of Washington. The proposed undertaking would involve separate contracts between WPPSS and AEC on the one hand; and between WPPSS and BPA on the other. A copy of the proposal is attached for your information.

At the present time, we are in the initial stages of negotiations with the WPPSS, and no contract has as yet been agreed upon.

In our evaluation of the WPPSS proposal, we studied carefully whether additional or amendatory legislation would be required to permit an organization other than the AEC to construct power generating facilities at the NPR. Apparently, no new legislation would be required for the AEC—in connection with its role in the matter—to enter into arrangements with WPPSS on the basis of its

proposal, as modified by the comments contained in our reply to the WPPSS, a copy of which is also attached.

In replying to your letter, we can comment on only those aspects of the proposal related to AEC's proposed role, AEC's authority to undertake arrangements of the nature proposed, and the potential benefits of such a project to AEC.

Last year, Congress disapproved authorizing appropriations for the construction of NPR generating facilities by AEC with Federal funds. In our judgment, this action did not pertain to the possible construction of the generating facilities by other agencies such as the WPPSS. Thus, we do not believe that AEC's possible participation in the project, as now conceived, would conflict with the expressed will of Congress.

Lease of land to WPPSS is, of course, a part of the proposal. It also involves the sale to WPPSS of steam produced in the NPR for use in generating facilities. With respect to making Federal property available to WPPSS in connection with this proposed project, the AEC has existing authority, under section 161g of the Atomic Energy Act of 1954, as amended, to lease property under its jurisdiction. In order to minimize serious energy losses in delivering steam, it is necessary for the generating facilities to be located in close proximity to the reactor. Inasmuch as the AEC has jurisdiction over land adjacent to the NPR, we might lease a parcel of land to WPPSS upon which the generating facilities may be constructed. We believe that the exercise of our authority in this instance would be in furtherance of our programmatic responsibility to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes and to make arrangements under which the practical value of production facilities for industrial or commercial purposes may be demonstrated.

AEC's position with respect to the financial aspects of the proposal is that AEC must be fully reimbursed for all additional costs which may be brought about by the installation of WPPSS of electric power generating facilities at NPR. We do not plan to make any commitment to operate the reactor beyond the period required for AEC purposes, but would agree in that event to lease the facility to WPPSS—with the right reserved to AEC to recapture the reactor if it should be again required for AEC purposes.

It is anticipated that there would be revenues to AEC resulting from the sale of steam to WPPSS. Excess steam produced in the course of operation of the NPR by AEC would be disposed of under the authority set forth in section 44 of the Atomic Energy Act of 1954, as amended. Section 44 requires, in part, that such energy be sold at reasonable and nondiscriminatory prices. AEC has adopted the position that since the steam is available as a byproduct of plutonium production, the reasonable price should be based on the value of the steam for its intended use, giving appropriate recognition to the uncertainty in the duration of the period during which AEC would operate the NPR.

AEC is seeking the advice of the Federal Power Commission to assist in the determination of NPR power values. As FPC has only recently begun its analysis and as AEC is currently only in the earliest stages of negotiations with WPPSS, we are not able to provide quantitative information at this time regarding the price at which AEC would provide steam to the WPPSS. The price negotiated with WPPSS for the sale of the steam, together with the duration of the period of AEC operation of convertibility might be recovered and the cost of plutonium reduced.

With respect to the provisions of the proposed agreements whereby the Government would be provided an option to acquire the plant by purchasing the outstanding bonds, I wish to make clear that AEC is making no commitment whatsoever to exercise this option. In order to exercise the option, it would be necessary for AEC to obtain specific authorization and appropriation of funds by the Congress.

In conclusion, I should like to state, again, that while we have the WPPSS proposal under consideration and are in the initial stages of negotiation, no final agreement has been reached between the Commission and WPPSS.

A similar reply has been forwarded to each of the cosigners of the April 18th letter. I am sure you recognize the difficulty of presenting, in a letter, all of the many aspects relating to this complex subject. Accordingly, I should appreciate the opportunity to meet with you and your colleagues, at your convenience, for the purpose of discussing the matter in detail.

Sincerely yours,

———— ————, *Chairman.*

(Note to the files: Letters identical to this sent to: Hon. John R. Pillion; Hon. John Taber; and Hon. Ivor D. Fenton, House of Representatives, who were also cosigners of the April 18th letter along with Representative Jensen.)

WEAPONS

Mr. EVINS. We shall turn now to the weapons program and we will place in the record pages 37 through 39 and also the associated construction pages.

(The justification follows:)

OPERATING EXPENSES

WEAPONS PROGRAM—OPERATING COSTS

Program statement

Estimate, fiscal year 1963	$786,310,000
Estimate, fiscal year 1962	749,000,000
Increase	37,310,000

Summary of estimates by category

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Development, test, production, and storage of atomic weapons	$503,033,205	$739,860,000	$777,670,000
2. Special test detection activities	14,637,458	9,140,000	8,640,000
Total weapons operating costs	517,670,663	749,000,000	786,310,000

JUSTIFICATION OF CATEGORIES

1. Development, test, production, and storage of atomic weapons, $777,670,000

The amount requested for fiscal year 1963 reflects the estimate of funds needed for the development, production, storage, and surveillance of atomic weapons required to meet military needs.

Atomic research has continued to yield new information applicable to development of weapons and such data will be incorporated in the design of new models which will greatly enhance the capabilities of the Armed Forces.

2. Special test detection activities, $8,640,000

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Seismic improvement program (Vela Uniform)	$12,147,638	$6,210,000	$5,800,000
High-altitude test detection (Vela Hotel and Sierra)	2,275,480	2,400,000	2,540,000
Related capital equipment	214,340	530,000	300,000
Total	14,637,458	9,140,000	8,640,000

Special test detection activities in the general area of weapons detonation detection studies and tests have been divided functionally into two major development areas: (*a*) Vela Uniform which encompasses all underground seismic work and includes the Nevada Test Site (NTS) underground series (Shade), the Dribble program (Tatum salt dome), the Shoal program (a nuclear shot in a seismic area), and other minor related underground studies; (*b*) Vela Hotel which is concerned with satellite detection of high-altitude detonations and Vela Sierra which directs itself strictly to surface detection of high-altitude shots.

Summary of Vela Uniform program

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Shade (NTS)	$8,705,780	$2,975,000	0
Shoal (seismic area)	51,832	300,000	$4,135,000
Dribble	2,247,781	1,560,000	0
Other Vela Uniform common costs and studies	1,142,245	1,375,000	1,665,000
Total	12,147,638	6,210,000	5,800,000

Much of the tunnel construction work completed and mined in fiscal year 1960 and fiscal year 1961 for the seismic improvement program underground work at NTS has been utilized in the current underground test series at NTS. The underground experiments previously planned for NTS and seismic information similar to that which the laboratories and the Department of Defense were attempting to determine is being gained from the current full scale weapons test series. Current plans provide for the continuation on only one major event, the Shoal program, plus minor studies related to general seismic and hydrological problem areas. The Dribble decoupling program in Mississippi has been deferred pending further review of the program. Exploratory drilling to determine the exact size of the salt dome will be completed in fiscal year 1962. Minor salt disposal and hydrological studies are also being carried out. Other Vela Uniform common costs and studies include Lawrence Radiation Laboratory effort, device preparation and ground shock studies.

Summary of Vela Hotel and Sierra

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Los Alamos Scientific Laboratory	$1,226,689	$1,400,000	$1,540,000
Sandia Corp	1,048,791	1,000,000	1,000,000
Total	2,275,480	2,400,000	2,540,000

The objective of the Vela Hotel program is to conduct sufficient research and development pertaining to the detection of nuclear detonations in deep space with satellite based sensor systems so that on completion of the program, it should be possible to specify the details of an operational detection scheme. The Atomic Energy Commission is assisting the Department of Defense by conducting research and development on detectors and logics—space-based data processing—for the approved DOD program.

Under the Vela Sierra program the AEC will perform research to develop a ground-based system for detection of nuclear detonations in space. This effort includes experimental measurements with air fluorescence and direct optical equipment, investigation of optimum optical systems and studies of X-ray source characteristics, shielding, fluorescence efficiency and signal characteristics.

The related capital equipment estimates provide for the laboratory and field equipment required in support of this program.

PLANT ACQUISITION AND CONSTRUCTION

Weapons Program—Construction Obligations

Program statement

Estimated obligations, fiscal year 1963	$56,585,000
Estimated obligations, fiscal year 1962	30,794,000
Actual obligations, fiscal year 1961	25,375,646

Obligations for the weapons program for fiscal year 1963 are estimated at $56,585,000 for the projects listed below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations, fiscal year 1963
63-c-1	Weapons production, development, and test installations.	$10,000,000	0	$10,000,000
63-c-2	Addition to special metallurgical facility, Mound Laboratory, Miamisburg, Ohio.	540,000	0	540,000
63-c-3	Production plant addition, Mound Laboratory, Miamisburg, Ohio.	300,000	0	300,000
63-c-4	Hydraulic centrifuge installation, Sandia Base, N. Mex.	700,000	0	700,000
63-c-5	Specialized plant additions and modifications, phase II, Oak Ridge, Tenn.	2,200,000	0	2,200,000
63-c-6	Pulsed power research facility, Lawrence Radiation Laboratory, Calif.	1,950,000	0	1,950,000
63-c-7	Gamma irradiation facility, Sandia Base, N. Mex.	650,000	0	650,000
63-c-8	Dynamic test complex, Lawrence Radiation Laboratory, California.	265,000	0	265,000
63-c-9	Non-destructive test facility, Oak Ridge, Tenn.	510,000	0	510,000
63-c-10	Processing facilities, Rocky Flats, Colo	3,000,000	0	3,000,000
63-d-1	Terminal facilities—115 kilovolt powerline, Los Alamos Scientific Laboratory, N. Mex.	1,950,000	0	1,950,000
63-d-2	Environmental control facilities, phase III, Kansas City, Mo.	1,200,000	0	1,200,000
63-d-3	Engineering building addition, Lawrence Radiation Laboratory, Calif.	4,000,000	0	4,000,000
63-d-4	Model shop addition (Sandia), Livermore, Calif.	820,000	0	820,000
63-d-5	Engineering model shop, Kansas City, Mo	1,000,000	0	1,000,000
63-d-6	Improvement of U.S. Highway 95, Las Vegas, Nev., to the Nevada Test Site.	10,000,000	0	10,000,000
63-1	General plant projects	10,000,000	0	10,000,000
62-c-1	Weapons production, development, and test installations.	15,000,000	$7,500,000	7,500,000
	Total	64,085,000	7,500,000	56,585,000

Explanation of projects above:

1. *Project 63-c-1. Weapons production, development, and test installations, $10 million.*—This project provides for the construction and acquisition of such additional production, development, and test facilities as may be required to further the weapons program. The specific nature of these facilities cannot be forecast at this time; however, the magnitude of the future production and development programs indicates that additional facilities will be required, either in the way of increased plant capacity or added plant or facilities needed to cope with new techniques or both. This project will assure availability of funds to meet new production requirements and to provide research, development, and test facilities in order to take advantage of advances or changes in the weapons field. It may also be used to provide facilities for the test detection and nuclear testing programs.

2. *Project 63-c-2. Addition to special metallurgical facility, Mound Laboratory, Miamisburg, Ohio, $540,000.*—This project provides additional specialized facilities in support of the weapons program. It provides for design and construction of an addition of 5,300 square feet to the existing special metallurgical facility including necessary process equipment. This addition to the existing facilities is required to provide capabilities for new and improved processing, recovery of material, and production-engineering.

3. *Project 63-c-3. Production plant addition, Mound Laboratory, Miamisburg, Ohio, $300,000.*—This project provides for a 4,500-square foot addition to the existing (11,420 square feet) detonator production building including process equipment procurement and installation. The 4,500-square foot addition will provide 3,200 square feet for detonator cable scaling, leak testing and final assembly, 400 square feet for explosives pressing, and 900 square feet for mechanical service equipment and corridors.

4. *Project 63-c-4. Hydraulic centrifuge installation, Sandia Base, N. Mex., $700,000.*—This project will provide a means of testing components, subassemblies, and weapons under conditions of combined linear acceleration and vibration. The cost estimate covers the acquisition and installation of a 25-foot rotating boom and associated equipment and the construction of a subsurface enclosure for the boom and instrumentation room.

One of the environmental problems which the Sandia Corp. has encountered in the design of weapon components is the combined effect of acceleration and vibration. The proposed facility will permit investigations responsive to this environmental problem. Sandia Corp. has made an extensive survey of other facilities available in the United States for this type of testing but has found them inadequate to provide "g" forces to which the Sandia components will be subjected. The addition of this centrifuge at Sandia will provide data considered essential for the development of reliable nonnuclear components.

5. *Project 63–c–5. Specialized plant additions and modifications, phase II, Oak Ridge, Tenn., $2,200,000.*—This project provides additional specialized facilities in support of the weapons program. It provides for construction of an addition of approximately 4,400 gross square feet to an existing plant; extensive rearrangement in the existing plant; installation of humidity and temperature controlled system; and addition of processing and fabrication equipment.

6. *Project 63–c–6. Pulsed power research facility, Lawrence Radiation Laboratory, California, $1,950,000.*—This project provides for the construction of a 29,000-gross-square-foot building in which experiments involving high energy electrical systems will be conducted. A portion of the building will be occupied by energy storage capacitor banks and the remainder will be used for laboratory and shop purposes.

This project will provide special capabilities needed for the weapons research and development program at the Lawrence Radiation Laboratory.

7. *Project 63–c–7. Gamma irradiation facility, Sandia Base, N. Mex., $650,000.*—This project provides for the construction of a 7,600-square-foot building to accommodate a dry gamma irradiation cell, a pool, and laboratory and office space.

This project which consists of three distinct parts will complement the Sandia engineering reactor facility (SERF) in providing needed environmental test data. The cell will produce the desired irradiation. The pool will provide a more efficient means of storing radioactive items. The additional laboratory space is necessary for the research and development program of which this project is an integral part.

8. *Project 63–c–8. Dynamic test complex, Lawrence Radiation Laboratory, California, $265,000.*—This project provides for additions of a shaker building (1,200 gross square feet) and a mechanical equipment building (680 gross square feet) to the existing dynamic test complex at the Lawrence Radiation Laboratory's environmental testing area (site 300).

An electrodynamic 7,500-force-pound shaker which is now located in the test tunnel complex will be installed in the proposed shaker building. This will make it possible to use the test tunnel complex for general environmental testing needed in the new weapons concepts, the purpose for which it was originally designed.

9. *Project 63–c–9. Nondestructive test facility, Oak Ridge, Tenn., $510,000.*—This project provides for construction of a 5,300-gross-square-foot addition to an existing building and necessary equipment for a nondestructive test laboratory. There is an increasing need for a nondestructive testing development laboratory at Oak Ridge in order to adequately support the weapons program.

10. *Project 63–c–10. Processing facilities, Rocky Flats, Colo., $3 million.*—This project provides for revision of processing facilities and construction of a 10,800-square-foot addition to an existing building including necessary additions and rearrangements to the building services. Revision of the processing facilities is necessary in order to provide adequate facilities to meet required specifications for materials. It also provides for a 1,000-square-foot building addition and necessary equipment for enlargement of the waste-treatment facilities.

11. Project 63–d–1. Terminal facilities, 115-kilovolt powerline, Los Alamos Scientific Laboratory, New Mexico, $1,950,000.—This project provides for the installation of switchgear and terminal facilities for utilization of electric power from a new 115-kilovolt transmission line. New facilities include a 115-kilovolt substation facility and related equipment, a 20,000-kilovolt-ampere transformer, modifications to the present powerplant, rearrangements and additions to switchgear, installation of controls, wiring, relays, and modification of duplex switchboards. This estimate also provides for the construction of a 115-kilovolt transmission line (approximately 10 miles) to connect Los Alamos with a commercial power source.

A second source of outside electric energy is necessary in order to assure a firm and reliable power supply to Los Alamos by 1964. The projected peak power demand will be substantially higher than firm capacity. Should a power failure occur on the existing 115-kilovolt transmission line, immediate arrangement would have to be made to curtail or temporarily drop loads on community circuits

in order to maintain continued service for essential laboratory programs. Any outage lasting more than a few hours would require curtailment of power to the technical areas and result in disruption of laboratory activities.

12. Project 63–d–2. Environmental control facilities, phase III, Kansas City, Mo., $1,200,000.—This project covers the third phase of a major program to provide the environmental controlled area required within the Kansas City plant. This area is for fabrication, inspection, and acceptance activities. This project involves the installation of a 1,200-ton environmental control system which will control the temperature, relative humidity, and dust-particle size in the air supply. Variations in the temperature and humidity make it impossible to fabricate to the stringent tolerances required, with adequate repeatability, or to provide sufficient confidence in inspection and acceptance activity results. This project will raise the environmentally controlled area within the plant to approximately 22 percent of the total.

13. Project 63–d–3. Engineering building addition, Lawrence Radiation Laboratory, California, $4 million.—This project will provide for a 110,500-gross-square-foot office and laboratory addition to the engineering building. The project will serve the dual purpose of making available additional space for the projected growth in employment associated with the expansion of research and development and resumption of testing, and the need to replace temporary and substandard buildings with new facilities designed and constructed in accordance with current requirements. Except for two small structures, all the buildings to be demolished were constructed in 1943 as a part of a Navy Flying School which was operated at the Livermore site during World War II. Many of these wooden buildings have sagging foundations, are infested with termites and dry rot, and require roofing and exterior surface treatment beyond the scope of routine maintenance. In addition to the generally unsatisfactory condition of the buildings, these structures are considered undesirable for operating purposes because of poor lighting, difficulty of keeping the interior at a comfortable temperature during periods of extreme heat and cold, and problems encountered in attempting to maintain standards of cleanliness.

When completed, this addition will provide office and laboratory space for approximately 430 people at Livermore. In addition, space will be provided for the normal storage, conference, and library requirements of an engineering structure.

14. Project 63–d–4. Model shop addition (Sandia), Livermore, Calif., $820,000.—This project will provide a 24,000-gross-square-foot addition to the existing model shop. The space will be occupied by the heat treating shop, micromodule laboratory, plastics shop, sheet metal shop, electronic fabrication, welding shop, production tester laboratory, and electrical laboratory. Adequate space for these functions was not provided in the original construction as the extent of the operation was not fully understood and new developments have arisen which were not anticipated. Technological advances in processes and equipment necessitate acquisition of more eleborate and complicated equipment which occupies much more space than the equipment planned 5 years ago. This equipment and associated instrumentation, new functions, and necessary Sandia support for Lawrence Radiation Laboratory development programs result in the need for additional space.

15. Project 63–d–5. Engineering model shop, Kansas City, Mo., $1 million.—This project provides for a new engineering model shop within an environmentally controlled enclosure which is required for the precision machining and microfinishing of weapon components designed to enter the production process. The model shop will be established within space currently available to AEC. An area of 7,800 square feet will be prepared and equipped with machining and inspection equipment. This new facility is necessary to support the development of new, faster, and more accurate methods of fabricating the precision parts required by the rapidly changing weapons technology.

16. Project 63–d–6. Improvement of U.S. Highway 95, Las Vegas, Nev., to the Nevada test site, $10 million.—This project provides for improving existing U.S. Highway 95 between the city limits of Las Vegas, Nev., and the turnoff to Camp Mercury at the Nevada test site, a distance of 58 miles. The present two-lane highway, with a 22-foot-wide bituminous-surfaced roadway, is inadequate for present-day traffic and in addition to its unsatisfactory width, has poor alinement and sight distances.

The Nevada Department of Highways has studied the proposed road improvement and recommends two 12-foot lanes in each direction separated by a suitable median strip, using the existing roadway insofar as practicable. A base course 20 inches thick would be topped with a 4-inch asphaltic concrete surface course.

The gradient, alinement, and sight distances would be improved and raised to present-day standards.

This project has been coordinated with other interested agencies. A recent report of a task force which included representatives of AEC, FHA, and NASA recommended that a four-lane highway be provided. The design standards and the estimate have been reviewed by the U.S. Bureau of Public Roads.

17. Project 63–1. General plant projects, $10 million.—This project provides for miscellaneous improvements, alterations, additions, replacements, and minor new construction of facilities and sites required in the operation of production, research and development, and other weapons program installations. In addition to work normally covered under this project in prior years, new general plant requirements will be incurred in fiscal year 1963 at the Lawrence Radiation Laboratory to provide major revisions to and new fire and safety installations in the major laboratory facilities. This project is essential to continued safe and efficient operations and to provide for adequate facilities required as a result of program advances, the increasing size of the weapons capital plant, the aging of many facilities and utilities, and rapid technological developments underscore the need for adequate general plant funds in the budget year.

18. Project 62–c–1. Weapons production, development, and test installations, $7,500,000.—The original authorization and appropriation of $7,500,000 was based on normal program requirements expected at the time the fiscal year 1962 budget was presented to the Congress. The entire $7,500,000 now available is required for subprojects, primarily for production purposes, which have already been authorized for construction.

It is proposed that the authorization for this project be increased by $7,500,000, from $7,500,000 to $15 million, to provide for needed support facilities, primarily at the Nevada test site (NTS), to accommodate expanded activity. Some of the major items under consideration are living quarters, motor pool facilities, medical facilities, light laboratory facilities, administrative buildings, and utility systems.

There has been no major base camp construction at NTS since 1958, despite the fact that there has been a steady growth in the number of continuing programs being conducted at the site. For example, the ROVER and PLUTO programs now occupy a large section, known as Jackass Flats, west of the weapons testing facilities at Frenchmen's Flats and Yucca Flats.

General LUEDECKE. General Betts will speak to the matter.

Mr. EVINS. General Betts, the committee will be pleased to hear you.

(Discussion off the record.)

Mr. EVINS. The committee will stand in recess until 1:30.

AFTERNOON SESSION

Mr. EVINS (presiding). The subcommittee will be in order.

General Betts, when we adjourned we were about to take up the weapons program. We will certainly be pleased to hear you. The justification statements have been placed in the record. You are asking for a total of $786,310,000 for weapons for the next fiscal year. Will you please go off the record with your answer, and give us some specific reasons for the substantial increase in weapons production cost for the next year? Please take from the record what you think is necessary for security reasons.

General BETTS. All right, sir.

(Discussion off the record.)

WEAPONS TESTING

Mr. EVINS. The committee noted a press release this morning, I believe, that your 14th atmospheric test had just been completed. Will you again go off the record and tell us some of the significant findings in your current test series?

(Discussion off the record.)

TEST DETECTION

Mr. EVINS. We notice in your special test activities there is a reduction. We read varying accounts of the likelihood of success in detecting tests. Please bring us up to date on this entire problem and give us the detail why this program is being cut back so substantially.

General BETTS. The VELA program, as originally constituted, planned for quite a few tests to be conducted at various yields and in various media in order to determine whether or not the seismic signal—the explosion could be detected by a seismic signal at various distances. One of the experiments that had been proposed was to conduct one of these tests in a seismic area, an area where we normally have a considerable amount of earthquake activity. Another series of experiments were chosen to prove how serious the problem is of being able to hide a nuclear explosion in a large cavity underground. That was probably the largest single block of costs associated with the VELA program.

Once we started underground testing, it was apparent that many of the tests we had planned and labeled VELA could now be conducted in connection with the events that would naturally take place in the underground testing program. Consequently we could retreat from that effort, and in fact some of our testing money, about $11.3 million in fiscal year 1962, came from reprograming the VELA funds to this effort.

The big effort that I mentioned we called the Dribble program—which was to study the question of muffling an explosion by setting it off in a larger underground chamber—has been postponed partially because of the high price associated with it, and partially because there is somewhat less pressure on the people in this technology in view of the progress that has been made toward the disarmament program. In other words, they are not pressing so hard.

(Discussion off the record.)

Mr. JENSEN. When you are talking about the Vela program, is it a part of the so-called Plowshare program?

General BETTS. No, sir.

Mr. JENSEN. What is the difference?

General BETTS. The Vela program is a program to improve our ability to detect nuclear testing in underground or outside of the atmosphere.

Mr. JENSEN. Simply a detection program?

General BETTS. Simply a research and development program to improve our ability to detect, that is correct, and to identify, I should add.

Mr. JENSEN. Would that be to detect detonations in foreign lands?

General BETTS. Yes, sir. It is related to the proposal for test ban where we have held to the position that we should not accept a ban unless we knew it could be adequately policed. This is to prove out the techniques.

FALLOUT FROM ATMOSPHERIC TESTS

Mr. JENSEN. What have you learned up to date since you began the atmospheric detonations relative to the degree of fallout which has occurred?

General BETTS. I don't think we have as yet learned anything with respect to fallout that would change our appraisal of this kind of a problem that resulted from prior test series.

Mr. JENSEN. What are the findings in as few words as you can express it?

General BETTS. Very bluntly, that everything that goes up must come down. In other words, we recognize that there will be some fallout of fission products. The higher the explosion the longer it takes fallout to occur, but nevertheless sooner or later bomb debris of any significance will come down.

Mr. JENSEN. Some of it surely is dissipated in the atmosphere, is it not?

General BETTS. Some of it decays or loses its radioactivity in the course of coming down. So that the higher the altitude of the explosion, the more of the decay will take place. There are some radioactive isotopes that are produced of such long lives that the decay is a matter of a few years that might be occasioned during the fallout period.

(Discussion off the record.)

PURCHASE OF ELECTRON TUBES FROM RAYTHEON CO.

Mr. EVINS. General Betts, I am sure you are familiar with the Comptroller General's report of March 1962 concerning purchases of certain electron tubes from the Raytheon Co. by the Sandia and Bendix Corps. The report contends that profits to Raytheon under the negotiated price purchase contract has been a total of 110 percent. The Comptroller is critical of the fact that AEC has not looked into production costs and profits on a contract of this type in an effort to develop savings for the Government.

Please tell us if this goes on regularly in fixed-price purchase agreements, or do you have some system for regularly reviewing the records of manufacturers on costs of this sort?

General BETTS. We do have a system. We have issued directions which require that in purchases of this sort that there be the right of audit in order to get into price determination or redetermination. In this case this was initially a development subcontract with Raytheon to one of our prime contractors, the Sandia Corp. After development Bendix Corp., another prime AEC contractor, bought the tube in quantity from Raytheon. The type of tubes involved had been developed by Raytheon and was not available anywhere else in the industry. A price was negotiated which was reduced on several subsequent purchases. But in spite of the fact that there was a clause in the contract which permitted AEC audit, for some reason not completely explained, advantage of that right of audit was not taken.

We have since issued rather firm instructions that people will take advantage of the right of audit where circumstances dictate. It does not make sense to have the clause in the contract and not do so. When we became aware of the situation within the Atomic Energy Commission, we went back to Raytheon, bringing our contractor into the picture, and we did get a concession from Raytheon on a later purchase of tubes which returned some of this profit to the Government. This concession is approximately $310,000. We kept after Raytheon but were unable to recover on any voluntary basis from them any further part of this.

Mr. EVINS. Are the contractors of the Atomic Energy Commission subject to review by the Renegotiation Board?

General BETTS. I believe they are.

Mr. BOLAND. They either are or are not under the laws. The law names the agency and you are one of them.

General BETTS. Yes. This was a subcontractor to one of our primes.

Mr. BOLAND. How about the regular contracts?

General BETTS. Yes.

Mr. HENNESSEY. Our contracts and subcontracts under them are subject to the Renegotiation Act to the same extent as the Defense Department.

Mr. EVINS. Has there been any consideration by the Renegotiation Board of this Raytheon contract of 110 percent profits?

General BETTS. Not as yet, sir. We have gone back from our point of view to try to get them to make a voluntary return of some part of this profit which they have refused to do. So that within the AEC pattern we had no further legal recourse.

Mr. EVINS. Initially when you let the contracts, has your contracting board authority or some criteria or standard on the profit amount that you authorize?

General BETTS. Yes, sir. The Bendix Corp. reviewed the proposed prices for this tube in detail. In fact, Bendix made vigorous efforts, at the time of award of the initial order, to get Raytheon to provide cost data or accept a price redetermination contract. All we can offer further in defense is that they accepted the proposed price and Raytheon's costs later proved to be not as great as had been estimated.

Mr. EVINS. If AEC has the right to review they certainly ought to exercise it, I should think.

General BETTS. We certainly should.

Mr. BOLAND. Did the right to audit run on to the Bendix Corp. and also to the Atomic Energy Commission?

General BETTS. In this case the Bendix Corp. contract that was let with Raytheon gave the AEC the right to audit the costs.

Mr. BOLAND. The right on Bendix only. How about the AEC? Could AEC do a little auditing?

General BETTS. Of course, since we can audit Bendix, this would carry over.

Mr. BOLAND. Have you made an effort to do it?

General BETTS. Post facto, yes, sir, but not at the time we were in the process of adjusting these tube costs.

Mr. BOLAND. That is all. Thank you.

WEAPONS PROGRAM CONSTRUCTION

Mr. EVINS. General Betts, referring to justification for weapons program construction obligations, you have listed about 18 construction items for a total of $56,585,000. Please briefly review the new plant construction items in your budget.

General BETTS. Yes, sir. Some of the increased cost of construction of these many items is related to the continually growing complexity of the program.

WEAPONS PRODUCTION, DEVELOPMENT, AND TEST INSTALLATIONS

Mr. EVINS. No. 1, test installations. Here is an item for $10 million. This is new. You did not have any funds for this last year. I believe all of these items are new.

General BETTS. That is the contingency item which we include each year to take care of the things which occur during the year that we cannot predict at the beginning of the budget cycle.

In the past this has ended up by providing in some cases for manufacturing facilities, but more often than not, technical facilities for which we did not have a firm estimate at the time the budget was submitted.

NONDESTRUCTIVE TEST FACILITY, OAK RIDGE, TENN.

Mr. EVINS. C–9, nondestructive test facility. What is this?

General BETTS. That is a facility for analyzing the effectiveness of production of nuclear weapons that does not in the process destroy those weapons. That explains the word nondestructive. For example, it will provide for X-ray examination of welds and things of that sort. A new technology in ultrasonics which will permit identification of the accuracy with which parts have been made, and other nondestructive test techniques of that sort.

PROCESSING FACILITIES, ROCKY FLATS, COLO.

Mr. EVINS. Processing facilities at Rocky Flats, Colo., for $3 million. Tell us about this one.

General BETTS. This is related to the necessity for plutonium that is required.

(Discussion off the record.)

TERMINAL FACILITIES—115-KILOVOLT POWERLINE, LOS ALAMOS SCIENTIFIC LABORATORY, NEW MEXICO

Mr. EVINS. You have an item for $1,950,000 at Los Alamos Scientific Laboratory for a 115-kilovolt powerline. Is the Government building this line? Who is using the power?

General BETTS. This power is required primarily for the Los Alamos Laboratory itself for technical facilities.

Mr. EVINS. Who is providing the power, the private utilities?

General BETTS. Power is to be provided by private utilities. This money indicated here is for a substation and terminal facilities at Los Alamos and for a line, if necessary, to connect it to a source of private power.

Mr. EVINS. Why shouldn't the private utilities provide this substation?

General BETTS. This is in the technical area and is the type not generally provided by private companies. We are negotiating for power and to try not to build a line, Mr. Evins. If we can get them to build the line, the money will not be expended that way.

Mr. EVINS. It is the normal practice if a private utility has a contract with the Government to supply them power, they supply their substations.

General BETTS. Yes, sir, but since this is considerably out of the way and in the technical areas, we would end up by having to pay it back in the rate that would be charged us for that power—we are trying to negotiate with them.

Mr. EVINS. You ought to negotiate a little sharper and sharpen your pencil. Is there any type of Government-produced power in the vicinity of Los Alamos that could be used?

General BETTS. No, sir. We are negotiating with two different power companies, one coming in from the north and one coming in more or less to the southeast.

Mr. EVINS. You are negotiating with them by agreeing to build a powerline and substation.

General BETTS. The substation is required by our internal distribution setup at the laboratory so this would not be appropriate for their installation. But the incoming powerline is certainly something which we would hope that they would be willing to build.

Mr. EVINS. You carry funds here for $1,950,000 for a 115-kilovolt powerline.

General BETTS. For terminal facilities and a powerline. The point is that we need the power and if we are not able to persuade the utility to make the investment, we would have to make the investment.

Mr. EVINS. If they can't provide you the power, you better locate it where the power is available from the Government. What about these two items for $10 million here, improvement in U.S. Highway 95, Las Vegas, Nev.? The Nevada test site and general plant project another $10 million.

GENERAL PLANT PROJECTS

General BETTS. The general plant project is to provide for those construction items which appear in the course of the year which cannot exceed $500,000 as a limitation to build small facilities of a technical nature or in some cases of an administrative nature.

Mr. EVINS. This is the Nevada test site?

General BETTS. The $10 million general plant project covers all of the development and production complex. It includes Los Alamos, Livermore, Sandia and anywhere else in this total production complex.

TERMINAL FACILITIES—115-KILOVOLT POWERLINE, LOS ALAMOS SCIENTIFIC LABORATORY, NEW MEXICO

Mr. EVINS. I have been informed that the Los Alamos facilities are located between the four corners and the Albuquerque general transmission area.

General BETTS. That is its general location.

Mr. EVINS. There is another bill before this committee in which funds are being provided for transmission lines in that area. I think the private utilities ought to build the lines and the substation if they are going to get a Government contract. Do you not have an REA cooperative in the region?

General BETTS. I don't know, sir. I assume we have.

Mr. DERRY. Yes, sir; there is. The Plains Generating Cooperative is in the region.

Mr. EVINS. Have they been consulted and asked to supply the power?

Mr. DERRY. They have been. The line that General Betts is referring to, there is $1.5 million for a substation transmission complex and $450,000 for a transmission line.

It is $1,950,000 for the entire project. The substation is a million five and the transmission line is $450,000. The latter amount is to provide for a transmission line from Los Alamos to the Plains Cooperative in the event we would take power from them. The Public Service Co. of New Mexico is presently supplying power for the Los Alamos Laboratory over the existing transmission line. If we got power from the Plains Cooperative, the REA Cooperative, we would have to build this line into their line in order to get power from their system. In any event, we do require the $1,500,000 substation in order to provide power for our own facilities at Los Alamos. You see, in order to get the additional power, which we require, the Public Service of New Mexico will build another transmission line in addition to the one we have in there now.

Mr. EVINS. I imagine if you would negotiate with them, either the cooperative or the New Mexico utility would be pleased to supply you with power and make the necessary adjustments in their contract.

General BETTS. I think our position is that we will try to make the best deal for the Government we can.

Mr. EVINS. They want it both ways. They want the fat contract and they also want you to provide the transmission line and the substation, too. I don't think you have to yield on everything.

Are there any questions, Mr. Boland?

IMPROVEMENT TO U.S. HIGHWAY 95, LAS VEGAS, NEV., TO NEVADA TEST SITE

Mr. BOLAND. With reference to the highway from Las Vegas to Camp Mercury, is this the total cost of the 58-mile run of the highway?

General BETTS. Yes, sir.

Mr. BOLAND. Does this represent the total cost of putting in the two 12-foot lanes in both directions with a median strip?

General BETTS. It does.

Mr. BOLAND. Is any part being paid by the State of Nevada?

General BETTS. I think Mr. Derry has more of the details.

Mr. DERRY. None of it.

Mr. BOLAND. Can you supply the committee with a figure on what the traffic run is on this highway between Las Vegas and Camp Mercury? Is it south and west below Camp Mercury? Who uses the highway besides those who are engaged in the work at the Camp Mercury site?

Mr. DERRY. It is U.S. Highway 95 so it runs between Las Vegas and Mercury and then goes on to Reno.

Mr. BOLAND. What sort of traffic do you have between Camp Mercury and Reno?

Mr. DERRY. Based on 1961 and the prior 10-year traffic count, there was something of the order of 1,000 to 1,500 cars a day. Presently the traffic count is running something on the order of 4,600 to 5,900 hundred cars per day.

Mr. BOLAND. Why does the Federal Government have to pick up the complete tab for the road improvement? Why doesn't the State pick up part of the tab? If that road is going to be improved

from Las Vegas to Camp Mercury, it certainly is going to be improved from Camp Mercury on to Reno by the State. I see no reason why the Federal Government should pay for this entire stretch of 58 miles of road.

Mr. DERRY. It is to our primary interest to have the road.

Mr. BOLAND. Of course. It is to the interest of the State, too, is it not?

Mr. DERRY. Most of the people who work at Camp Mercury and the test site live in Las Vegas and they use this road as a commuting channel.

Mr. BOLAND. There is a benefit to the State by the very fact that we have such numbers working out there. There will be a benefit accruing to the State if we pick up the entire tab for the route from Camp Mercury to Las Vegas. I would think that you ought to sit down with the State highway department in Nevada and find out whether or not they are willing to pick up part of the tab. Is a Federal highway administration or NASA going to pay any of the cost here? NASA is going to use the site, is it not, for its own tests?

Mr. DERRY. This is part of that. The road is used partly to serve the part of the site where we also test for NASA.

Mr. BOLAND. How many people will be employed under the NASA operations out there?

Mr. DERRY. 2,000.

Mr. BOLAND. They are spending $3.8 billion this year. Why don't you get NASA to pick up part of the tab here? They ought to do it. They have plenty of money. I would think part of the request would be in their budget.

General BETTS. This is one Government.

Mr. BOLAND. I understand this is one Government. You don't have to explain that to me. I understand that quite properly.

General BETTS. We have coordinated with NASA.

Mr. BOLAND. I understand that. I want to save money in the NASA budget. We have the NASA budget before the Independent Offices Subcommittee. They have $3.8 billion in it. I would suggest, Mr. Chairman, that the Commission sit down with NASA and see if we can't get the money out of here and part in NASA.

I also suggest that they have some dealings with the Nevada Highway Department.

Mr. EVINS. I think the gentleman's point is well taken. I think they ought to deal with the Highway Department of Nevada.

General BETTS. May I add with respect to the Highway Department of Nevada, this is one of the major Federal roads we are discussing, and the Federal-State agreed division of costs is about nine to one in this area. At some point in time one would expect the Bureau of Public Roads to put in this road.

Mr. BOLAND. Will you clear the record up and let me know whether or not this $10 million pays for the entire cost of the two, 12-lane highways running in either direction from Camp Mercury to Las Vegas?

General BETTS. It does; yes, sir. What I wanted to say, it is in their plan at some point in time that the State of Nevada would put up a million, roughly, and the Federal Government would put up the other $9 million from the Bureau of Public Roads.

Mr. BOLAND. With respect to this $10 million.

General BETTS. With respect to this stretch of the road. This is at some rather considerable distance in the future in terms of their planning and in terms of the ability of the State of Nevada to put up their million dollars.

Mr. BOLAND. I suggest that there should be an agreement now with reference to what the State will contribute to this. I for one am not going to give $10 million for this stretch of road, Mr. Chairman. I won't vote for it unless we get some agreement with the State of Nevada.

In addition to that, AEC should meet with NASA to determine its share of the Federal cost.

Mr. EVINS. Is there an alternative, General, in case you don't build the road? Would you be coming in with a request for more funds for housing on the base?

General BETTS. This is the difficult situation which we face. We would hope that if we can improve the transportation situation between Las Vegas and the site that we could hold off, if not the whole effort to build housing there, at least reduce it very considerably.

General LUEDECKE. The activities at the site of both NASA and other areas are becoming a little more stable to the extent that we feel we can see on ahead and see what the population is going to be. There has been pressure developing to build a community out there to house the people who will be permanently employed on the site. We want to very much avoid this if it is at all possible.

Mr. EVINS. General, I think you should take back with you the request and the wishes and views of the committee that you should get an agreement with the State as soon as possible concerning its paying a million dollars of this cost.

Mr. PILLION. Mr. Chairman.

Mr. EVINS. Mr. Pillion.

Mr. PILLION. I would like to express my complete accord with the statement of the gentleman from Massachusetts. I think it is a great mistake for the Atomic Energy Commission to get into peripheral activity such as roadbuilding which is properly the function and responsibility of the Federal Bureau of Public Roads and the State of Nevada. For the Atomic Energy Commission to get into a roadbuilding program I think is away beyond its proper functions. I recall being out to the test site there a couple of years ago, and I saw hundreds and hundreds of trucks and automobiles owned by the U.S. Government sitting around doing nothing. For every truck or car that was running, there were 20 or 30 somewhere around some building. Evidently every employee has two or three Government cars at his disposal. So it seems we must be furnishing an individual automobile service for every employee. They come and go not in their own cars, but always Government cars. I think that is a matter that ought to also be looked into quite seriously. It seemed to be an awful waste of money. I have to run my own car to get to work. Every member of this committee has to. Why two or three trucks or vehicles should be furnished for every employee or some such figure is beyond my comprehension. I certainly agree with everything that the gentleman from Massachusetts has said. That highway will be part of a longer interstate highway, will it not?

Mr. DERRY. This is a Federal-aid highway. It is not part of the Interstate Highway System. It is an existing highway that runs now between Las Vegas and Reno, and then goes farther north.

Mr. PILLION. It is a State highway. They are getting all the revenue and all the income in that State from it. There is no reason why they should not get together with the Federal Bureau of Public Roads and build a highway under ordinary auspices.

Mr. EVINS. I think the general gathers the consensus of the committee, and if you can give us assurance by letter it would be helpful.

Mr. BOLAND. May I say it should be more than a million dollars? This is not part of the Federal Interstate System. If it involves a combination of the Federal, county, and the State, then the Federal cost ought to be between 40 and 50 percent.

May I just ask this question, General? Who is going to maintain this highway?

General BETTS. The State.

Mr. BOLAND. Do you have an agreement to build this?

General BETTS. We do not have an agreement. If we did build this, it would be through the Bureau of Public Roads.

Mr. BOLAND. I understand. But you would be paying the bill.

Mr. MCCARTHY. We in effect would be turning the money over to the Bureau of Public Roads. We have an exchange of correspondence with them.

Mr. BOLAND. The Bureau of Public Roads is not paying anything?

General BETTS. That is right.

Mr. JENSEN. Mr. Chairman, may I ask this of General Betts: What is the difference about this tract of road as compared with any other Federal road? Wherein could we be justified, as a committee, in appropriating money for the Atomic Energy Commission or any other Federal agency for this stretch of road?

General BETTS. We fully appreciate and understand the concern you have expressed. We had the same kind of concern. We recognized the problem of the road in terms of some dozen or more deaths that occurred during fiscal year 1961. We went and discussed this matter with the Bureau of Public Roads and with the State. We found out that at some time in the future it was intended that this road be increased to a four-lane divided highway. With the formula that now exists for Federal support of that road, the Federal Government would pick up about $9 million of that through the Bureau of Public Roads and the State would pay a million. So we urged the State and the Bureau of Public Roads to move that up to now in their program. Both stated that they did not have funds available at this time to do that.

Mr. EVINS. What you are asking us to do is to take $10 million out of the Treasury funds, whereas if it was built under the highway trust funds it would be paid by the gasoline taxes.

General BETTS. What we are suggesting is that in view of the necessity to improve the transportation situation between Las Vegas and the test site that we move ahead with this road with, in effect, a million dollars of Federal subsidy.

Mr. EVINS. You would be setting a precedent here in which every project in the country would say, "Why don't we build a road to this project?"

General BETTS. We have done this before.

Mr. JENSEN. I understand that the only purpose for your asking for these funds is to expedite the construction of this four-lane highway between these two points.

General BETTS. This is our primary purpose.

Mr. JENSEN. What is so urgent about the expediting of the construction of this stretch of the road? Is there a great urgency to the tune of $10 million?

General BETTS. I don't know how to put the urgency on the problem in terms of moving people back and forth from Las Vegas to the test site. I would say the urgency from my point of view is that there is mounting pressure to build some sort of community out nearer the test site so that the people do not have to travel this 2 to 3 hours a day.

Mr. JENSEN. Is that the responsibility of the Atomic Energy Commission and of this committee?

General BETTS. Our responsibility there is to get a job done, Mr. Jensen.

Mr. JENSEN. I realize that.

General BETTS. This appears to be a factor in getting it done, and it becomes a responsibility.

Mr. JENSEN. I realize that, but does it become so urgent and the need so great that you must ask this committee to appropriate this huge sum of money just to rush the construction of this stretch of road?

General BETTS. It was so judged by the Commission.

Mr. JENSEN. Mr. Chairman, if we were to allow this, we would set a precedent wherein many agencies of the Government would come to the Appropriations Committees of Congress and request funds for all kinds of roadbuilding for which there was no authorization. The precedent would certainly be something that I would not want to be a party to. I am going to say frankly that knowing what we know about it now from this colloquy which has been taking place, which was first talked of by the gentleman from Massachusetts, Mr. Boland, and the other members of the committee that it appears to me we would be completely justified in not asking any more questions but just delete the amount from the bill.

Mr. EVINS. Mr. Pillion, do you have a question?

Mr. PILLION. What type of road do you have now between Las Vegas and the test site?

General BETTS. Just a plain two-lane surfaced road.

Mr. PILLION. It is in pretty good repair?

General BETTS. It is in pretty good repair. The site location is not quite modern.

Mr. PILLION. For a State highway it is a pretty good highway?

General BETTS. Yes, sir.

Mr. PILLION. It is in good repair and good shape and things are not too bad. If you were to build this highway next year you could not get any assurance from the State of Nevada that they would at some future date, 10 years from now, reimburse you for what part they will have allocated for a highway 10 years from now.

General BETTS. We might. I do not know, sir.

Mr. PILLION. But you are already asking for the appropriation without that condition.

General BETTS. That is correct.

Mr. PILLION. So you are not in a position to ask for an appropriation if you have not been able to work out a fair reimbursement and tie them down legally to repay you, which I question you would be able to do. I assume that more employees travel from Las Vegas to California than they do from Las Vegas to the test site.

General BETTS. No, sir. Las Vegas to the test sites.

Mr. PILLION. Yes, or the other direction. Who comes in from Las Vegas on that other highway?

General BETTS. You mean people generally, not referring to our employees?

Mr. PILLION. Your employees go in and out.

General BETTS. I am sure there is a heavy traffic in that direction.

Mr. PILLION. Would you think of building a highway in the other direction?

General BETTS. Our only purpose in making this recommendation relates to traffic load that has been imposed on this road by people who work at the test site, and live in Las Vegas.

Mr. PILLION. How many accidents?

General BETTS. Ninety-eight injured and 15 killed, 8 of whom worked at the Nevada test site during 1961. Through April 20 this year we have had six killed on this stretch of road.

General LUEDECKE. 115 accidents last year.

Mr. PILLION. How does that compare with the other highways?

General BETTS. I don't know, sir.

Mr. EVINS. Doesn't the State have some responsibility with respect to enforcement of traffic laws on the road? That is not the patrol duty of the Federal Government.

General BETTS. Yes, sir. I think they have been very cooperative in terms of holding down the speed.

Mr. EVINS. You have no assurance that this test site may be a permanent operation. It may be abandoned or discontinued or indefinite.

General BETTS. This is part of the problem.

Mr. BOLAND. Did all the accidents and fatalities occur between Camp Mercury and Las Vegas?

General BETTS. The number we have indicated have been on this stretch of the road.

Mr. EVINS. If there are no further questions, we will turn to the reactor development portion. Thank you, General Betts.

FALLOUT FROM ATMOSPHERIC TESTING

Mr. JENSEN. General Betts, will you please furnish for the record a statement by the proper official of the Atomic Energy Commission giving the best possible proof relative to the effect of fallout created by atmospheric testing on human beings? As you know, General, there are a number of our citizens who believe there is great danger in fallout to the health of our people, especially to babies to the end that we read in the newspaper that a few people (I hope ill informed) have suggested that babies not be fed milk.

I hope, General, that the Atomic Energy Commission can honestly and definitely assure us that fallout from atmospheric atomic testing will not even to the slightest degree contaminate foods or feeds, especially cow's milk.

May I say, Mr. Chairman, in all sincerity that should even a relative few American babies be denied fresh cow's milk, it would be tragic, since the dairy cow has for many past years been known as the foster mother of man. Will you please furnish the statement I have requested.

(The information follows:)

It isn't possible to give assurance that fallout from weapons tests to date whether in milk or other foods or simply on the ground will cause no harm to any single individual in this or succeeding generations. On the other hand, the added risk either in terms of tangible genetic defects or in terms of possible bone cancer, leukemia, and the like, is extremely small when weighed against other risks to which we are all subjected. One group of estimates based on the best scientific information available to date is as follows: There is a zero to one one-hundred-thousandths chance of developing leukemia as a result of fallout exposure; zero to one three-hundred-thousandths chance of developing bone cancer, and a one one-millionth chance of an infant being born with a gross physical or mental defect among the first generation offspring. These estimates give as an upper limiting case a total of some 700 cases of bone cancer and 2,000 cases of leukemia over the next 70 years with general agreement that the true value would fall well below this figure. As to the matter of strontium 90 in milk: (1) Strontium 90 contributes little if anything to the genetic effect, (2) it contributes no more than 50 percent of the dose from fallout to bone marrow and approximately four-fifths of the dose to the bone. Milk is an extremely important item of the diet, particularly of infants and children. Because milk is such a complete food, and because foods that would be available as substitutes for milk in the diet are likely to have as much if not more strontium 90 in them than milk, it would be wrong, in my opinion, to withdraw milk from anybody's diet solely because of its strontium 90 content.

IMPROVEMENT TO U.S. HIGHWAY 95, LAS VEGAS, NEV., TO NEVADA TEST SITE

General LUEDECKE. We will follow up immediately with NASA and the Bureau of Public Roads and the State.

Mr. EVINS. Please get us a letter from the State.

(The following telegram was received from the Governor of the State of Nevada and provided to the committee by the AEC.)

CARSON CITY, NEV., *June 6, 1962.*

Gen. A. R. LEUDECKE,
General Manager, Atomic Energy Commission,
Germantown, Md.:

In order to expedite the construction of the Las Vegas-Mercury Highway, Nevada will match with its 10.03 percent approximately $500,000 for each of the first 2 years to the cost of construction provided Federal funds amounting to $9 million are provided. In the event this money is allocated, Nevada will prosecute the construction with all haste.

GRANT SAWYER,
Governor of Nevada.

REACTOR DEVELOPMENT

Mr. Reporter, we will place in the record pages 53 through 184, and also the associated construction pages.

(The justification follows:)

OPERATING EXPENSES

Reactor Development Program—Operating Costs

Program statement

Estimate fiscal year 1963	$503, 745, 000
Estimate fiscal year 1962	429, 774, 000
Increase	73, 971, 000

The reactor development program includes the development of economically feasible nuclear powerplants for civilian power and commercial ship application, Euratom program, and development of reactors and reactor systems to meet a wide range of military and space requirements. Briefly stated, the objectives in the separate activities are:

Civilian power reactors

1. To achieve safe, reliable, and economically competitive production of electric power from reactors in high energy cost areas of the United States by 1968.
2. To help Euratom nations and other countries effect a transition to nuclear power.
3. To develop breeder-type reactors taking full advantage of nuclear energy from uranium and thorium.
4. To establish a complete and sound technological base for a future atomic energy industry.

Merchant ship reactors

1. To demonstrate the practicality of nuclear powered merchant ships.
2. To develop nuclear propulsion systems which can compete economically in world commerce.
3. To insure safe operation of nuclear powered merchant ships and their acceptance in world commerce.

Military reactors

1. To develop land-based reactor systems to meet military requirements for powerplants for use at remote locations and for unique military purposes.
2. To develop nuclear propulsion plants suitable for installation in naval vessels ranging from small submarines to large surface ships.
3. To determine the feasibility of nuclear application in missiles.

Rocket and satellite power sources

1. To develop and determine the feasibility of nuclear application in rockets and satellites.

General reactor technology

1. To provide broad support for civilian, maritime, military reactor, and space and auxiliary power source programs through the development of fuel and materials, moderators, control techniques, separation systems, and to develop use of plutonium and thorium as a fuel.

Advanced concepts

1. To develop and demonstrate nuclear application of advanced concepts for a variety of applications.

Nuclear safety

1. To conduct investigations related to nuclear safety problems which have general application.

The increase of $74 million in the reactor development program in fiscal year 1963 as compared to fiscal year 1962 is broken down as follows:

(*a*) An increase in the Rover program of $31.4 million for the development, fabrication, and testing of nuclear reactor engines.

(*b*) An increase of $22.4 million for satellite and small power sources for research and development, fabrication and testing of prototype units.

(*c*) An increase in Euratom of $1.2 million for research and development related to the Senn, Sena, and KBWP reactor programs.

(*d*) An increase of $1.7 million for general reactor technology mainly for destructive testing and irradiation damage program, component development, and chemical separations.

(*e*) An increase of $1.5 million in advanced concepts for research and development, fabrication and operation of reactor experiments.

(*f*) An increase of $6 million in nuclear safety principally for proof testing and purchase of vehicles required for aerospace safety environmental research and development.

(*g*) An increase of $9 million for naval reactors principally for the development and fabrication of improved naval reactor prototype cores.

(*h*) An increase of $5.5 million in the missile program primarily to initiate fabrication of a ground test reactor.

(*i*) A decrease of $1 million in the power demonstration program because of completion of construction of reactors and their related research and development which were authorized in prior years.

(*j*) A decrease of $3.1 million in merchant ship reactors consistent with completion of tests and trials of NS *Savannah*.

(*k*) Other decreases of $0.6 million in various categories, mainly the termination of the ANP program.

There follows a table of the estimates by category:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Civilian power reactors	$76,979,188	$84,056,000	$84,156,000
2. Cooperative power reactor demonstration program	19,322,936	10,464,000	9,416,000
3. Euratom program	723,871	2,829,000	4,000,000
4. Merchant ship reactors	5,679,240	9,342,000	6,200,000
5. Army power reactors	14,427,430	11,782,000	11,700,000
6. Navy propulsion reactors	84,945,859	90,252,000	99,300,000
7. Rocket propulsion reactors	24,857,731	43,400,000	74,800,000
8. Missile propulsion reactors	22,890,018	23,500,000	29,000,000
9. Satellite and small power sources	22,308,741	54,055,000	76,468,000
10. General reactor technology	45,114,769	58,287,000	60,000,000
11. Advanced systems research and development	19,035,144	18,684,000	20,205,000
12. Nuclear safety	11,378,116	16,446,000	22,500,000
13. Airplane propulsion reactors	68,239,079	478,000	
14. Operational services	768,470	1,179,000	1,300,000
15. Other capital equipment	7,711,205	5,020,000	4,700,000
Total	424,381,797	429,774,000	503,745,000

1. Civilian Power Reactor Program, $84,156,000

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(*a*) Water-cooled reactors	$36,027,215	$41,292,000	$34,425,000
(1) Shippingport (pressurized water reactor)	20,530,038	24,160,000	14,200,000
(2) Large central station (seed and blanket)			5,000,000
(3) Experimental boiling water reactor (EBWR)	1,250,356	836,000	200,000
(4) Boiling water reactor experiment (BORAX-V)	1,161,127	1,550,000	1,000,000
(5) Boiling nuclear superheat reactor (BONUS)	1,077,956	1,200,000	1,125,000
(6) Heavy water components test reactor (HWCTR)	916,035	2,400,000	2,500,000
(7) Canadian cooperative	359,865	1,800,000	1,400,000
(8) Water-cooled reactor, other, civilian	10,731,838	9,346,000	9,000,000
(*b*) Organic-cooled reactors	6,661,299	7,617,000	8,670,000
(1) Organic moderated reactor experiment (OMRE)	1,991,632	2,053,000	1,966,000
(2) Experimental organic-cooled reactor (EOCR)	759,386	1,300,000	2,254,000
(3) Organic-cooled reactor, other, civilian	3,910,281	4,264,000	4,450,000
(*c*) Gas-cooled reactors	13,087,975	12,342,000	12,800,000
(1) Experimental gas-cooled reactor (EGCR)	7,973,516	8,053,000	7,735,000
(2) Gas-cooled reactors, other	5,114,459	4,289,000	5,065,000
(*d*) Liquid-metal-cooled reactors	18,379,122	20,829,000	25,761,000
(1) Experimental breeder reactor No. 1 (EBR-I)	1,088,005	670,000	350,000
(2) Experimental breeder reactor No. 2 (EBR-II)	6,719,789	6,675,000	8,834,000
(3) Sodium reactor experiment (SRE-I)	1,370,670	1,972,000	2,000,000
(4) Liquid-metal-cooled reactor, other, civilian	9,200,658	11,512,000	14,577,000
(*e*) Studies and evaluations	2,823,577	1,976,000	2,500,000
Total	76,979,188	84,056,000	84,156,000

The major objectives of the civilian power program continue to be directed toward—

(*a*) Reducing the cost of nuclear power to levels competitive with power from fossil fuels in high-energy-cost areas of this country by 1968.

(*b*) Supporting a continuing long-range program to further reduce the cost of nuclear power in order to increase the economic benefits and extend these benefits to wider areas.

(*c*) Maintaining the U.S. position of leadership in the technology of nuclear power for civilian use.

(*d*) Developing breeder-type reactors to make full use of the nuclear energy latent in both uranium and thorium.

A. WATER COOLED REACTORS, $34,425,000

(*1*) *Shippingport plant reactor (pressurized water reactor)*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$20, 530, 038	$24, 160, 000	$14, 200, 000
Research and development	9, 302, 930	8, 970, 000	6, 635, 000
Fuel fabrication	7, 126, 591	9, 265, 000	2, 500, 000
Operations	1, 734, 847	2, 160, 000	2, 390, 000
Irradiations	175, 478	715, 000	153, 000
Test reactor services	448, 099	660, 000	645, 000
Related capital equipment	1, 742, 093	2, 390, 000	1, 877, 000

The Shippingport pressurized water reactor program continues to be directed toward advancing the basic technology of pressurized water reactors through the design, development, modification, maintenance, operation, and testing of a power reactor suitable for operation as a full-scale central station powerplant. The level of effort for this project will be reduced substantially in fiscal year 1963 from fiscal year 1962 due to scheduled completion of fabrication of PWR core 2. PWR core 2 is a major effort toward developing and testing an advanced reactor which includes new types of high performance fuel elements and which has the potential of reducing the cost of power produced by nuclear energy.

PWR core 1 and core 2 are both of the seed-and-blanket design. The first highly enriched seed of the first reactor core (PWR core 1 seed 1) installed in the Shippingport Atomic Power Station operated almost 2 years, from December 1957 to October 1959, achieving 5,806 equivalent full power-hours of operation. The reactor resumed criticality with a second seed of improved design in April 1960. The second seed (PWR core 1 seed 2) reached the end of its useful life on August 14, 1961, after operating for 7,900 equivalent full power-hours. With the depletion of the second seed, the total hours of operation of PWR core 1 reached a total of 13,706 equivalent full power-hours compared to the original design objective of 8,000 equivalent full power-hours. A total of 902,800,000 kilowatt-hours of electricity had been generated at Shippingport through August 14, 1961, more than half of this energy having been obtained from the natural uranium blanket. The peak burnup of the blanket reached 20,000 megawatt-days per ton of uranium oxide. This represents the highest natural uranium oxide fuel depletion achieved so far in any reactor.

The third seed to be used in core 1 began operation in October 1961. This seed is expected to continue operating until early fiscal year 1963 when it will be replaced with a fourth seed if physical evaluation of PWR core 1 blanket fuel bundles confirm current estimates of probable core 1 blanket life. When the core 1 blanket reaches the end of its useful lifetime, the Shippingport plant will be shut down for required modifications prior to installation and operation of PWR core 2, which has a design rating of 150 megawatts gross electric power. The first seed of PWR core 2 is designed for 10,000 equivalent full power-hours of operation and the blanket is designed for 2 seed-lives. This core will have more than twice the power density and five times the design energy output of PWR core 1.

During fiscal year 1962 evaluation of PWR core 1 seed 2 test results will be completed and analysis of seed 3 operating data will begin. Review of plant modifications and component improvements in connection with the higher power level of PWR core 2 will be conducted. Research and development effort on core 2 will continue. A thermal analysis based upon final nuclear information and as-

built dimensions will be completed. Construction of a heat sink to be used for dissipation of power generated by PWR core 2 above 100 megawatt equivalent is scheduled for completion late in the fiscal year. Depleted core 1 seed and blanket assemblies will be examined to gain information concerning the condition of fuel elements after extended periods of operation and to determine the amount of plutonium formed in the natural uranium blanket fuel. An irradiation testing and evaluation program on oxide fuel materials will be carried on. Work on the conceptual design of core 2, seed 2 will be initiated with the objectives of increased seed lifetime and further reduction in cost.

In fiscal year 1963 a comprehensive evaluation of PWR core 1 performance will be made, including analysis of seed 3 test results. Metallurgical analyses of several depleted seed and blanket fuel assemblies will be performed and the results used to confirm nuclear design models and to obtain a better understanding of the power potential of the natural uranium blanket in seed and blanket cores. Reactor engineering effort and proof testing of core 2 components will continue. Design and development of seed 2 for PWR core 2 will be carried on, including experimental critical studies and irradiation tests of zirconium oxide-uranium oxide ceramic fuels to very high burnups. Test and evaluation of reactor plant systems, components operation, maintenance and refueling techniques will continue and reports will be prepared for wide dissemination to further the advancement of power reactor technology. Costs will continue to be incurred for PWR core handling equipment and for design and procurement of replacement components for the Shippingport plant. Anticipated revenues from sale to the Duquesne Light Co. of steam generated by the reactor plant, estimated at $2,700,000 in fiscal year 1963, is reflected in the revenues portion of the budget.

(2) Large central station (seed and blanket) reactor-development and design

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	0	0	$5,000,000
Research and development	0	0	4,800,000
Test reactor services	0	0	200,000

This project provides for undertaking a program of development and design to determine the potential of seed and blanket cores for large central station reactor plants. Specifically, this effort will involve carrying out development and design work for a 500-megawatt electrical central station reactor and associated components and systems, utilizing the seed and blanket reactor concept.

The Shippingport project has shown ways of making major improvements in the seed and blanket reactor core concept for large size reactors and of obtaining 65 percent, or more, of the total core power from natural uranium, an improvement factor of about 30 percent over present designs. The long life being obtained with the PWR core 1 blanket has further emphasized the desirability of increasing the blanket power fraction since the cost of power generated from the natural uranium blanket is much less than that from the seed. To achieve these objectives, which are particularly applicable to large size reactors in the range of 500 megawatts electrical, it is necessary to conduct both analytical studies and experimental work, which will include extensive large scale critical mockup experiments in the following areas:

(*a*) More efficient seed-blanket arrangements including smaller sized seed with larger blanket to seed volume ratios, double seeds, etc., which are particularly applicable to large sized cores.

(*b*) Development of methods for rapid seed refueling.

(*c*) Optimization of seed lifetime based on the refueling methods finally developed.

(*d*) Reducing the amount of moderation in the seed through significant boiling of the coolant to the extent permitted by thermal considerations in order to further increase the percentage of power from the natural uranium blanket.

The above concepts, together with other means for further improving performance of large size seed and blanket reactor plants, will be investigated starting in fiscal year 1963 and extending into fiscal year 1964 at a total estimated cost of $7,500,000. The study and development work will include investigations in the

areas of core physics, metallurgy, thermal and mechanical design, as well as in the design of primary coolant components that will be required for such a large reactor plant (500 megawatts electrical or greater). During fiscal year 1963 the feasibility of various reactor concepts will be investigated, nuclear materials for a large critical mockup will be ordered, critical experiments conducted, heat transfer tests performed, and associated materials development work carried out. It is estimated that costs incurred during fiscal year 1963 will be approximately $5 million. Work to complete the study in fiscal year 1964 will cost about $2.5 million.

It is anticipated that this work will aid materially in evaluation of the importance of the seed-blanket concept to obtain economic power from large central station nuclear reactor plants. The seed and blanket concept has several features which may prove to be significant advantages. For example, this concept maximizes the power generation from natural uranium fuel in a reactor moderated and cooled with ordinary water; it minimizes the number of mechanical control rods required and reduces the economic penalties which would result from higher chemical processing costs or lower plutonium value.

(3) Experimental boiling water

Reactor (EBWR)	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,250,356	$836,000	$200,000
Research and development	667,749	501,000	0
Fuel fabrication	76,000	28,000	0
Operations	501,000	307,000	200,000
Equipment	5,607	0	0

The experimental boiling water reactor will be in operation in fiscal year 1962 demonstrating higher power operation, determining the thresholds of instability as well as water carryover and steam carryunder. With the completion of the fiscal year 1962 program, it is felt that the power demonstration program will demonstrate the additional information required to evaluate the technical and economic aspects of boiling water reactor technology. As a consequence of this, EBWR will be shut down unless the results of that program or other programs such as Pu recycle dictate further operation. The fiscal year 1963 estimates only include provision for closeout and cleanup of this plant. Plans are being reviewed to use this facility in other phases of the reactor development program.

(4) Borax V

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,161,127	$1,550,000	$1,000,000
Research and development	554,000	366,000	368,000
Fuel fabrication	401,000	427,000	133,000
Operations	164,000	711,000	488,000
Related capital equipment	42,127	46,000	11,000

This reactor facility, a modification of a former plant, was completed in April 1961, and efforts since that time have been directed toward preparing the plant for its initial operation. Current plans are to start operational tests with the boiling core late in fiscal year 1962. These tests will last 2 or 3 months, after which the central superheat experimental program will begin and continue into fiscal year 1963. In fiscal year 1963 peripheral superheat experiments will be undertaken. The objective of BORAX V is to obtain operational experience and data on an integral superheat reactor prior to BONUS and Northern States power operation. The fiscal year 1963 research and development effort is on the development of instrumented superheater fuel assemblies of an advanced design and the development of equipment to analyze the stability of the reactor (i.e., reactor water height and steam separation). The fuel fabrication costs decrease in fiscal year 1963 with only replacement superheat fuel assemblies of various types being fabricated for the BORAX V experimental program. Operating costs remain relatively stable. Equipment costs decline as the plant goes into operation.

(5) Puerto Rico Water Resources Authority reactor (BONUS)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,077,956	$1,200,000	$1,125,000
Research and development	1,077,956	297,000	350,000
Fuel fabrication		835,000	100,000
Operations		64,000	525,000
Related capital equipment		4,000	150,000

During fiscal year 1960, the AEC and Puerto Rico Water Resources Authority entered into a joint program under which the AEC is to (1) construct a power reactor of the integral nuclear superheat variety at Punta Higuera near Rincon, P.R., (2) perform certain preconstruction research and development, and (3) fabricate the first core and train operating personnel. The Puerto Rico Water Resources Authority furnishes the land, conventional equipment and administration building, performs site preparation, purchases the steam from and operates the plant.

In fiscal year 1962 preconstruction research and development will continue and a program of preoperational training will be initiated. Major costs to be incurred in this year are for the fabrication of the first core of the reactor.

With the completion of core fabrication in fiscal year 1963, emphasis will be directed to continuation of training of reactor operators and other preoperational startup activities prior to plant completion. In addition, the preconstruction research and development will come to an end and a program of postconstruction research and development aimed at the accumulation of information on fuel element behavior, reactor operating and control characteristics essential to the design of advanced superheat plants will be initiated.

(6) Heavy water components test reactor (HWCTR)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$916,035	$2,400,000	$2,500,000
Research and development	404,992	300,000	250,000
Fuel fabrication	75,113	725,000	625,000
Operations	412,959	1,271,000	1,500,000
Related capital equipment	22,971	104,000	125,000

This reactor provides a test facility to conduct irradiation tests on fuel elements being considered for heavy water moderated systems and will test reactor components such as pumps, valves, and instrumentation.It will also provide operating information on a heavy water moderated system under conditions similar to those suitable for power production.

The research and development effort for this plant will decline as the reactor nears completion. The major cost increase in fiscal year 1962 is attributable to the prestartup training of reactor technicians and operating personnel in the startup, operation, control, monitoring, refueling, and maintenance of the plant.

Increased costs in fiscal year 1963 reflect full-year operation of the reactor for testing of advanced fuel elements and various other components and concepts for heavy-water moderated and natural uranium fueled power reactors.

The research and development effort will be concerned primarily with the successful startup and operation of the plant. Fuel fabrication in both fiscal year 1962 and fiscal year 1963 provide for fabrication of fuel and driver elements to be tested in the reactor. Various configurations of metal and oxide tubes will be fabricated, irradiated, and analyzed.

Such items of equipment as a handling and inspection device for irradiated fuel, flux monitors, etc., will be required as the plant becomes operable.

(7) Canadian cooperative program

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	$359,865	$1,800,000	$1,400,000

By Public Law 86–457, (86th Cong.) dated May 13, 1960, funds were authorized to the Commission to perform research and development work specifically directed toward heavy-water moderated nuclear powerplants to be constructed in Canada. This program is an expansion of the general agreement for cooperation between the United States and Canada, which came into effect in June 1957.

This cooperative effort consists of the exchange of personnel and detailed information on design, construction, and operation of current and projected heavy-water moderated power reactors included in the programs of AEC and AECL together with research and development technology and economic information relevant to such reactors. This information will include engineering data developed under the cooperative program and the reciprocal use of pertinent facilities, equipment, and materials. The program involves various research and development efforts as approved by a joint technical board, comprised of United States and Canadian officials.

The principal effort throughout fiscal year 1962 and most of fiscal year 1963 will be the development initiated in midfiscal year 1961 of a prototype onpower refueling machine for use by the Canadians in their CANDU reactor.

(8) Water-cooled reactors—Other

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$10,731,838	$9,346,000	$9,000,000
Research and development	10,333,647	8,665,000	8,795,000
Fuel fabrication		229,000	50,000
Irradiations	120,000	138,000	
Test reactor services	138,000	146,000	
Related capital equipment	140,191	168,000	155,000

In addition to the work described above under specific water reactor concepts, there are basic development efforts also conducted on pressurized and light-water reactors, superheat reactors, and heavy-water reactors.

(a) Spectral shift reactors

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,602,123	$1,577,000	$800,000
Research and development	1,574,118	1,198,000	730,000
Fuel fabrication		229,000	50,000
Related capital equipment	28,005	150,000	20,000

The principal work underway in fiscal year 1962 and 1963 is the development of the spectral shift reactor concept. The prime effort is directed toward obtaining physics measurements utilizing 4.9 percent enriched UO_2 clad with stainless steel and 2.5 percent enriched UO_2 clad with aluminum, with varying M/W ratios in a mixture of D_2O and H_2O enabling the optimization of the nuclear design for a prototype or full scale plant. To this end additional fuel (2.5 percent enriched UO_2, Al clad) is to be procured in fiscal year 1962 and critical and exponential experiments performed in both fiscal years. The present and future potential design studies of a large spectral shift reactor will be completed in fiscal year 1962. The research and development on the optimization of a shaft seal for a large main coolant pump will continue in fiscal year 1963.

(*b*) *Nuclear superheat reactor*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,503,859	$3,802,000	$4,000,000
Research and development	4,166,514	3,500,000	4,000,000
Irradiations	120,000	138,000	
Test reactor services	138,000	146,000	
Related capital equipment	79,345	18,000	

This activity is comprised primarily of work on the development of the nuclear superheat reactor concept. Specific tasks include decontamination and pressure vessel radiation damage and examination of core 1A from EBWR.

The nuclear superheat development program was initiated in fiscal year 1960 at Combustion Engineering, Inc. and the General Electric Co. The work initially undertaken under these contracts will be completed in fiscal year 1962.

The steam-cooled power reactor evaluation was completed in March 1961. This study (*a*) reaffirmed the economic incentive for nuclear superheat, (*b*) identified those concepts which possessed the greatest potential, and (*c*) delineated problem areas which require additional development work.

Based on the results of the development program obtained thus far, and the conclusion of the steam-cooled power reactors study, the superheat program for fiscal year 1962 and fiscal year 1963 has been formulated and additional work will be initiated in the following areas:

(*a*) High burnup superheater fuel irradiation and fuel development.
(*b*) Superheat reactor components proof testing.
(*c*) High quality and superheated steam heat transfer.
(*d*) Corrosion, erosion, and coolant chemistry.
(*e*) Multiple coolant tube fuel element physics.
(*f*) Mixed spectrum superheat reactor analysis and critical experiment.
(*g*) Steam-water separation tests.
(*h*) Pressure tube superheat reactor analysis.

(*c*) *Heavy water reactors concept*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,625,856	$3,967,000	$3,000,000
Research and development	4,593,015	3,967,000	2,900,000
Related capital equipment	32,841		100,000

This program is to continue the development of necessary technology and to solve the major problems related to determining the optimum plant design conditions for a heavy-water moderated natural uranium fuel reactor. During fiscal year 1963 all technology will be reevaluated and a determination made as to the optimum concept that should be considered for construction and operation in the reactor development program to produce economic power. Costs in fiscal year 1963 also provide for new equipment items essential to the development effort.

(*d*) *Elk River*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	0	0	$200,000

Costs provided for fiscal year 1963 provide for the formulation of additional tests above and beyond that required for routine plant operation (i.e., rod oscillation tests, power asymmetrics, etc.).

This information is needed in order to obtain the maximum benefit from the operation of the reactor and in the design of advanced plants. To the extent

possible, operational data will be obtained with the plant as originally constructed in order to avoid interference with the primary objective of demonstrating high plant availability factor. Evaluation of these data will also help insure that the plants are operated in a safe manner.

(e) Operational analysis—Privately financed reactors

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	0	0	$1,000,000

An important step in reduction of nuclear power costs is through the identification of areas of design conservatism and limitations such that this information can be factored into subsequent nuclear powerplants.

The estimates for fiscal year 1963 provide for the inauguration of a postconstruction research and development program utilizing privately financed reactor facilities assuming that private reactor owners are willing to participate in such an effort. It is contemplated that this program would involve the performance of special plant tests, analysis, and, in some instances, additional development programs, over and above those tests and analysis required for safe and reliable plant operation. Examples of research and development required include: periodic removal and destructive examination of fuel; insection examination of advanced fuel elements; detailed examination of components for radioactivity buildup; deliberately induced power asymmetries, etc.

B. ORGANIC COOLED REACTORS, $8,670,000

(1) Organic-moderated reactor experiment (OMRE)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,991,632	$2,053,000	$1,966,000
Research and development	1,008,604	1,047,000	959,000
Fuel fabrication	196,320	217,000	252,000
Operations	719,537	733,000	657,000
Related capital equipment	67,171	56,000	98,000

An integral part of the organic program for fiscal year 1962 and fiscal year 1963 is the continued operation of the OMRE as a core and component testing facility, a facility for demonstrating the satisfactory solution of the fouling problem, effectiveness of coolant purification techniques, and testing the range for possible operating conditions of this type of reactor, as well as a source of coolant materials for the overall program. Directly associated with the operation of the OMRE are various fuel projects concerned with the fabrication of experimental uranium metal aluminum clad and APM–UO_2 fuel elements and core loadings for the reactor, and hot cell examination and evaluation of the fuel elements tested.

Cost levels for this activity remain relatively constant although some fluctuation between years may be expected in the various accounts within the activity.

Equipment requirements involve such items as a high-pressure gas compressor, temperature recorders, bi-pass heaters, and maintenance equipment essential to the operation of the plant.

(2) Experimental organic cooled reactor (EOCR)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$759,386	$1,300,000	$2,254,000
Research and development	759,386	680,000	550,000
Fuel fabrication	0	0	300,000
Operations	0	530,000	1,164,000
Related capital equipment	0	90,000	240,000

The experimental organic-cooled reactor (EOCR) is a flexible experimental tool which will be used primarily in the achievement of the longer range potential of the organic-cooled concepts. It will provide the facilities to demonstrate improved (i.e., cheaper and/or more radiation resistant) coolants and fuel elements, the upper limits in operating conditions for organic-cooled reactors, and the possible use of other moderators such as graphite or D_2O in organic-cooled systems.

The EOCR construction is scheduled for completion in early fiscal year 1963. Upon completion of the installation of the two initial in-pile loops, the reactor will be brought to criticality and the initial "operational" core loading established. In addition to the usual physics measurements to determine control rod worth, available excess reactivity, etc., at least 3 to 4 months will be utilized to perform the following reactor measurements; flux mapping, temperature coefficient, void coefficient, dynamic response to ramp additions of reactivity, and gamma flux mapping.

In addition, in-pile measurements to verify the flow distribution and hydraulic characteristics in the reactor core will be undertaken and the reactor will then be operated at a significant power level.

The increase in operating costs represents full staffing of personnel essential to operate the reactor.

(3) Other organic-cooled reactors

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$3,910,281	$4,264,000	$4,450,000
Research and development	3,632,387	3,918,000	4,175,000
Operations	41.186		
Irradiations	22,381	137,000	80,000
Test reactor services	1,355	55,000	
Related capital equipment	212,972	154,000	195,000

It is the objective of this basic research and development program to develop the necessary technical information to raise the status of the organic moderated and cooled reactor concept from the successful operation of the experimental field installation to that of an economically operated large scale central power station. The effort required is predicated upon the necessity of obtaining a more thorough understanding of the behavior of the organic moderator-coolant under irradiation, its performance in the transfer of heat from the reactor core to the steam generator, the problems associated with the removal and disposal of its waste products, the effects of its characteristics on fuel element design requirements, and its behavior as a moderator.

A primary effort in this activity in fiscal year 1963 is directed to the solution as rapidly as possible of the problems associated with organic coolants. Work therefore is underway to investigate organic film formers in the decomposition products, and the effect of gammas and fast neutrons; to conduct basic studies on radiolytic damage, film formation studies using electron radiation, and stabilizers to improve coolants by additives; to develop the pressure-volume-temperature relationships for terphenyls; develop methods to reclaim used coolants and determine the thermodynamic properties of organic liquids and vapors; to irradiate under reactor conditions various coolants with additives, etc.; and to study basic kinetic properties of terphenyls in an effort to understand and predict organic coolant in-reactor properties.

In addition, the estimates provide for research and development associated with construction of a 160 MWt organic power and industrial heat reactor which in addition to demonstrating the capabilities of the organic cooled and moderated reactor concept would also demonstrate the use of process heat from a nuclear powerplant. This program is essentially an extension of the research and development which had been underway since fiscal year 1961 in connection with the prototype organic power reactor (programed under the cooperative power demonstration reactor program). The proposed program consists of specific tasks on development and proof testing of individual components associated with the plant, including work on fuel element development and testing (including heat transfer and process development work), critical experiment, fuel handling system, control-safety rods and drives, process equipment, and failed fuel element detection and location system.

To insure that the information generated at the Piqua reactor is properly analyzed and used to the best advantages for future reactors, a program of

postconstruction research and development was initiated in fiscal year 1962 at a level of $85,000 and will continue in fiscal year 1963 at a level of $170,000.

The areas of principle assistance are in matters relating to plant safety, reactor hazards, modifications to equipment or operating procedures, further optimization of operation conditions, and fuel element replacement schedules.

More specifically, the following tasks of work will be performed: (*a*) Initial determination of operation characteristics, (*b*) reactor core and fuel element technology, (*c*) coolant technology, (*d*) instrumentation and control, and (*e*) equipment performance.

The estimates also provide for various items of new and replacement equipment essential to the research and development program.

C. GAS-COOLED REACTORS, $12,800,000

(*1*) *Experimental gas-cooled reactor (EGCR)*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$7,973,516	$8,053,000	$7,735,000
Research and development	7,198,204	5,629,000	4,702,000
Fuel fabrication	0	894,000	391,000
Operations	360,082	1,005,000	1,538,000
Irradiations	127,844	232,000	150,000
Test reactor services	114,505	0	0
Related capital equipment	172,881	293,000	954,000

One of the objectives of the civilian power program is to develop a gas-cooled reactor system which can produce electricity at a cost competitive with conventional fuels in most areas of the United States by mid–1970. One approach to reaching this objective will be the operation of the flexible experimental prototype gas-cooled reactor (EGCR).

Research and development will continue in fiscal year 1962 and fiscal 1963 aimed at completing irradiation tests on fuel and moderator material and conducting necessary postirradiation examinations. This data on operating characteristics of key materials is essential in order to form an accurate prediction of reactor operating characteristics and anticipated like of key components. New and unique components such as the charge and service machines will also be performance and life-tested before assembly into the reactor. In fiscal year 1962 and increasingly in fiscal year 1963, design and development work on a second core for the EGCR will be undertaken so that purchase specifications for an improved core can be prepared. Supporting efforts on graphite studies and on fuel element testing will diminish. TVA, the operating contractor for the plant, will be engaged throughout fiscal year 1962 and fiscal year 1963 recruiting and training reactor operating and maintenance staff and in other preoperational efforts.

Increased costs for equipment in fiscal year 1963 are related to the research and development effort and also provide for items essential to the preoperational testing and training program.

(*2*) *Gas-cooled reactors, other*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$5,114,459	$4,289,000	$5,065,000
Research and development	4,183,784	3,629,000	4,024,000
Irradiations	64,490	191,000	621,000
Test reactor services	640,793	75,000	0
Related capital equipment	225,392	394,000	420,000

Major advances in performance over that anticipated from the EGCR will be required to achieve the objectives of the gas-cooled reactor program. Accordingly, a vigorous advanced research and development program is being pursued with special emphasis on the development of improved fuel elements that are

capable of higher temperature operation, longer burnup and better neutron economy.

A major research and development effort in this activity in fiscal year 1962 and fiscal year 1963 is on beryllium-clad fuels. This is a continuation of previous development work with the inclusion of key work formerly carried out under the ECNG–FWCNG program. If a beryllium fuel element can be successfully developed, it would find application in the EGCR and ECNG–FWCNG type reactors. In addition, the program envisions intensification of efforts on other improved reactor fuels and materials. In particular, all ceramic fuels which provide higher operating temperatures and better neutron economy are being developed. Higher performance reactors using these new materials will require certain improved components which will be developed and will require improved understanding of the chemistry of high temperature reactor systems.

The estimates also provide for various items of new and replacement equipment essential to the research and development program.

D. LIQUID METAL COOLED REACTORS, $25,761,000

(1) Experimental breeder reactor No. 1 (EBR–I)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,088,005	$670,000	$350,000
Research and development	85,000	0	0
Fuel fabrication	597,000	351,000	0
Operations	403,132	314,000	350,000
Related capital equipment	2,873	5,000	0

A plutonium core (Mark IV) has been fabricated and will be installed in this reactor at the end of fiscal year 1962 and experimental operation will be continued through half of fiscal year 1963 to determine breeding gain, neutron flux distribution, radiation effects, and operating characteristics. After obtaining this information on plutonium fuel nuclear behavior, the objective of the EBR–I, which was to establish the feasibility of fast reactors, will then have been accomplished. It is then proposed that the reactor will be shut down, unless the results of the Mark IV test indicate the need for continued effort.

(2) Experimental breeder reactor No. 2 (ERB–II)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$6,719,789	$6,675,000	$8,834,000
Research and development	4,519,713	3,835,000	3,455,000
Fuel fabrication	697,000	27,000	500,000
Operations	1,469,457	2,552,000	4,605,000
Irradiations	0	0	0
Related capital equipment	33,619	261,000	274,000

The EBR–II, located at the NRTS, achieved "dry" criticality on September 20, 1961. The experiment was successfully completed; "wet" criticality is scheduled for late calendar year 1962. This reactor is a sodium-cooled fast-neutron power reactor with a gross electrical output of 20 megawatts which will be fueled initially with U^{235} and later with plutonium. It is the only reactor powerplant at the present time to include an integral fuel-processing facility where the irradiated fuel is processed, fabricated, and assembled for return to the reactor.

During fiscal year 1962, and to a lesser degree in fiscal year 1963, research and development as it is applied to the EBR–II will be continued on systems development, design, and analysis; the engineering development of improved reactor internals, core structure, fuel and blanket assemblies, and components directly associated with the reactor; the metallurgical development of fast reactor fuel elements; and theoretical and experimental fast reactor physics. Specific emphasis will be directed toward completing the fuel cycle facility and the various processes that will be employed therein.

The major increase in the fiscal year 1963 estimates is due to power operation of the reactor, and startup and operation of the fuel cycle facility. Contributing to the increased costs is provision for initiation of procurement of core II, a plutonium fuel jacketed in refractory metal tubes and bonded with sodium. The estimates also provide for various items of new and replacement equipment essential to the research and development program.

(3) Sodium reactor experiment (SRE–I)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,370,670	$1,972,000	$2,000,000
Research and development	634,536	1,046,000	1,158,000
Fuel fabrication	0	155,000	260,000
Operations	719,763	716,000	556,000
Related capital equipment	16,371	55,000	26,000

The continued operation and maintenance of the sodium reactor experiment is required to evaluate future sodium cooled reactors as a source of economically competitive nuclear power. The experimental nature of this plant requires an intensive and continuous analysis of its performance. Anomalies in reactor operation have been detected and interpreted to provide data useful in setting reactor operating conditions and predicting plant performance. Maximum operation of the plant will provide advanced SCR projects with data necessary to the development of sodium cooled reactor concepts. Present plans are to have the SRE reach full power operation early in fiscal year 1963 and operate on a sustained basis throughout that year.

The fiscal year 1963 estimates provide for continued operation of the SRE I with the Th–U core loading throughout the fiscal year. Cost increase is expected in research and development and is attributable to (1) increased effort in experimental physics to provide data necessary for safeguarding the SRE, verifying calculational techniques, and evaluating the core parameters of the SRE due to changes during operation, and (2) evaluation and interpretation of core 2 (Th–U) performance. Fabrication of a uranium carbide core loading for SRE will continue throughout the fiscal year, with plans for inserting the new core into the reactor in fiscal year 1964. Anticipated revenue from sale of steam generated by the reactor is estimated at $75,000 in fiscal year 1963. This income is reflected under the revenues applied portion of the budget.

(4) Liquid metal cooled reactors, other

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$9,200,658	$11,512,000	$14,577,000
Research and development	7,563,008	10,506,000	11,985,000
Fuel fabrication	1,096,000	166,000	1,300,000
Operations	0	60,000	0
Irradiations	65,543	293,000	599,000
Test reactor services	19,231	43,000	64,000
Related capital equipment	456,876	444,000	629,000

In addition to the work on specific liquid metal cooled reactors, described above, there is conducted under this activity basic research and development work efforts which are not clearly defined as separate projects or where the scientific information to be obtained has wide applicability in both the fast breeder reactor and sodium reactor programs reactor systems.

a. Fast breeder reactors

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,238,432	$5,112,000	$6,700,000
Research and development	2,895,921	4,674,000	4,965,000
Fuel fabrication	1,096,000	166,000	1,300,000
Operations	0	60,000	60,000
Irradiations	7,000	18,000	77,000
Test reactor services	0	0	8,000
Related capital equipment	239,511	194,000	290,000

The majority of costs in this activity in fiscal year 1962 and fiscal year 1963 are in fast reactor physics using ZPR–VI and ZPR–IX, system evaluation, fuel development, and improved methods of pyrometallurgical reprocessing of fast reactor fuels. The increased research and development effort in fiscal year 1962 and fiscal year 1963 is attributable to increased emphasis on the fast ceramic reactor program (EFCR) and on activities of general applicability to the overall sodium reactors program.

The fast ceramic reactor program has successfully developed a high burnup fuel on the laboratory scale. Provisions will now be made to investigate the feasibility of fabricating such fuel elements of a size and by a process which is attractive by engineering methods. Some fuel elements of this type will be irradiated and evaluated in TREAT and EBR–II. Other work will include determining the feasibility, both theoretically and experimentally, of using such fuel elements in sodium-cooled reactors which can leak fission products gases to a common plenum or directly to the sodium. Permissible leaky or vented fuel elements would contribute substantially in decreasing costs for fuel element fabrication. Fiscal year 1963 fuel fabrication costs provide for required fuel plates and blanket assemblies for the ZPR's III, VI, and IX. The estimates also provide for various items of new and replacement equipment essential to the research and development program.

b. Sodium graphite reactors

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,962,226	$6,400,000	$7,877,000
Research and development	4,667,087	5,832,000	6,960,000
Irradiations	58,543	275,000	522,000
Test reactor services	19,231	43,000	56,000
Related capital equipment	217,365	250,000	339,000

This basic research and development program is strongly oriented toward the continued development of an improved sodium graphite reactor as well as the development of fuels for use in high temperature liquid metal cooled reactors. Equal emphasis is placed on the sodium components development program, primarily a Commission-sponsored effort to develop within industry a competence for the manufacture of reliable and economical components external to nuclear cores and common to sodium cooled reactors, including fast breeder reactors.

The research and development effort is comprised of the following:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,667,087	$5,832,000	$6,960,000
Basic program	3,551,580	3,919,000	4,416,000
Sodium component development	1,115,507	1,913,000	2,544,000

The basic research and development program includes continuing efforts in the areas of system evaluation, physics analyses and calculations, fuel development and fuel process development. The increase in cost in fiscal year 1963 is due in part to the increased effort being devoted to the out-of-pile and in-pile research and development on uranium carbide fuel, including increased irradiation costs.

The estimates also provide for initiation in fiscal year 1962 and expansion in fiscal year 1963 of a postconstruction research and development program of the Hallam nuclear power facility reactor operations to analyze operational data. This analysis will determine the degree of conformity of the actual plant operating parameters to the stated design objectives, estimate the degree to which each design or operating limit should be increased (or decreased) for future design use, prepare formal reports on these anlyses and their results for distribution, and reevaluate continously the technical specifications which form a part of the operation authorization. The estimates for this work in fiscal year 1962 and fiscal year 1963 respectively are $90,000 and $430,000. The sodium components development program represents a consolidation of sodium components development and testing for the overall sodium reactors program. The major costs in fiscal year 1962 and fiscal year 1963 are associated with the modification of existing facilities at AI and equipment procurement to complete the sodium component test installation early in fiscal year 1963.

The estimates also provide continuation of research activities and design and fabrication of components such as steam generators and sodium heat exchangers. Some funds will be used in further exploring designs and fabrication techniques for reducing costs and improving reliability of steam generators.

The estimates also provide for various items of new and replacement equipment essential to the basic research and development program.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
e. Studies and evaluations	$2,823,577	$1,976,000	$2,500,000

The direction of any multitudinous development effort requires not only critical technical evaluation of the existing programs and projects but also careful planning for future programs. These activities require continuing advice and assistance from authorities in various fields in the conduct of detailed technical studies and the preparation of reports. In addition, the performance of specific computational studies may require the use of computers and other tools. This assistance is obtained from the national laboratories insofar as possible. Some information, such as information on specific concepts and costs, must be obtained from authoritative industrial contractors. In addition, this program enables the introduction and consideration of new ideas in reactor concepts which may eventually be more promising than those currently under development. The work in this program may, therefore, generally be categorized as being in three areas: Technical assistance, evaluation studies, and reactor concepts evaluations. Descriptions of these areas of work with fiscal year 1963 estimates are as follows:

(*a*) *National laboratory technical assistance groups, $1,500,000.*—A nucleus of a technical assistance group is engaged at each of the national laboratories and at the Hanford Works in the performance of specific computational analysis, special research investigatious, and consultant services. Arrangements have been made which enable them to call upon experts with specific knowledge in particular fields. These groups assist in studies to make cooperative analyses, task force studies, conceptual design studies relating to planned programs, and evaluation of new reactor concepts. In addition to the above, these groups may also undertake work of a more sustained nature. For example, both Oak Ridge National Laboratory and Hanford are currently studying the fuel values of Pu and U^{233} in various reactor concepts in order to help establish a firm technical basis for any buy-back price established. In addition, Hanford is conducting a continuing evaluation of various graphite-moderated power-producing reactors.

The following is a breakdown of the cost by laboratories:

Brookhaven National Laboratory	$400,000
Oak Ridge National Laboratory	400,000
Argonne National Laboratory	300,000
Hanford Works	400,000
Total	1,500,000

(b) *Evaluation studies, $500,000.*—This activity is comprised of studies by industrial contractors or architect-engineers on the various technical and economic aspects of concepts which have reached the engineering stage of development. Similar studies are anticipated in fiscal year 1963 along with special studies to assist the various offices of the division to plan their research and development programs. Examples of these latter studies are requests received from the Army Reactors Office to examine new reactor concepts that are submitted for remote unattended use.

(c) *Reactor concepts evaluation program, $500,000.*—This activity provides a sustaining program for the continuous review and evaluation of new and advanced power-reactor concepts for varying application and provides a sound basis for advancement of the technology. Promising new concepts are studied and scrutinized and compared against existing concepts and other measurement criteria. Concepts are either initiated, continued, or eliminated as results are obtained and evaluated. Studies on the fluidized bed reactor will be continued during fiscal year 1962. In addition, work on other new reactor concepts such as the suspended-fuel reactor may be performed. This work primarily consists of exploratory studies and does not duplicate experimental work undertaken and supported under the budget category "Advanced systems research and development." For example, during fiscal year 1962 the contractor will complete his preliminary exploratory work on the fluidized-bed reactor. If the results are encouraging, future work would be supported under the above-mentioned budget category. Similar studies will be underway in fiscal year 1963.

2. Cooperative Power Reactor Demonstration Program, $9,416,000

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Water-cooled reactors	$6,191,723	$4,782,000	$3,362,000
(1) Yankee Atomic Power Co	37,279	24,000	
(2) Rural Cooperative Power Association (RCPA)	336,868	300,000	840,000
(3) Northern States Power Co	1,559,867	1,400,000	715,000
(4) Carolinas-Virginia Nuclear Power Group	3,011,244	1,935,000	600,000
(5) Consumers of Michigan	1,194,610	1,123,000	1,007,000
(6) Small nuclear powerplant	51,855		
(7) LaCrosse boiling water reactor			200,000
(b) Organic-cooled reactors	2,043,060	2,487,000	501,000
(1) City of Piqua, Ohio	1,027,799	902,000	501,000
(2) Intermediate-size organic reactor (POPR)	1,015,261	1,585,000	
(c) Gas-cooled reactors	7,706,865	72,000	
(1) East Central-Florida West Coast	797,426	72,000	
(2) Philadelphia Electric Co	6,909,439		
(d) Liquid-metal-cooled reactors	3,381,288	3,123,000	1,257,000
(1) Consumers Public Power District	2,728,700	2,810,000	1,007,000
(2) Fast reactor systems (R. & D.)	652,588	313,000	250,000
(e) Unsolicited proposals			4,296,000
Total	19,322,936	10,464,000	9,416,000

A stated purpose of the Atomic Energy Act of 1954 provides for a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes. The power demonstration reactor program initiated for this purpose has as its objective the stimulation of industrial participation in the development and application of nuclear technology to the generation of power and other civilian uses. This assistance program is directed toward meeting this objective.

A. WATER-COOLED REACTORS $3,362,000

(1) *Yankee Atomic Electric Co.*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$37,279	$24,000	0
Research and development	37,279	0	0
Irradiations	0	24,000	0

This reactor, a pressurized-water 134,000-electrical-kilowatt nuclear powerplant located near Rowe, Mass., achieved criticality in August 1960 and design-power operation in January 1961.

Since the start of this project in late fiscal year 1956, the Commission has in accordance with its contractual agreement assisted the Yankee Atomic Electric Co. in the performance of research and development. This effort has encompassed tasks in fuel element development, nuclear design and reactor physiochemistry, mechanical design, thermal and hydraulic design, control rod development, instrumentation and control, plant systems development, plant safety analysis, criticality experiments and radiation damage experiments. During fiscal year 1961, procedures for plant startup experiments were established and final reports describing all aspects of the work performed during the program were prepared. The estimates for fiscal year 1962 cover final irradiation services in connection with the preconstruction research and development effort.

(2) *Rural Cooperative Power Association*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$336,868	$300,000	$840,000
Research and development	335,103	0	0
Fuel fabrication	1,765	0	0
Operations	0	300,000	840,000

The reactor supported by research and development under this activity was approved as a second round proposal and will be a closed cycle boiling water power reactor and conventional fuel-fired superheater.

Initial startup of this reactor scheduled for fiscal year 1962 was delayed because of safety questions which were raised on the suitability of the pressure vessel. Efforts are underway to resolve these questions and to insure compliance with all regulatory requirements preparatory to operation of the reactor.

The estimates for fiscal years 1962 and 1963 provide for preoperational training of reactor operators and other prestartup costs. No revenues from sale of steam are anticipated for fiscal year 1963.

(3) *Northern States Power Co.*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	$1,559,867	$1,400,000	$715,000

This program provides for the performance by AEC of research and development assistance associated with a nuclear reactor of an advance boiling water type with nuclear superheater to be constructed and operated by the Northern States Power Co. as part of its system. The plant is scheduled for completion and operation by early fiscal year 1963.

The preconstruction research and development assistance will be essentially completed during fiscal year 1962. Efforts on the postconstruction research and development assistance initiated in fiscal year 1961 will be expanded in fiscal year 1962 and continue in fiscal year 1963 at a level of approximately $375,000.

(4) Carolinas-Va. Nuclear Power Association, Inc.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$3,011,244	$1,935,000	$600,000
Research and development	2,709,454	1,419,000	600,000
Test irradiations	50,293	370,000	0
Test reactor services	251,497	146,000	0

This activity provides for preconstruction research and development leading to construction of a heavy water moderated and cooled, slightly enriched uranium fueled prototype power reactor.

With the reactor scheduled for completion and operation in early fiscal year 1963, the preconstruction research and development program is projected to decrease. Beginning in fiscal year 1962 and at a slightly higher level in fiscal year 1963 such preconstruction resesrch and development tasks as plant performance and components evaluation, and metallurgical analyses will be underway.

(5) Consumers Power Co. of Michigan

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,194,610	$1,123,000	$1,007,000
Research and development	1,177,218	1,123,000	1,007,000
Related capital equipment	17,392	0	0

The program covers certain work aimed at (1) demonstrating the feasibility of increasing the power density of oxide-fueled boiling water reactors, (2) determining the effects of high power density operation upon fuel life exposure, (3) reducing the fabrication costs of high performance fuel, (4) determining the optimum conditions for high power density operation in the Consumers plant, and (5) developing design criteria for a 300 MWe high power density reactor core using the design and performance data of the Consumers reactor as a basis for calculations.

(6) Small nuclear powerplant

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	$51,855	0	0

This program was authorized in fiscal year 1960. Costs incurred in fiscal year 1961 involved site selection and preliminary design. No costs will be incurred in fiscal year 1962 and fiscal year 1963 in view of the recent decision to defer construction of the project.

(7) Lacrosse boiling water reactor

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	0	0	$200,000

This project will involve a boiling water nuclear reactor with a net electrical capacity of 50 megawatts electric, net, to be constructed by Allis-Chalmers under direct contract with the Commission. The Dairyland Power Cooperative, under a separate contract with the Commission, will provide the reactor site and the turbogenerator facilities; will operate and maintain the reactor plant for a period

of 10 years as part of their electrical systems and will purchase all steam produced by the reactor.

The estimated costs in fiscal year 1963 cover salaries and per diem expenses for the Dairyland employees undergoing training, travel, and other preliminary expenses incurred by Dairyland prior to their operation of the reactor plant and provision for incremental G. & A. costs related to their activities on the project.

B. ORGANIC COOLED REACTORS, $501,000

(1) City of Piqua, Ohio

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,027,799	$902,000	$501,000
Research and development	9,020	0	0
Fuel fabrication	784,612	535,000	0
Operations	233,764	300,000	501,000
Related capital equipment	403	67,000	0

The objective of this activity is to provide technical assistance to the city of Piqua for the construction and operation of an 11.4-megawatt electric organic cooled and moderated nuclear reactor.

With the completion of this reactor scheduled for early fiscal year 1963, the estimates for fiscal year 1962 provide for preoperational testing, startup operations and operation of the reactor for the latter half of the fiscal year. The major cost decrease in fiscal year 1963 is the result of the completion in fiscal year 1962 of fabrication of fuel elements for the plant.

In fiscal year 1963, the reactor will be operated at a 50- to 70-percent load factor for the production of steam. Revenues in the amount of $125,000 for fiscal year 1963 from the sale of steam are reflected in the revenues portion of the budget.

(2) Intermediate size organic reactor prototype (POPR)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,015,261	$1,585,000	0
Research and development	948,366	1,549,000	0
Irradiations	0	30,000	0
Test reactor services	0	6,000	0
Related capital equipment	66,895	0	0

Research and development has been underway in connection with an intermediate size (50 MWe net) organic cooled and moderated prototype, construction of which was authorized in fiscal year 1961. The recent decision not to proceed with plant construction has resulted in discontinuance of the research and development effort for this plant.

C. GAS-COOLED REACTORS, 0

(1) East central and Florida west coast nuclear power groups

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$797,426	$72,000	0
Research and development	679,972	72,000	0
Test reactor services	117,454	0	0

This project was terminated late in fiscal year 1961; the costs estimated for fiscal year 1962 represent carryover costs resulting from this termination.

(2) Philadelphia Electric Co.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$6,909,439	0	0
Research and development	3,939,166	0	0
Irradiations	95,979	0	0
Test reactor services	2,584,926	0	0
Related capital equipment	289,368	0	0

During fiscal year 1960, a power demonstration contract was executed by the Commission with 51 electrical utility companies, headed up by the Philadelphia Electric Co., for the construction of a high-temperature gas-cooled reactor at Peach Bottom, Pa. The General Atomic Division of General Dynamics was given the responsibility for the research and development work on the reactor.

The Commission obligation of $12,500,000 for preconstruction research and development was fully expended by the end of fiscal year 1961. The budget estimates, therefore, assume that no additional AEC costs will be incurred until the reactor is constructed.

D. LIQUID-METAL-COOLED REACTORS, $1,257,000

(1) Consumers Public Power District

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,728,700	$2,810,000	1,007,000
Research and development	1,562,408	932,000	307,000
Fuel fabrication	1,027,921	1,684,000	0
Operations	0	100,000	700,000
Test irradiations	125,895	90,000	0
Test reactor services	8,229	4,000	0
Related capital equipment	4,247	0	0

The purpose of this program is to provide technical assistance leading to construction and operation of a 75-megawatt electrical (net) sodium cooled graphite moderated nuclear power station at Hallam, Nebr., scheduled for design power operation early in fiscal year 1963.

The estimates for research and development are expected to decline considerably as plant construction nears completion, with the program effort in fiscal year 1963 directed principally toward examination and evaluation of test fuel elements. The decreased cost estimates for that year also reflect completion of the first core loading for the reactor. Personnel of CPPD will take over the reactor late in fiscal year 1962 and be engaged in its initial startup.

(2) Fast reactor systems (R. & D.)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	$652,588	$313,000	$250,000

This program provides for continued research and development assistance to industrial sponsored fast breeder power reactors. During fiscal year 1961, and to a greater extent in fiscal year 1962, AEC laboratory facilities were utilized in development, irradiation testing, and postirradiation examination of various fuel materials. The fiscal year 1963 estimates contemplate continued efforts in these areas.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(e) Unsolicited proposals	0	0	$4,296,000

The 86th Congress, by Public Law 86–457 dated May 13, 1960, authorized the use of "funds not to exceed $15 million in the aggregate to provide research and development assistance in support of unsolicited proposals from the utility industry to construct nuclear powerplants." Public Law 87–315 dated September 26, 1961, authorized the use of an additional $7 million in the aggregate for the same purpose. In the proposed authorization bill for fiscal year 1963 under section 110(b), the Commission is requesting modification to use funds now available for the third round of the cooperative power reactor demonstration program for design assistance as well as research and development, in accordance with the criteria submitted to the Joint Committee on Atomic Energy and in accordance with the provisions of subsections 111 (b) and)f) of Public Law 85–162. Under such arrangements as proposed by the Commission, it may furnish funds for design assistance without regard to the provisions of section 169 of the Atomic Energy Act of 1954.

Under section 110(c) of the proposed authorization bill for fiscal year 1963, the Commission also is requesting authorization to use funds, available in support of unsolicited proposals from the utility industry to construct nuclear powerplants, for a cooperative arrangement with any person or persons for participation in a nuclear power project which would be used to generate electricity and process steam. Any such arrangement that AEC enters into will be in accordance with the criteria for the third round of the Commission's power reactor demonstration program, including the provisions of section 111(b) of Public Law 85–162; provided, however, that under any such arrangement, the Commission may furnish funds for design assistance without regard to the provisions of section 169 of the Atomic Energy Act of 1954.

The fiscal year 1963 estimate provides the costs to be incurred for the types of proposals mentioned above.

The following tabulation portrays the prior year and planned funding pattern for the various reactors which comprise the cooperative power reactor demonstration program.

Cooperative power reactor demonstration program

[In thousands]

A. FISCAL YEAR 1958 COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM

	Total authorization		Obligations						
	Previous estimate	Revised estimate	Fiscal year 1958	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963	After fiscal year 1963
FIRST ROUND									
Consumers Public Power District—Hallam:									
Preconstruction R. & D	$16,010	$16,010	$2,464	$6,438	$3,903	$1,701	$1,026	$307	$171
Unusual maintenance and fuel cycle costs	8,000	8,000	8,000	0	0	0	0	0	0
Construction	28,877	30,800	6,500	6,308	9,414	5,860	2,718	0	0
Total	52,887	54,810	16,964	12,746	13,317	7,561	3,744	307	171
Fast breeder R. & D	3,600	3,600	695	21	511	792	1,021	0	560
Total first round	56,487	58,410	17,659	12,767	13,828	8,353	4,765	307	731
Operations	27,610	27,610	11,159	6,459	4,414	2,493	2,047	307	731
Construction	28,877	30,800	6,500	6,308	9,414	5,860	2,718	0	0
SECOND ROUND									
Elk River:									
Preconstruction R. & D	0	0	0	0	0	0	0	0	0
Construction	8,797	11,304	9,269	127	0	0	1,908	0	0
Postconstruction operating expenses	2,176	2,176	2,176	0	0	2	−2	0	0
Total	10,973	13,480	11,445	127	0	2	1,906	0	0
Piqua:									
Preconstruction R. & D	3,500	3,500	200	3,300	0	0	0	0	0
Construction	7,927	8,103	0	7,211	294	315	283	0	0
Postconstruction operating expenses	2,423	2,547	0	1,846	36	497	168	0	0
Total, Piqua	13,850	14,150	200	12,357	330	812	451	0	0
Chugach:									
Preconstruction R. & D	2,300	2,300	2,300	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0
Postconstruction operations	0	0	0	0	0	0	0	0	0
Total, Chugach	2,300	2,300	2,300	0	0	0	0	0	0
Total, 2d round	27,123	29,930	13,945	12,484	330	814	2,357	0	0
Operating	10,399	10,523	4,676	5,146	36	499	166	0	0
Construction	16,724	19,407	9,269	7,338	294	315	2,191	0	0

3D ROUND									
Northern States:									
Preconstruction R. & D.	7,500	7,500	5,500	2,000	0	0	0	0	0
Postconstruction R. & D.	1,000	1,000	500	310	0	1	189	0	0
Total, Northern States	8,500	8,500	6,000	2,310	0	1	189	0	0
Carolinas-Virginia:									
Preconstruction R & D	10,145	10,145	0	10,145	0	0	0	0	0
Postconstruction R & D	3,760	3,760	0	1,472	612	−612	2,288	0	0
Total Carolinas-Virginia	13,905	13,905	0	11,617	612	−612	2,288	0	0
East Central-Florida West Coast NPG:									
Preconstruction R & D	2,100	1,733	0	6,097	124	−4,265	−223	0	0
Postconstruction R & D	0	0	0	2,344	0	−2,344	0	0	0
Total ECNG–FWCNG	2,100	1,733	0	8,441	124	−6,609	−223	0	0
Total third round	24,505	24,138	6,000	22,368	736	−7,220	2,254	0	0
Operating	24,505	24,138	6,000	22,368	736	−7,220	2,254	0	0
Undesignated	26,998	22,635	0	0	0	0	0	3,268	19,367
Total fiscal year 1958 program	135,113	135,113	37,604	47,619	14,894	1,947	9,376	3,575	20,098
Operating	80,283	84,906	21,835	33,973	5,186	−4,228	4,467	3,575	20,098
Construction	54,830	50,207	15,769	13,646	9,708	6,175	4,909	0	0
B. FISCAL YEAR 1960 COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM									
Other prototype reactors R. & D.	0	0	0	0	0	0	0	0	0
Intermediate size organic reactor	$7,000	$7,000	0	0	0	$2,067	$533	0	$4,400
Consumers of Michigan:									
Preconstruction R. & D.	3,200	3,200	0	0	0	3,200	0	0	0
Postconstruction R. & D.	1,382	1,382	0	0	0	1,011	371	0	0
Total consumers	4,582	4,582	0	0	0	4,211	371	0	0
Philadelphia Electric:									
Preconstruction R. & D.	12,500	12,500	0	0	$12,405	3	92	0	0
Postconstruction R. & D.	2,000	2,000	0	0	2,000	0	0	0	0
Total Philadelphia Electric	14,500	14,500	0	0	14,405	3	92	0	0
Small size nuclear prototype water reactor:									
Preconstruction operating expenses	1,760	1,760	0	0	345	19	−3	0	1,399
Construction	12,000	12,000	0	0	80	11	0	0	11,909
Total small size nuclear prototype water reactor	13,760	13,760	0	0	425	30	−3	0	13,308

B. FISCAL YEAR 1960 COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM—Continued

	Total authorization		Obligations						
	Previous estimate	Revised estimate	Fiscal year 1958	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963	After fiscal year 1963
La Crosse boiling water reactor (Dairyland):									
Preconstruction operating expenses	$1,145	$1,145	0	0	0	0	$1,145	0	0
Construction	13,000	11,180	0	0	0	0	11,180	0	0
Total LACBWR	14,145	12,325	0	0	0	0	12,325	0	0
Other fiscal year 1960 authorized construction	0	1,820	0	0	0	0	0	0	$1,820
Preconstruction R. & D	1,513	1,513	0	0	0	0	0	$1,513	0
Total other	1,513	3,333	0	0	0	0	0	1,513	1,820
Total fiscal year 1960 program	55,500	55,500	0	0	$14,830	$6,311	13,318	1,513	19,528
Operating	30,500	30,500	0	0	14,750	6,300	2,138	1,513	5,799
Construction	25,000	25,000	0	0	80	11	11,180	0	13,729

C. FISCAL YEAR 1961 COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM

Prototype reactor	$25,000	$25,000	0	0	0	0	0	0	$25,000
Unsolicited proposals	15,000	15,000	0	0	0	0	0	$15,000	0
Total fiscal year 1961 program	40,000	40,000	0	0	0	0	0	15,000	25,000

D. FISCAL YEAR 1962 COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM

Fiscal year 1962 program	$7,000	$7,000	0	0	0	0	0	0	$7,000
Total	237,613	237,613	$37,604	$47,619	$29,724	$8,258	$22,694	$20,088	71,626
Operating	132,783	137,406	21,835	33,973	19,936	2,072	6,605	20,088	32,897
Construction	104,830	100,207	15,769	13,646	9,788	6,186	16,089	0	38,729

3. Euratom

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$723,871	$2,829,000	$4,000,000
Research and development	722,432	2,600,000	3,646,000
Irradiation services	1,386	58,000	113,000
Related capital equipment	53	171,000	241,000

The research and development portion of the joint United States-Euratom cooperative program is aimed primarily at the improvement in performance of the power reactors to be constructed under the joint program and at lowering fuel cycle costs. The incorporation of such an activity in the joint program has been based on experience within the U.S. Atomic Energy program which has demonstrated repeatedly that major gains can be achieved in improving the performance and in lowering the operating costs of large reactors if an associated research and development program is established. It is believed that such a program will lead to substantial improvements in power levels, and savings in the fuel cycle with a resultant lowering in unit power costs. A vigorous research and development program also is expected to provide further important assurance to the industries involved that costs will decrease with time and experience so as gradually to diminish the necessity for the U.S. Atomic Energy Commission to provide fuel element guaranties as contemplated by section 4 of the Euratom Cooperation Act of 1958 (Public Law 85–846).

The increase estimated in fiscal year 1963 results from research and development activities related to the SENN reactor; initiation of research and development work related to a SENA pressurized water reactor (Franco-Belgium); and initiation of research and development activities connected with a KBWP (West German) organic moderated reactor.

Public Law 85–846 authorized $3 million for research and development for this program. This amount was increased by $7 million in Public Law 86–50. A further increase of $5 million in authorization (making a total of $15 million) is being requested for fiscal year 1963 based upon the following:

(*a*) Currently authorized work will be completed and, in several cases, will be extended in line with the phases of effort essentially as outlined in the proposals received to date.

(*b*) That an invitation will be issued for proposals for research and development specific to the SENN reactor.

(*c*) That acceptable reactor project proposals will be received for the SENA (PWR) and KBWP (organic) projects.

4. Merchant ship reactors, $6,200,000

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(*a*) Water-cooled reactors:			
NS *Savannah*	$5,589,759	$8,831,000	$5,900,000
Water cooled, other	(14,288)	61,000	0
(*b*) General research and development	103,769	450,000	300,000
Total	5,679,240	9,342,000	6,200,000

The objective of the merchant ship program is the development of economically competitive nuclear merchant ships. To attain this goal, the Atomic Energy Commission is cooperating with the Maritime Administration, Department of Commerce, in a joint developmental program which involves the engineering application of technically proven reactor concepts to several types of vessels and a longer range program directed toward the optimum combination of nuclear reactor systems and advanced ship designs. The program also includes various supporting activities aimed at assuring that nuclear merchant ships are freely accepted in unrestricted world commerce with a minimum of restrictions imposed due to the nuclear features of the vessels. In the joint program, the Commission is responsible for the nuclear phases of the projects; the Maritime Administration is responsible for the conventional marine phases of the work.

a. Water-cooled reactors

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Total, NS *Savannah*	$5,589,759	$8,831,000	$5,900,000
Research and development	3,482,224	3,500,000	2,395,000
Fuel fabrication	498,244	75,000	800,000
Operations	1,086,841	4,393,000	2,070,000
Irradiations	93,625	863,000	70,000
Test reactor services	384,270	0	535,000
Related capital equipment	44,555	0	30,000

The fiscal year 1963 estimates provide for a full year of experimental operation involving the conduct of extended sea trials and the demonstration operation of the NS *Savannah* in domestic and foreign runs. Upon completion of these activities by the end of fiscal year 1963, it is then expected that the vessel will be turned over to the Maritime Administration for licensed operation and future funding.

The research and development estimate provides for continuation of ORNL support, including inspection services and operational assistance; continuation of long-term fuel irradiations and examinations at VBWR; NS *Savannah* supporting activities in the form of environmental surveys, safety assessments, safeguards reports and foreign and domestic acceptance, and essential completion of the NS *Savannah* upgrading modifications.

The estimates for operations provide for the conduct of extended sea trials, including demonstration of the vessel in domestic and foreign runs, experimental operation, maintenance, repair, and servicing of the nuclear powerplant, and necessary modifications to the powerplant to incorporate the changes developed under the upgrading program. AEC funding responsibilities concerning the experimental operation, maintenance, repair, and servicing of the nuclear portion of the NS *Savannah* project are covered by the AEC–MA interagency agreement of March 1959. The estimate also includes closeout costs associated with the shipbuilder's startup, tests, and trial activities.

Test reactor experiment costs will continue in fiscal year 1963 in accordance with the long-term irradiation program on core I fuel which is required for this prototype plant. The program provides for proof testing at conditions approximating reactor operation but at concentration levels in excess of those on the NS *Savannah*. The program is expected to continue into fiscal year 1964. Several interim pool examinations and evaluations are scheduled in the program for fiscal year 1963. Also the corrosion and coolant chemistry work will maintain the loop within the specifications for the NS *Savannah* reactor.

Water cooled, other

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	($14,288)	$61,000	----------

The estimates provide for the completion of research and developmental efforts directed toward the improvement of pressurized water reactor plants, with the objective of development of designs having a greater degree of simplicity through the elimination of separately performed functions and their related equipment. The efforts that have thus far been completed are concerned with systems analyses and self-pressurization.

b. General research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Research and development	$103,769	$450,000	$300,000

The first applications of nuclear power to merchant vessels are being directed to larger vessels with higher power ranges, because of the engineering and fabricating problems that have existed in developing compact, high unit power, self-regulating systems. The estimates presented herewith for fiscal year 1962 provide for work done on those applications of nuclear power to maritime usage, such as the use of multiple nuclear powerplants for large and/or fast ships requiring high power and the advantages and costs of evolving a single indirect cycle water reactor plant to ships of high power demands, such as tankers.

Developmental and experimental work being performed by others will involve other promising systems applicable to maritime usage, including work on high power density plants that can meet maritime needs and requirements in such applications as the integrated ship, the rapid loading and unloading container ships, as well as advanced applications of hydrofoil and surface effects vessels. The work proposed in fiscal year 1963 will be directed to conducting systems engineering and analysis of the applicability of these advanced concepts to merchant ships.

5. Army Power Reactors, $11,700,000

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(*a*) Water cooled reactors	$4,981,206	$4,095,000	$3,175,000
(*b*) Gas cooled reactors	7,483,531	6,845,000	5,825,000
(*c*) Military compact reactor	1,191,071	0	2,000,000
(*d*) General research and development	771,622	842,000	700,000
Total	14,427,430	11,782,000	11,700,000

The Army reactors effort will continue in three primary areas of military applications: (1) small, packaged plants for use at remote installations which, because of their relative inaccessibility make the use of nuclear power attractive from the standpoint of economics as well as from the standpoint of simplified logistic support; (2) relatively large plants to supply substantial blocks of power for major military installations which, because of their operational importance, cannot afford any interruption in the supply of fuel for the generation of power; and (3) mobile plants to support directly military operations in the field.

Due to DOD reinstatement of the Army requirement, work is being reinstated on the military compact reactor.

Work will continue on the development, construction, and operation of portable plants aiming at minimum size, weight, cost, and crew size; also, experimentation in the mobile, gas-cooled reactor concept leading to major improvements in operating and performance characteristics, especially in startup, shutdown, and relocation times.

a. Water-cooled reactors

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,981,206	$4,095,000	$3,175,000
(1) Stationary medium power reactor No. 1 (SM–1)	453,835	516,000	400,000
(2) Stationary medium power reactor No. 2 (SM–2)	782,310		
(3) Portable medium powerplant No. 1 (PM–1)	1,584,091	1,479,000	1,175,000
(4) Stationary low powerplant (SL–1)	2,160,970	1,200,000	300,000
(5) Portable low powerplant (PL–2)		500,000	
(6) Antarctic reactor, Byrd (PL–3)		400,000	1,300,000

The water-cooled reactor program will continue to emphasize core development as the key to improving the attractiveness of nuclear power for various military applications. These efforts will be directed at improving the fuel cycle and overall plant performance, through developments leading to reduced core size, increased power per unit of core volume, and extended core life. Replacement pressurized water core improvement programs will continue both for the flat-plate cores of the Army plants and for the tubular element cores of the AF–USN plants.

The SL–1 core was examined and removal accomplished in the latter part of fiscal year 1962 and the detailed laboratory examination and restoration of the site to be completed in early fiscal year 1963.

(1) SM–1 research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$453,835	$516,000	$400,000
Research and development	431,634	346,000	350,000
Test irradiations		78,000	
Test reactor experiment		92,000	50,000
Related capital equipment	22,201		

This program will provide improved replacement cores for the Army SM–1, SM–1A, and PM–2A, through incorporation of successive design improvements into each replacement core. In fiscal year 1962–63, the first step will be taken to incorporate basic SM–2 element design into replacement cores for the SM–1 and SM–1A plants. This new core design will increase core life from 16 MW/years to 28 MW/years. This development is based upon results obtained from minature fuel plates irradiated during fiscal year 1962 and examined in early fiscal year 1963. Actual core procurement will be by DOD funding, using specifications prepared under this AEC program.

(2) SM–2 and NTP

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$782,310	0	0

The SM–2 and nuclear test plant were discontinued in fiscal year 1962 in the absence of firm plans to procure a reactor of this type.

(3) PM–1

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,584,091	$1,479,000	$1,175,000
Research and development	688,821	715,000	575,000
Fuel fabrication	477,660	410,000	
Test operation		177,000	
Test irradiation		1,000	350,000
Test reactor experiment	415,085	59,000	250,000
Related capital equipment	2,525	117,000	

The PM–1 started operation in February 1962 and will be performance tested under AEC cognizance for approximately 6 months. Operational responsibility for the plant will be transferred to the Air Force upon satisfactory completion of the initial test program, but the AEC program for performance evaluation will continue as a part of the PM plant development program.

Within the PM–1 program, metallurgical techniques have been developed which are adaptable to producing highly loaded tubular stainless steel dispersion type elements. Further development of the use of isostatic pressing combined with particle coating is expected to make possible quantity production of elements having the optimum distribution of UO_2 for high irradiation capability.

Starting in fiscal year 1962 and continuing through fiscal year 1963, the development program on two advanced cores, 3A (high power-long life) and 3B (small size) will include the investigation of increased amounts of local boiling, flow redistribution under boiling conditions, critical experiments and nuclear analysis to optimize the fuel and burnable loading, and long-term irradiation tests on fuel and burnable poison elements.

In parallel with the core development program, plant design and development work will proceed, using DOD funds, on high capacity PM plants and smaller P–1 type plants, incorporating features to attain better relocatability, lower capital cost, fewer operators, and increased reliability.

(4) *SL–1*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,160,970	$1,200,000	$300,000
Research and development	900,053		
Fuel fabrication	80,922		
Operations	92,100		
Recovery operations	1,042,972	1,200,000	300,000
Related capital equipment	44,923		

Recovery operations conducted by the General Electric Co. at the site of the SL–1 will be completed in fiscal year 1963, assuming no unusual problems. Core removal was accomplished in the second quarter of fiscal year 1962. Detailed examination of the core, preparation of final reports, and restoration of the site will be completed in early fiscal year 1963.

(5) *Small nuclear powerplant (PL–2)*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	0	$500,000	0
Research and development	0	500,000	0

In fiscal year 1962 primary efforts will be directed toward completion of tests and analyses necessary to confirm the PL–2 design and to bring the design drawings and reports to a point that construction of a plant of this type could be initiated in the future without requiring a preconstruction R. & D. program. Efforts in this direction will include the completion of life tests on the prototype control rod drive mechanisms, hydraulic tests to confirm the present core design; completion of a reference PL–2 refueling system design; drawings of a reactor support structure using lightweight materials; drawings of a reduced size turbine lubricating oil system; analog studies to define transient performance limits of the present plant design; packing and installation plans for the plant; the preparation of the core procurement specifications; and the establishment of expected limits of radioactive waste release with and without special gas-handling equipment.

(6) *Antarctic reactors, Byrd (PL-3)*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total		$400,000	$1,300,000
Research and development		400,000	1,100,000
Fuel fabrication			200,000

The second nuclear powerplant for the Antarctic will be installed by Byrd station in snow tunnels. A contract was awarded in fiscal year 1962 to study various reactor concepts, prepare conceptual designs for several plants for comparative evaluation, and to design, develop, and construct a plant after selection of the preferred concept. Because of the remoteness of the application and since no power testing will be performed prior to shipment, it is expected that the plant will be a limited extrapolation of our present designs with the principal development effort devoted to meeting the requirements of installation and shielding in snow tunnels, the Antarctic air transportability and installation time limitations, etc.

In general, the fiscal year 1962 effort was that associated with the selection of a concept in the initiation of development programs related to the selected concept. The fiscal year 1963 effort will be devoted to completing the development programs, fabrication of the cores, and test of the plant.

(b) GAS-COOLED REACTORS

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$7,483,531	$6,845,000	$5,825,000
(1) Gas-cooled reactor, experimental	1,579,182	1,434,000	1,300,000
(2) Mobile low power (ML-1)	3,737,501	3,198,000	3,500,000
(3) Mobile low power (ML-1A)	245,168	348,000	400,000
(4) Gas cooled, other, Army	1,921,680	1,865,000	625,000

The overall objective of the Army gas-cooled reactor systems program (AGCRSP) is to develop gas-cooled, mobile, nuclear powerplants in the 300- to 1,000-kilowatt (electric) range for military field applications. The immediate objective of the AGCRSP is to provide the DOD with demonstrated plans and specifications for a militarily useful, mobile, gas-cooled nuclear powerplant of 300- to 500-kilowatt (electric) output by January 1, 1963. The ML–1, the prototype of the desired military powerplant achieved criticality in fiscal year 1961 and will be operated at full power initially in late fiscal year 1962. Tests will be conducted on the ML–1 to demonstrate its characteristics and the data resulting from the tests will be factored into the plans and specifications for the military field plant to be designated the ML–1A.

In fiscal year 1963, tests to demonstrate the characteristics of the ML–1 will continue and will include demonstrations of the safety aspects of normal operation, startup and shutdown procedures, relocation of plant to another site within the NRTS as well as procedures associated with actual transporting of the plant from place to place.

(1) Gas-cooled reactor, experimental

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,579,182	$1,434,000	$1,300,000
Research and development	160,399	0	1,300,000
Fuel fabrication	169,550	100,000	0
Test operation	1,226,005	1,224,000	0
Reactor experimental fabrication	23,228	100,000	0
Related capital equipment	0	10,000	0

The GCRE operation was discontinued during fiscal year 1962 as a result of difficulties with the pressure vessel. As a result, design and development of an improved vessel was initiated in fiscal year 1962. Concurrent with this effort work was carried forward on systems analysis for a solid moderated reactor concept which would serve as an advance version of GCRE. In the early part of fiscal year 1963 a selection will be made as to whether installation of an improved pressure vessel or development of an improved GCRE represents the most effective alternative means of utilizing the GCRE facility in support of the AGCRSP.

(2) ML–1

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$3,737,501	$3,198,000	$3,500,000
Research and development	3,014,360	2,034,000	1,885,000
Fuel fabrication	283,602	200,000	485,000
Test operation	439,539	865,000	700,000
Test irradiation			
Related capital equipment		99,000	430,000

The reactor and control cab were delivered to NRTS in fiscal year 1961 and criticality was achieved in March 1961. A power conversion skid will be delivered to NRTS in April 1962, mated to the reactor and full power operation achieved in June 1962. The ML–1 will then be operated through fiscal year 1963 to determine if performance is in accord with design. Any minor deficiencies

which may be revealed during operation and evaluation of this prototype plant and which may prevent the plant from operating in accordance with its design specifications will be corrected. It is essential that these corrections be made as quickly as possible in order that operation of the plant may be continued to demonstrate its desired characteristics. In addition, other areas, where significant improvements to plant operation and performance can be made, will be investigated and modifications made where indicated. Capital equipment funds are required in anticipation of procurement activities resulting from these evaluations of plant test operations.

Safety demonstrations with the ML–1 to be conducted in fiscal year 1963 account for the increase in R. & D. funds required. Safety aspects of normal operation, startups and shutdowns and relocation of the plant will be investigated. All costs are incurred by the Aerojet General Corp.

(3) ML–1A

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$245,168	$348,000	$400,000
Research and development	245,168	348,000	400,000

The purpose of this subactivity is to produce plans and specifications for the fabrication of an ML–1-type mobile nuclear powerplant which may be used by the DOD to purchase field plants. In order to insure that these plans and specifications are demonstrated by operation of the ML–1, the date for submittal of the ML–1A plans is January 1963.

Included in this subtask is the preparation of ML–1A performance specifications, and a maintenance package to include operating and maintenance instructions, parts lists, etc., based on ML–1 operating experience. Aerojet General is engaged in this effort.

(4) Gas cooled reactors—Other—Army

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,921,680	$1,865,000	$625,000
Research and development	534,964	1,195,000	625,000
Fuel fabrication	29,977	----------	----------
Test irradiation	262,897	170,000	----------
Test reactor experiment	1,093,842	500,000	----------

The following is a contractor breakdown of the work to be accomplished in fiscal year 1962–63.

	Fiscal year 1962	Fiscal year 1963
Total	$1,865,000	$625,000
Aerojet-General Corp	1,795,000	565,000
Battelle Memorial Institute (.1)	50,000	50,000
Franklin Institute (transfer to Office of Naval Research) (.1)	20,000	10,000

The portion of the subtask accomplished by Aerojet General Corp. is fuel element development to perform the required R. & D. including in-pile and out-of-pile, capsule and element experiments to develop the basic designs for improved type fuel elements for the AGCRSP. The military characteristics for ML–1A specify a 10,000 hour full power life for the core. The improved fuel element design is designated ML–1–II and is due to be loaded in fiscal year 1964. Research and development funds are required in fiscal year 1963 to evaluate performance of the core including power distribution, flux mapping, checks on orifice calculations, etc.; to complete mechanical testing and orificing of ML–1–II core models; to continue in-pile tests in GETR (the results from which lead 1B–3L

operation by a significant period); and in general to insure that the AGCRSP has a 10,000-hour full-power core.

Materials research, primarily in the area of fuel burnup capability, will continue to be conducted at Battelle Memorial Institute for application to future AGCRSP plants.

Gas-lubricated bearing research being conducted under Office of Naval Research contract will continue to be sponsored in anticipation of future application of AGCRSP plants.

(c) Military Compact Reactor (MCR)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,191,072	0	$2,000,000
Research and development	1,189,019	0	2,000,000
Related capital equipment	2,053	0	0

The phase I (concept evaluation and selection) effort on the military compact reactor was completed in fiscal year 1961. During fiscal year 1962 the Department of Defense evaluated phase I results and reaffirmed the Army's requirement for a mobile nuclear powerplant for use in support of military operations in the field. The liquid metal-cooled powerplant is characterized by a requirement for minimum weight and volume, great reliability, and a high degree of mobility, a 2–3 megawatt electrical power output and the ability to operate under the environmental and operational extremes typical of military campaigns. The conceptual design of such a plant has been completed.

Work in fiscal year 1963 will be devoted to performing detailed studies and experiments in critical areas such as those related to core and fuel development, radiation shiled development, liquid metal coolant system development, hazards analysis, instrumentation and control development. The work scheduled for fiscal year 1963 will permit the rapid development of the prototype by providing data necessary to fix the final design of the plant.

(d) General Research and Development, Army

General development programs will be continued, in fuel element support development at ORNL, in code development, in advanced studies, and in operation of AREA hot cells.

The following is a breakdown of costs for this activity:

General R. & D.—Army

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$771,622	$842,000	$700,000
Research and development	761,416	685,000	340,000
Test operation		105,000	360,000
Test irradiation		15,000	
Related capital equipment	10,206	37,000	

The following is a breakdown by contractor for the period fiscal year 1962–63:

	Fiscal year 1962	Fiscal year 1963
Total	$842,000	$700,000
Oak Ridge National Laboratory:		
Research and development	354,000	300,000
Test irradiation	15,000	
Related capital equipment	37,000	
Total	406,000	300,000
The Martin Co.: Research and development	213,000	0
Phillips Petroleum: Operation of AREA	105,000	360,000
Other contractors, advanced studies: Research and development	118,000	40,000

ORNL has provided continuing support for the Army plants since design and fabrication of the first SM–1 core. ORNL efforts include development of improved UO_2 stainless steel fuels having longer core lives, low cost boron dispersion control rods, and highly stable europium oxide dispersions for control rods. In addition, ORNL performs postirradiation examination of elements removed from Army plants, and assists in the resolution of plant operating problems.

A survey code which includes an automated burnup calculation is to be completed in fiscal year 1962. This code will permit rapid survey calculations to be performed on future Army water cores with a minimum of cost.

In fiscal year 1962 and fiscal year 1963, the AREA hot cells will continue to be operated and to analyze fuel elements and capsules of interest to the Army program and reports of findings will be prepared. In late fiscal year 1962 or early fiscal year 1963, utilization of the facilities will increase primarily due to the initiation of ML–1 core II fuel element examinations.

Advanced studies initiated in the latter part of fiscal year 1962 will include preliminary design studies of a capsulized secondary system using a high speed turbine as well as investigations of the applicability of thermionic systems for military purposes. This work will continue into fiscal year 1963.

6. Naval propulsion reactors, $99,300,000

The objective of the naval reactors program is the development of naval nuclear propulsion plants and reactor cores in a wide range of power ratings to meet military requirements specified by the Department of Defense. The pressurized water nuclear propulsion plants and cores under development by the Atomic Energy Commission are suitable for installation in Navy ships ranging from small submarines to large combatant surface ships. Emphasis continues on the research, development, and design of pressurized water reactor cores of higher power density and longer life. Test operation and evaluation of naval reactor prototype plants and cores and improvement of naval nuclear propulsion systems, components, materials, and operating techniques will continue. Development and construction of a natural circulation reactor prototype plant and work on a single reactor destroyer nuclear propulsion plant is underway.

7. Rocket propulsion reactors, $74,800,000

The objective of the rocket propulsion reactor program is to develop in cooperation with the National Aeronautical and Space Administration a safe and reliable nuclear rocket engine for flight application in the national space program, and also to develop nuclear technology for advanced rocket propulsion systems.

The fiscal year 1963 program will continue the research and development effort and provide for the fabrication of a series of experimental reactors for test at the Nevada Test Site, including the fabrication of reactors for integration with a nuclear rocket engine propulsion system, to demonstrate feasibility of a flight system.

8. Missile propulsion reactors, $29,000,000

The objective of the missile propulsion reactors program (Project PLUTO) has been expanded from the feasibility demonstration to include the development of nuclear reactors for application to ramjet systems.

The fiscal year 1963 program will continue the research and development and test effort, initiate the fabrication of a reactor for ground testing, and provide for development leading to reactor improvements and the investigation of advanced concepts and configurations.

9. Satellite and small power sources, $76,468,000

Summary	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Radioisotope power units	$2,693,591	$4,560,000	$3,227,000
2. Space reactor power units	15,754,162	31,994,000	44,824,000
3. Advanced space power systems	3,860,988	17,501,000	28,417,000
Total	22,308,741	54,055,000	76,468,000

The satellite and small power sources program has as its objective the development of long-lived, lightweight, compact nuclear-electric power sources for space vehicles and other specialized applications. In recognition of the electrical power needs for these applications, and the long leadtime associated with providing systems of high reliability and endurance, the AEC initiated the systems for nuclear auxiliary power (SNAP) development program in 1955. The scope of the early program has since been expanded in concurrence with increasing DOD, NASA, and other governmental agency requirements, and with the President's communication satellite policy.

The SNAP program has three major divisions: (1) The radioisotope program which develops small power sources in the low power ranges utilizing encapsulated isotopes as the heat source; and (2) the space reactor program which develops compact power sources, utilizing a reactor as the heat source; and (3) the advanced space power systems directed at the development of high power for large space systems. Each of these programs is discussed by subactivity below.

1. Radioisotope Power Units

(a) *SNAP 7 A and B*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,693,591	$4,560,000	$3,227,000
(a) SNAP 7 A and B	665,468	634,000	750,000
Research and development	519,996	22,000	0
Fuel fabrication	0	472,000	650,000
Test operations	0	30,000	65,000
Device fabrication	40,000	96,000	35,000
Related capital equipment	105,472	14,000	0

During fiscal year 1962, a 5-watt unit was delivered to the Coast Guard, and the development of a 30-watt unit progressed. This unit will be completed, fueled, acceptance tested, and delivered to the Coast Guard during the first quarter of fiscal year 1963. The units will be used for floating and shore-based navigation lights.

(b) *SNAP 7 C and D*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$515,768	$1,360,000	0
Research and development	384,285	23,000	0
Fuel fabrication	0	1,212,000	0
Test operations	0	30,000	0
Device fabrication	50,983	95,000	0
Related capital equipment	80,500	0	0

During fiscal year 1962, a 5-watt and 30-watt unit will be delivered to the Navy, thus completing this development program. These units will be used for an Antarctic land-based weather station and a boat-type automatic weather station.

(c) *SNAP 9 (transit)*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$95,786	$763,000	$200,000
Research and development	2,245	100,000	0
Fuel fabrication	20,264	279,000	110,000
Test operations	0	20,000	60,000
Device fabrication	73,277	364,000	30,000

During fiscal year 1962, the development of this unit for the Navy progressed toward completion. This unit will be completed, fueled, acceptance tested, and delivered to the Navy during fiscal year 1963. It will be used in the TRANSIT satellite program.

(d) SNAP 11 (Surveyor)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	0	$325,000	$410,000
Research and development	0	210,000	40,000
Fuel fabrication	0	0	60,000
Test operations	0	20,000	30,000
Device fabrication	0	95,000	280,000
Test irradiation	0	0	0
Test reactor experiment	0	0	0

The feasibility study of Surveyor (lunar soft landing) was completed during fiscal year 1961. The tentative delivery schedule requires two units in time for flight early in calendar year 1964. Research and initial fabrication and testing of units will begin in fiscal year 1962. In fiscal year 1963, system fabrication will be essentially completed.

(e) SNAP 7E

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	0	$240,000	0
Research and development	0	20,000	0
Fuel fabrication	0	188,000	0
Test operations	0	3,000	0
Device fabrication	0	29,000	0

The Department of the Navy has requested the development of a 5-watt thermoelectric unit for underwater application. This requirement is being met by modifying a SNAP 7C-type generator. The delivery of this unit to the Navy is scheduled for the end of fiscal year 1962.

(f) SNAP 13

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	0	$318,000	$300,000
Research and development	0	318,000	100,000
Fuel fabrication	0	0	80,000
Test operations	0	0	90,000
Device fabrication	0	0	30,000

SNAP 13 is a low-power cesium vapor thermionic unit being developed to test the feasibility of using a radioisotope heat source in such an energy conversion device. The thermionic conversion principle holds promise of higher efficiencies, lower weight, and smaller size than thermoelectric generators. This generator will be designed at a power range which is useful for many space applications. Tests will be conducted on an electrically heated unit in fiscal year 1962. A generator will be completed and possibly fueled in fiscal year 1963. Work on an improved thermionic unit will begin in fiscal year 1963.

(g) General research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,416,569	$920,000	$1,567,000
Research and development	1,152,658	907,000	1,539,000
Fuel fabrication	86,600	0	0
Test operations	170,249	0	0
Test irradiations	0	0	18,000
Test reactor experiment	4,042	13,000	10,000
Related capital equipment	3,020	0	0

This area covers the research and development activities that provide the radioisotope technology upon which is based the program for the development of devices to meet the special requirements of other agencies. This effort is comprised of power system technology, thermoelectric system development, and thermionic system development. Power system technology involves the improvement of materials and techniques; explosion and impact tests and related studies to establish safety criteria; conduct of power flattening studies to perfect technology to extend the useful life of power units fueled with short half-life fuels. Thermoelectric system development involves the investigation of high temperature materials; the development of a unit utilizing inexpensive mixed fission products; the development of a cerium 144 underwater unit; the development of a refuelable generator concept; test evaluation of a chemical fuel cell using a radioisotope regenerator medium; and the development of a unit to demonstrate the advanced thermal barrier concept. The thermionic system development involves studies of a vacuum, cesium or barium diode thermionic unit which is expected to lead to the development of a multicell generator. This development will significantly increase the power level potential of radioisotope fueled units.

This distribution of funds to the areas discussed above is as follows:

	Fiscal year 1962	Fiscal year 1963
Power flattening studies	$30,000	$49,000
Safety program	255,000	75,000
Regenerative fuel cell	0	225,000
Thermoelectric system development	527,000	740,000
Thermionic system development	95,000	450,000
Irradiation units and test reactor experiment	13,000	28,000
Total, general research and development	920,000	1,567,000

2. Space Reactor Power Units

(a) SNAP 2

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$15,754,162	$31,994,000	$44,824,000
(a) SNAP 2	10,032,767	14,367,000	17,400,000
Research and development	6,973,704	9,185,000	11,465,000
Fuel fabrication	680,027	596,000	804,000
Test operations	580,949	907,000	1,072,000
Reactor fabrication	768,551	2,482,000	3,089,000
Test irradiation	3,216	15,000	2,000
Test reactor experiment	0	47,000	51,000
Related capital equipment	1,026,320	1,135,000	917,000

SNAP 2 is a 3-electric-kilowatt auxiliary power system, comprising a reactor, heat exchanger, and mercury vapor turboelectric conversion system. This system is being developed for Air Force space applications with the first developmental flight test to be conducted in the joint AEC/Air Force SNAPSHOT program. The total system weight including radiator is approximately 1,050 pounds (unshielded) for the SNAPSHOT flights and is designed for orbital startup and a 1-year unattended operation in space. The shield necessary for electronic equipment will weigh approximately 300 pounds. Conceptual design of the system was initiated in fiscal year 1957. The subsequent development has progressed to the stage where the developmental reactor and certain nonnuclear package systems began tests in fiscal year 1962. These tests will continue into fiscal year 1963, and fabrication will be completed and test initiated on a package system to demonstrate orbital startup. The developmental reactor test will be completed, and fabrication of the first flight reactor will be initiated.

The subsystems development effort requires an increase in fiscal year 1963 largely in the component development area, related primarily to the development and test of the power conversion system incorporating an improved contained rotary unit design. Considerable development also remains to be accomplished to effect weight and performance improvement. Reactor and shield analysis will be completed based on the developmental reactor test. A complete analysis of the safety problem as related to the flight test objectives will be necessary. Improvement of fuel element quality control procedures is necessary, and post irradiation analyses of developmental reactor fuel elements will be performed. Flight system design will be essentially completed. Environmental tests of package system mockups will be accomplished. The flight test shield will be designed and tested, as will the flight control system and required telemetry equipment. Fabrication and testing will increase in fiscal year 1963 as emphasis will be placed on the fabrication and testing of development systems hardware required for the package system mockups. The major areas of effort are as follows:

	Fiscal year 1962	Fiscal year 1963
Engineering and analysis	$809,000	$1,489,000
Subsystem development	4,912,000	7,754,000
Reactor development	4,628,000	3,350,000
System development and qualifications	2,883,000	3,742,000
Delivery systems	0	92,000
Flight test support	0	56,000
Related capital equipment	1,135,000	917,000
Total, SNAP 2	14,367,000	17,400,000

(b) SNAP 4

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$434,084	$1,000,000	$800,000
Research and development	400,813	902,000	600,000
Fuel fabrication	0	0	0
Test operation	0	0	0
Reactor fabrication	0	0	0
Test irradiations	10,328	0	50,000
Test reactor experiment	9	14,000	50,000
Related capital equipment	22,934	84,000	100,000

In 1959, the Navy placed a requirement with the AEC to conduct a program of component development and evaluation of a nuclear powerplant in the 1 to 4 megawatt range for a specialized Navy application. Design and parameters studies and component evaluation were conducted during fiscal year 1961, and preliminary component development and a critical experiment will be conducted during fiscal year 1962. During fiscal year 1963 the program will include the development of components, and reactor analysis, including in-pile experiments and postirradiation analysis.

(c) *SNAP 8*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,412,735	$5,205,000	$8,800,000
Research and development	957,462	2,446,000	3,200,000
Fuel fabrication	34,945	867,000	1,100,000
Test operations	0	309,000	2,200,000
Reactor fabrications	331,145	1,031,000	1,500,000
Test irradiations	15	15,000	0
Test reactor experiment	1,316	54,000	0
Related capital equipment	87,852	483,000	800,000

The SNAP 8 program is based on the NASA requirement for a 30- to 60-kilowatt electric nuclear auxiliary power system for use in the NASA space program. NASA is carrying out the program development of the power conversion system under a separate contract, to be integrated with the reactor under development by the Commission. The SNAP 8 reactor will produce 600-kilowatt thermal. The SNAP 8 experimental reactor (S8ER) will attain criticality in fiscal year 1962.

The development of the SNAP 8 auxiliary power system for NASA is directed at delivery of flight reactors in early calendar year 1965.

The fiscal year 1963 increase is in the area of systems engineering and component development. The emphasis in each of these areas in fiscal year 1963 will shift from the ground prototype reactor to the flight prototype reactor which is scheduled for nuclear testing in mid-calendar year 1964. The fuel element development will be emphasized to permit completion of the development of a flight qualified core in fiscal year 1963, as will the shield and control assembly. Because of the tight schedule for delivery of a flight qualified system, component testing and evaluation must be emphasized to assure reliability in the flight test program. A significant portion of the fiscal year 1963 increase is for the fabrication and testing of development and qualification systems.

An equipment increase is required related to fabrication and assembly of the flight qualified system.

The major areas of effort are as follows:

	Fiscal year 1962	Fiscal year 1963
Engineering and analysis	703,000	1,000,000
Subsystem development	1,790,000	2,200,000
System development and qualification	2,229,000	4,800,000
Flight test support	0	0
Related capital equipment	483,000	800,000
Total SNAP 8	5,205,000	8,800,000

(d) *SNAP 10–A*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,083,052	$9,647,000	$16,700,000
Research and development	1,690,017	4,998,000	6,509,000
Fuel fabrication	92,466	700,000	429,000
Test operation	0	938,000	2,706,000
Reactor fabrication	139,371	2,516,000	5,208,000
Related capital equipment	161,198	495,000	1,848,000

SNAP 10–A is a 500-watt electric auxilliary power system utilizing a reactor, an electromagnetic pump, and conversion elements. There are no moving parts. The total system weight is 550 pounds (unshielded), and the shield required for the electronic equipment will weigh approximately 200 pounds. The unit is designed for orbital startup and a 1-year unattended operation for space application. This system is being developed for the joint AEC–Air Force SNAPSHOT program. Conceptual design and development was accomplished in fiscal years

1960 and 1961 which has led to the fabrication and test of a prototype system in fiscal year 1962, and the development and test of flight systems in fiscal year 1962–63.

Effort in fiscal year 1963 will increase primarily due to the fabrication and qualification testing of developmental systems and for flight systems for delivery to the Air Force. An equipment increase is required related to the fabrication assembly of the systems, and for ground handling equipment for the delivery system. Liaison and reactor safety related to the flight test is intensified. Component development will continue with emphasis on the power conversion subsystem development required to complete the final operational design. The major areas of effort are as follows:

	Fiscal year 1962	Fiscal year 1963
Engineering and analysis	$1,066,000	$1,069,000
Subsystem development	3,422,000	1,889,000
Reactor development	1,721,000	2,205,000
System development and qualification	1,905,000	2,813,000
Delivery systems	949,000	5,963,000
Flight test support	89,000	913,000
Related capital equipment	495,000	1,848,000
Total	9,647,000	16,700,000

(e) General research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,791,524	$1,775,000	$1,124,000
Research and development	1,423,943	1,522,000	563,000
Test irradiations	0	0	96,000
Test reactor experiment	0	76,000	135,000
Related capital equipment	367,581	177,000	330,000

This effort is conducted to produce basic technical information applicable to SNAP reactor projects. This work includes basic analysis and experimentation, fuel and material development, and safety studies. Beginning in fiscal year 1962 and continuing in fiscal year 1963, effort will be emphasized in the areas of in-pile irradiation of materials, component design, and shielding materials analyses, as well as the investigation of selected fuel and materials at higher temperatures.

Equipment increase is required related to development of flight temperature fuels and materials.

3. Advanced space power systems

Fiscal year 1961	$3,860,988
Fiscal year 1962	17,501,000
Fiscal year 1963	28,417,000

This program has been initiated in conformance with the President's policy statement concerning communication satellites. It will be directed at the development of high power nuclear auxiliary power systems which can provide the high levels of electric power required for large communication systems, as well as for reconnaissance systems and large space probes.

10. General Reactor Technology, $60,000,000

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Applied and reactor physics development	7,525,442	7,460,000	7,780,000
(b) Reactor fuels and materials development	17,849,351	26,598,000	27,110,000
(c) Reactor components development	2,510,938	3,487,000	4,500,000
(d) Chemical separations	6,424,014	7,390,000	8,620,000
(e) Waste processing development	2,263,927	1,710,000	1,460,000
(f) Thorium utilization	0	2,375,000	2,300,000
(g) Plutonium utilization	8,541,097	9,267,000	8,230,000
Total	45,114,769	58,287,000	60,000,000

The general reactor technology program includes three areas of research and development which apply to long-range civilian, military, and space reactor problems and problems that are common to a variety of reactor concepts and thus not suitable for support under the specific projects. These areas are: (1) A program in reactor physics, (2) a program of fuels and materials development directed toward improving the performance of reactor fuels and toward obtaining a better fundamental understanding of reactor materials, and (3) an engineering and development program directed toward the solution of fundamental engineering problems such as heat transfer, applicable to all reactor concepts and to the development of components generally useful in power reactors. In addition to these three programs applied directly to reactor design, there are four other programs within the general reactor technology effort: The program in chemical separations is directed toward reduction of this item in the fuel cycle cost for power reactors and to the development of methods for processing new fuel types. The waste processing program is directed to pilot plant studies of waste calcination processes and development of techniques for handling pyro-process equipment waste associated with metal solvent systems. The thorium utilization program is directed to optimizing the use of this element for the production of U^{233}. The plutonium utilization program is directed to optimizing the use of Pu as a reactor fuel. These latter two programs have been recently transferred from the civilian power category. The general objectives of general reactor technology programs are to provide basic data on reactor systems and related problems, to carry out engineering development of a general and fundamental nature, and to investigate the feasibility and potential of new methods for improving reactors and associated nuclear devices.

Most of the activities performed in general reactor technology are unique in that they are not being carried out elsewhere, and represent areas that are frequently major technical obstacles in the way of further progress in reactor and related nuclear technological advancement.

(a) Applied and reactor physics

Fiscal year 1961	$7, 525, 442
Fiscal year 1962	7, 460, 000
Fiscal year 1963	7, 780, 000

This activity includes continued research on a number of separate but related major research areas discussed individually below. The subprograms represent the integrated effort necessary to obtain fundamental reactor physics information not logically or efficiently obtained under any one project but nonetheless required for reactor technological advancement. Elements of cost under this activity are as follows:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$7, 525, 442	$7, 460, 000	$7, 780, 000
Research and development	6, 435, 989	6, 613, 000	6, 754, 000
Irradiations	204, 129	379, 000	350, 000
Test reactor services	0	0	44, 000
Related capital equipment	885, 324	468, 000	632, 000

The subprograms provided for under this heading are:

(1) Reactor physics:

Fiscal year 1962	$4, 750, 000
Fiscal year 1963	5, 084, 000

Provided here are studies on basic combinations of reactor materials in the form of exponentials, subcriticals, and critical assemblies to determine reactor system behavior with regard to conversion coefficients, reactivity life, effects of enrichment, effects of changes in neutron spectra, etc., as well as general correlations of experiments with theory. Also included are investigations aimed at the accurate measurement of constants fundamental to reactor design such as neutron ages, resonance integrals, and the number of neutrons produced per fission. Data developed under this program permits the designers of specific reactors to obtain higher power output cores, longer reactivity life, and greater safety. It increases understanding of existing systems and permits the optimization of future systems more economically and with greater confidence.

The increase in fiscal year 1963 is principally for fuel and staffing for a high conversion critical experiment at the Argonne National Laboratory.

(2) Neutron physics:

Fiscal year 1962	$1,315,000
Fiscal year 1963	1,541,000

Provided here are investigations designed to yield data on the fission process and the interaction of neutrons with matter. The program provided herein is coordinated with the national effort through the Neutron Cross Section Advisory Group. It differs from other programs primarily in the emphasis on measuring cross sections in detail sufficient for reactor design applications as opposed to the majority of U.S. cross-section efforts that emphasize the study of nuclear forces, nuclear structure, and the development or confirmation of nuclear models. This is a relatively stable effort. The increase from fiscal year 1962 to fiscal year 1963 reflects the utilization of the recently completed Rensselaer Polytechnic Institute accelerator.

(3) Radiation effects:

Fiscal year 1962	$790,000
Fiscal year 1963	450,000

Exposure to radiation environment has a variety of effects on the various materials used in reactors. These funds are for research to analyze and explain radiation damage to reactor materials, such as metals, alloys, and ceramics. The research work is to determine physical property changes in materials subjected to nuclear radiation. Included also is the development of techniques and instruments for conducting such research.

The decrease reflects termination of studies on radiation effects on organics and graphite.

(4) Shielding:

Fiscal year 1962	$467,000
Fiscal year 1963	460,000

This program is concerned with basic shielding studies directed to the advancement of shielding technology of value to a wide variety of shielding requirements. Included are generalized studies of radiation penetration through ducts, investigation of optimization methods to minimize weight, generation of both microscopic and integral type handbook data, and the evaluation of calculational methods and codes for the determination of shield effectiveness.

(5) Data centers:

Fiscal year 1962	$138,000
Fiscal year 1963	245,000

This program provides for two centers. The Reactor Physics Constant Center at ANL is responsible for the compilation, evaluation, and publication of nuclear data, formulas, reactor constants, etc., exclusive of microscopic reactor cross sections. Reactor cross sections are evaluated and published by the Brookhaven National Laboratory's Reactor Cross Section Evaluation Center.

The increase in fiscal year 1963 is identified with the cyclic requirements for revision and updating of the "Reactor Physics Constant Handbook" for publication.

(b) Reactor fuels and materials development

Fiscal year 1961	$17,849,351
Fiscal year 1962	26,598,000
Fiscal year 1963	27,110,000

This activity is comprised of two subactivities: (1) High temperature materials research and development, and (2) general reactor fuels and materials development.

(1) High temperature materials

	Fiscal year 1962	Fiscal year 1963
Total	$8,876,000	$7,746,000
Research and development	6,724,000	6,625,000
Irradiations	1,882,000	1,094,000
Test reactor services	188,000	
Related capital equipment	82,000	27,000

Subsequent to the termination of the ANP program on March 30, 1961, a technical team from the Atomic Energy Commission reviewed research in progress at Pratt & Whitney Aircraft—CANEL, General Electric—Evandale, and Oak Ridge National Laboratory, with the intent of utilizing uniquely competent manpower, facilities and equipment on advanced high temperature materials research. Evolving from this review, a research and development program on nuclear materials, directed toward their use at high temperatures, has been undertaken at these organizations. Areas of research include basic and engineering investigations on ceramic and metallic nuclear fuel, development of protective coatings for use in high temperature corrosive environments, containment of molten metals at elevated temperatures, and studies of the effects of radiation on properties of metals and alloys at high temperatures. Such research is of prime importance to the success of advanced civilian, military, and space reactors.

The level of research and development effort at Pratt & Whitney is $950,000 and includes studies on high strength structural alloys, oxidation resistant systems, preparation and properties of UC, physical properties of liquid metals, and irradiation of ceramic fuels.

The level of research and development for General Electric of $4,500,000 includes studies on such projects as fuels in nonoxidizing atmospheres, ceramic fuel elements, UO_2 stabilization, fission product migration, coated particles, direct conversion materials, and BeO irradiation.

The ORNL budget of $1,175,000 includes studies on effects of radiation on physical properties of alloys, high temperature hardware materials, corrosion resistance and stability of high temperature materials, and high temperature bearing materials.

(*2*) *Reactor fuels and materials—other*

	Fiscal year 1962	Fiscal year 1963
Total	$17,722,000	$19,364,000
Research and development	15,429,000	16,439,000
Irradiation services	1,405,000	2,030,000
Test reactor services	110,000	
Related capital equipment	777,000	895,000

Objectives of investigations performed under this activity are:

(*a*) Assistance toward realization of economic nuclear power by more efficient utilization of fissionable and fertile materials in reactor cores; both military and civilian;

(*b*) Obtaining fundamental and design information of nuclear fuels and materials;

(*c*) Selection and evaluation of potential new reactor materials as to feasibility, application and production.

Research necessary to meet the first objective requires intensive efforts to increase reactor core life, burnup, stability to radiation, to reduce fuel fabrication costs, and to ensure high temperature operation of fuel assemblies. To implement the second objective requires operational data over a broad range of temperature, environment, stress, and radiation fields. The third objective necessitates studies on materials now considered exotic or scarce, such as rare earth metals, complicated refractory alloy, ceramics, and cermets. Methods of production fabrication, testing, and utilization must be established on new materials which possess potential reactor worth.

While much has been accomplished in the past, effort in this area must continue at a relatively high level in order that significant improvements are realized in terms of (*a*) use of plutonium, U^{233} and other materials including the rare earths; (*b*) achievement of higher power and longer lived fuels and fuel elements; (*c*) greater stability of materials under conditions of irradiation and high temperature; (*d*) nondestructive testing; and (*e*) fabrication techniques which are simplified and at the same time result in higher quality product.

(*a*) Fuels:

Fiscal year 1962	$8,880,000
Fiscal year 1963	9,960,000

Fuels research can be divided into two categories, metallic fuels and ceramic fuels. Metallic fuels include pure uranium and plutonium and alloys of these metals having improved properties. In this program are studies to understand the influence of structure and fabrication history on radiation stability and reactor lifetime and to obtain physical and mechanical data necessary to reactor designers. Alloys are prepared and evaluated in order to improve resistance to corrosion by coolants (i.e., water, liquid metals, gases, etc.) and to reduce radiation induced swelling.

Certain ceramic fuels such as UO_2 possess excellent resistance to corrosion by reactor coolants and are more resistant to swelling on irradiation than metal fuels. However, with the exception of the carbides, they have low thermal conductivity and are brittle. Research on ceramic fuels strives to improve the performance in a nuclear reactor.

In this program improvements are sought through variations in materials preparation techniques or development of ceramics of different elemental composition.

The increase in fiscal year 1963 reflects expansion of study and development of thermionic fuels of the mixed carbide type in solid solution for application in potential SNAP systems; testing and evaluation of high heat output fuel core elements including a number of experimental elements and increased development of specific fuels and fuel systems.

(*b*) Cladding and container materials:

Fiscal year 1962	$3, 235, 000
Fiscal year 1963	2, 500, 000

Materials used for cladding purposes must be compatible with the fuel material, they must have adequate strength at operating temperatures and must be compatible with the reactor collant. They must also be resistant to radiation damage and should have a low cross section for neutrons in the spectrum encountered. Materials for structural applications should have adequate strength at operating conditions, be compatible with the reactor environment and resistant to radiation damage.

The program on cladding and container materials is devoted mainly to improve the properties of candidate metals or alloys, evaluation of environmental effects, and to characterization of elevated temperature properties.

Included are investigation of materials for the containment of boiling mercury at 1,400°F and of boiling sodium at 2,400° F; studies on the development and testing of better alloys for cladding nuclear fuel for operation above 1,000° F; and selection and testing of containment materials for boiling potassium systems in nuclear powered space systems.

(*c*) Fabrication techniques:

Fiscal year 1962	$360, 000
Fiscal year 1963	600, 000

Fuel element fabrication can be considered to involve all the steps between chemical processing and the production of assemblies ready to be placed in reactors. It is particularly unique in comparison with other fabrication processes in two regards. First, it is mandatory that all elements fabricated meet stringent requirements on quality and dimensions to avoid possible in-reactor failure. Second, the use of recycle fuel or plutonium requires adaptability to remote or glove box operation.

It is highly desirable that fabrication costs of fuel elements be reduced, since such a reduction could have an appreciable effect on the overall fuel cycle cost. The programs under this subactivity are intended to devise processes and techniques leading to such reductions.

The increase is attributable to establishment of an engineering metallurgy group in a national laboratory to investigate the basic parameters controlling metal forming; and, studies of fabrication techniques for plutonium alloys to improve quality of plutonium fuels.

(*d*) Irradiation techniques:

Fiscal year 1962	$1, 980, 000
Fiscal year 1963	3, 300, 000

Design of reactor cores and components requires a sound understanding of exposure to the neutron and gamma fluxes on material properties. It can never be safely assumed that pre- and post-irradiation examination will give an adequate determination of what took place during the exposure. This requires that com-

plex and expensive capsules must be devised to obtain data while the material is being irradiated.

Programs conducted under this activity reflect a net increase entirely represented by a program necessary to determine the safety of reactor pressure vessels and core structures and a radiation damage investigation of reactor structural materials covering a systematic and comprehensive investigation of the effects of irradiation on completely characterized materials under known conditions of temperature, flux, and environment.

(*e*) Physical and mechanical properties:

Fiscal year 1962	$1, 115, 000
Fiscal year 1963	1, 100, 000

Beside the normal development work on fuels and materials, it is necessary to conduct a certain amount of research on more general topics. An example is the study of mechanical metallurgy or determination of properties of materials at temperature levels above those studied previously.

Such research providing a sound base for the more specific research on reactor fuels and materials is continuing at essentially the fiscal year 1962 level.

(*f*) Control materials:

Fiscal year 1962	$998, 000
Fiscal year 1963	350, 000

Control rods contain elements of strong neutron absorption ability. They are used to regulate the flux distribution within the reactor core and thus the power output. The requirements for a good control-rod material are as follows:

(1) High neutron absorption characteristics.
(2) Maximum burnup of the high cross section elements and all high cross section daughter products.
(3) Resistance to radiation damage.
(4) Good strength at operating temperatures.
(5) Good corrosion resistance.
(6) Low cost.

These requirements cannot all be met by any one material for all operating conditions. It is therefore necessary that for each condition, a balance be made to determine the material that is most desirable.

The objective of this program is to provide the reactor design engineer with improved methods for the neutronic design of the power reactor control system, with better means of selecting suitable materials for the control system, and with new possible control materials.

The decrease is attributable to completion of a control-rod materials research and development project.

(*g*) Moderators:

Fiscal year 1962	$595, 000
Fiscal year 1963	974, 000

Moderator materials serve to slow down neutrons from the energy of production during fission to the energy at which they react with the fuel to produce additional fissions. This slowing down must take place with little absorption of the neutrons by the moderator. The requirements of a good moderator are as follows:

(1) Large moderation ratio (a measure of the ability to slow down the neutrons effectively with little absorption).
(2) Good mechanical properties at operating conditions.
(3) Good corrosion resistance.
(4) High density of moderating atoms.
(5) Good thermal and radiation stability.

Among the most effective moderator materials are ordinary water, heavy water, beryllium, beryllium oxide, and graphite. Certain metal hydrides are very attractive for use in compact nuclear reactor cores.

The primary problems in use of the solid moderators are fabrication and evaluation of properties. It is in these two areas that effort has been centered, primarily on graphite and on the zirconium-hydrogen system.

The fiscal year 1963 increase reflects expansion of studies of beryllium oxide moderator utilization.

(*h*) Nondestructive testing:

Fiscal year 1962	$559, 000
Fiscal year 1963	580, 000

The value of nondestructive testing of fuel element and reactor fabrication is obvious. Considering the great cost involved and the critical need for high-quality components, advances made in nondestructive testing can have a profound influence on both cost and quality of the finished products. Nondestructive testing is particularly valuable in applications involving radioactive materials, since the techniques devised are amenable to remote handling.

The stringent inservice integrity requirements for nuclear components, particularly reactor fuels, demand sensitive, discriminating, and reliable methods for preirradiation nondestructive testing. Advances at Hanford have been achieved in several phases of the basic studies and development on new and advanced techniques of testing.

Improved methods for testing thin-metal sections for thickness, defects, and surface bonding are resulting from some new ultrasonic test methods. They are based on previously unexploited types of vibrations which are described theoretically as lamb waves.

New methods of broadband electromagnetic testing which have been developed analytically are being experimentally verified. These promise to surpass conventional electromagnetic or eddy current methods in the ability to detect small defect indications and to resolve multivariable test problems.

Nondestructive testing automation and quantitative data readout methods previously developed under this program have been successfully applied to a large-scale reactor fuels fabrication operation.

(c) Reactor components development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,510,938	$3,487,000	$4,500,000
Research and development	2,431,950	3,342,000	4,266,000
Irradiation services	1,000	4,000	6,000
Related capital equipment	77,988	141,000	228,000

The purposes of work program performed under this activity are to develop fundamental information and equipment which will permit the building of reactors having higher power density, more effective means of operation and control, greater reliability, and ultimately, lower costs. In addition, research and development activities involving a wide variety of military and space nuclear devices are performed. This program falls into four related but separately identifiable areas as follows:

(1) Heat transfer, fluid mechanics, and coolant technology:

Fiscal year 1962	$2,007,000
Fiscal year 1963	2,685,000

The nature of the work underway and proposed ranges from general investigation of heat transfer phenomena and coolant behavior as applied to reactor engineering to fairly specific items of hardware and component development for both subcooled and boiling regimes for water and liquid metals, and high-temperature gas coolants. All of this effort is aimed at achieving greater performance (high power densities, thermal, efficiences, etc.) in reactor systems through improved utilization of generated heat and/or through improvements in our ability to operate systems at temperatures and heat fluxes which are considerably higher than those in use at the present time.

The increase in fiscal year 1963 results from:

(*a*) Assumption of several projects in this program funded in fiscal year 1962 under the SNAP program. These projects include the determination of heat transfer, erosion, corrosion, and thermal and transport properties of boiling rubidium and cesium; and the effects of high gravity flow (vortex flow) on the heat transfer and fluid dynamics characteristics of boiling potassium and mercury.

(*b*) Increased effort in the National Laboratories on boiling liquid metal heat transfer studies and two-phase flow hydraulic instability studies.

(*c*) Initiation of additional development work in the gas-suspension program in order to have a gas-suspension coolant ready for utilization in an experimental reactor (GCRE) in late fiscal year 1964, since the reactor will be available at that time.

(2) Instrumentation and control:

Fiscal year 1962	$840, 000
Fiscal year 1963	840, 000

This area of investigation includes: (1) the development of improved and more reliable instrumentation and control systems utilizing the latest developments in electronics, solid-state devices, and computer techniques, with emphasis on basically improved and new instruments for whole classes of reactor rather than engineering modifications suitable only for a single reactor; (2) investigation of new nondestructive fuel-burnup measurement methods for optimizing fuel cycles in reactor cores; (3) demonstration of feasibility of new and simplified hydraulic and other control-rod-drive mechanisms; and (4) development of techniques and equipment for remotely inspecting and testing radioactive reactor system components.

In fiscal year 1963 emphasis will be given to:

(*a*) Development of experimental methods for making nondestructive measurements of fuel burnup in reactor fuel elements.

(*b*) Development of methods and instruments for making shutdown reactivity measurements in reactors.

(3) Remotely operated equipment:

Fiscal year 1962	$490, 000
Fiscal year 1963	755, 000

Provided for here is the development of advanced viewing systems, special manipulators, and remotely operated machines for (1) handling, storing, and processing of radioactive materials and fuel elements; and (2) performing reactor and nuclear chemical plant postaccident rescue and salvage operations. With increasing emphasis being placed on recycled fuels, investigations of highly irradiated materials, and "closed cycle" operation of reactor and processing facilities, it is necessary to develop new types of equipment and systems capable of effectively operating in highly radioactive environments.

(*a*) *Cobalt 60 irradiation facility.*—The major portion of the increase shown reflects the planned fabrication and operation of a cobalt 60 irradiation facility for measuring visible light transmission of viewing window glasses under conditions of controlled radiation level, temperature and illumination. Other new work includes direction-synchronized remote viewing equipment and development of programed manipulator arms for automatic routine operations.

(*b*) *Rescue and salvage equipment.*—The SL–1 accident emphasizes the need to develop special equipment to facilitate rescue and salvage operations in contaminated areas following reactor and nuclear chemical plant accidents. It is planned to initiate work in fiscal year 1963 leading to mobile equipment transportable by air, land, or water to accident sites.

(4) Advanced component development:

Fiscal year 1962	$150, 000
Fiscal year 1963	220, 000

This program provides for the development of various components for general high-temperature reactor utilization. The objective is to provide feasible design concepts of components for future high-temperature reactor projects, thus alleviating the necessity for crash programs at a later date under individual projects to develop necessary primary loop components.

This subactivity consists of continuing projects at Battelle to study lubrication and wear characteristics of sliding surfaces of equipment immersed in molten sodium and other metals; and investigations at Franklin Institute to develop gas-lubricated bearings in large sizes for application to circulating compressors, particularly turbomachinery, for use in gas-cooled reactor systems. The increased estimate in fiscal year 1963 over fiscal year 1962 results from the initiation of a gas component development program in fiscal year 1963 to develop and test prototype items of equipment prescribed by the studies at the Franklin Institute. The main effort will be placed on compressors and allied equipment for use in high-temperature gas-cooled reactor systems up to 2,500° F.

(*d*) *Chemical separations*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$6,424,014	$7,390,000	$8,620,000
Aqueous chemical processing	2,381,695	2,954,000	3,881,000
Volatility processing	1,768,611	2,227,000	2,526,000
Low decontamination studies	1,633,865	1,263,000	1,122,000
General chemical and separations development	639,843	946,000	1,091,000

Chemical separations and development programs are directed toward the following objectives:

1. The development of processing techniques for new and advanced fuels in proportion to their anticipated importance.
2. The development of new process methods required in the attainment of long-term economic fuel cycles.
3. The exploitation of those new aspects of chemistry and chemical engineering technology which arise from the development of reactor systems.
4. The solution of those broad-based nuclear technology problems common to many reactor systems requiring the application of chemical and chemical engineering effort.

(*1*) *Aqueous chemical processing*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,381,695	$2,954,000	$3,881,000
Research and development	2,195,540	2,559,000	3,370,000
Irradiation services	0	257,000	211,000
Related capital equipment	186,155	138,000	300,000

Principal goals are the development of increasingly versatile dissolution "head ends" for major fuel types, scouting and early development on potentially important new fuels, and continued investigation of radically new processing approaches.

(*a*) *Process development.*—Major emphasis is placed on process development of those advanced fuels and/or processing techniques required if (1) industrial participation is to be encouraged, (2) fuel cycle costs are to be lowered sufficiently to permit attainment of the 10-year plan objectives, and (3) sufficient data is to be available to permit evaluation of the economics of proposed new fuels. It is a further function of this program to develop technology which will allow "interim" reprocessing of advanced fuels and which will provide advanced technology for existing fuels. Increased effort is being directed toward carbide and ceramic fuels. Chop and leach and titanium head-end methods are being actively pursued as alternates to stainless steel and zirconium chemical decladding techniques.

(*b*) *Engineering demonstration.*—Emphasis will be placed on design, construction, and operation of hot pilot plant facilities. The increased level of support is due to the need for those expendable and capital equipment funds required to permit the overall savings associated with the reorientation of the Oak Ridge National Laboratory, Savannah River Operations Office, Hanford Operations Office, and the Idaho Chemical Processing Plant processing programs in fiscal year 1961.

(*2*) *Volatility process development*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,768,611	$2,227,000	$2,526,000
Research and development	1,572,263	2,142,000	2,394,000
Related capital equipment	196,348	85,000	132,000

Two different approaches are being pursued.

General development will be continued at ANL on the potentially versatile fluid bed, gas-solid reaction approaches. Efforts in the preparation, handling, and separation of PuF_6 have been remarkably successful during the past few years. Since the utility of volatility techniques for application to power reactor fuels hinges around the ability to handle Pu, it is essential that this work be moved ahead as fast as possible. Within the total dollars indicated, an expansion of the PuF_6 work has been programed both in laboratory and pilot plant facilities, at the expense of less urgent work.

Studies on the application of fluidized beds for application to advanced fuels will also continue at the Brookhaven National Laboratory at a low level, primarily in scoping studies as distinct from the main line effort at ANL. Part of the indicated expansion results from a transfer of the engineering portion of studies being conducted by the Division of Research.

The development of fused salt volatility technology is an exclusive responsibility of ORNL. The volatility hot pilot plant will be used for demonstration processing of portions of irradiated S1W and/or A1W (naval) cores, with the associated studies of corrosion and equipment problems. Studies on niobium and stainless steel fuels will be conducted.

(3) Low decontamination studies

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	1,633,865	1,263,000	1,122,000
Research and development	1,594,974	1,245,000	1,072,000
Irradiation services		1,000	5,000
Related capital equipment	38,891	17,000	45,000

This program is in actuality broader in scope than implied by the terms chemical processing or pyro-metallurgical processing alone, since it involves the total fuel cycle from reprocessing through decontamination, reenrichment, and refabrication, probably performed in a remotely operated facility closely integrated with a reactor. This approach contrasts with most fuel cycle development work which is based on the major assumption that manual handling will be required at some point during the fuel cycle and that high fission product decontamination is therefore essential. The first approach is becoming increasingly important because recycled civilian fuels are isotopically contaminated and may require remote fabrication techniques.

Work on closed fuel cycle techniques for uranium oxide (UO_2) fuels will be continued in fiscal year 1963. Highly irradiated samples of UO_2 clad in stainless steel have been reprocessed by the technique under study. These samples will be refabricated and reirradiated to high burnup in fiscal year 1962. The effort will be continued in fiscal year 1963 with plans for additional reprocessing-reirradiation cycles up to an eventual level of 100,000 MWD/ton.

Work will be continued on the further development of the promising oxide-carbide cycle for decladding and processing of UC fuels.

With the EBR–II in mind, promising techniques for recovery of U and Pu from "melt refining" skulls (residues which result from the primary process) will be continued. Increasing emphasis will be placed on Pu recovery from molten metal systems, and on recovery methods for advanced EBR–II and related type fuels. The program is expected to continue without major change in direction or support.

(4) General chemistry and chemical engineering

(a) Chemical engineering:

Fiscal year 1961	$639,843
Fiscal year 1962	946,000
Fiscal year 1963	1,091,000

Provided for here is (1) the continued development of direct fission fragment radiation as an initiator of chemical reactions, in particular, nitrogen fixation, and (2) the development of methods for accurate burnup analysis of highly irradiated fuel test specimens. No techniques are presently available for current power fuels or any high enriched fuels other than test specimens irradiated at water reactor temperatures.

A new study will attempt to compare overall nuclear power costs involving on one hand, conventional fuel shipment and centralized multipurpose plant fuel cycles, with one involving onsite, single-purpose, integrated plants. A major commercial interest has proposed this study based on the strong trend in the power industry toward multiple plants at one site which in turn raises the throughput of an onsite plant such that overall costs show excellent promise of competitiveness.

(*e*) Waste processing development:

Fiscal year 1961	$2, 273, 927
Fiscal year 1962	1, 710, 000
Fiscal year 1963	1, 460, 000

Work under this activity is primarily directed toward the chemical and chemical engineering problems associated with the treatment of extremely radioactive wastes produced in chemical processing plant operations. These waste problems begin with the dissolution of the fuel element itself and are initmately affected by dissolution agents and flow sheets as well as by actual storage technology.

The decrease in fiscal year 1963 reflects rescoping of research and development effort in line with current evaluation of requirements.

The major cost of this program results from operation of the waste calcination facility at the Idaho Chemical Processing Plant. Operation of this engineering pilot plant will be continued in fiscal year 1963 to demonstrate the conversion to solids of highly radioactive chemical reprocessing wastes.

Laboratory studies of fluidized bed waste calcination including waste from stainless steel and zirconium fuel processing will continue at virtually the same level as fiscal year 1962.

(*f*) Thorium utilization:

Fiscal year 1961	0
Fiscal year 1962	$2, 375, 000
Fiscal year 1963	2, 300, 000

The program will cover (1) development of complete fuel cycle technology for various kinds of reactors including those presently proposed or being built and promising new types, with the objective of achieving low fuel cycles costs and (2) the development of reactor concepts and systems capable of achieving high conversion ratios, including breeding, with Th–U^{233} fuels.

As a result of evaluation studies and the development of general technology for thorium systems, a reactor concept which has exceptional promise for producing economic power with thorium fuel may evolve. If this occurs and a reactor project or development program is established, this work will be excluded from the thorium utilization program. The program will be reserved for special fuel cycle work for established reactor projects, for investigation of problems which are common to several types of thorium reactors, and for initial development of promising new thorium reactors or fuel cycle processes for which there are at present no major programs.

Specific activities performed in this program include thoria pellet development and testing, development of new thorium fuels, physics studies for thorium reactors, investigation of thoria processing methods, metallurgical development for thorium reactors and thoria fuel cycle development.

The level of effort continues at the fiscal year 1962 level.

(*g*) Plutonium utilization:

Fiscal year 1961	$8, 541, 097
Fiscal year 1962	9, 267, 000
Fiscal year 1963	8, 230, 000

This program is comprised of two subactivities, plutonium recycle test reactor (PRTR) and a general plutonium research and development effort. These subactivities are described below.

(1) Plutonium recycle program

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$7,503,563	$8,034,000	$7,000,000
Research and development	4,794,762	4,338,000	4,110,000
Fuel fabrication	1,884,552	0	575,000
Operations	431,787	2,800,000	1,460,000
Irradiation services	0	520,000	0
Test reactor services	25,380	0	255,000
Related capital equipment	367,082	376,000	600,000

The purpose of this program is to develop technology for the safe and economical recycling of plutonium in thermal heterogeneous power reactors and to demonstrate this technology in a practical way in the plutonium recycle test reactor. Recycling plutonium will permit (1) the use of plutonium in power reactors burning natural or slightly enriched uranium and (2) the development of a reactor system capable of operating on a fuel cycle independent of enriched uranium feed. A combination of experimental theoretical and analytical studies is intended to develop the knowledge required to define optimal methods for the use of plutonium as a reactor fuel under a wide variety of technical and economic conditions.

The research and development program will continue to provide the technology necessary for the economic utilization of plutonium as a thermal reactor fuel. The principal areas in which efforts will be continued are physics and instrumentation, fuel reprocessing, materials development, plutonium and uranium fuel fabrication, reactor and fuel cycle analysis, reactor engineering support, and PRTR operations.

Fuel fabrication costs increase as the complete mixed oxide loading is fabricated. Costs for test operations decrease with continued operation of the plant. The fiscal year 1963 test operating program contemplates (1) operation with high exposure plutonium spikes enrichment, (2) a gradual change from a zoned core to a uniformly enriched mixed oxide loading, (3) continued evaluation and improvement of reactor equipment such as seals, pumps, controls, etc.

(2) Plutonium reactors—Other

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,037,534	$1,233,000	$1,230,000
Research and development	840,595	1,036,000	1,140,000
Irradiation services	0	16,000	10,000
Test irradiation services	0	46,000	50,000
Related capital equipment	196,939	135,000	30,000

Under this activity, determinations are being made as to the feasibility of utilizing plutonium oxide and compounds either alone or in conjunction with uranium or thorium compounds as well as other inert compounds, as a reactor fuel in various forms and in different coolant and moderating environments. Virtually all phases of the fuel cycle will be examined.

Most of the work started in fiscal year 1962 will continue. Characterization studies of plutonia-urania and plutonia-thoria systems will be completed.

Once the development effort on these fuels has proceeded sufficiently far, a detailed reactor physics study will be summarized and the overall economics of plutonium fuel systems will be assessed.

11. Advanced Systems Research and Development, $20,205,000

There follows an itemization of costs for this category:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$19,035,144	$18,684,000	$20,205,000
(a) Molten salt reactor experiment	3,295,289	5,020,000	5,465,000
(b) Pebble bed reactor experiment	535,485	1,630,000	1,730,000
(c) Experimental beryllium oxide reactor	2,931,421	1,834,000	1,700,000
(d) Ultra high temperature reactor experiment	1,073,158	1,245,000	2,600,000
(e) LAMPRE	3,526,374	3,746,000	4,649,000
(f) HRE-2	2,193,068	0	0
(g) Homogeneous reactors, other	1,466,338	0	0
(h) Plasma thermocouple	1,696,400	1,635,000	1,797,000
(i) Research reactors, research and development	1,271,011	1,041,000	384,000
(j) Test reactor, research and development	504,925	1,650,000	880,000
(k) Other advanced systems	541,675	883,000	1,000,000

(a) *Molten salt reactor experiment*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$3,295,289	$5,020,000	$5,465,000
Research and development	2,218,625	1,877,000	1,964,000
Reactor fabrication	995,618	2,695,000	3,025,000
Test irradiations	13,973	55,000	11,000
Related capital equipment	67,073	393,000	465,000

The objectives of the molten salt reactor experiment, which will be a single-region graphite moderated reactor having a design rating of 10 thermal megawatts, are (1) to test and demonstrate the performance, reliability, maintenance, and safety of the molten salt concept under continuous operation, (2) to provide experience in the operation and maintenance of a molten salt system, and (3) to provide technical information necessary to the further development of the concept as a power-breeder reactor.

During fiscal year 1962, the reactor design and modifications to the reactor building will be completed. Research and development effort will concentrate on finalizing the design of reactor components and systems, completing the investigative chemical studies of the fuel and continuing inpile tests with graphite fuel and INOR–8. All reactor equipment will be placed on order.

During fiscal year 1963, fabrication of all major reactor components will be completed, and the reactor installed. Major components will be tested and the pumps will be run in development loops prior to installation. Fuel and coolant will be prepared for addition to the reactor. The costs for fiscal year 1963 will increase by $0.4 million due to the peaking of fabrication costs and the installation of the reactor.

(b) *Pebble Bed Reactor Experiment*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$535,485	$1,630,000	$1,730,000
Research and development	529,266	1,575,000	1,595,000
Related capital equipment	6,219	55,000	135,000

The objective of the small (3–10 megawatt-thermal) pebble bed reactor experiment is to test coated particle fuel under various operating conditions and to test unique characteristics of the pebble-bed concept, such as simplified fuel handling during full power operation. Research and development, which has been underway for several years at ORNL, will be continued in fiscal year 1963. The research and development will emphasize adaption and testing of coated particles to the spherical fuel required for the pebble-bed concept. This will

include studies of the characteristics of any fission products released from the fuel, and their deposition in the system. The reactor experiment will be designed to test the operating characteristics of coated particle fuel and the unique characteristics of the pebble-bed concept such as simplified fuel handling during reactor operation. The increase in costs in fiscal year 1963 over fiscal year 1962 is related to the beginning of conceptual design so that final design and reactor fabrication may be started in fiscal year 1964.

(c) *Experimental beryllium oxide reactor*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,931,421	$1,834,000	$1,700,000
Research and development	2,539,026	1,406,000	895,000
Fuel fabrication	0	190,000	130,000
Test operations	0	0	275,000
Test irradiation	60,301	68,000	275,000
Test reactor experiment	311,593	30,000	125,000
Related capital equipment	20,501	140,000	0

Based upon work to date on water cooled and moderated reactor systems, it appears possible to design and build nuclear propulsion plants which can be expected to approach economic competitiveness in specialized applications. Work through fiscal year 1960 showed that the basic beryllium oxide moderated helium gas-cooled reactor concept possessed promise for use in intermediate power range stationary powerplants as well as for application to the marine propulsion field. The attainment of truly competitive nuclear propulsion for broad application depends upon the availability of a highly efficient, lightweight and compact plant which is largely self-regulating and reliable and which possesses superior safety features and is amendable to remote operation. Design and feasibility studies conducted in fiscal year 1957 indicated that a nuclear propulsion plant consisting of a high temperature gas cooled reactor directly coupled to a closed cycle gas turbine shows excellent promise for the attainment of this low cost and reliable propulsive power objective. Since the latter part of fiscal year 1958, the AEC and the Maritime Administration have been carrying forward a jointly financed developmental effort aimed at proving out this concept for merchant ship application.

During fiscal year 1961, General Atomics provided continuing research and development support for the experiment. Research and development included nuclear design of the reactor core, fuel elements, control rods, and other reactor internals. The fiscal year 1962 funds provided will cover the continuation of remaining necessary research and development at a reduced level, fabrication of fuel elements and the irradiation and postirradiation testing of materials under development for application for the reactor core and internals. The cost of construction of this experiment (except for core fabrication) is funded under construction project 62-d-2 (experimental beryllium oxide reactor).

The present schedule calls for completion of the construction of the experiment late in the second half of fiscal year 1963, at which time test operations will begin. Research and development will continue at a reduced level in fiscal year 1963 to support the installation and operation of the experiment and to initiate reference design efforts and materials work aimed at a follow-on experiment which will ultimately test a reactor coupled to a closed cycle gas turbine.

(d) *Ultrahigh temperature reactor experiment*

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,073,158	$1,245,000	$2,600,000
Research and development	744,410	753,000	1,250,000
Reactor fabrication	243,854	437,000	1,350,000
Related capital equipment	84,894	55,000	0

The objective of this program is to obtain basic data contributing to the future development of high temperature gas cooled reactors through the operation of an experimental reactor employing unclad porous graphite fuel elements at temperatures up to 2,400° F., and to evaluate the potential of this reactor concept for high temperature process heat applications.

During fiscal year 1962 and fiscal year 1963 nuclear calculations required for detailed design of the core and reflector will be conducted; design of the reactor system will be completed, and development work will proceed on the fuel, control rods, and other reactor components. Two high temperature out-of-pile loops will be operated to investigate fuel and helium gas performance. Techniques for the accurate determination of gas leaks will be developed. The procurement of reactor components and equipment will be initiated. During the last quarter of fiscal year 1963, assembly and installation of the experiment will begin as construction of the facility is completed. The installation of the experiment will be completed in fiscal year 1964 and system checkout will begin, aimed at the first nuclear operation during the summer of 1964. The increase in fiscal year 1963 reflects the progression of the program into the hardware fabrication and installation phase. The cost of housing and related service facilities is funded under the construction project 62–d–7 ultrahigh temperature reactor experiment building, LASL, New Mexico.

(*e*) *Los Alamos molten plutonium reactor experiment* (*LAMPRE*)

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$3,526,374	$3,746,000	$4,649,000
Research and development	3,375,287	3,522,000	4,354,000
Related capital equipment	151,087	224,000	295,000

The LAMPRE program being conducted at LASL concerns the investigation of means for utilizing plutonium fuels for reactor application. The most important technical program to be solved initially is establishing the feasibility of the plutonium fuel concept and developing the appropriate specifications for the containment system and the fuel materials.

The initial reactor experiment, LAMPRE–I, went critical early in calendar year 1961 without incident. During critical operation the LAMPRE–I behaved very well though there was an unexpected decrease in reactivity. The operation of this experiment will develop valuable experience in the behavior of this fuel while undergoing fission.

Future LAMPRE-type systems will be tested in the fast reactor core test facility (project 61–d–5) which is scheduled to be operational by the end of fiscal year 1964. Considerable work must be carried out prior to that time in the areas of hydraulic experimentation and critically testing on molten plutonium fuels to determine the core design best suited for the experiment.

The experimentation with the high temperature steam generator loop will be completed during fiscal year 1963, and the loop will be converted to test the compatibility of material in high temperature sodium and to conduct experiments in the dynamics of molten core designs. The investigation of the behavior of contained materials will receive increased emphasis. The costs in fiscal year 1963 will provide for a slight increase in scientific effort, and for the major procurement related to experimental loops, materials for reactor studies, and offsite research and development contracts.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(*f*) Homogeneous reactor experiment No. 2	$2,193,068	0	0
(*g*) Homogeneous reactors, other	1,466,338	0	0

Effort on the above programs was terminated in fiscal year 1961. The homogeneous reactor experiment, and its related research and development, was conducted to investigate the engineering problems of operating and maintaining fluid-fuel reactors. This work has been superseded by the molten salt reactor experiment which has more simplified fuel reprocessing, high operating temperature potential, and less severe materials problem.

(h) Plasma thermocouple

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,696,400	$1,635,000	$1,797,000
Research and development	1,647,923	1,581,000	1,725,000
Test irradiations	0	8,000	0
Related capital equipment	48,477	46,000	72,000

The LASL effort to develop a thermionic conversion system to generate electricity from a nuclear fission heat source is continuing at essentially a level effort. The major research and development areas that are under investigation are (1) high temperature materials (2) basic physics of the conversion process (3) in-pile development of components and (4) reactor design and systems studies. The high temperature demanded by this system requires investigation of properties of material in the range of 1,500° to 2,500°K, with carbides being of particular interest. The understanding of the physics of thermionic cell operation involves the accumulation of data obtained from the study of electrically heated assemblies, visual examination of light emitted by the plasma and spectroscopic determination of ion distribution in an operating cell. Particular emphasis will be placed on improving the instrumentation of in-pile experiments conducted in the Omega west reactor, and the post-mortem analyses of these experiments. The effort on the reactor design and systems studies is small, and serves primarily as a guide for developing the plasma cell rather than being directed at a particular mission or application.

(i) Research reactors research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,271,011	$1,041,000	$384,000
Research and development	1,230,240	908,000	324,000
Related capital equipment	40,771	133,000	60,000

This activity consists of the following areas of work at the national laboratories:

	Fiscal year 1962	Fiscal year 1963
Argonne National Laboratory	$88,000	$84,000
Brookhaven National Laboratory	350,000	300,000
Oak Ridge National Laboratory	603,000	0
Total	1,041,000	384,000

The Argonne effort consists of 2 scientific man-years on a design concept for a high performance advanced research reactor to satisfy the needs of the Research Division.

The Brookhaven National Laboratory effort includes the theoretical and experimental development of a pulsed reactor. During fiscal year 1962, based on the conceptual design performed in fiscal year 1961, the two most promising designs will be evaluated. In fiscal year 1963, the most promising of the two concepts will be selected for further study and experimental development. Approximately 7 man-years are devoted to this research in fiscal year 1963. This contractor is also performing the research and development effort required to support the high flux beam reactor now being constructed under the physical research program.

The ORNL design and development effort pertaining to the high flux isotope reactor for the Division of Research will be completed in fiscal year 1962. No additional work in this area is planned for fiscal year 1963.

(j) Test reactor research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$504,925	$1,650,000	$880,000
Research and development	504,925	1,582,000	795,000
Test irradiations	0	58,000	70,000
Related capital equipment	0	10,000	15,000

This activity provides primarily for the design and development of the advanced test reactor. The following table indicates the research and development areas involved.

	Fiscal year 1962	Fiscal year 1963
Fuel element development	$760,000	$285,000
Critical experiments	330,000	280,000
Material development	40,000	0
Mechanical control development	150,000	15,000
Research and development liaison	40,000	0
Other research and development	330,000	300,000
Total	1,650,000	880,000

The above effort is required to provide the design and development support needed to permit the successful design and construction of the advanced test reactor.

(k) Other advanced systems R. & D.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$541,675	$883,000	$1,000,000
Research and development	541,675	881,000	930,000
Related capital equipment	0	2,000	70,000

This activity provides for the study and investigation and evaluation of various promising reactor concepts. The following table reflects the areas of investigation:

	Fiscal year 1962	Fiscal year 1963
ANL reactor evaluations	$150,000	$377,000
Westinghouse thermoelectric research	149,000	0
Bureau of Mines, coal gasification research	454,000	0
General Atomics, coal gasification research	130,000	0
Studies on thermionic research, plutonium cores, cavity reactions, etc	0	623,000
Total	883,000	1,000,000

The Argonne work is primarily devoted to evaluation of advanced research reactor concepts such as boiling sodium reactors, pulsed reactors, and a design study of Th–U 235 seed blanket. This effort involves about 14 scientific man-years.

During fiscal year 1963, it is anticipated that contracts will be placed in such areas as a study of the cavity reactor concept, including critical experiments, a preliminary design study of a plutonium core loading for high enrichment power package reactor application. Also included are funds for additional work (contractors not now specified) in the areas of direct conversion such as properties of thermoelectric and thermionic materials and fuel cells. Other areas which appear to warrant investigation include thorium blankets slightly enriched in U 235 for seed blanket loadings; and power core loadings containing central zones of

slightly enriched uranium and peripheral zones of slightly enriched thorium, for optimum power flattening over core lifetime; and slightly enriched core loadings controlled by self-shielded burnable poisons.

12. NUCLEAR SAFETY, $22,500,000

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$11,378,116	$16,446,000	$22,500,000
(a) Nuclear safety research and development	7,624,627	8,581,000	9,675,000
(b) Effluent control research and development	3,514,711	5,685,000	6,945,000
(c) Engineering field tests	238,778	2,180,000	5,880,000

The increasing dimensions of the reactor development program and the increased emphasis on safety problems attendant to this growth have led to the establishment of a nuclear safety program to more effectively coordinate nuclear safety activities with other groups both in and outside of the AEC. In carrying out these activities full recognition is given to the fact that safety problems are an integral part of each reactor or other project; however, it is essential to carry out investigations into safety problems which are of general applicability and to provide for an independent review and analysis of significant safety questions. These estimates provide for such a program which centers around the following principal areas:

(1) Investigations aimed at a better understanding of the safety problems associated with various reactor systems.

(2) Developmental work to provide more effective methods for the control of radioactive wastes and to provide engineering data and information of the fate and behavior of radioactive materials in the environment.

(3) Identification and resolution of the multiple safety problems imposed by nuclear propulsion and power devices for space application.

(4) Conduct of a program of engineering proof-testing of various systems under actual or approximated conditions to prove their reliability with respect to safety.

(a) Nuclear safety research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$7,624,627	$8,581,000	$9,675,000
Reactor kinetics	4,310,063	4,483,000	5,069,000
Chemical reactions	1,168,529	1,610,000	1,989,000
Reactor containment	1,016,314	1,134,000	1,307,000
Fast reactor safety	1,129,721	1,354,000	1,310,000

The aim of this activity is to develop a better knowledge of the potential hazards associated with the operation of reactors of various types. These hazards can result from a reactor power runaway, containment rupture, and fission product release to the environment. The work is intended to provide data which will permit the design of reactor systems of various types which meet both the goals of safety and economic operations. This work is divided in four principal areas: reactor kinetics, chemical reactions, reactor containment, and fast reactor safety.

(1) Reactor kinetics

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$4,310,063	$4,483,000	$5,069,000
Research and development	1,493,024	2,443,000	1,355,000
Fuel fabrication	−967	420,000	530,000
Operations	1,635,331	905,000	2,370,000
Reactor fabrication	1,041,906	275,000	650,000
Related capital equipment	140,769	440,000	164,000

Studies of reactor kinetics are carried out to determine the abnormal behavior of reactors in the range between normal power operations and runaway leading to destruction. Through such studies, the factors leading to self-shutdown and means of preventing runaway and destruction are determined. These studies have centered around heterogeneous water reactor systems and simple homogeneous systems. This work involves the SPERT facilities as well as specific studies carried out by various contractors; studies on homogeneous systems, undertaken with the KEWB facility will be brought to completion in fiscal year 1962.

The SPERT program is intended to provide information with which to evaluate the safe operating characteristics of pressurized water, boiling water, heavy water, and open pool reactors. The experiments, carried out in four facilities of different design, may be categorized as follows: Static experiments to determine such core characteristics as void and temperature coefficients; step tests in which the system is suddenly made supercritical; stability tests involving spontaneous or induced oscillations; and ramp tests in which reactivity is added to the reactor at a constant rate. The work planned for the various SPERT experiments over the period covered by this submission is as follows:

(*a*) SPERT I is an open vessel unpressurized light water moderated heterogeneous reactor specifically designed to provide an understanding of reactor behavior through the destructive range. In fiscal year 1961 work in this facility involved investigations of dynamic void growth and other effects that contribute to reactor self-shutdown during a power excursion as well as studies of overall kinetic and safety aspect of low enrichment oxide cores which heretofore had not been studied. During fiscal year 1962 tests of an aluminum plate-type core are being initiated which will be terminated with a series of destructive tests in fiscal year 1963. The destructive tests are necessary to determine the causes of shock formation, energy, partition, and reactivity changes due to core disassembly.

(*b*) SPERT II consists of a reactor vessel and coolant flow system designed for operation with either light or heavy water; its objective is to determine experimentally the importance of prompt neutron lifetime on reactor kinetic behavior. This facility was completed in fiscal year 1960 with initial criticality achieved early in fiscal year 1961. During the past year a transient program with aluminum cores was initiated using heavy water as a coolant moderator. Tests of an expanded core under flow and high initial temperatures and pressures will be initiated in fiscal year 1962. Tests of a close-packed core will be conducted in fiscal year 1963. Detailed measurements of void production during transient operations will also be conducted in fiscal year 1963.

(*c*) SPERT III is a pressurized water, forced circulation plant, and is the most versatile facility developed for studying the potential hazards of nuclear reactors. During fiscal year 1961 transient testing was carried out on a stainless steelclad plate-type core including investigations of the effects of system pressure and collant behavior at ambient temperatures. Failure of the pressurizer vessel in the second quarter of fiscal year 1962 will delay the experimental program in SPERT III approximately 16 months. It is estimated that a replacement vessel will be installed by January 1963 and that the testing program will resume shortly thereafter.

(*d*) SPERT IV, recently completed, is a pool facility which will permit detailed study of reactor stability based on varying conditions of coolant flow, height of water above the core, and other hydrodynamic effects. The plant will start operating in fiscal year 1963 and pool stability studies with and without forced coolant will commence. It is anticipated that the most of fiscal year 1963 will be occupied with stability studies for various core geometries and hydrodynamic conditions.

(*e*) SPERT control center: The four SPERT reactors are served by a remote central control facility containing the reactor control systems, office, and shop space. All such space is centrally located as the nature of the experiments carried out in the reactors themselves preclude the use of the reactor buildings for these purposes. As the four SPERT reactors constitute an integrated research effort, a substantial portion of the SPERT personnel are assigned to the control center to furnish technical support to all four reactors. The estimates for the control center therefore reflect the technical support, overhead, and administrative costs for the entire SPERT program. The major activities of the control center include experiment analysis and planning, instrument development, engineering services relating to required plant modifications and data reduction.

Costs for the SPERT program are summarized as follows:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$2,739,810	$3,250,000	$3,625,000
SPERT I	199,968	400,000	450,000
SPERT II	259,114	250,000	600,000
SPERT III	225,125	615,000	845,000
SPERT IV	902,220	315,000	265,000
SPERT control center	1,153,383	1,670,000	1,465,000

(f) KEWB

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$370,560	$70,000	0
Research and development	370,560	70,000	0

The KEWB program, initiated in 1955, has been directed toward the experimental study of the kinetic behavior of water boiler type reactors. The experimental program planned for this facility was substantially completed in fiscal year 1961 with the work involving the KEWB cylindrical core. The analysis of experimental data and the preparation of a comprehensive report covering the 7 years work on this program will be completed in fiscal year 1962.

(g) Other reactor kinetics

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,199,693	$1,163,000	$1,444,000
Research and development	1,122,463	1,078,000	1,355,000
Related capital equipment	77,230	85,000	89,000

Other reactor kinetics work includes various studies and engineering investigations not performed in the SPERT or other rectors. The costs for fiscal years 1962–63 reflect a continued and expanding effort to increase fundamental knowledge relating to the problems of kinetics as they relate to reactor safety problems. Included are heat transient investigations involving studies of void growth and measurements; fast transient studies conducted out-of-pile using electrical heating for a single reactor fuel channel; studies of void and pressure transients in organic reactor systems as well as void coefficients in organic and sodium reactors. Studies will also be undertaken of fuel criticality accidents, potential accidents in fuel storage, and the safety problem associated with chemical processing of nuclear fuel.

(2) Chemical reactions

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,168,529	$1,610,000	$1,989,000
Research and development	1,123,776	1,545,000	1,894,000
Irradiation services	0	16,000	16,000
Related capital equipment	44,753	49,000	79,000

The main purpose of the work under this activity is to carry out investigations into metal-water reactions, spontaneous ignition of metal, fission product release, and other chemical reactions which involve hazardous releases of energy or fission products. During the period covered by this submission, ANL will be engaged in

a program to investigate chemical reactions between fuel or cladding and coolants as well as ignition involving uranium, zirconium, plutonium, and thorium metals. At BNL, investigations will be carried out to determine the chemical form of the fission products released during fuel meltdown. ORNL will be engaged in fission product release studies both in and out of pile including large-scale experiments to determine more realistic values for fission product transport from the reactor core region to the containment building and outer environment.

(3) Reactor containment

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,016,314	$1,134,000	$1,307,000
Research and development	1,014,589	1,131,000	1,307,000
Related capital equipment	1,725	3,000	0

The objective of this program is to study the dynamic properties of pressure vessels and secondary containment systems to improve safety and to reduce construction costs. One phase of the effort consists in testing the leakage characteristics of conventional building materials and components for use in containment structures. Work is also underway on an experimental and analytical study of containment systems during loss of coolant accidents involving boiling and pressurized water reactors. Missile penetration studies should be completed in fiscal year 1963. Design criteria are being developed for blast-resistant shields and vessels. A significant area of new work to be initiated in fiscal year 1962–63 will concern plastic deformation of containment structures to determine their energy absorption potential to the point of rupture.

(4) Fast reactor safety

Fiscal year 1961	1,129,721
Fiscal year 1962	1,354,000
Fiscal year 1963	1,310,000

The objective of this program is to identify major hazards associated with fast reactors and develop means of eliminating or minimizing them in the design and operation of plants of this type. The principal effort in this program is carried out by ANL and centers around the TREAT pulsed reactor which is utilized for inpile meltdown studies on various types of fast reactor fuels. Analytical studies are carried out by several contractors to determine the size and magnitude of the various self-shutdown mechanisms such as the Doppler coefficient, to study various means by which reactivity may be accidentally inserted during fast reactor operation, and to more realistically represent the accident models which are postulated in the premise of core meltdown and reassembly. The estimates for the overall program are as follows:

ANL

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$1,003,494	$1,163,000	$1,260,000
Research and development	706,000	1,076,000	800,000
Operations	238,000	0	345,000
Irradiation services	53,000	18,000	95,000
Related capital equipment	6,494	69,000	20,000
Other	126,227	191,000	50,000
Total	1,129,721	1,354,000	1,310,000

The work of ANL has been primarily concerned with the meltdown on EBR II and Fermi-type fuel pins; on the effects of nonuniform flux; on meltdown tests in a transparent capsule; and to observe meltdown of irradiated pins. In addition, development of experimental loops was undertaken including both a single-pin sodium loop and a multiple-pin large loop. The single-pin loop should be installed in the reactor in fiscal year 1962. In fiscal year 1963, installation of a

large sodium loop will make it possible to run excursions which more clearly reproduce the behavior of a whole fast reactor fuel assembly. Also, the program will extend its range to oxide, carbide, and other alternate fuel concepts. It is expected that work will become concentrated on those aspects of meltdown which lead to design principles insuring safe disassembly on melting and other basic phenomena such as transient boiling, fission gas release, and chemical interactions.

Other fast reactor safety work includes theoretical investigations of fast reactor safety problems to provide a basis for experimental studies and specific reactor design. These investigations currently center around the technology of sodium coolant behavior under boiling conditions.

(b) Effluent control research and development

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$3,514,711	$5,685,000	$6,945,000
Research and development	3,411,979	5,562,000	6,790,000
Related capital equipment	102,732	123,000	155,000

Radioactive waste materials in either gaseous, liquid or solid forms are involved in essentially all operations associated with nuclear energy facilities. Because of the characteristics of the radioactivity involved, its ability to cause damage to human tissue and its potential danger as an environmental contaminant, the safe handling and final disposition of these wastes are an integral and important characteristic of nuclear energy activities. Basically there are three objectives of the developmental programs covered by this activity. These are: (a) to develop systems of management of all types of radioactive wastes; (b) to establish technical criteria for the disposal of radioactive effluents into the environment; (c) to obtain knowledge of fundamental phenomena and processes in waste disposal. The increase in effort reflected in these estimates represents the continued expansion of work in this area which will enable the AEC to effectively discharge its responsibilities with respect to the disposition of radioactivity. The program for the fiscal years 1962–63 time periods is characterized by the transition of several important studies from the laboratory to field demonstration stage. This program may be subdivided in the four areas discussed below:

(1) Environmental studies

Fiscal year 1962	$1,815,000
Fiscal year 1963	2,095,000

These investigations involve a detailed evaluation of specific environments for the purpose of establishing technical criteria for the safe dispersal of radioactive effluents into environment. Geophysical investigations are conducted to obtain data on ground dispersal systems and oceanographic survey work to provide the needed additional data to better understand the fate of specific radioactive nuclides. The increase reflected in fiscal year 1963 relates to a moderate expansion of the investigations in the above areas plus the initiation of investigations into environmental parameters which might affect the operation of mobile reactors.

(2) Low and intermediate level waste studies

Fiscal year 1962	$810,000
Fiscal year 1963	1,480,000

The work included in this area of study is directed toward the development of improved systems for the handling, treatment and disposal of low and intermediate level liquid wastes. During the period covered by these estimates the work will be characterized by continued work on synthetic and natural ion exchange plus mineral exchange processes for the removal of radionuclides, foam separation techniques for decontaminating low and intermediate level wastes and on the development of techniques for deep well disposal methods. The major area of increase in fiscal year 1963 is related to the transition from the pilot plant scale demonstration of the hydrofracturing technique for the disposal of intermediate level radioactive wastes into shale formations to a field demonstration using actual ORNL waste as well as the initiation of site selection, and process equipment design for a field test to develop the various parameters involved in the injection of low-level wastes into deep geologic permeable formations.

(3) High level waste studies

Fiscal year 1962	$2, 626, 000
Fiscal year 1963	2, 875, 000

This program provides for the development of hot pilot plants of the various fixation methods heretofore developed in the laboratory plus continuation of the feasibility studies for storing aged high-level wastes in salt and in deep bedrock formations. A major area of increase in fiscal year 1962–63 is related to the development, installation, and test operation of experimental pot and ball mill calcination processes; these will be installed in existing hot cells at the NRTS Chemical Processing Plant.

(4) Gaseous effluent studies

Fiscal year 1962	$434, 000
Fiscal year 1963	495, 000

Work under this heading includes studies directed toward the development of new and improved systems for control of gaseous and particulate effluents with increasing emphasis being given to higher temperature collection and removal techniques which could be applicable to nuclear propulsion systems. Various meteorological studies on atmospheric transport and diffusion will continue with emphasis being given to studies in coastal and harbor areas.

(c) Engineering field tests

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Total	$238, 778	$2, 180, 000	$5, 880, 000
Research and development	238, 778	2, 180, 000	5, 880, 000

A major aspect of the comprehensive nuclear safety program now being accelerated and expanded is the testing in the field under actual operating or malfunction conditions, or as close to those as can be realized, of nuclear components and systems to demonstrate their functioning and reliability with respect to safety. This testing program has been divided into two main areas of activity. The first of these involves the conduct of safety tests of various nuclear devices for aerospace application; the other will be concerned with the safety of terrestrial nuclear systems. Both areas will involve the full-scale and probable destructive testing of nuclear systems.

(1) Aerospace testing

Fiscal year 1961	$238, 778
Fiscal year 1962	1, 980, 000
Fiscal year 1963	5, 280, 000

This effort includes both ground tests of aerospace systems and components to establish their reliability with respect to nuclear excursion, fire, impact, etc., as well as flight testing to determine atmospheric reentry burnup characteristics. During fiscal year 1962 reentry tests were conducted using the so-called piggyback method whereby the test articles were carried in passenger pods aboard five Air Force ATLAS missiles which were launched as part of the ATLAS development program. Work was also initiated on a comprehensive program aimed at establishing the safety of the SNAP 10–A and similar reactor systems. This effort, which will extend through fiscal year 1962, will include a series of SNAP 10 safety experiments such as nuclear excursion tests, mechanical, shock, vibration, and impact tests, and high temperature environmental tests simulating a launch pad fire. It is also planned to conduct reentry burnup experiment tests of SNAP systems in midfiscal year 1963. Because of the size of the payload to be tested as well as the reentry angle and velocity required, it will not be possible to utilize the piggyback methods. Present plans provide for the delivery of two vehicles of the SCOUT type for this purpose; NASA or Air Force range facilities will be utilized.

(2) Land-based reactor systems

Fiscal year 1961	0
Fiscal year 1962	$200, 000
Fiscal year 1963	600, 000

This program is based upon the premise that the attainment of established goals for power reactor development is to a large extent dependent upon obtaining positive answers to questions of safety. Terrestrial reactor safety work to date has been based largely upon laboratory and other scientific scale investigations. To satisfactorily resolve these questions of safety it is necessary to undertake a program which will involve engineering testing of entire systems and components up to full scale in size. As presently envisioned, this program will involve destructive tests on various types of reactor cores, large-scale investigations on the effects of the release of fission products within a containment shell, and a continuing effort to examine the safety features of nuclear components of specific system designs. This program was started at the national reactor testing station in the latter part of fiscal year 1962. The effort consists primarily of planning assigned safety tests and determing the scope and nature of later experiments to be performed and of initiating conceptual design of facilities which will be required for the conduct of this program. In fiscal year 1963 conceptual design of facilities will be completed and design of a destructive test of a low enrichment uranium oxide core will be completed and procurement of required components initiated. In fiscal year 1963 it is also planned to initiate work on the destructive test of a reactor core in a pressure vessel in order to determine what forces are applied to the pressure vessel during a violent nuclear excursion. Similarly, work will begin on a large-scale water reactor loss of coolant accident test. From this experiment it should be possible to determine for the first time the general extent of fission product deposition within the containment shell.

13. Airplane Propulsion Reactor, 0

The aircraft nuclear propulsion program has been terminated. This action was taken following a decision by the President as announced in his fiscal year 1962 budget message to cancel the development program for nuclear military aircraft. Since March 1961, effort has been directed to an orderly closeout. The costs of $478,000 for fiscal year 1962 provide for completion of certain physical termination tasks, inventory of equipment, subcontract settlement, and costs of employee termination; therefore, no funds are required in fiscal year 1963.

14. Operational Services, $1,300,000

Included in this category are the distributed costs of the materials testing reactor, engineering test reactor, the commercial test reactors (General Electric and Westinghouse), operations of the national testing station, and such other costs as startup and standby, transportation, and security shipment. A summary by activity follows:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(*a*) Test reactors	0	0	0
(*b*) National reactor testing station	$173,435	$150,000	$400,000
(*c*) Reactivity measurement facility	170,005	40,000	0
(*d*) Sampling and analytical services	10,240	25,000	30,000
(*e*) Stanby costs	55,365	809,000	700,000
(*f*) Beryllium inventory losses	247,114	0	0
(*g*) Transportation and security shipments	112,311	140,000	170,000
(*h*) Other operational services	0	15,000	0
Total	768,470	1,179,000	1,300,000

(*a*) *Test reactors*

	Fiscal year 1962	Fiscal year 1963
Test reactors, net	0	0
Gross costs	$11,268,000	$12,915,000
Less special services	1,100,000	1,300,000
Net distributions—AEC users	10,168,000	11,615,000

Gross cost of operation of test reactors will be distributed to users either by direct charge or transfer to other offices.

Gross costs distributed to AEC users in fiscal years 1962 and 1963 are as follows:

	Fiscal year 1962	Fiscal year 1963
Program 2000	1,045,000	1,100,000
Program 3000	165,000	56,000
Program 4000	8,812,000	10,260,000
Program 5000	127,000	190,000
Program 6000	19,000	9,000
Total	10,168,000	11,615,000
Irradiation units	530,000	693,000
MTR–ETR	500,000	650,000
Commercial	30,000	43,000

The ANP loops will be reoriented to other users during fiscal year 1962, and it is assumed that, by the end of fiscal year 1962, all space in the MTR–ETR will be occupied. Complete utilization will be made of these reactors in fiscal year 1963.

(*b*) *National reactor testing station*

	Fiscal year 1962	Fiscal year 1963
National reactor testing station, net	150,000	400,000
Gross	6,100,000	6,775,000
Revenues	1,095,000	1,175,000
Distribution credits	4,855,000	5,200,000

Gross costs, except those for advanced planning, will be offset by cash revenues from users or by distribution to users. Advance planning funds are used by Idaho or placed under contract for special services at the NRTS. These services are not related to any particular activity but are essential to efficient administration of the site operations. The types of services contemplated in fiscal year 1962 and fiscal year 1963 are (1) underground water studies in cooperation with U.S. Geological Survey, (2) aggregate investigations and overall site development. (3) halogeton and predatory pest control, (4) provision for award of damage claims resulting from cancellation of stock grazing permits, and (5) criteria studies for construction of future projects.

(*c*) *Reactivity measurement facility*

	Fiscal year 1962	Fiscal year 1963
Reactivity measurement facility, net	40,000	0
Gross	240,000	260,000
Revenue	200,000	260,000

The net cost of the reactivity measurement facility will decrease $60,000 in fiscal year 1963. The ARMF will be in complete operation and all costs will be distributed to users, in contrast to fiscal year 1962 when a net cost of $60,000 will result due to the modification of the ARMF and transfer of the RMF from the MTR canal to the ARMF building as well as calibration and checkout of the RMF at its new location.

(*d*) *Sampling and analytical services*

Fiscal year 1962	$25,000
Fiscal year 1963	30,000

The New York Office, in connection with the processing of scrap, will perform analyses of uranium scrap recovered, and conduct a technical administrative and economic review of the scrap recovery program.

(e) Standby costs

Fiscal year 1962	$809,000
Fiscal year 1963	700,000

Standby costs of $600,000 in fiscal year 1962 and $500,000 in fiscal year 1963 are estimated for the ANP facilities at Idaho, plus $220,000 in fiscal year 1962 and $200,000 in fiscal year 1963 for the radiochemical processing plant at Oak Ridge National Laboratory.

(f) Beryllium inventory losses

Fiscal year 1962	0
Fiscal year 1963	0

Responsibility for beryllium ingot contracts was transferred to the weapons program during fiscal year 1961.

(g) Transportation and security shipments

Fiscal year 1962	$140,000
Fiscal year 1963	170,000

Security shipments are made by both Chicago and Idaho to various parts of the country and involve MTR–ETR irradiated material, CPP reprocessed materials; fuel elements, and special courier services. The increase in fiscal year 1963 is attributable to increased processing of fuel at the chemical processing plant.

(h) Other operational services

Fiscal year 1962	$15,000
Fiscal year 1963	0

This activity includes DRD portion of cost of personnel filter devices prepared by the Department of Army and used at AEC installations throughout the country.

15. Other Capital Equipment, $4,700,000

The estimates for costs incurred for "Other capital equipment" by fiscal year are as follows:

Fiscal year 1961	$7,711,205
Fiscal year 1962	5,020,000
Fiscal year 1963	4,700,000

Equipment associated with each specific activity has been included in the individual request for the activity. However, there are many pieces of equipment required by the contractors and field offices which cannot be specifically identified with any one activity. They are items which are used for more than one area of research and development and include such things as shop-type equipment, health and safety equipment, motor vehicles, typewriters, and other general-purpose equipment. The estimates for fiscal year 1963 include requirements for the following installations:

	Fiscal year 1962	Fiscal year 1963
Los Alamos Laboratory	$120,000	$100,000
Oak Ridge National Laboratory	812,000	450,000
Knolls Atomic Power Laboratory	290,000	450,000
Westinghouse Laboratory (Bettis)	1,250,000	1,200,000
Reynolds Electric Co	0	100,000
Phillips Petroleum Co	865,000	1,200,000
Brookhaven National Laboratory	90,000	100,000
Argonne National Laboratory	1,600,000	1,100,000
Oak Ridge operations office	−53,000	0
Savannah River operations office	46,000	0
Total	5,020,000	4,700,000

Total costs for capital plant investment for the reactor development program through fiscal year 1961 were $700 million. Much of the general-purpose equipment charged to this category is for replacement of items acquired in prior fiscal years.

PLANT ACQUISITION AND CONSTRUCTION

Reactor Development Program—Construction Obligations

Program statement

Estimated obligations, fiscal year 1963	$77, 950, 000
Estimated obligations, fiscal year 1962	165, 701, 769
Actual obligations, fiscal year 1961	84, 767, 131

Obligations for the reactor development program for fiscal year 1963 are estimated at $77,950,000 for the projects listed below:

Project No.	Title	Estimated cost	Funded through fiscal year 1962	Estimated obligations, fiscal year 1963
63-e-1	Housing for lithium-cooled reactor experiment	$5, 000, 000	0	$5, 000, 000
63-e-2	Modifications to reactors	5, 000, 000	0	5, 000, 000
63-e-3	Organic power and heat industrial reactor	20, 000, 000	0	20, 000, 000
63-e-4	Research and development test plants for Project Rover	10, 000, 000	0	10, 000, 000
63-e-5	Modifications and additions, CANEL, Middletown, Conn	1, 400, 000	0	1, 400, 000
63-f-1	Cafeteria, ANL, Illinois	1, 500, 000	0	1, 500, 000
63-1	General plant projects	8, 100, 000	0	8, 100, 000
61-d-9	Advanced test reactor	47, 000, 000	33, 550, 000	13, 450, 000
59-d-10	Flexible experimental prototype gas-cooled reactor	51, 000, 000	40, 000, 000	11, 000, 000
58-e-11	Sodium reactor experiment (SRE) modification, Santa Susana, Calif	4, 700, 000	2, 200, 000	2, 500, 000
	Total	153, 700, 000	75, 750, 000	77, 950, 000

EXPLANATION OF PROJECTS ABOVE

1. Project 63-e-1—Housing for lithium-cooled reactor experiment, $5 million

This project provides new construction and/or modification to existing facilities (including equipment, auxiliaries, utilities, roads, and other site improvements), for the assembly, test, and disassembly of an advanced, high-performance lithium-cooled reactor experiment fabricated of columbium base alloy. The successful completion of this project will provide the design and performance data necessary for the fabrication and test of compact, high-temperature, high-performance prototype reactor systems for space applications. The general objectives of this experiment are to obtain engineering performance data, physics data, operating experience, data on the structural integrity of the reactor system by post-test analysis.

2. Project 63-e-2—Modifications to reactors, $5 million

This project provides for the modification of AEC-owned experimental reactors, critical assemblies, and major test cells. A major segment of the reactor development program is dependent upon the effective use of these facilities and funds must be available to effect the modifications and improvements which are dictated by progress in research and development and by operating experience. While it is not possible to anticipate accurately the modifications which will be required, it is envisioned that this project would provide for items such as the upgrading of the EBR–II through the provisions of improvements to the control system, installation of additional instrumentation to facilitate the test program and the design and development of improved components; modifications to ZPR–III in order to accommodate larger plutonium fuel loadings. Extensive and complex test cells for the SNAP and PLUTO programs are now in existence or planned and there will be a continuing need for modifications to these to accommodate more advanced experiments and those required by the changing nature of test operations.

3. Project 63-e-3—Organic power and heat industrial reactor, $20 million

This project provides for the design and construction of a 160-MWt organic power and heat industrial reactor (OPHIR) which would demonstrate the organic cooled and moderated reactor concept for the generation of electric power and it would enable the Commission to achieve the objective of the POPR (prototype of an advanced type of 300-MWE organic power reactor.) In addition, it would also demonstrate the capabilities of the organic cooled and moderated reactor concept for process heat.

Studies of the potential organic cooled and moderated power reactors have indicated that they can be made competitive with fossil-fired plants in high fuel cost areas of the United States in the near future. In order to demonstrate this capability, a prototype plant suitable for extrapolation to 300 MWE should be constructed in the immediate future. The organic power and heat industrial reactor will demonstrate this capability of organic power reactors for generation of large central station electric power.

4. Project 63–e–4—Research and development test plants for Project ROVER, $10 million

This project provides for the design and construction of such additional developmental and test facilities as may be required to support the ROVER program in fiscal year 1963 and subsequent years. The scope of the facilities cannot be determined at this time as detailed requirements will only become known as the research and test programs progress. This project will, however, assure the availability of funds for necessary facilities as the need for them becomes apparent.

To meet the objective of the ROVER program, the test and other facilities presently available must be expanded to permit the testing of reactors of significantly higher power for extended periods of time. Based upon present knowledge of facility requirements, it is probable that substantial modifications must be made to the existing ROVER test complexes at NTS to permit the conduct of more extensive diagnostic tests. It is also anticipated that there will be a considerable expansion of facilities required for fallout studies and other reactor safety work as well as the specialized shops, waste disposal, and decontamination facilities and other supporting and service areas.

5. Project 63–e–5—Modifications and additions, CANEL, Middletown, Conn., $1,400,000

This project provides for modifications and additions to existing facilities to provide the following areas required in the fabrication of large columbium components to be used in the lithium cooled reactor experiment: (1) A welding and annealing room and associated Argon purification system to provide an inert atmosphere to prevent oxygen contamination at elevated temperatures, and (2) modification of the fabrication shop to provide a "clean" room to insure freedom from contamination for columbium materials and components during assembly, storage, and inspection.

6. Project 63-f-1—Cafeteria, Argonne National Laboratory, Illinois, $1,500,000

This project provides for the construction of a cafeteria to be located in the west area, ANL. It will involve a 36,000 square-foot, single-story structure which will contain complete food preparation, serving, and dining facilities for a cafeteria operation seating 950 persons. Based on this capacity and 2½ times turnover, it will serve approximately 2,400 persons. Present cafeteria facilities at ANL consist of a 450-seat facility in the east area and one of 350 seats located in the physics building in the west area. Both of these facilities are now badly overcrowded. The need for adequate cafeteria facilities will become more acute with the expansion of the laboratory. In addition, the number of visitors to the AMU and the scientific community in general continue to expand. Most of this growth will be centered in the west area where major research facilities are located. Replacement of the small west area cafeteria with the proposed facility will provide adequate eating facilities at the laboratory.

7. Project 63–1—General plant projects, $8,100,000

The work contemplated under this project consists of many miscellaneous improvements, alterations, and additions, including minor new construction. Similar work is performed annually in order to provide for the continuity of operations, improvements to techniques, and reduction in operating costs in the various facilities of the reactor development program.

8. Project 61-d-9—Advanced test reactor, $13,450,000

The advanced test reactor is an experimental four-lobe high-flux reactor and loop system designed to operate at 250 MW and to provide environmental conditions (flux, coolant, temperature, pressure, flow rate, etc.) representative of the advanced reactor requirements of various reactor and materials development programs. This reactor and its related experimental facilities will provide needed heat generation values and neutron fluxes which are manifold greater than can be provided in any present test reactor. In addition, better instrumented and more sophisticated experiments will be possible in this reactor as a result of planned design features among the most important of which are temporal consistency and

minimal special variation of experimental flux. Funds presently available to the AEC total $33,550,000. Additional appropriation of $13,450,000 will be required in fiscal year 1963 for completion of construction of the basic project and test loops.

This amount includes an increase of $7 million over the previously estimated total cost of $40 million. The increase is based on completion of title I design and 40-percent completion of title II for the reactor, and partial completion of title I on the loops. It will provide for: (1) Increased cost of architect-engineering services; (2) increased construction costs related to provision of a leak-tight building, winter construction, escalation, and change to stainless steel in the primary system, pumps, and valves; (3) additional equipment requirements, increased electric power requirements, and additional mockup requirements; and (4) revision of previous preliminary estimates for the nine test loops (now estimated to cost $13,500,000).

9. Project 59–d–10—Flexible experimental prototype gas-cooled reactor, $11 million.

This project includes the design and construction of the major test facility in the gas-cooled reactor program and will simultaneously demonstrate prototype features of large-scale reactors. Construction of this reactor will provide construction and cost experience upon which future central station powerplants will be built. Operation of this prototype-size reactor will determine the limits of performance of this type reactor, establish maintenance and reliability characteristics, and establish a basis on which fuel cycle costs of gas-cooled reactors can be reasonably predicted. The facility will be able to accommodate large in-pile facilities for irradiation of advanced fuel elements, and the experimental capability will permit testing of a variety of normal- and low-enrichment fuels from natural uranium elements to combined fuel-moderator elements which encompass the fuel designs now contemplated for civilian gas-cooled reactors at the proposed operating conditions of these reactors.

Public Law 85–590 authorized the appropriation of $51 million for a gas-cooled, graphite moderated, reactor prototype of about 40 megawatts of electrical output. Subsequent technical review of the Commission's overall gas-cooled reactor program pointed up the need for a more flexible experimental reactor to advance technology on a broad front and the authorization was reduced to $30 million. Construction was started in August 1959. In November 1960, the total estimate was revised to $40 million, the current amount of funds available for this project.

Subsequently, further review of the project completed in March 1962 based on design completion of 99 percent and construction completion of 38 percent has resulted in a revised total estimated cost of $51 million. This additional increase of $11 million, for which appropriation is requested herein, is required for (1) unanticipated difficulties encountered in basic design of the project and its related components, (2) reactor plant equipment changes and revisions, (3) delay in completion of construction, (4) possible claims, and (5) addition of new items required for safety.

10. Project 58–e–11—Sodium reactor experiment (SRE) modification, Santa Susana, Calif., $2,500,000

This project provides for (1) the design, development, fabrication and installation of an advanced design reactor system to replace the present system in the sodium reactor experiment (SRE), and (2) other engineering changes in the SRE in an effort to correct functional difficulties or improve the performance of the original reactor installation. Completion of this project will result in an SRE rating of 45 megawatts (thermal) at a reactor outlet temperature of 1,200° F. Funds in the amount of $2,200,000 are currently available for this project. An additional appropriation of $2,500,000 is required in fiscal year 1963 for the engineering and construction of phase II, advanced reactor system.

Mr. EVINS. We shall be pleased to hear the very able director of the reactor development program, Mr. Pittman.

Dr. PITTMAN. Thank you, sir.

Mr. EVINS. You may give us such statement as you wish to give us at this point.

Dr. PITTMAN. Yes, sir. From the tenor of the previous questions I assume that one of the major things that this committee is interested in is the increase in the new fiscal year over the previous year, so I would like to take a few moments to explain this.

Mr. EVINS. You are asking for an increase of $73,971,000 for reactor development.

PROJECT ROVER

Dr. PITTMAN. Yes, sir. The major portion of the increase is an increase of approximately $31 million in the rocket propulsion reactor portion of our program. This is the Project Rover program that we and NASA are jointly undertaking to develop nuclear energy as a means of placing rockets in orbit or to the moon or to the planets.

The time schedule on the first test of the nuclear rocket program is in 1966 and 1967. Therefore we are getting into the fiscal years when this program which is a very large program between ourselves and NASA is beginning to get under full steam.

We have within the past year, as you know, selected an industrial contractor, the Aerojet General Nucleonics Co., with the Westinghouse Co. as a subcontractor to take on the responsibility of building the NERVA engine rockets for the test phase of this program.

There will be eventually some 40 or 50 different rockets that will be tested in various ways prior to the launching of the first rocket into a test flight in 1966.

Mr. EVINS. The major portion of your increase, Mr. Pittman, is based upon the request of NASA and their program; is that correct?

Dr. PITTMAN. This $31 million is all AEC money. In addition to this, there is a rather large number of dollars that NASA is requesting. The total program for this period is about $150 million, of which about half is ours and the other half is NASA for the 1963 period.

Mr. EVINS. Will NASA reimburse you for all the work you do for them?

Dr. PITTMAN. We are requesting the $75 million in our budget. NASA is requesting roughly $75 million for nonnuclear aspects. The program is run by a joint group of NASA and AEC, headed by Mr. Finger. If you would like to have detailed discussion I would like to turn it over to Mr. Finger.

Mr. EVINS. The joint special committee has been set up between AEC and NASA and you are asking for your own funds in your budget and they are asking for their funds in their budget.

Dr. PITTMAN. That is right. It is not a committee. It is run by this group of people, with one man, Mr. Finger, who reports both to AEC and NASA with full responsibility.

SNAP PROGRAM

Mr. EVINS. How much is related to the reactor development program exclusive of NASA?

Dr. PITTMAN. $31 million of the increase is in the Rover program, sir. In addition to that, another large aspect or another large phase of our program that is increasing is in that phase of the program where we are developing reactors for use in space for satellite programs and for power programs in space. This will increase between 1962 and 1963 by $22 million. This is the second largest increase.

This is the program which uses both isotopes and nuclear reactors for the development of power in the range of a few watts to as much as a megawatt or more, for use in space to furnish the necessary power to transmit signals back to this earth from orbit. It will be used eventually for ion propulsion schemes to help move the systems from

one orbit to another. It will be used for television transmission in these satellites.

This is becoming an increasingly large program in AEC's efforts. It is one of the most important activities of the nuclear energy program. We are embarking this year for the first time on a new program called SNAP 50, the high-powered program that will eventually lead to the type of power device to make it possible to put rather large uses of power in space.

Mr. EVINS. You have been addressing yourself so far to space programs and programs in connection with NASA. We have read press reports and other notices of cancellation of one potential power project after another. Please tell us which projects, if any, stand a chance of coming to maturity in the civilian power program.

CIVILIAN POWER PROGRAM

Dr. PITTMAN. The civilian power program is going on at approximately the same level in 1963 as it did in 1962, approximately $94 million. The situation with regard to the civilian power program is that we are quite convinced as was mentioned the other day in Admiral Rickover's testimony that the water reactor systems that we have had under development for some time have now reached the point of technology where they are capable of producing power that will be competitive in high-cost regions of this country within the next few years.

Mr. EVINS. How many civilian power reactor programs is AEC working on at this time?

Dr. PITTMAN. You mean different concepts?

Mr. EVINS. Different types of reactors for civilian power.

Dr. PITTMAN. The concepts are boiling, pressurized water, nuclear superheat, heavy water organic cooled, sodium graphite, gas cooled, and the fast breeder reactors.

Mr. EVINS. That is about eight.

Dr. PITTMAN. Eight different basic systems that we are working on at this time.

Mr. EVINS. How many have you worked upon in the past? Some 16 or 20? You have refined them down to about eight basic fundamental concepts.

Dr. PITTMAN. We have dropped from our consideration in the past the aqueous homogeneous reactor system because it did not seem to be ready at this time. We have dropped the sodium-cooled, heavy water moderated system. We have dropped the liquid metal cooled reactor system. I am sorry, the liquid metal fueled reactor system. Those three which we have worked on at one time or another are no longer part of our program. All of the others have been carried forward to the point where we now know that they are engineeringly feasible, in the case of water reactors, even economically feasible.

Mr. EVINS. I want to commend you as a Director and commend the AEC because I think they are a little belatedly accepting some of the suggestions of this committee that you concentrate on a few that are practical and acceptable rather than scattering your efforts too widely over the field. It has been my thought all along that you ought to pick out a few that are promising and concentrate on them and move to completion. Do we have any that are nearing the stage

of completion or construction that will be of material benefit in civilian power programs?

Dr. PITTMAN. Yes. This year there should be 10 power-producing prototype reactors coming on stream. Those reactors will not be economical in themselves. They are relatively small in size, varying from 10 to 12 megawatts up to 50 to 60 megawatts. But each of them in different concepts will give us the type of information that we have been spending so much money and effort on the past 4 or 5 years, will give us the culmination of that information to allow us to say whether or not these systems offer economic power.

Mr. EVINS. Will you list those reactors by name for the record and location?

Dr. PITTMAN. Yes.

(The information follows:)

Civilian power producing prototype reactors to reach criticality and be in operation in fiscal year 1963

Reactor	Location	Type	Net megawatts electrical power level
Experimental breeder reactor No. 2 (EBR-II).	NRTS, Idaho	Fast breeder	16.5
Hallam nuclear power facility, Consumers Public Power District.	Hallam, Nebr	Sodium graphite	7.6
Elk River reactor, Rural Cooperative Power Associates.	Elk River, Minn	Boiling water	22.0
Piqua nuclear power facility, city of Piqua, Ohio.	Piqua, Ohio	Organic cooled and moderated.	11.4
Enrico Fermi atomic powerplant, Power Reactor Development Co.	Lagoona Beach, Mich	Fast breeder	60.9
Pathfinder atomic powerplant, Northern States Power Co.	Sioux Falls, S. Dak	Boiling water, nuclear superheat.	62.0
Big Rock nuclear powerplant, Consumers Power Co.	Big Rock Point, Mich	Boiling water	47.8
Carolinas-Virginia tube reactor, Carolinas-Virginia Nuclear Power Associates, Inc.	Parr, S.C	Pressure tube, heavy water.	17.0
Humboldt Bay powerplant, unit No. 3, Pacific Gas & Electric.	Humboldt Bay, Calif	Boiling water	48.5
Indian Point unit No. 1, Consolidated Edison.	Buchanan, N.Y	Pressurized water	255.0

Mr. EVINS. You are undertaking a large central station seed-blanket reactor. Please give us some of the details about this concept and how it differs from others. What are its prospects for producing economically competitive electric power?

Dr. PITTMAN. This is the seed and blanket concept that Admiral Rickover discussed with you the other day, Mr. Evins. The primary difference between this and the other concepts we are looking at is the way that the uranium is used in the core. It is a water-cooled reactor, a pressurized water reactor, quite similar in many respects to that which is used at the Yankee Atomic Electric Plant and others. The difference is that instead of using a uniformly enriched uranium core throughout, you use natural uranium with spikes of highly enriched uranium located at strategic points around the core. This allows the production of a fairly large fraction of the power from natural uranium which has not been through the gaseous diffusion plant and therefore is not dependent on the burning of coal to produce nuclear power.

As far as the economics of this system are concerned, the main reason we want to enter into this development program that is proposed in this budget is to find out the physics and the engineering aspects that will tell us whether or not this can be economically competitive with the other water systems.

Mr. EVINS. The experimental boiling water reactor and the Borax 5 reactor seem to have reached the end of their usefulness. Can you please tell the committee what value these experiments have been?

Dr. PITTMAN. The experimental boiling water reactor at Argonne was a reactor that gave essentially all of the initial information about the boiling water scheme which has led to the construction and operation already of the Commonwealth Edison Co. plant near Chicago. It has led to the construction of two large plants in Europe and has led to the initial phases of the construction of the so-called Bodega Bay plant which is a large 375-megawatt plant being built by Pacific Gas & Electric with no Government assistance at all for the purpose of producing hopefully economic power in the California area.

We feel that experimental boiling water reactor (EBWR) has reached the end of its usefulness as an experimental boiling water reactor, and we are not proposing to continue its operation throughout fiscal year 1963. However, because of our interest in using plutonium as a fuel since plutonium will be an excellent fuel in the future, we are going to use that facility to fuel it with plutonium and get information about the use of plutonium.

The Borax 5 is just coming into operation for the first time as an experiment that will furnish us technology about the use of water reactors for nuclear superheat. The trouble with water reactors is that they produced saturated steam—and this includes Shippingport. The steam that comes off of water reactor is not superheated. To utilize this steam requires very large turbines. Modern powerplants do not use turbines of this type. In order to make a water reactor give us the type of steam that can be used in modern efficient steam turbines, we have to superheat it. You can superheat by using fossil fuel but we feel in the nuclear energy program our objective is to get the most out of nuclear energy. This is why we are using the Borax 5 reactor as well as the Bonus and Pathfinder plants to use the best modern turbines in use today.

I have always felt it was a shame for us to come along with the newest technology and have to go back 40 or 50 years in the technology of the turbines to use in this scheme.

Mr. EVINS. Mr. Pittman, are there very successful reactors in which you have the prototypes completed and located? Has there been a wide application and use and acceptance of them by the private utilities and others? Are they buying what you have developed?

Dr. PITTMAN. They are not yet buying what we have developed and the reasons are that there is not yet statistical operational experience from the reactors we have built to show them what these reactors will do. There is a fairly great degree of interest and enthusiasm on the part of the large utility companies, particularly those utility companies in the high-cost areas and areas that can't burn coal. That is why the Californians are so interested, also because of the smog problem. The interest is there.

The main thing utilities need to be shown is statistical operational data that comes from these plants which we are now building is such

that they can extrapolate to the economics of these plants. I personally think that the enthusiasm they are showing will result in the purchase of quite a few plants in the next few years.

Mr. EVINS. After you develop these workhorses, so to speak, you are experimenting with more sophisticated reactors?

Dr. PITTMAN. That is right. The plants that we feel are ready for commercial application today, we feel can only be competitive in those areas in the country where fossil fuels are high, 35 or 40 cents a million B.t.u. There is no evidence that the price of fossil fuel is going to rapidly increase so we are trying to shoot at a moving target and define reactor systems that will compete.

COOPERATIVE RESEARCH AND DEVELOPMENT PROGRAM WITH CANADA

Mr. EVINS. On page 1080 of the hearings last year, you showed us a budget estimate for $1 million in research on Canadian program cooperation. In your justification you show you are spending $1,800,000, nearly twice the amount estimated. Please explain this overrun of about 50 percent in your current program.

Dr. PITTMAN. In the course of carrying out this program with the Canadians under our cooperative effort we undertook, because of capabilities of American industry, to handle this kind of job to help them in the development of the best possible charging machine needed for this device. If heavy water natural uranium reactors are to be useful to us at all, you must be able to charge and discharge them without shutting them down for days or weeks. You have to do it continuously.

This requires a very complicated charging and discharging machine. The main reason for this increase in cost is that during the course of developing this charge machine, we found it was much more complicated than we originally estimated. The increased costs are partially for that plus the fact that we have distributed to each activity equipment which previously was lumped in one account in the budget.

Mr. EVINS. What about the increased cost of the Canadian portion of the project?

Dr. PITTMAN. The $800,000 increase is split between the additional charges for equipment, and this, Mr. Evins, is part of a continuing program of which the total authorization was $5 million.

Mr. EVINS. Mr. Pittman, you can appreciate it is a little discouraging and disconcerting to this committee to approve a project based on what we assume is a firm figure and next year you come up with a revised estimate and your initial estimates were inaccurate. The committee expects you to stand within your program justifications.

Dr. PITTMAN. I feel just as badly about any overruns we have as you do. One of the major problems in development programs is that as you go you learn. Very often the learning is on the more costly rather than the less costly side.

Mr. EVINS. Wouldn't it be better to delay the completion of the project instead of going ahead and expanding and then coming to the committee?

Dr. PITTMAN. On construction projects, this is right. On the operational program where we have going programs if you stop them—have a hiatus, you find generally it costs more to stop and come back at a later date than to continue it.

REPROGRAMING OF FUNDS

Mr. EVINS. Based on your budget presentation last year you planned to spend this year a total of $5,350,000 under the heading, "Water-Cooled Reactors, Other." Now you show us on page 65, the justification, that you are spending a total of $9,346,000 on this program. Here again is another overrun nearly twice the amount.

Dr. PITTMAN. In this particular case of "Water-cooled reactors, other," there is an increase of $125,000 for radiation services that was not covered in this activity at the time. The program itself did not increase, but we have to pay money for radiation service in the MTR and ETR. It is really a transfer of funds from one activity to another. In addition, we increased, and this is the major increase, we found we were getting into trouble on the nuclear superheat program. We increased our nuclear superheat program by about $2 million because of the problems we were having with the cladding material on the fuel. It was not standing up under the steam. We felt we had to get a decent cladding material. This is part of the expansion.

Mr. EVINS. Mr. Pittman, you speak of transferring funds from one project to another. The committee really is not aware of what we are appropriating for when you operate on this basis. They ought to be firm figures. They ought to be submitted to the committee accurately as to what your needs are. If you find you need additional funds, you should request them either in a supplemental or otherwise.

Dr. PITTMAN. Mr. Chairman, these were not additional funds. It was a reorientation of where the funds were to be spent. For instance, we now have under "Water cooled, other," all of those activities that are not specially applied to one of the projects that we had in mind. For instance, we have two ways of looking at the water-cooled program. It is either funds that are applied to the specific projects such as Shippingport, EBWR, Borax, Bonus, or the heavy water component test reactor, or it comes under this "other" water reactors. The reason we did that is that we felt it would be to our advantage as well as to the advantage of those who are using these figures to know what a specific project was costing us. Therefore, we have transferred out of what used to be pressurized water reactors and put into "Water cooled, others." It is a recategorization rather than additional expenditure. I think we can give you in every case exactly where the money showed up in the previous budget and where it shows up now. In some cases we have gone over and other cases we have gone under to balance it off. I think we can give you a complete breakdown of that if you like it. The whole point is that we have tried to make the categorization.

Mr. EVINS. I believe it would be well if you supply the breakdown for the "other." This is your catchall.

Dr. PITTMAN. All right, sir.

(The information follows:)

Comparison of fiscal year 1962 estimates

[In thousands]

	Fiscal year 1962 congressional	Add equipment	Revised total	Present estimate	Change
Civilian Power—Water-cooled reactors: Water-cooled reactors, other	$6,850	$168	$7,018	$9,346	+$2,328
Pressurized water (spectral shift)	1,500	150	1,650	1,577	−73
Light water, superheat	1,350	18	1,368	3,802	+2,434
Heavy water	4,000	0	4,000	3,967	−33

In view of unresolved problems remaining from R. & D. performed prior to fiscal year 1962 on the nuclear superheat program and based upon results of the steam-cooled reactor study (requested by the JCAE by Public Law 86–457) which reaffirmed the economic incentive for nuclear superheat, it was concluded that additional nuclear superheat developmental efforts aimed principally at improving fuel elements should be undertaken in order to resolve the technical uncertainties with respect to superheat fuel elements as well as evaluating the potential of the superheat concepts in meeting both the short and long range objectives of the civilian power program.

The decreased costs in "Pressurized water," and "Heavy water reactors, other," are due to more refined estimates of costs.

Dr. PITTMAN. We are not attempting to confuse the issue or hide any expenditures from this committee.

OPERATIONAL ANALYSIS, PRIVATELY FINANCED REACTORS

Mr. EVINS. On page 68 of the justification, your program provides $1 million for operational analysis, privately financed reactors. You give the committee no specifics as to where you will spend this money. Please elaborate on this catchall item.

Dr. PITTMAN. We and the private industry of the country have spent a fair amount of money developing such reactors as the Yankee reactor, the Consolidated Edison, Commonwealth Edison reactor, and others. The objective of this particular million dollars is to be able, as these reactors go forward with their operation, to get the information from them and to analyze that information in such a way that it will be of most use to our program and the program of the private power industry of the future. This money will not be spent in any way that will enhance the operation of the particular reactor we are working with. If we put a piece of equipment in the reactor, it will be a piece of equipment that we want to gather information on and not one that will improve the operating conditions of the reactor itself. The basic purpose of this is to take full advantage of the privately financed reactors that are in existence and will be in existence so we can get the maximum amount of information available for all the people interested.

Mr. EVINS. You are spending a million dollars to analyze the results of privately financed reactors.

Dr. PITTMAN. We are spending a million dollars to first assure that the results we want are being gathered and the data is being taken. Secondly, to analyze this in such a way that it will be useful to our program and everybody else.

Mr. EVINS. What agreements do you have at this point to assure that you will be provided the information?

Dr. PITTMAN. The first one we worked out is with the Yankee reactor. The situation there is that we will make a contract with that particular reactor operator so that he will give us all the operating information that is coming from the reactor. More importantly, that he will let us gather information that he would not otherwise be interested in gathering. I think this is the more important factor. We can put instrumentation into his reactor and gather information that will be very valuable to all of the people in this business that we would not otherwise get.

Mr. EVINS. Will the reactor owners cooperate fully in this program?

Dr. PITTMAN. This is right, sir, they will. There is no question about that. The problem is this. You take the Consolidated Edison reactor, a privately constructed reactor with no AEC funds. The same with Commonwealth Edison. They have built that reactor for one purpose and that is to produce power at the cheapest possible price, which we are very interested in. We are quite convinced in those two cases, as they get operating, we would find if there were an instrument in those reactors that is not now in them that might cost $40,000 or $50,000, if we could put that in, we could get information out which would be very valuable to us and anybody else who is going to build a reactor in the next 5 or 10 years, as well as to Commonwealth and Consolidated.

Mr. EVINS. Mr. Director, how did you arrive at the round figure of a million dollars? Why couldn't it be refined more or less?

Dr. PITTMAN. If I could refine it, it might come out to $968,228, but I can't refine it that way. It is our estimate of the order of magnitude of this program for the coming year. Obviously it is not a program we have worked out with each of the companies.

Mr. PILLION. You had nothing for this item in 1962?

Dr. PITTMAN. No, sir.

Mr. PILLION. How many reactors will you be working on to get this information that you want?

Dr. PITTMAN. Initially we will talk about Consolidated Edison, Commonwealth Edison, consumers plant in Michigan, a privately owned plant. They won't be in during this period. This would be a continuing program, so as the P.G. & E. plant comes in we would be able to do that. Initially the Yankee plant. These are the ones we would be talking about during the next year.

Mr. PILLION. How many instrumentations will you put into one of the plants? They are not all going to be different.

Dr. PITTMAN. They will all differ, depending on the type of plant, the amount of instrumentation that is there, and the degree to which the data that we want is coming out. In addition to instrumentation—I use that as an example of where we will actually spend money for a piece of equipment that will go in the reactor—most of this is to take the information, to bring it together, to assimilate it, to make it into a meaningful form and publish it, and make it available.

Mr. PILLION. If you had one man getting the information that you want out of one of these plants at a cost of say $10,000 and you have five companies, you have a $50,000 expense, plus instrumentation, say another 50. That is $100,000. Why should it cost a million?

Dr. PITTMAN. I wish it were that simple, sir. It is not that simple. To begin with, I mentioned $50,000 as something that we might put

one piece of equipment in one reactor. There is also the situation if you ask a reactor operator to do something that is going to cause his reactor not to produce power that he would otherwise be getting reimbursed for, if he were producing, if it is worth that much for our program, then he has to be reimbursed for this kind of loss of power. That is included in here.

(Discussion off the record.)

Dr. PITTMAN. Since each of these has to be different, we have to make a rather broad estimate as to what they need to be. But we estimate that there will be down time from these reactors, and we do estimate we will have to do this.

INVESTMENT OF PRIVATE INDUSTRY IN NUCLEAR REACTORS

Mr. JENSEN. Dr. Pittman, you have been with the Atomic Energy Commission a long while, haven't you?

Dr. PITTMAN. Yes, sir.

Mr. JENSEN. How long?

Dr. PITTMAN. I have been with the Atomic Energy Commission since 1948, and I was at Los Alamos from 1944 to 1948. So essentially since 1944.

Mr. JENSEN. You have been with the Atomic Energy Commission in some phase since its inception, almost, haven't you?

Dr. PITTMAN. Practically. They started. I came soon after that.

Mr. JENSEN. I know you have been before this committee a lot of times. Can you tell the committee about how many dollars private industry has invested in atomic reactor plants?

Dr. PITTMAN. If I can remember the figure, the private investment is in the range of $400 to $500 million, but I would like to correct this for the record.

Mr. JENSEN. I wish you would put it in the record.

(The information follows:)

Current costs of private industry

[In millions of dollars]

	Utilities		
	Costs incurred through Dec. 31, 1961	Remaining costs to be incurred	Total costs
Research and development	40.3	4.2	44.5
Plant and equipment	267.1	119.5	386.6
Fuel fabrication	9.7	19.7	29.4
Land-training-use charge waived	6.7	2.7	9.4
Total, projects under construction	323.8	146.1	469.9
Total, projects completed	85.6		85.6
Grand total	409.4	146.1	555.5

Mr. JENSEN. The private utilities benefit from the knowledge.

Dr. PITTMAN. Yes, sir.

Mr. JENSEN. The private utilities benefit from the information which you furnish them.

Dr. PITTMAN. Absolutely. As a matter of fact, if they didn't have the information there would not be a private industry.

Mr. JENSEN. And the Atomic Energy Commission profits from the information that the private utilities provide.

Dr. PITTMAN. We profit, and the people of the country, from the information developed by these private reactors.

Mr. JENSEN. In fact, you are working hand in glove and in good neighborly spirit with private utilities.

Dr. PITTMAN. Our whole theory of operation is that we carry out the basic development program and early experimental programs. When it gets to the point of building power reactors, we do everything possible to build them under cooperative ventures with either private or public utilities. Then when they get further along, with commercial units producing power and on an economic basis, the AEC is out. We go through the phase where it is all AEC, to the phase where it is all private, and in the middle we are cooperating.

ECONOMIC POWER FROM NUCLEAR REACTORS

Mr. JENSEN. Economic competitive atomic power is how many years away, except in the high-fuel cost areas in this country? How many years do you estimate it would take before atomic power is competitive with hydro power?

Dr. PITTMAN. If you add hydropower, you are almost putting it to the point where nuclear energy will not be competitive with hydropower. We are not looking to the point of competing with hydropower. Maybe someday it will. Our first goal is to make it competitive with fossil fuel.

Mr. JENSEN. If I remember, we had a very able engineer for the Central Valley project in California testify before this committee a number of years ago to the effect that thermal power was the cheapest power produced, except in areas like the Pacific Northwest where the great Grand Coulee Dam and Bonneville and others were constructed many years ago when the cost was considerably cheaper than today's prices. Thermal power is now produced with gas and coal in some areas for around 3.5 mills a kilowatt-hour.

Dr. PITTMAN. In those areas where coal is quite cheap, that is right.

Mr. JENSEN. Of course, it will run to as much as 7 mills or more in the high fuel cost areas. But to build a hydropower plant today at the present cost of material and labor, I think the record will show that in general thermal plants can produce power cheaper than hydropower plants today. I think you will find that to be true.

Dr. PITTMAN. The reason I made the statement I made, and probably I should not get into this area, because it certainly is far beyond my competence, that the hydroplants produce other benefits than power to which their initial cost can be charged in many cases.

Mr. JENSEN. You probably refer to flood control, navigation, and irrigation.

Dr. PITTMAN. We have tried to shoot for competition with thermal plants, rather than with hydro plants. With thermal plants you can aim for the cost per kilowatt of construction and the cost of operation of the plant. That is what we are basing our competitive arguments on, that is, the thermal plants.

Mr. JENSEN. I don't want the record to indicate that I have any doubts about your sincerity, Doctor, or any member of the Atomic Energy Commission. I know you are dedicated people, having been

in this game for the past 18 years, and I appreciate your great knowledge of your job. We always like to see you before the committee.

Dr. PITTMAN. Thank you.

Mr. JENSEN. Your testimony is good and to the point.

Mr. EVINS. While we are commending the Director——

Mr. JENSEN. But you did not give me the time as to when atomic power will become competitive?

Dr. PITTMAN. No, sir. I was hoping you would forget that question. I will give you an answer for what it is worth. If I may forget hydro and think only of thermal, I think that a plant in the range of 350 to 400 megawatts, using either pressurized or boiling water systems, could be started within the next year. In other words, if some utility decided to start one right now in that size range it would be competitive over its life if built in one of the higher cost areas such as possibly California or New England or even possibly New York. I have to define high cost areas in the 35- or 40-cents-per-million British thermal units of fuel for thermal power, over the life of the plant on essentially present technology. It would be competitive. If you ask me when it will be competitive with a large fraction of the power of the United States, I will have to say that this will be in the 1970's and if you want a date, I will be perfectly happy to give you a date of 1975, as the time when nuclear power will begin to make itself felt as an economic factor in the utility business of this country. I don't think that it will happen much before 1975. So maybe Admiral Rickover and I are not arguing too far off. I am saying you can start today building plants that will be competitive in a few areas of the country if you build big ones. I will say by 1975 there will be enough areas of the country so it will have a real impact on the utility business of the country.

Mr. JENSEN. You base your competitive figures on the fact that atomic energy reactor plants have a longer life than a fossil fueled thermal plant?

Dr. PITTMAN. No, sir. I think right now this is one of the problems utilities are having. They don't know what life expectancy to calculate in their economic calculations. So they are probably using a somewhat shorter period. I think personally they will last as long as any plant that is built for the fossil fuels. In order for the statement I made to be true, it has to be a baseload plant. They have to use it 80 or 90 percent of the time. It can't be on and off.

Mr. EVINS. Mr. Director, my admiration for you personally is very great. We think you are a very dedicated man and very knowledgeable. Certainly you are skilled in this field. We have great respect for the Commission. My thought was that you should be sharper in bargaining and dealing with the private utility companies. I notice it was significant that our colleague stated that we get free information from the utilities and the Director responded that we get the benefit of their developments. He didn't use the word "free." I don't think we get much from them free. Whereas most of the giving is on this side of the bargaining table. I think that you could be a little better business administrator. You are a great scientist and technician and great people in developing these arts. You developed them and you now have them on the shelf, and we are developing more sophisticated prototypes, but they are not using them. Most of the giving is on the Government side of the table.

Mr. JENSEN. My only answer to that is that I am happy that the private utilities pay local, State, and Federal taxes which we need very badly in our treasuries. I think that is sufficient answer to that.

COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM

Mr. EVINS. It has previously been noted in these hearings there is only one new project in prospect in your justification under your cooperative power reactor demonstration program. What efforts if any will be made to get this program going again? We built many other types but the cooperative power reactor program is not moving along at great speed.

Dr. PITTMAN. Our program of cooperation with the utilities during 1963 will consist of, in essence, two areas. One, we will attempt by the use of modified authorization that we have asked the Joint Committee to provide us with, to initiate a cooperative program with the utility industry for the construction of large 400-megawatt or better powerplants with the basic objective to demonstrate that power can be produced in the competitive range that I have been talking about. The way we hope to encourage the construction of such reactors is through the use of research and development effort that we have been able to use all along and in addition through the payment for design for the plant itself. This should decrease the capital cost to the user.

Mr. EVINS. Why do you need a total of $4,296,000 for unsolicited proposals when the prospects of getting any are very bleak?

Dr. PITTMAN. If you are on page 83, that $4,296,000 for unsolicited proposals is the money we estimate will be needed in the event that the southern California Edison-Westinghouse project, which has been under discussion with the Commission for some time, go forward and is constructed. If you recall, this plant is being held up because of a site problem. The Southern California Edison Co. is desirous of locating this at Camp Pendleton in California. They have not yet been able to obtain the use of that site from the Navy or the Marines. Therefore, the reactor project has not gone forward. Our part in that program is the research and development contract with Westinghouse. This is the money we estimate will be needed in 1963.

Mr. EVINS. What changes have taken place since the initial programing?

Dr. PITTMAN. For that particular project?

Mr. EVINS. Yes.

Dr. PITTMAN. The thing that has changed since we initially went into it is that the Southern California Edison people have not been able to get the site nor have they been able to find another satisfactory site from the standpoint of both safety and the availability of water. This is a large plant. It does need a lot of cooling water. In California those areas where there is plenty of cooling water are not many.

COOPERATION WITH EURATOM

Mr. EVINS. What funds appropriated for the current year have been obligated to date on the Euratom program?

Dr. PITTMAN. I think Mr. Kratzer, who is here, has the exact figure. It is about $9.8 million either obligated or ready for obligation. In

other words, programs that have been accepted and ready to move ahead.

Mr. EVINS. I will make the further observation, you have continually presented optimistic testimony to the committee on this program but again this year you have predicted a budget estimate on events that have not yet taken place. Please give us in specific details as to why any additional funds are necessary for this program at this time.

Mr. KRATZER. As the committee knows we have $10 million authorized and appropriated for this program. We have actually to date and under contract close to $4 million. It was $3.7 million as of March 31, 1962.

Mr. EVINS. You have a $6 million carryover?

Mr. KRATZER. We don't have that carryover, sir, because as Dr. Pittman said, there are a number of other contracts not yet in effect, but which have been approved by the Joint Board which meets in Brussels and approves these programs. Once this approval is given by the Joint Board, we must go ahead and enter into contracts with the contractor in the United States. We have been holding back on the final approval of these contracts in order to wait and see how the response came along to the second invitation for reactors under the joint program; in other words, the reactors to be completed by December 31, 1965.

Mr. EVINS. How long has the Euratom program been underway?

Mr. KRATZER. The program actually got underway in 1958. That is when our agreement with Euratom was executed.

Mr. EVINS. How many projects have been developed?

Mr. KRATZER. We have accepted one project located in Italy.

Mr. EVINS. You mean we, the United States, have taken on the responsibility?

Mr. KRATZER. The United States and Euratom approved one reactor to be built in Italy. That reactor is built with private funds, but there are certain financial incentives offered under the program that help bring it into operation.

Mr. EVINS. That is not the only one Euratom is active in?

Mr. KRATZER. No; that is not the only reactor. I am not sure if I understand the question. That is the only one that has been accepted under the joint program with Euratom. There are other reactors which may be built in response to the invitation issued in the fall of 1960. The Commission and Euratom extended an invitation for two additional reactors to be completed by December 31, 1965. The responses to that invitation are still coming in.

Mr. EVINS. Could you give the committee a rundown as to how much we have contributed or appropriated to this Euratom program?

Mr. KRATZER. I will break that down into two parts. First of all, the joint research and development program, the item under consideration at this time. The U.S. appropriation has been $10 million, of which about $6 million has been obligated.

Mr. EVINS. You said four.

Mr. KRATZER. Obligations to date under contract are $4 million but there is an additional $2 million which have been approved by the Joint Board in Brussels and on which we must proceed with negotiation of contracts as soon as possible.

Mr. EVINS. In other words, you still have $4 million appropriated and available to you?

Mr. KRATZER. No, sir. Let me run down this item by item because it is confusing. There are $10 million appropriated.

Mr. PILLION. Authorized?

Mr. KRATZER. Appropriated also. There are $3.7 million as of March 31 under contract. In addition to this, there is an amount bringing it up to $6 million—I think the exact figure is $5.8 million—which have been approved by the Joint Board in Brussels but for which contracts have not yet been negotiated. There is an additional amount of about $3 million—bringing it up to $9 million—which have been approved here in Washington. In other words, approved by Dr. Pittman's technical people, but which have not yet been approved by the Joint Board consisting of ourselves and Euratom in Brussels.

It is these contracts which we have been holding off on pending the response to our 1965 invitation for reactor proposals. So that our contribution to date has been, from the standpoint of appropriations, $10 million, broken down in the manner which I indicated.

One thing I would like to point out, and we are quite gratified by this, this was to be a program in which Euratom and the U.S. contributions were to be on a par. So far Euratom has actually got under contract $13 million for this program, so they are very far ahead of us. As I say, this is an aspect of the program with which we are all pleased.

From the reactor standpoint we have one reactor under actual construction that is the SENN reactor.

Mr. PILLION. That is in Italy.

Mr. KRATZER. That is right.

Mr. PILLION. How many more in prospect?

Mr. KRATZER. The response to the 1965 invitation has come along in this fashion: We have one complete proposal from the SENA organization, a joint organization of France and Belgium to build a 210-megawatt pressurized water reactor in France, but serving the geographic area of the northern part of France and Belgium. That reactor is under final stages of consideration by the United States and Euratom. We can expect, but I can't assure you that it will come in, a proposal to build a large boiling water reactor in Germany from the RWE utility in Germany, which is the largest privately owned utility in Germany. We have received a proposal from another utility in Italy, the Seln Co., for a pressurized water reactor which is already under construction outside of the joint program.

Finally, we again expect, but cannot assure you that it will come in, a proposal from another utility in Germany for an organic moderated reactor. This is known as the KBWP proposal.

Mr. PILLION. As I understand it, then, you have an authorization for this Euratom program of $10 million, of which you either contracted or obligated about nine.

Mr. KRATZER. About nine.

Mr. PILLION. The $4 million that you are asking for 1963, is that within that $10 million or is it over and above?

Mr. KRATZER. That is over and above, sir.

Mr. PILLION. Then you don't have authorization for it?

Mr. KRATZER. No. We are requesting additional authorization.

Mr. PILLION. This is subject to authorization of the additional $5 million?

Mr. KRATZER. No.

Mr. MCCARTHY. Within the $10 million that we have this $4 million represents the cost we will incur in 1963 from that $10 million.

Mr. PILLION. This $4 million is within your authorization?

Mr. MCCARTHY. That is right. The funds are authorized. These are the estimated costs in 1963 incurred against the program. We are asking the committee to appropriate $5 million additional moneys in 1963. This will be obligational money in 1963.

Mr. EVINS. What do you propose to do with the $5 million?

Mr. MCCARTHY. It is $5 million subject to additional appropriation by this committee.

Mr. JENSEN. And subject to additional authorization.

Mr. MCCARTHY. Yes, sir; for which we are asking the Joint Committee.

Mr. PILLION. May I just ask one more question? You are dealing now with the European phase of this situation.

Mr. KRATZER. Yes, sir.

Mr. PILLION. Are you the gentleman who is also knowledgeable about the international situation all around the world?

Mr. KRATZER. I will try to answer your questions. Yes, I have that responsibility.

REPRESENTATION IN FOREIGN COUNTRIES

Mr. PILLION. Senator Ellender made a trip recently and he came back and criticized very severely the idea that we had an Atomic Energy Commission attaché in Japan and probably other areas throughout the world. How many attachés and officials do we have sitting around the countries outside of the United States?

Mr. KRATZER. We have foreign offices in Tokyo, as Senator Ellender said, Paris, London, Brussels, Chalk River, Canada, and Buenos Aires, Argentina. With the exception of London and Chalk River, these are regional offices which have responsibilities for a number of countries.

Mr. PILLION. What do these people do?

Mr. KRATZER. They serve two purposes. First to assist in our program of cooperation with the other government in the field of atomic energy.

Mr. PILLION. Cooperation is such a vague word. It is like coordinator, expediter. Just what do they do besides cooperate? Cooperate means absolutely nothing to me.

Mr. KRATZER. They review the atomic energy programs of these other countries for two purposes. First, to identify the areas in which we can be of some assistance to them. We have a program of being of assistance, of cooperating with other countries in the field of peaceful uses of atomic energy. We supply information. We sell materials at full cost. These people in these countries, by being constantly in touch with the corresponding officials of the other countries and reviewing their atomic energy program, find these areas where we can cooperate, where we can be of assistance.

Secondly, and very importantly, they extract information out of the programs of those countries and many have very creditable programs and return it here to the United States so that it can be used by the Commission and made available through the Commission to those phases of U.S. industry who can use it. We are getting useful information now out of Western Europe. They have developing atomic energy programs. We are getting useful information out of Tokyo.

Mr. PILLION. How many reactors does Japan have?

Mr. KRATZER. Japan has, I would say, three to four research reactors in operation.

Mr. PILLION. How different are they from ours?

Mr. KRATZER. They are not different in type, but certain research work that goes on in these reactors is different.

Mr. PILLION. How many people do we have in Japan?

Mr. KRATZER. We have two professional people in Japan, and a secretary.

Mr. PILLION. Aren't they more or less just doing the same thing we are?

Mr. KRATZER. No, sir. It is very difficult to communicate with scientists abroad, I might say, and it is extremely important that this country have people in that country who go visit their labs and plants and talk to their scientific people and learn what they are doing. This is really a special phase of a program which the United States follows across the board in the field of science. That is, to have scientific attachés. These were dropped by the State Department several years ago but in the past few years the program has been reinstituted and greatly expanded.

Mr. PILLION. Can you give us anything specific of value to the Atomic Energy Commission that anyone of these attachés has sent to us; anything that is new, different, and valuable to us?

Mr. KRATZER. I can't do that offhand, sir, but I will be glad to supply for the record a résumé of technical information that we have received from several of our offices.

Mr. PILLION. I don't want technical information. I want information that is different, valuable to us.

Mr. KRATZER. Information that we did not previously have, yes, sir.

Mr. PILLION. That is right.

General LUEDECKE. Cooperation in this case is used in sense of an agreement for cooperation, under the Atomic Energy Act, in which a specific program is spelled out between the two countries. Then cooperation is rendered.

Mr. PILLION. I remain very, very unsold.

Mr. EVINS. I was thinking along the same lines with the gentleman. We developed the art. We provided them with the information. We have exhibits over there, and we have our employees over there to find out where we can help them out.

Mr. KRATZER. And to acquire information.

Mr. EVINS. I would like to see something concrete in form that we have received.

(The matter referred to follows:)

EXAMPLES OF INFORMATION OBTAINED BY AEC FROM COOPERATING COUNTRIES AND INTERNATIONAL ORGANIZATIONS

Among the major projects in nuclear science and technology on which the AEC is obtaining new and worthwhile information are the following. AEC scientific representatives are a principal means for collecting and reporting this information.

1. *The German pebble bed high temperature gas-cooled reactor.*—This experimental reactor is the only one of its type under construction anywhere in the world.

2. *The Norwegian boiling heavy water reactor (Halden project).*—This reactor is in operation and developing information of interest to the United States in such areas as in-core instrumentation, boiling reactor dynamics, and spectral shift control. This is the only boiling heavy water reactor in existence.

3. *The United Kingdom advanced gas-cooled reactor project.*—This project is related to the U.S. experimental gas-cooled reactor project and high temperature materials technology. The United Kingdom program of gas-cooled reactors is in an advanced stage and therefore has been providing the Commission with construction, fabrication, and research information otherwise unobtainable. Information from the AGR has resulted in direct savings in construction of the U.S. advaced gas-cooled reactor.

4. *Feed materials technology.*—The United Kingdom has developed information on the fluidized bed process for feed materials production, which is being considered for application in the United States.

5. *Eurochemic fuels reprocessing plant (Belgium).*—This is the only plant being constructed exclusively for the processing of a range fuel enrichments and types of fuels configurations from civil reactors.

6. *French fast-reactor project.*—This project is planned to be the first fast reactor to use a core of mixed uranium and plutonium oxides, one of the most promising types of fast reactors. In some of its aspects, the French project may serve to advance the technology of the U.S. fast-reactor program.

7. *French beryllium oxide program.*—France has developed an advanced research and development program on beryllium oxide leading toward its ultimate use as a moderator for gas-cooled reactors. The program has produced beryllium oxide superior in certain characteristics to that being produced in the United States.

8. *Italian thorium reprocessing program.*—The Italian program for reprocessing irradiated mixed uranium-thorium fuels, and refabricating fuel elements from the recovered U 235–U 233 mixture is the only program of its kind. This type of fuel will be employed in at least two U.S. power reactors.

9. *United States-Canadian joint program on heavy water-reactor technology.*—The Canadians are preeminent in this field, which is of increasing worldwide interest. The United States is working closely wth Canada on research and development and this economically obtains information that could only be duplicated at great expense.

10. *Netherlands homogeneous slurry reactor.*—This is the most advanced slurry reactor project in existence, and, since the discontinuance of the U.S. homogeneous reactor project, is the most important effort now underway on aqueous homogeneous systems.

11. *Japan.*—An extensive exchange program is now being developed between the United States and Japan. Included in this exchange are research on semihomogeneous and boiling slurry reactors (of substantial interest to the United States but not being pursued here), computational codes for light-water moderated reactors, uranium carbide and uranium oxide fuels, and reactor safety (with particular attention to seismic problems).

COOPERATION WITH EURATOM

Dr. PITTMAN. Mr. Chairman, may I make a comment on Euratom particularly that may or may not have been evident? All of the money that is spent by the United States for this program is spent in this country in AEC laboratories or in industrial or university laboratories in this country.

MILITARY COMPACT REACTOR

Mr. EVINS. On page 104 of your justification, the Department of Defense has reinstated the Army's requirement for a military compact reactor. Tell the committee something about this requirement which was just recently abandoned.

Dr. PITTMAN. The military compact reactor is a reactor scheme that was established by the military going back to 1958. We initiated the first phases of the program to find out the type of reactor that could be used to meet the needs of the military for a highly mobile reactor in the power level of one to two megawatts. The initial requirement had tied to it the need for a land propulsion system, to drive a train or a truck or something like that. It was this phase that was of considerable uncertainty in the military. Because of this it was dropped as a military requirement about a year ago last December, I think it was. The military, however, reviewed the reactor concept and discussed the reactor with us and have reinstituted a similar project, a military compact reactor, but not with the idea that it will be used for propulsion of land vehicles at all. Rather it is a reactor that can be kept in a very small size, can be moved around, can be used for furnishing power to the troops in the field, can be started quickly, shut down and moved and restarted quickly.

We had no program underway at the time which would allow us to do this. We reinstituted the program which has gone through the first phases under the previous so-called military compact reactor.

Mr. EVINS. Is this going to be experimental work in connection with a compact reactor unit for the military?

Dr. PITTMAN. It will be the construction of a prototype which will be used as the takeoff point by the Army in the purchase of subsequent reactors for field use. We will construct the prototype. We will demonstrate what it can do.

Mr. EVINS. Haven't you had enough experimentation and research and knowledge and development to hand this information over to them?

Dr. PITTMAN. No, sir. We have reached the point where we can identify the type of reactor it will be. It will take us about 4 or 5 years to even get the first test.

Mr. EVINS. Why was that abandoned after so many years of research?

Dr. PITTMAN. The only research and development that was done under the old requirement was a study to identify the type of reactor that was used and it was dropped. After that there was a hiatus of 6 or 7 months.

Mr. PILLION. Is it the same type of reactor that you have at McMurdo in the Antarctic?

Dr. PITTMAN. No, sir. The reactor at McMurdo is a water-cooled reactor. The objective there was that it could be flown in packages no larger than 15 tons each, a total of 30 tons for two packages. This is a much more highly compact reactor. That one took several months to assemble for use. This one you want to move it in and 6 hours later operate it. After it is operating for a while, you want to be able to shut it down and move it out 6 to 12 hours afterward. It is not something where you take pieces in and construct it. It is all on the back

of trucks that move to the place where you need it, and when you want to run you shut it down and move on.

Mr. PILLION. What you want is something like a generator.

Dr. PITTMAN. It is an electrical generator.

Mr. PILLION. You want to run the camp with it.

Dr. PITTMAN. Instead of having to carry oil with you, it has its own fuel that will last for great lengths of time.

CONTRACTS WITH UNIVERSITIES AND COLLEGES

Mr. JENSEN. Mr. Chairman, I would like to ask a question or two at this time as I may have to go to a conference shortly.

How many contracts do you have with universities and colleges?

Dr. ENGLISH. I can give you an approximate answer. If you count the lump-sum contracts in biology and medicine and physical research, I think the total will come to around 900.

Mr. JENSEN. 900 colleges?

Dr. ENGLISH. No, not colleges. This is the total number of contracts.

Mr. JENSEN. Some colleges may have more than one contract?

Dr. ENGLISH. That is correct. I cannot give you the total number of universities represented by this total number of contracts.

Mr. JENSEN. Will you supply it for the record?

Dr. ENGLISH. Yes, indeed.

Mr. JENSEN. I would not expect you to name the colleges and universities, but give us the number of colleges with whom you have contracts and the number of contracts that certain colleges have. You must have a number of colleges that have four or six contracts.

Dr. ENGLISH. That is right.

(The information follows:)

DIVISION OF RESEARCH

Off-site lump-sum contracts with colleges and universities, fiscal year 1961

Number of lump-sum contracts or projects	Number of universities	Total number of lump-sum projects	Number of lump-sum contracts or projects	Number of universities	Total number of lump-sum projects
1	36	36	10	1	10
2	22	44	11	3	33
3	15	45	12	1	12
4	14	56	15	1	15
5	6	30	16	1	16
6	8	48	17	1	17
7	3	21			
8	7	56	Total	121	457
9	2	18			

NOTE.—The above figures exclude cost reimbursable contracts with educational institutions, as well as all contracts with other nonprofit institutions, with commercial firms, and with Government agencies.

DIVISION OF BIOLOGY AND MEDICINE

Off-site lump-sum contracts with colleges and universities, fiscal year 1961

Number of lump-sum contracts or projects	Number of universities	Total number of lump-sum projects	Number of lump-sum contracts or projects	Number of universities	Total number of lump-sum projects
1	54	54	10	1	10
2	22	44	12	3	36
3	18	54	16	1	16
4	12	48	17	1	17
5	12	60	27	1	27
6	2	12			
8	5	40	Total	134	436
9	2	18			

NOTE.—The above figures exclude cost reimbursable contracts with educational institutions, as well as all contracts with other nonprofit institutions, with commercial firms, and with Government agencies.

Mr. JENSEN. Do you feel that you have benefited to any great degree by these contracts with these universities and colleges?

Dr. ENGLISH. We certainly do. A major and very important part of the Commission's basic research program, the unclassified part, is carried out in the university laboratories.

Mr. JENSEN. The major part?

Dr. ENGLISH. A very major part in terms of basic research contributions. Our own laboratories obviously contribute much basic research as well as research of direct, or programmatic, interest to the Commission. But as far as spreading the base and generating the new knowledge in basic fields in the physical and biological sciences, we feel this program is very important.

Mr. JENSEN. Do you have officials of the Atomic Energy Commission stationed at each one of those colleges?

Dr. ENGLISH. No, not at all. In fact, at none of them.

Mr. JENSEN. None of them?

Dr. ENGLISH. Not for these small lump-sum basic research contracts I am referring to.

General LUEDECKE. We do when we have an operating contract, such as for operating the laboratory at Argonne.

Dr. ENGLISH. Yes. The University of California operates the Lawrence Radiation Laboratory, and we have an office there.

Mr. JENSEN. I have been there.

Dr. ENGLISH. Also at Princeton University, where we have the Sherwood program, a major program.

Mr. JENSEN. But you have no member of the Atomic Energy Commission staff at any of these universities and colleges?

Dr. ENGLISH. No.

Mr. JENSEN. Do you have visitation?

Dr. ENGLISH. Yes, they are visited. The way these contracts are made is that the proposals for research are evaluated by the technical staff here in Washington in the AEC with consultation, as I think the Chairman indicated in his testimony, with scientists who are outstanding in the field, so as to reach a decision to accept a given proposal. The contract is actually made with the university by one of the AEC field offices. These are our centers like Chicago Operations Office, the Oak Ridge Operations Office, the New York Operations Office.

STUDENTS INTERESTED IN NUCLEAR SCIENCES

Mr. JENSEN. I think it must have been 5 or 6 years ago when the Atomic Energy Commission testified before this committee that there was a great dearth of students who were majoring in the nuclear sciences. I asked them what they were doing about it. They said they didn't know what they could do. I said it would appear to me that the Atomic Energy Commission could send out pamphlets to high schools and encourage high school students to get interested in the nuclear sciences. Then whenever possible efforts might be made to get the high school superintendent to request that a member of the Atomic Energy Commission or staff come to the school and talk of the need for more scientists and explain to the students the great advantage which would accrue to a student who took up the nuclear sciences.

I ventured that by so doing they could encourage many high school students to study the nuclear sciences. They did that. I was told a couple of years afterward that it brought good results.

Now may I ask this: Are members of the Atomic Energy Commission or members of the Atomic Energy Commission staff going out and making talks, whenever they find time, to high schools and colleges relative to the great benefits that could accrue to themselves and their country?

Dr. ENGLISH. Yes, this is true. In fact, you may have noticed in the paper just recently that the Chairman of the AEC participated in the awarding of prizes to high school students in the school science fairs. When we talk about the training and education program, there are summer institutes which the Commission is contributing funds for the training of high school teachers.

In addition, through organizations like the Oak Ridge Institute for Nuclear Studies at Oak Ridge, Tenn., and our National Laboratories, there is a program for the staffs of the laboratory to make talks to high school students and also in the case of Oak Ridge to bring in for summer training high school teachers so that they can be taught modern technology involved in atomic energy. They can then go back to their high schools, to teach this advanced knowledge, as well as making lecture tours to other high schools. So really all of these things are being done. This is not to say that I think we have the problem under control.

Mr. JENSEN. Without a doubt that has encouraged a great number of high school students to major in the atomic sciences.

Dr. ENGLISH. I think it has. As far as training at the graduate level, in addition to the fellowship program, we have the research contracts which the Commission supports in the physical sciences, engineering sciences, and biological and medical sciences. These, in addition to the research results, contribute much to the training of graduate students. But as you will recall in the Chairman's opening statement, he saw fit in the very early part of his statement to single out the training and education program of the Commission as one in which the Commission has a great deal of interest and feels is one that should be certainly prosecuted very vigorously.

EQUIPMENT GRANT PROGRAM

Mr. JENSEN. Is the Government furnishing high school laboratories with any facilities on the atomic sciences?

Dr. ENGLISH. In the training education and information program there is an equipment grant program for universities and colleges. These are not facilities in the sense of laboratories or construction of laboratory benches, and the like, but the supplying on a grant basis of equipment for instruction in the fields of atomic energy, like counting equipment, geiger counters and the like. These are for college level instruction. We did have, in the biological sciences, the same sort of program, and also in the engineering sciences. In addition, the Commission supplies, on a "free of use charge" basis, material for research reactors of which there are a number at universities around the country. These two equipment grant programs are rather modest, something like a total of $2 million. But the number of requests which the Commission receives for equipment grants far exceeds the amount of funds we have available for this purpose.

(Discussion off the record.)

PROPULSION REACTORS

Mr. EVINS. Mr. Director, for the rocket propulsion program you are asking for $74.8 million, and for missile the propulsion reactor you are asking for $29 million. These are large sums. For the satellite and small power sources you are asking for another $76,468,000. Please explain why all these large increases are necessary. The program has been increased a hundred percent over last year.

PROJECT ROVER

Dr. PITTMAN. Two of these three areas are our biggest increases. I would like, if I may, to introduce Mr. Harry Finger to say a few words about it. It is the rocket program.

Mr. EVINS. I understand you have some slides to exhibit.

Dr. PITTMAN. I would like to do that on the missile program.

Mr. EVINS. Mr. Finger, we will be glad to hear you again.

Mr. FINGER. Thank you, sir. On the rocket program, which is the only one to which I will make comment, we are in a position now where we are starting to expand our engine contractor effort. As Dr. Pittman mentioned earlier, AEC and NASA signed jointly a contract with Aerojet General which started the development of the first nuclear rocket engine, the NERVA engine. The principal subcontractor is the Westinghouse Electric Co.

During the first year of the contract they will be doing and have been in process of doing detailed engine design work and component test work, but they will in this later phase start getting more into the hardware aspects of the program, including more into the conversion of the reactor that Los Alamos is studying for us, converting that into a flight type reactor, one that will stand all the flight stresses that are imposed on these systems in rocket application.

The increase, therefore, is in large measure due to the work of the industrial contractor, that is, the increase in the ROVER nuclear rocket budget. The largest increase is in that area. In addition,

there is an increase in support at Los Alamos. Specifically we are building more reactors this year than last year. Last year Los Alamos built 5½ reactors in fiscal 1962. In fiscal 1963, they will be building 7½ reactors, but in addition to that the industrial contractors will be building 4½ reactors. So the large difference is the increase in the number of reactors and the hardware we are building, as well as the R. & D. work that has to go along with that. These systems, I should mention, are considered to be the real hope of long range space travel. It is very clear if we want to travel long distances in space with a high payload, we will have to go to the use of nuclear energy rather than continuing to use these chemical combustion systems we have been using to date, and undoubtedly will continue to use for a significant time to come.

Mr. EVINS. What progress is being made by NASA on the development of engines that go into reactors that AEC is presently developing?

Mr. FINGER. As Dr. Pittman mentioned, we are running this program jointly out of a single office which is staffed by people from both NASA and AEC. I manage the joint office. Therefore, we are operating on a single program. When we talk about what success does NASA have on the engine, we are really talking about the success of that single program, which means AEC and NASA, toward meeting the objective of developing one of these nuclear rocket systems. The Los Alamos Laboratory is responsible for doing the early research work on the reactors and all the tests that have been conducted to date.

Mr. EVINS. Is the engine development work currently underway with the reactor development?

Mr. FINGER. Yes. We have work underway on this engine contract. This Aerojet-Westinghouse contract, which is a joint NASA–AEC contract—it does rely on getting reactor data out of the Los Alamos tests. Until a firm reactor design can be arrived at through those tests, the industrial contractor's effort will be somewhat restricted. It is very important that we get such data before we let the contractor go into a full-blown hardware program.

Mr. EVINS. We spent a lot of money several years ago on an atomic powered airship. It was later abandoned. It was not feasible. Are we going to be successful in this missile program with nuclear power?

Mr. FINGER. Yes, I am convinced. I think we have all learned a great deal from these other programs. Although I hear the reasons for difficulty in these programs described in different ways by different people I think there are a couple of points to be made. One is that we do have a requirement that before we go into major hardware production and development on the engine, and on the vehicle for that matter, we have a good indication of successful reactor operation as we intend to use it in a flight system. This is a very basic requirement.

In addition to that, we are working with a system that has extremely high performance potentials even in its early version. So we can take some of the early reactor systems we are working with and put them in the upper stages of the chemical rockets we will be developing for the lunar mission and get substantial increases in the payload that these systems could deliver.

Mr. EVINS. NASA has always been rather adept at putting out target dates when they are going to achieve these various objectives, and the AEC is a little reluctant to set target dates. Do you wish to propose any target dates?

Mr. FINGER. Dr. Pittman mentioned the joint NASA–AEC target dates on this, and this is to fly the first system in 1966–67.

Mr. EVINS. I got his statement with respect to commercial atomic power.

Dr. PITTMAN. We have a target, the joint office and joint agencies have a target of flying the first device in 1966 or early 1967. That is the target date.

Mr. FINGER. That is a joint NASA–AEC target.

Dr. PITTMAN. It will be extremely difficult to meet that target.

Mr. PILLION. What is the Soviet doing to get their much larger capsules into the orbit of the earth? Are they using a rocket propulsion?

Mr. FINGER. They are using, we believe, fairly conventional chemical combustion rocket systems, but theirs are substantially larger than ours. Titov, when he was here, mentioned that the thrust of his rocket was 1.2 million pounds takeoff. Our ATLAS which just fired Carpenter into orbit has a takeoff thrust of 360,000 pounds. It is something of three to four times as great.

Mr. PILLION. How do you get the thrust out of a rocket engine as distinguished from the chemical reaction or chemical blowup and then the thrust? What is the difference between the rocket and the other?

Mr. FINGER. The nuclear rocket system?

Mr. PILLION. Yes.

Mr. FINGER. In the chemical rocket system, we store a fuel like kerosene and oxygen in two separate tanks and mix these and burn them and produce a hot gas. What we want is a hot gas. In the nuclear rocket system, rather than storing two fuels, we use one fuel, hydrogen, as a propellant, and we just pass it through the reactor and heat it to high temperature. There is no combustion.

Mr. PILLION. And that gives you propulsion?

Mr. FINGER. That produces the hot gas which produces thrust and the propulsion.

Mr. PILLION. These rocket propulsion reactors that you are working on, will they be usable for a manned space missile for military use? Would that be possible with the work on this? I don't think that going to the moon right now is the first order of business. I think the manned military situation is the first order of business. Will this take care of it? Will it furnish the propulsion power for it?

Mr. FINGER. There are several parts to the answer I will give here. As I indicated earlier, the major performance advantages of this system come up when we talk about very distant missions, lunar missions, planetary missions, and missions that require very heavy payload. There is an advantage that this can provide as well when we talk about putting payloads into an earth orbit, but they are not as great as the advantages over the chemical combustion systems that we get by going longer distances to the moon and to the planets. We expect, although our primary emphasis is developing systems that can be used in the

scientific and manned space flight program that is being conducted by NASA, there is not much question but that all of this technology should be considered and is being considered by the military in all the possible missions they can define for space applications.

The Air Force has studies of various nuclear rocket engines systems. They should and are, I know, considering this system as well for any possible application that they can arrive at.

PROJECT PLUTO

Mr. EVINS. Has a weapons system been developed for the project Pluto? If not, why should the committee continue to appropriate funds for the development of this reactor concept at an increasing cost each year?

Mr. BOLAND. May I ask here, does this program concern itself with all stages of rocket propulsion, or are you confining it to the first stage, second, or what?

Mr. FINGER. The early systems will apply most readily to the upper stages. But our advanced technology program is trying to learn how to make these systems into the bigger and higher thrust so we can bring them in the lower stages.

Mr. JENSEN. I was at Cape Canaveral when SATURN was launched. It was my good pleasure to visit with Dr. von Braun and Dr. Debus, the two great scientists.

Mr. EVINS. Tell us about the Pluto project.

Dr. PITTMAN. Mr. Finger told you about the project for going into space. Pluto is for a low level nuclear ramjet. There has been done a lot of work and if the committee will allow me, I would like to make a short presentation with some vugraphs that will tell you what we have done and what the future of that looks like in about 15 minutes.

Mr. EVINS. You may proceed.

Dr. PITTMAN. Then we can answer any questions at any time, but I think this might be useful.

Mr. Hoffman is chief of the Pluto branch responsible for this program and will conduct the discussion.

Mr. HOFFMAN. Mr. Chairman, it is a pleasure to be here. As you all know, the Pluto project got started in 1956 when the Department of Defense asked the Atomic Energy Commission the one question: is it feasible to build a reactor for a nuclear ramjet missile?

When we examined the requirements for such a device, we found that there was no material known to man that at that time would endure the environmental conditions both with respect to the neutronics and aerodynamics. So we started into a very extensive research program on materials.

For 3 years we labored on materials. When we had the confidence that we had a material in hand to build a reactor, we did indeed build one. The first device was this IIA–1. This is a far cry from a flyable machine. It is not intended to be that at all. It is an engineering test device to prove what we learned in the laboratory was indeed correct, that we did know how to fabricate the fuel elements and that we did have an understanding of the aerothermodynamic principles.

The reactor is mounted within this test device which is entirely supported on this railroad flatcar. The core is some 32 inches in

diameter and 4 feet long, contained in this black section which is the outer surface of the reactor.

Our first objective was to prove we knew how to build the core. So we subordinated all other problems to that main objective. We water-cooled the reflector, nozzle and pressure vessel. Much of the plumbing is associated with the water cooling and the electrical conduits are for the devices which measured the performance of the unit.

We ran this reactor four different times. The first was in May 1961 at partial power, and then in September and October at full power. The next slide shows the test results of the three major runs of this one reactor. It successfully survived all of these tests.

On October 5, we drove the reactor to the full conditions. In essence, we flew the reactor statically.

On October 6, we again operated the reactor. This time we purposely imposed a higher than design thermal stress upon the reactor to gain a feel for the thermal stress conditions that will be experienced by Tory IIC.

The next reactor is the Tory IIC. This is a photograph of a model. As you see, it looks more like a flyable machine. You might consider that the rest of this device is part of the facility.

The next slide will show the differences between the two reactors. This is a slice through both Tory IIA–1 and Tory IIC. In Tory IIA the red part is the reactor core and the gray part is the 2-foot-thick graphite water-cooled reflector in which we had our control drums located. These control drums are cylinders of graphite in which we had boron-loaded steel tubes. They operated synchronously and controlled the neutronics of the core. We did this and indeed proved the integrity of that core.

In Tory IIC, our next experiment——

(Discussion off the record.)

This faces up to the total problem of a flyable machine.

To refresh your memory, the next slide shows the comparison between the two reactors as far as design considerations are concerned.

As a result of the extremely successful tests on the Tory IIA–1, we were able to eliminate a backup reactor which we had scheduled earlier in the program. There was no technical justification for duplicating the highly successful IIA–1. We are proceeding directly to IIC.

In addition to the experimental reactor programs, we are also conducting advanced research and development work at Livermore to develop materials and designs.

I must emphasize these are only a limited number of tests. We asked the laboratory to continue to develop materials and designs for a smaller reactor core. The reactor diameter is the limiting diameter for the missile. The smaller the frontal area, the smaller the missile we can build. We have asked the laboratory to develop materials and designs such that we could get longer cruise life out of the vehicle. This would expose new applications. We have asked them to perfect techniques that would help to reduce the complexity of the reactor and hence the cost. Some of the things that they are doing in response to these assignments look like this.

(Discussion off the record.)

Mr. Hoffman. In addition to all the work we are doing, the Air Force has been studying applications for a nuclear ramjet propulsion system and the next slide shows three configurations they have looked

at actively. They are pursuing most actively the first one. These are missiles that are unmanned.

This brings me to the end of our official slides.

Dr. PITTMAN. Mr. Chairman, maybe from this point on it would be better just to have questions and discussion on the basis that we felt this would be useful for the committee to be brought up to date. We feel this has been one of the more successful programs from the reactor program. We have made a very successful test. As Mr. Hoffman said, we did not feel it necessary to go through a three-step procedure, but rather we could eliminate the TORY IIA–2, which means we can go from the first test to the IIC test. There seems to be nothing limiting in the reactor to prevent it from doing those things we set out to do, namely, a thousand feet at mach———and to carry a payload of———.

Mr. EVINS. We have all been excited and encouraged about the success in our space program and certainly we are in this thing very deep. It is a very costly program. We look for advancement. I think the American public is very much interested in it.

Mr. BOLAND. I am wondering whether or not the Department of Defense has indicated a military requirement for this.

General LUEDECKE. They have not indicated a military requirement to go directly from the position that we are now at to a flight test weapons system. Their interest, I think, is best covered by a communication from Dr. Brown to the Atomic Energy Commission, which I will be happy to submit for the record, and would read the pertinent paragraph at this time.

We have given approval to the Air Force for a program consistent with $7 million in fiscal year 1962 and $24 million in fiscal year 1963 and with the following objectives:

(Discussion off the record.)

With respect to the PLUTO program for its original purpose, we are developing with the Air Force the scope of work necessary to carry out a program aimed at these objectives.

Mr. BOLAND. What have we put into this program so far? It started back in 1956. Is Ted Merkel still in charge?

General LUEDECKE. Yes. Over the period of time the operational funds amount to $107 million.

Mr. BOLAND. What do you anticipate the future expenditures would be?

General LUEDECKE. I would like Mr. Hoffman to give the projection.

Mr. HOFFMAN. We project a total of $141 million additional from fiscal year 1964 through fiscal year 1966.

Mr. BOLAND. This is the projection?

Mr. HOFFMAN. This is AEC cost only.

Mr. BOLAND. That is the 10 year cost actually, 1956 through 1966.

Dr. PITTMAN. Yes. This is only the AEC cost.

Mr. BOLAND. Do you have the Air Force cost?

Mr. HOFFMAN. Yes. Their estimated cost through flight test would be about $500 million.

Dr. PITTMAN. In addition to the interest that has been expressed for the Air Force by Dr. Brown, the Navy has also expressed a tentative interest.

Mr. BOLAND. What is the range of speed of the ATLAS, TITAN, or some of our bigger missiles now? How fast do they fly?

Mr. HOFFMAN. They are about 18,000 miles per hour.

Mr. BOLAND. What is the great advantage of this particular missile as opposed to the conventional missiles that we have?

Mr. HOFFMAN. May I answer that question?

Mr. BOLAND. Yes.

Mr. HOFFMAN. All the missiles we have either in being or in development travel the ballistic route. They all have a fixed trajectory in other words, be it the POLARIS, ATLAS, TITAN, or MINUTEMAN. These are calculable. Once you fire one you can calculate back rather rapidly where it came from. The missile that would use a nuclear ramjet propulsion system has been designed in preliminary design only at this point by several companies. A nuclear ramjet powerplant offers the capability of flying around the world. This offers the advantage of being able to strike the enemy from any direction whatsoever. He can no longer fix his defense posture in any one segment. He must look at it from an omnidirectional standpoint. It offers the greatest payload of any missile designed. We think of one, two, three, and even five percent for ballistic missiles as useful payload. When you couple the unlimited range, the omnidirectional strike capability with the high payload fraction, you expose a new and different threat to the enemy. Any defense posture that he may have that would be common for any ballistic missile would not suffice for a low altitude omnidirectional high-speed nuclear ramjet missile.

Mr. BOLAND. Would you describe this as the ultimate weapon?

Mr. HOFFMAN. I don't believe one can describe any weapon as an ultimate weapon.

Mr. BOLAND. As compared to what we have now, would you say it was so?

Mr. HOFFMAN. No. There is no such a thing as an ultimate weapon; for man has long learned that for every new device, he can think of a counterdevice. This is an evolution.

Mr. BOLAND. Are we going to be able to guide this all the way around the world and land it?

Mr. HOFFMAN. There are several contracts with industrial contractors, one with IBM and one with Chance-Vought and others, to develop guidance systems or components guidance systems that would predict very accurate delivery of warheads from such a device.

Mr. BOLAND. You have not advanced as rapidly in this program as you anticipated when you started in 1956. I got the impression when I was at the Livermore Radiation Laboratory that we were going to have this thing operational in 4 years. We have now moved into the sixth year, and we are not even close to it.

Mr. HOFFMAN. I suspect from your conversations with the laboratory that these were time periods in which it would be technically possible to have these operational. I suspect at the time it was true. The decisionmaking processes are a little bit longer.

Mr. JENSEN. I was at the site last year. This missile as I understand it has a mechanical guidance system?

Mr. HOFFMAN. That is right, sir.

Mr. JENSEN. We were told then that there was no radar at the present time that could pick up this missile on a radar screen. Do you agree with that?

Mr. HOFFMAN. Yes, sir.

Mr. JENSEN. It is an intriguing proposition. There is no question about that. Do you propose that you can bring this missile back and salvage it and the only thing you will lose is the warhead in the flight?

Mr. HOFFMAN. Although it would be technically possible to bring this back and salvage it, I am not so sure that this is one of the things you would want to do. Remember now, it is being flown with an atomic powerplant that would be radioactive. It would have to be handled very specially and carefully. It would have to be handled in special facilities. These are the attendant problems although technically it would be possible to bring it back. I don't know whether tactically you would want to bring it back.

General LUEDECKE. We may have to divide the consideration into two parts. One is what do we do with them as a test vehicle and the other, using them as a weapons system operationally.

Mr. JENSEN. I can understand why this missile cannot be associated with any weapon system we have today. In fact, it is so different than any other missile in its flight and in its operation that it need be a system in itself, so to speak.

Dr. PITTMAN. It is a system in itself.

(Discussion off the record.)

Mr. PILLION. So we shouldn't get oversophisticated and delay it for 6 more years to do things that we don't need it to do.

Mr. HOFFMAN. We have addressed our primary effort as you stated. If you recall we are citing one of our objectives for our long-range research and development program. This would be in the future to expose new and different applications. I would like to cite one. One, for example, if you wanted to turn such a device into a reconnaissance vehicle without men. You may want to have longer duration.

Mr. PILLION. Something like the U–2.

Mr. HOFFMAN. That is right. This is a design goal and should not be confused with our immediate objective.

Mr. PILLION. Now the next question. If you develop this into a weapon similar to what you show here, and got on mass production basis—how would the cost compare with the cost of an ATLAS or TITAN now? Could you come within a comparable figure so that you could physically and financially substitute this or have it as an added missile to the MINUTEMAN or TITAN or ATLAS? Would it come within the fiscal range that would make that possible?

Mr. HOFFMAN. I can answer it this way. The Air Force has conducted very extensive cost effectiveness studies, which is what you are citing.

Mr. PILLION. Firepower per dollar.

Mr. HOFFMAN. They have conducted extensive studies on cost effectiveness. The contractors have also conducted such studies. I believe the Air Force study which shows that such a device was extremely effective costwise in comparison with these other systems that you mentioned.

Mr. PILLION. That is what I want to know. Is it fiscally and economically, firepower per dollar, worthwhile.

Mr. HOFFMAN. It is, indeed. The factor that throws the cost effectiveness heavily in favor of such a system is the fact that it carries so much payload per pound of airframe.

Mr. PILLION. Then besides that we have the other advantages.

Mr. EVINS. If there are no further questions, the committee will stand adjourned until 10 o'clock tomorrow.

TUESDAY, MAY 29, 1962.

Mr. CANNON. The committee will be in order.

Resuming the reactor development inquiry, Dr. Pittman, we are aware, and I take for granted you are aware, of some publicity on conflicts between the AEC and NASA with respect to who is doing or going to do what is provided in the SNAP program.

We shall be glad to have your comment in some detail.

Dr. PITTMAN. I think General Luedecke will respond to that.

General LUEDECKE. Mr. Chairman, may I respond to that?

SNAP PROGRAM

The publicity with respect to disagreement, I think, between the Commission and NASA was confined to the one project, the SNAP–50 program. This is a program which is the outgrowth of the liquid-cooled program of Pratt & Whitney on the ANP. The program is a long one and probably would not come to fruition with a product until about 1970.

Mr. CANNON. It involves considerable sums?

General LUEDECKE. I believe the estimate for completion is about $140 million.

Mr. CANNON. It is a little indefinite. It has been estimated by some to involve about a quarter of a billion dollars, over some 5 or 10 years. Would you say that is fairly accurate or a little exaggerated?

General LUEDECKE. For this unit that sounds a little high to us, sir.

Mr. CANNON. It sounds a little high. I hope it is high.

General LUEDECKE. It is quite indefinite, though, that is true.

We have been discussing with NASA the timing to proceed with the various elements of this program—consisting primarily of a heat source for reactor conversion equipment to electrical energy and conversion of that to propulsion energy in terms of ion propulsion.

Mr. CANNON. Now, there was some agreement or understanding between AEC and NASA. As I recall it, there were some memorandums of general understanding which laid out general lines between the two in 1960 or originating in 1960 at least. What is the nature of that understanding?

General LUEDECKE. That memorandum of understanding was directed primarily at Rover at that time.

Mr. CANNON. Would you say that is no longer an issue?

General LUEDECKE. The Rover part of that is no longer an issue. The memorandum is slightly broader than that in that it recognized the responsibility of the two agencies as provided by statute—AEC's responsibility for any reactor or reactor components and NASA's responsibility for such other aspects of the system as required for it to function in their mission. I think that agreement is still a valid one.

Our disagreement at the moment is with respect to SNAP–50. This is the only disagreement I know of and it relates to timing and undertaking.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. Back on the record.

General LUEDECKE. Our lack of understanding with NASA at the moment is on timing with respect to the undertaking of development of the other components of the system and the organization under which this would be done.

Mr. CANNON. This understanding, the Rover issue having been eliminated, leaves us just where we started. The statement is made emphatically on at least one side that there is no understanding and apparently no attempt to reach an understanding. We would like to know when there can be a general agreement under which we will know where to put this money. When will they reach an understanding?

General LUEDECKE. I can't tell you specifically when we will get an understanding. The Commission met with NASA during the last week. I think once they have agreed upon the timing that is necessary, it will not be too much of a problem.

Mr. CANNON. That was just last week?

General LUEDECKE. Yes.

Mr. CANNON. That was long subsequent to the drafting of the budget?

General LUEDECKE. Subsequent to preparing this budget, yes, sir, although I will say this is not the first time they had met. They have had previous meetings, also.

Mr. CANNON. Was this last meeting decisive? Did they reach some definite conclusion?

General LUEDECKE. No, sir, not with respect to these two points—the timing and manner of pursuing the project organizationally.

Mr. CANNON. The matter that concerns the committee of course is how much is in the NASA budget and how much is in the Air Force budget for this program, and specifically in both instances, what the money is for.

General LUEDECKE. Our budget reflects funds for the development of a reactor which will be our responsibility, I think, under any kind of arrangement or agreement that we would reach with them. Dr. Pittman can cover in detail what we would expend our funds for.

Mr. CANNON. I would be glad, Doctor, if you would, when the transcript comes to you, answer this question as specifically as you can. We would like to know where the lines of demarcation are between the two for the special purposes for which the money will be spent.

Dr. PITTMAN. May I make a short comment right now and we will explain it in more detail for the record, if you like, Mr. Chairman.

Mr. CANNON. Very well.

Dr. PITTMAN. Basically what the Commission is asking money for in the 1963 budget is to develop the reactor part of this system which is the Commission's responsibility regardless of what the final resolution of the problem between ourselves and NASA relative to the conversion part of the equipment. Incidentally the Air Force is also interested in this.

Mr. CANNON. That is the basic consideration.

Dr. PITTMAN. Yes, sir. The only point of disagreement is who has the responsibility for developing the rotating equipment that can convert the power of the reactor into electrical current. That is the point that is not yet resolved. Our budget has the money in it for the development of the reactor. This reactor is a very advanced reactor—a new technology. We think it will take several years even to build the first experiment. We are talking about 1965 for the first experiment. The money we have in the fiscal year 1963 budget is for the development of this experiment. This reactor is the type of reactor that was developed by Pratt & Whitney in the old ANP program, and the activity that we are carrying out is to make that technology, which was very valuable advanced technology, applicable to this SNAP program. All the money we have is in that, sir.

Mr. CANNON. Off the record for one moment.

(Discussion off the record.)

Mr. CANNON. Back on the record. You may proceed.

Dr. PITTMAN. What I was saying was that our plan for the 1963 budget for which we are asking funds is for the development work for the first experiment to be built at Idaho, and operate that experiment. It won't be completed in 1963, but the 1963 money goes toward this unit and in the future operating that experiment in such a way so that we can build a prototype of the unit that will actually be used in space.

During this period, we, NASA, and the Air Force, will make a determination as to who is going to fund for the conversion equipment that will take the heat out of the reactor and convert it into electricity. That development program will go on and then the conversion equipment will be married to the reactor and we will have a prototype of the system that will actually be used in space.

We don't think that this will be in a position to be flown until 1969 or 1970. It is not a short development program.

Mr. CANNON. Isn't that a little beyond the date on which the public has been led to believe it would be ready?

Dr. PITTMAN. No, sir. Here we are talking about two different things. The public has been given the idea that we will be ready to launch a nuclear rocket into space in the period of 1966 or 1967. That schedule we are still holding. This is the Rover program where a very high powered reactor, which furnishes the thrust, that gets the rocket into space, is the objective.

Mr. CANNON. How does that compare with the method used by the Russians? The Russians have been very successful. They put up sputnik a long time ago and we have not yet equaled the sputnik. That is, we have not developed sufficient thrust to put that volume of weight through the stratosphere.

Dr. PITTMAN. Mr. Finger is here, and I would like to ask him to comment on that. He is head of our joint NASA and AEC program. But the Russians have used chemical propulsion. I would like to ask Mr. Finger to comment on that.

Mr. FINGER. Mr. Chairman, the Russian rockets are very conventional chemical rocket systems, but they are larger than those that we have as you have indicated. We have not yet matched the thrust that they have used in all of their high payload deliveries into orbit.

They have, as I mentioned yesterday, about 1.2 million pounds of thrust in their first stage. We are competing with that with the ATLAS which has a thrust of about 360,000 pounds.

Mr. CANNON. That was some time ago. Have they been standing still in the meantime or are they also making progress?

Mr. FINGER. I would assume they are making progress but I frankly don't know.

Mr. CANNON. We are not in a position to gauge just what they are doing or what progress they have made.

Mr. FINGER. That may be known elsewhere in the Government, but I personally don't know what progress they have made beyond the 1.2 million pounds of thrust. I should add that we have now flown twice, and very successfully, the first stage of the SATURN rocket, with dummy upper stages, and that will produce a million and a half pounds of thrust. Those first two flights were certainly outstanding successes.

Dr. PITTMAN. These are nonnuclear flights, though, that Mr. Finger is talking about. They are chemical flights.

Mr. FINGER. All these vehicles are nonnuclear vehicles. They are chemical combustion.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. Back on the record.

Dr. PITTMAN. I was just giving a general rundown of what we are planning to do. The plan is to build the reactor experiment (SNAP–50). This is the experiment that will tell us all of the problems of running a high temperature, about 2,000° F. lithium cooled reactor, which means that we have to use columbium, a material that we know very little about. It is a new material that was developed in quantity by the Pratt & Whitney people for the ANP program. We will build this experiment and operate it and simultaneously we will be doing engineering development for the prototype. This experiment and prototype will be tested at Idaho.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

HOUSING FOR LITHIUM COOLED REACTOR EXPERIMENT

Dr. PITTMAN. We plan to use the facilities that were built at Idaho for the ANP program to the greatest extent possible. There are, as you can recall, large numbers of facilities out there. We are making maximum use of such facilities. We do have a construction item that we will come to later for the conversion of those for this particular experiment.

Mr. CANNON. That is what you have provided for in this budget?

Dr. PITTMAN. Yes, sir; and that is all we are providing in this budget. We are not providing in this budget for the areas which are in conflict between ourselves and NASA at the moment.

(The following additional information was provided by AEC.)

The Commission conceives its role in the production of electrical power in space as one of design, development, and test of a complete power package, including the power source and energy conversion system. This position is taken in view of the requirement for extreme reliability of each component and interdependence of these components in the power system. The power source and

energy conversion loop are closely integrated and thermodynamically coupled through a common heat exchanger. This system must be tested as a combined unit in a nuclear facility which involves all the attendant safety considerations.

Also, there is the consideration that both NASA and the DOD have potential electrical power requirements for several applications and, further, it may be necessary to provide electrical power requirements direct to the communications industry for their electronic payloads. It is, therefore, believed that maximum progress and efficiency can be achieved if the combined power and conversion unit is under the cognizance of a single agency.

Mr. BOLAND. You have $5 million in here for the construction at the test site in Idaho for the reactor you are talking about. Now, what are you utilizing the hangar for that was out there? That cost about $7 million, as I remember, or more. You had a hotbox out there. You had a machine shop. You had an area where you used the locomotive and innumerable buildings on that site used explicitly, and I think solely, in the ANP program.

Dr. PITTMAN. That is right, sir.

Mr. BOLAND. What do you want all this money for? You have better than $70 million for plant acquisition and construction.

Dr. PITTMAN. The $5 million that we are asking for in item 63–e–1, which is the housing for the lithium-cooled reactor experiment I have been discussing, the purpose of that $5 million is to modify the large hangar building that is out there, to make it possible to put this lithium-cooled experiment in that hangar.

Now, that hangar building was built for the operation of the direct cycle ANP program on which GE was working. Therefore, it does not have equipment in it for liquid-metal-cooled reactors. This particular reactor we are working on is a liquid-metal-cooled reactor. We plan to use, to the greatest extent possible, the facilities of the maintenance and assembly building, hot cells, and all the facilities that are possible to be used.

The reason we are able to keep this down to only $5 million for the construction of the housing for this reactor is the fact that we are able to use these facilities. As this program grows and as the full SNAP 50 program gets underway with the prototypes and the testing that will be necessary prior to flight testing, those facilities will be used to a much greater extent. For the first experiment we will only be able to use one relatively small corner of that rather large hangar building.

MODIFICATIONS AND ADDITIONS, CANEL, MIDDLETOWN, CONN.

The only other project that deals with SNAP 50 is 63–e–5, which is the $1.4 million job to be done at CANEL, that is the laboratory of Pratt & Whitney owned by the Government.

The point there is that in handling columbium, which is the metal to be used in this experiment, we found it necessary that it has to be welded and heat treated in an inert atmosphere, and not just in small pieces, but relatively large pieces half the size of this table.

HOUSING FOR LITHIUM-COOLED REACTOR EQUIPMENT

Mr. BOLAND. What is the new construction you need which will be included in the $5 million for housing the lithium-cooled reactor experiment?

Dr. PITTMAN. This is the construction that is necessary to modify the existing facilities that are now out at Idaho to make it possible to assemble the reactor that will be fabricated at CANEL—to assemble it, test it, to run the reactor at its full power level, then to disassemble it and take it apart and examine all the fuel elements and all of the components of that reactor to see what the results of this experiment were.

It will be necessary, therefore, to put in the equipment that will make it possible for us to handle high-temperature lithium that is being pumped through the reactor as a coolant.

GENERAL PLANT PROJECTS

Mr. BOLAND. You have $8.1 million in there for general plant project. I see no justification for it. This is a lot of money, incidentally. That is 63–1. You give us four lines here and that is all. You talk about new construction and alteration and additions.

Dr. PITTMAN. Yes, sir. The general plant project is an item that we put in each year for small things that come up throughout the entire program. In this case the $8.1 million applies to everything that is being done in the whole reactor development program.

Mr. BOLAND. What are some of the large items?

Dr. PITTMAN. They can't be very large, because we are not allowed to cover anything in this that is more than $500,000. If it is more than that, it has to be a line item. I can give you the types of things that we have done before.

Mr. BOLAND. Will you just supply that for the record?

Dr. PITTMAN. I will supply for the record a breakdown of last year's project.

Mr. BOLAND. Not all of it, but just some of the projects.

Dr. PITTMAN. This is the type of thing that comes up every year that you can't predict ahead of time, that costs less than $500,000, but you know it may happen. The figure is more of an experience figure than anything else each year.

(The matter referred to follows:)

General plant projects reactor development program, fiscal year 1961

Description and location of project	*Total estimated cost*
Chicago Operations Office:	
Santa Susana, Calif.:	
Sodium components test installation, capable of testing heat exchangers and steam generators under conditions anticipated for advanced sodium systems	$157,000
Development and test facilities for ground support equipment necessary for the handling, packaging, and transporting of SNAP flight configurations, during final performance testing, delivery and launch site handling	140,000
SNAP development laboratory for (1) liquid metal coolant and hydraulic experiments, (2) SNAP–10 heat transfer development experiments, and (3) other related components experiments	113,000
National Reactor Testing Station, Idaho: Addition to the laboratory and service building of Argonne National Laboratory to provide office space only	110,900
Argonne National Laboratory, Lemont, Ill.:	
Air-conditioning of the 2-story office and laboratory building (building 203) which houses the Argonne National Laboratory reactor engineering group	265,000
Addition to electrical substations, buildings 200, 202, and 203, including installation of a 1,00-kilovolt-ampere transformer at each of the substations (3 each) along with the necessary switchgear and modifications of existing facilities to interconnect with the present distribution system	190,000
East area steam lines and installation of unit heaters on loading docks, buildings 4 and 5	154,000
Hydrogen building, consisting of 2 laboratories, assembly area, boiler, utility and toilet rooms, and a high bay experimental area	103,500
Air-conditioning of administration area, building 200	88,000
Idaho Operations Office:	
National Reactor Testing Station, Idaho:	
MTR–ETR experimenters standby power source	360,000
Chemical processing plant special analytical facility	144,000
Construction of Wilson Blvd	140,000
Fiscal year 1961 road-surfacing program	114,000
Central facilities water distribution system expansion	90,000
Oak Ridge Operations Office:	
Oak Ridge National Laboratory, Oak Ridge, Tenn.:	
Expansion of steamplant, building 2519	378,000
Radioactive containment improvements	348,600
Additional water supply	287,000
Cell exhaust ventilation filter system modifications	184,000
Radioactive containment improvements, building 4507	183,000
Containment of radioisotope production laboratory, building 3028	148,316
Cell ventilation filters, radioisotope area	103,000
Reactor area field shop, building 3104	100,000
Containment of radioisotope production laboratory, building 3029	95,000
Pittsburgh office:	
Naval reactor facility, National Reactor Testing Station, Idaho:	
Expended core facility hot cell and associated facilities	335,000
Central steamplant	287,000
Storage warehouse for spare equipment	87,700
Bettis Field, Pittsburgh, Pa.:	
Automatic sprinkler system for fire protection	183,000
Sewage-disposal system	176,500
Shipping and receiving building	110,813
Security, medical and receptionist building addition	100,000
Office space addition to assembly test building	103,500

Mr. Cannon, I think unless there are other questions, that is all I planned to say on SNAP 50.

GENERAL REACTOR TECHNOLOGY

Mr. CANNON. On page 132, Doctor, of the justification you show an expenditure of $58,287,000 for the general reactor technology program in the current fiscal year 1962.

Dr. PITTMAN. Yes, sir.

Mr. CANNON. Last year, on page 132 of the hearings, you showed a budget estimate of $47,790,000. Will you give us a little information on that item? Instead of your estimate of $47 million you are this year spending $58 million.

Dr. PITTMAN. To the $47 million we have added two items that were previously budgeted in another area.

Namely, the thorium utilization program which in the congressional budget that you had showed about $1.4 million, and the plutonium utilization and plutonium recycle program, which shows approximately $7.7 million. So those two have been added to the items that we talked to you about specifically in the $47 million that you had a year ago.

These are not new programs, they were moved from one part of the budget to another, they were identified last year, but they were identified under the civilian power program. We felt it was more reasonable to show them under general nuclear technology program.

In addition to that, equipment which used to be shown as a lump sum in place in the budget has now been identified to the greatest extent possible with the programs to which the equipment will be applied, and in which the equipment will be used. That accounts for about $2.7 million.

Mr. CANNON. Has that been pinpointed?

Dr. PITTMAN. That has been pinpointed. The $2.7 million has been pinpointed for each of the areas of the whole program and in this general reactor technology program it has been broken down in the physics, reactor fuels, components, and chemical separation activities. We will give you a breakdown of this. If you take those two factors into consideration, the revised total for the budget that was before you would be about $56.4 million, whereas the figure that we are showing, the present estimate, is $58.2 million. The major difference in this is increases in such things as the cost of irradiations that had to be carried out.

I would say that the two major actual increases over and above what we talked to you specifically about at one place or another in the budget last year were an increase in the cost of irradiation services. We have found that the irradiation services that go with this particular program were more expensive than we had thought they would be at the time we talked to you last year.

Mr. CANNON. Is that also true of item (f) here? We have the same situation on thorium utilization? Last year you told us it would be $1,435,000. We find here in your justification you have spent $2,375,000.

Dr. PITTMAN. We started out with $1,435,000. This equipment problem that I talked about where instead of having it lumped all at

one place in the budget is $400,000. That $400,000 brought it up to $1.8 million. In addition to that, we have added $540,000 which reflects that portion of related Oak Ridge National Laboratory nuclear fuel material work that was formerly under another activity of reactor fuels and materials and also that reflects some closeout costs for the homogeneous experiment. We closed that out in the previous year, but some of the cost went over into 1962. It was not a new program. It was a closeout of an old program.

You will remember we decided not to go forward with the homogeneous reactor experiment. That brought the total of $2,375,000.

NUCLEAR SAFETY

Mr. CANNON. On page 166 of the justifications, you show an expenditure of $16,446,000 for the nuclear safety program for the current fiscal year.

Dr. PITTMAN. Yes, sir.

Mr. CANNON. Last year on page 1106 of the hearings you gave us a budget estimate of $12,493,000 for this program. Did you purposely overrun your estimate or have you actually added to this program something not in contemplation when you submitted the budget last year—as in these previous items?

Dr. PITTMAN. We of course have added this equipment item. The equipment item was an item that previously had been budgeted as one lump sum for the whole division, and it was spread. That amounted to some $639,000 that had to be added to the figure that you had of $12,493,000. And $639,000 was for this equipment. In addition to that, there have been some changes, increases in some cases and decreases in others, in the program itself. The major change in the program was adding environmental research and development to this category. This plus the aerospace safety program and the reactor engineering program are essentially three new programs that we have had in this area.

With the advent of reactors going into space, we found that we have to do a lot more safety development work in order to identify the types of problems that will be encountered in reactors being put into space, not only identify the problems but also solve the problems so that we can go into space. So the big increases in that program or the primary increases in that program have been in the space program. They were not anticipated at the time we came in last year.

Mr. CANNON. Doctor, you are showing a $6 million increase for this purpose in fiscal year 1963. On the basis of last year's budget estimate it is actually a $10 million increase. How is that accounted for?

Dr. PITTMAN. It is primarily accounted for by two things. One, the space program that I just mentioned which is just getting underway. We have a contract with a specific contractor to carry out our basic development program for space safety. This is the Sandia Corp. Such things as what happens to the reactors when they reenter from outer space, when they come into the atmosphere. Do they burn up completely or fall in big blobs? Where do the fission products go, and what will be their influence as they fall? Particu-

larly, do they burn out and come out very slowly or do they fall in large chunks? That is one type of the safety program. This will include Rover, SNAP, and as we get into the Pluto program, what happens to that from the safety standpoint?

Another thing that has bothered us for many years in the civilian power program is what are the consequences of a reactor accident. In one of these large reactors that we hope to use for civilian power, what will be the consequences of such an accident. We have made calculations to the point now where we think further calculations are not going to give us the answers. Therefore, we have to go into an experimental program (1) that will determine what will be the actual results of the accident and (2) what will be the consequences. So we have introduced in our 1963 budget a completely new program to determine what happens if a reactor has an accident and what will be the consequences, because if we don't do this we will have a very difficult time in the future finding places to put reactors and finding people who are willing to use reactor systems.

One other important item in this increase——

Mr. CANNON. I might say that has been one of your problems from the beginning.

Dr. PITTMAN. It certainly has, sir.

Mr. CANNON. We are surprised that you have not yet obviated that difficulty or at least developed some system which would provide this information you say you need. The reason the Shippingport project was delayed so long was that everyone was afraid that there might be a breakaway in that congested area, a flareup, the consequences of which would be very serious. That adds to the remarkable record made by Admiral Rickover in solving the problem when nobody else dared to even touch it. He went in to an uncharted field and in record time obviated the risks and got the reactor operating.

REGROUPING OF ACTIVITIES

There is one thing we would like to say rather emphatically to your agency and to the Bureau of the Budget. We fully realize you are dealing with a very complicated program, that in many respects it is an uncharted field. You can't say yet what can be done or what can be expected. But it has been evident in the hearing, as all members of the committee are aware, that we have continuing difficulty with your justifications, as I have indicated, because of regrouping of activities, of changing of programs, and variation in names. It is impossible for our staff, without intensive and what seems to be unnecessary study, to determine just what you are doing with money previously appropriated and how your budget request compares with your going program.

Let me say that we shall not expect from now on to have this same problem again. Next year we will instruct your budget officer as to just what is wanted and we wish you would be in a position to adhere to the program as you originally outline it to us and as presented in the budget.

It is an intricate program. Our staff is overloaded. If you will adhere in your budget during the year to what we are led to expect, we should appreciate it. We ought not to have to do as we have had

had to do this year—trace all items to find that you added this or subtracted that.

Mr. EVINS. Mr. Chairman, one of the difficulties as I see their program is that they develop a project and put it on the shelf and nobody buys it and uses it, and they start experimenting on another one, a more sophisticated one. I have tried to urge that they take five or six of them and develop them so they will be complete. They develop them and put them on the shelf and move on to another type. Now they are moving into the space program and we don't know where this will lead them.

Mr. CANNON. In all of our research programs as indicated the other day, there is no penalty for failure and responsibility and position are shifted from time to time. As yau say, they lay a project on the shelf and take up something else. Nobody is charged with failure, but it is a failure. We expect you to carryout each program to its end, and when you fail to get results, we trust you will report to us to that effect. We would like to know what the defect is, and where the difficulty lies.

General LUEDECKE. In our budget for next year, Mr. Chairman, we will coordinate closer with the staff to assure that these items are reflected in such a manner that the committee can read them in the context of the budget.

Mr. CANNON. The gentleman from Massachusetts.

AUTHORITY TO EXCEED BUDGET ESTIMATES

Mr. BOLAND. Where do you get the authority? Last year in 1962 the evidence indicates that this item of nuclear safety was around $12 million-plus. How will you go ahead and spend $16 million on that program? Where do you get the authority to do this? Who makes the determination and who tells you that you can do it?

Dr. PITTMAN. The actual increase, Mr. Boland, over items identified in the budget, and this is the problem we are having here, and it was not done with the intent of hiding anything that we did, items that were identified elsewhere in the budget this year, we identified with safety, because they had more of a safety aspect than they did civilian power aspect.

Mr. BOLAND. You are talking about 1962?

Dr. PITTMAN. Yes. We did increase the amount of money that we spent under the category of nuclear safety even after we took the identifiable items from the last year's budget. This was done on the basis of the new program that we felt had to be started in 1962.

NUCLEAR SAFETY

Mr. BOLAND. Now, with respect to the new program that you felt had to get started in fiscal 1962, would you again tell us what that new program was and why it had to get started in 1962 and what the cost was?

Dr. PITTMAN. All right, sir, I will try to do that. It was primarily a new program started in the safety area, in the space activity. As we moved forward in the space program, you will recall last year

for the first time we put a nuclear device into orbit, two small isotope units were placed into orbit. In the course of doing this, in the course of looking at the types of approvals that would be necessary before everybody who has to be satisfied could be satisfied that nuclear energy in any form could be used in space application, even in this relatively simple isotopic device, we put into orbit last year, it became clear to us that we were going to have to have a lot of information about what happens in the event there are failures on the pad, say of a reactor, there is a failure after it is launched but before it gets into orbit, there is a failure so that then it does not quite make orbit but almost does, and goes a certain distance and therefore comes back in with the possibility of burnup, or finally what happens after it has gotten into orbit, maybe it stays there for several years, and then comes back after the reactor has been used but it is an active reactor. We found that we did not have the type of information that is necessary to answer the questions that these launchings and reentries of nuclear devices would raise.

We felt that with the SNAP 2 and 10 programs, so-called SNAPSHOT programs, we have with the Air Force, which we were hoping to launch in 1963 and 1964, now it is late 1963 and early 1965.

In order to get the information which would satisfy everybody and would enable us to make these launchings for the Air Force, we had to start a program that we did not have underway. So we started working with the Air Force for instance on piggyback, putting some of our equipment on some of the scout vehicles they were sending in ballistic trajectory so that we could find out what happens to components of the reactor system as they went up and came back under burnup conditions.

We started a program with the Sandia Corp. to be the focal point for all the safety aspects of these devices in space. This was the first step really in determining the answers, getting the answers to the problems of going nuclear in space, and how to resolve them. That is one big item we have.

Another one is that during the course of the year it became more evident to us that the problem of fabricating pressure vessels for commercial reactors was going to be bad. We ran into potential difficulties about how long were these vessels to last under irradiation. So we instituted a new program to attempt to find out as quickly as we could—it will still be a several year program—what are the effects on the ductile temperature of the pressure vessel under pressure as it is irradiated and for length of irradiation that we expect during the life of the reactor.

For example, we found out in order to do this, to use rockets for testing, we cannot continue to depend on piggybacking on some other agency's vehicles. So we have included in fiscal year 1963 budget money for the purchase of our own scout rockets. There is about $2 million in 1963. So there will be an expansion of this program in 1963. But those that I mentioned earlier were the two main things that we added in 1962.

In addition to that, as I mentioned, we did increase the $12 million a little, about $600,000 or $700,000, by transferring equipment that previously was lumped in one place in the budget and $600,000 was the portion that went into safety.

Mr. BOLAND. How much money are you spending in the environmental research and developmental program with respect to space?

Dr. PITTMAN. The $2.1 million is the best estimate that we have as of this moment for the space activity.

Mr. BOLAND. Now you are not duplicating what NASA is doing here, are you?

Dr. PITTMAN. No, sir; the responsibility for the safety aspects of the nuclear program rests with the Commission. NASA does such things as determine the effect of irradiation on components, on the type of components that they have the responsibility for. But the whole responsibility for the nuclear safety aspect of the space program rests with the Commission.

Mr. BOLAND. Thank you.

Mr. PILLION. Mr. Chairman.

Mr. CANNON. The gentleman from New York.

QUESTION OF IMPORTANCE OF SOME COMMISSION PROGRAMS

Mr. PILLION. I am somewhat disturbed by what I consider to be an apparent lack of information concerning the results and values of a great deal of these expenditures. We see these programs continually mounting yet we get no report that I can find giving us what has been accomplished with all this money that we are spending.

Now, on page 2 we find that we start off with a raw materials program of $500 million, which I concede is necessary. Special nuclear materials, $537 million. I assume that is necessary. Certainly the weapons, $786 million, is the primary purpose of the Atomic Energy Commission and its primary function.

Now, everything below that amounting to about $2.8 billion is not a direct contribution to the primary function of the Atomic Energy Commission. We get reactor development, physical research, biology and medicine, training and education, civilian application, community relations, which are all more or less in my estimation secondary appropriations as compared to the primary function of the Atomic Energy Commission.

I just raise that because here we are up to $2.8 billion. We keep getting one sheet after another of very fine, vague phrases and generalities which appear to have no immediate end result of a practical nature. I just raise that, Mr. Chairman, because I keep wondering about all these increases and these peripheral activities of the Atomic Energy Commission. I think that certainly we ought to make a reevaluation of $1 billion being spent for purposes that are not directly related to national security and defense which is the prime purpose of the Atomic Energy Commission, and not the study of biology, etc.

Mr. CANNON. It has been a very expensive program from the start.

Mr. PILLION. It is a very expensive program.

ORGANIC POWER AND HEAT INDUSTRIAL REACTOR

Mr. CANNON. And we would like to observe every possible economy. Among others, there is one item I would like to ask about here. On page 446, of the construction program, project No. 63–e–3, organic power and industrial heat reactor, appears to the committee to be a rather important item. What progress are you making? What is the situation there?

Dr. PITTMAN. The organic reactor system has been in our program, as you recall, for some years.

Mr. CANNON. But you don't seem to have made much progress.

Dr. PITTMAN. We are making progress with the development program. Two years ago we had money in the budget for the construction of a reactor similar to this; I think it was $25 million that we had in the budget. We had authority from the Joint Committee and from the Congress, and the money from this committee for the construction of that under cooperative conditions.

We tried first a cooperative venture by going out with an invitation to the private power industry under third round conditions where we would do the research and development and they would build the reactor. There was no interest on the part of utilities companies at that time in the construction of such a reactor primarily because the Piqua reactor had not operated, and secondly because we were at that time having some difficulties in the operation of the OMRE with regard to the fouling of the fuel elements. So there were some technical difficulties that were beginning to show themselves at that time and therefore the utility companies who would be putting money up were not interested in that particular concept at that time.

Mr. CANNON. Has that now been obviated?

Dr. PITTMAN. We are still having problems, but let me go forward.

Secondly, a little later we attempted to interest the publicly owned utilities under the conditions where we would build the reactor and they would furnish the power conversion equipment to make the electricity. We did get one proposal from a public company, a publicly owned utility company. The problem there was that it was sitting on a gasfield down in the Southwest. What they could pay for electricity was so little and the amount of electricity they could use and guarantee they would use was so uncertain that we felt it would not be a good proposition for the Government to build that reactor under those conditions.

At about that same time we were also considering the construction of this reactor at one of our own sites such as Savannah River or Oak Ridge or Paducah. Savannah River turned out to be one that could use the power and also because they were in a higher cost conventional power area.

We did not like, and I still do not like, the idea of the Commission building a reactor for the demonstration of generation of power and building it at our own sites because the one thing you don't get then is the demonstration by a utility company. Having them operate it and letting the other utilities come in and see that a utility company under their normal operating procedure is able to operate this reactor and make it work and produce power.

So we did not move right ahead with the construction, hoping we could find a utility company or some group of companies that would be willing to cooperate with us in the construction of this reactor. This brings us now essentially up to this spring.

At that time a group of companies consisting of the Packaging Corp. of America, which is a pulp and paper producing company, together with Atomics International and Gilberts Associates, those three came in to talk to us about the possibility of our building a reactor of this type up in Michigan on the site of the paper company. The

Packaging Corp. of America to furnish the power conversion equipment, and pay for the steam. They are in a high-cost area so the whole thing looks pretty good.

Mr. CANNON. They would consume the entire output?

Dr. PITTMAN. Yes. They are not a utility company. What we have done now is to modify the purpose of the reactor slightly. We will build the same reactor we have been talking about before, 50-megawatt reactor, which will give us all the information we need to build a larger organic reactor for the production of electrical current, but we will build it under a plan so some of the steam will be used in the paper industry. We will build it for the accomplishment of electricity but also showing that nuclear energy can be used for process heat in the paper industry.

As far as I know at this moment there is no objection to moving forward with this.

Now, there is still the technical problem. You asked about the technical problem. It still is in existence at this time.

Mr. CANNON. And you expect to go ahead?

Dr. PITTMAN. We expect to go right ahead.

You asked about the status of the technical problem. We still have not completely solved the technical problem. The problem is that the fuel element is in this organic material that is flowing around the reactor. The organic material in the course of flowing around the reactor becomes irradiated and breaks down. It is an oil, it is somewhat unstable. It breaks down and deposits material on this fuel element. A little bit does not make any difference, but if the deposits are too much, then the space between this fuel element and the next one clogs up and the coolant can't flow. As soon as it ceases to flow, the reactor will start melting. We want to be sure that before we build the reactor we have the problem of the clogging up of these fuel elements completely licked. The experience in the past year and a half has been good. We are quite optimistic about the possibilities of solution of this. I think we will be able to move forward with this reactor quite soon.

CAFETERIA, ARGONNE NATIONAL LABORATORY, ILLINOIS

Mr. CANNON. In that same program—on page 446—I see you have a cafeteria with 36,000 square feet, a project for which you are requesting $1,500,000. That appears to the committee to be rather exorbitant.

Dr. PITTMAN. I asked Mr. Derry just before the meeting about whether this was in line with other cafeterias. He tells me this is completely in line, in fact a little less than the cost of the average cafeteria, that is dollars per square foot, than the cafeteria built at Germantown or any cafeterias built around here. So I am quoting the opinion of our expert, Mr. Derry, when I say he said this was in line and if anything a little bit more reasonable than the cost of the usual cafeteria.

Mr. CANNON. Does this include all equipment?

Dr. PITTMAN. Yes, sir; this includes cafeteria equipment.

Mr. PILLION. Mr. Chairman.

Mr. CANNON. The gentleman from New York.

Mr. PILLION. On the question of the cafeteria that is being built at Argonne?

Dr. PITTMAN. Yes, sir.

Mr. PILLION. How many employees do you have there?

Dr. PITTMAN. 4,700, I am informed, is the latest figure. This assumes that there will be an increase, a projected increase in the number of people.

Mr. PILLION. I understand that the new cafeteria will house or be able to feed something like 900 people at one time?

Dr. PITTMAN. Yes, sir; 950 people.

Mr. PILLION. Do you intend to operate the new one and the old one?

Dr. PITTMAN. We now have two. One of the old ones will be shut down. Actually the cafeteria that we will shut down is in the basement of the physics building. It is a building that was built for scientific purposes, and is being used for cafeteria space because we had no other space. We would move out of that and actually use that for its original purposes, and put some computers and other equipment for the physics people in that building. So the other cafeteria will remain open and this one will replace one.

Mr. PILLION. The one now in existence will feed how many and the one that is proposed will feed how many?

Dr. PITTMAN. One feeds 350 and the other 450.

Mr. PILLION. This figure is something like $40 a square foot of space. That is rather high, is it not, for that type of construction?

Dr. PITTMAN. This includes the equipment that is necessary for running the cafeteria. As I mentioned, I checked with our construction expert who says this is completely consistent, if anything a little lower than the average cost of cafeterias with equipment and facilities and utilities and everything else.

Mr. PILLION. You are building over and above present needs by how much?

Dr. PITTMAN. This is anticipating a growth to about 5,000 people, sir. This cafeteria would serve more than just the lunch people. It serves both breakfast, lunch, and light supper.

AUTHORIZATION OF APPROPRIATIONS FOR CONSTRUCTION PROJECTS

Mr. PILLION. Do you have specific legislative authority for this or does your Commission just proceed to build these things? For instance, could it build a laundry, could it build a dry cleaning establishment? Could it build a movie? Could it build a swimming pool? Do you have unlimited authorization to spend money?

General LUEDECKE. No, sir; we do not have unlimited authority. All of these are line items which were placed before the Joint Committee on Atomic Energy for authorization of appropriations for their construction.

Mr. PILLION. Have they been authorized specifically?

General LUEDECKE. They are in the present authorization bill, action on which is not yet complete.

Mr. PILLION. Then these are subject to authorization?

General LUEDECKE. Yes, sir.

Mr. PILLION. How much of this whole budget is subject to authorization? We don't know here whether these are authorized or subject to future authorization.

Mr. MCCARTHY. All of the projects with the 63 prefix, Mr. Pillion, are in the presently proposed authorization bill. In other words, the two digit prefix indicates the year of authorization. You will notice on page 446 all of these items are to be authorized, and are in the present bill under consideration by the Joint Committee on Atomic Energy.

Mr. PILLION. Before we markup we must have a harmonizing between your requests here and what will be in the authorizing legislation.

Mr. MCCARTHY. I assume so; yes, sir.

On that next page 447, those items you will notice are previously authorized items.

COST OF CAFETERIAS

Mr. CANNON. Supplementing what Mr. Pillion has said, we will ask you to include in the record a breakdown of the cost of the construction of this cafeteria item.

Dr. PITTMAN. We will be very happy to, sir.

(The information follows:)

Cafeteria, Argonne National Laboratory—Cost of Construction

Details of Cost Estimate:

1. Engineering design and inspection (9.3 percent of construction costs)	$98,000
2. Construction costs:	
(*a*) Site work	78,000
(*b*) Buildings (36,000 square feet)	900,000
(*c*) Utilities	80,000
Total	1,058,000
3. Equipment:	
(*a*) Food service equipment	175,000
(*b*) Furniture	29,000
Total	204,000
4. Contingency (approximately 10 percent of other costs)	140,000
Total estimated costs	1,500,000

ADVANCED TEST REACTOR

Mr. CANNON. Continuing in the same category on page 447, project 61–d–9. Although we were led to believe last year that advanced test reactor would cost approximately $40 million, you are spending $47 million. What has occasioned that increase?

Dr. PITTMAN. The increase in this reactor has in a word been caused by the fact that it is a new type reactor that we have never built before. It is a very advanced high flux test reactor. It will be the highest flux reactor certainly in this country of this size when we get through. Basically the problem was at the time we submitted the estimate we did not have enough engineering, detailed engineering data to give

us the final cost. As we have gone forward with the engineering design and have resolved the complications of this reactor and have gotten the cost based on known design rather than on conceptual design, we found they were considerably higher. I think if I may say it, it is a factor of ignorance that comes in whenever you try to make an estimate before you have the design. You can't estimate the things you don't anticipate and you can't anticipate them until you get it.

Mr. CANNON. It is a margin of several million dollars on that item.

Dr. PITTMAN. It is. The only way you can get around this on a new project like this, where you are not just making minor improvements on old projects, but where you are getting into a completely new system like this, the only way you can get around like this is to have a complete engineering design before you make an estimate. That of course slows down the progress of the program by having to do that sequentially rather than simultaneously.

OVERRUN LIMITATION ON CONSTRUCTION PROJECTS

Mr. CANNON. You know we have a rule which we apply to many of our bills in which we permit readjustment within a 15-percent limit. We do not permit reprograming beyond the 15-percent limit unless we are notified and have an opportunity to pass on it. We realize, as you have just said, that you are proceeding here in new territory, uncharted areas. It is impossible to always estimate accurately what your costs are going to be, but we trust by this time you have had sufficient experience to estimate approximately what the cost will be. We are not going to apply the 15-percent rule to you because we realize the difficulty of your situation. We trust, however, you will keep an eye on this and observe this rule as much as possible.

PHYSICAL RESEARCH

Dr. McDaniel, you are Director of the Division of Physical Research?

Dr. MCDANIEL. Yes, sir.

Mr. CANNON. You are asking for $216 million for the physical research program. What has been spent on this item in prior years?

Dr. MCDANIEL. For fiscal year 1962, we expect our costs to be $175,978,000.

It is an increase of $40,022,000.

Mr. CANNON. What is the nature of that increase?

PROJECTED INCREASE IN FISCAL YEAR 1963 OVER FISCAL YEAR 1962

Dr. MCDANIEL. Of the $40 million increase, about $23.9 million is rquired for the physics and mathematics program. Of that $23.9 million, the high-energy physics program accounts for about $17.2 million, and reflects primarily the scheduled transfer of activities from construction at the major sites to operating, as well as the increased cost due to more sophisticated experiments being carried out, requiring more complex instrumentation and data analysis.

Mr. CANNON. We shall insert pages 224 through 265 of the operating justification and the associated pages for construction.

(The data referred to follows:)

OPERATING EXPENSES

PHYSICAL RESEARCH PROGRAM—OPERATING COSTS

Program statement

Estimate fiscal year 1963	$216,000,000
Estimate fiscal year 1962	175,978,000
Increase	40,022,000

The physical research program is directed toward discovering natural laws relevant to the Commission's responsibilities for the development, use, and control of nuclear energy. Within this framework, investigations are undertaken in the fields of physics, chemistry, metallurgy and materials, and controlled thermonuclear research. There follows a brief statement of principal objectives within each scientific discipline:

Physics

1. To attain a comprehensive understanding of those phenomena which contribute to the establishment of a consistent theory, explaining, in general, the behavior of nuclei, nuclear components, and nuclear forces.
2. To advance the study of nuclear forces and to build up both a theoretical and empirical knowledge of nuclear structure and nuclear processes.
3. To provide the basic nuclear data, particularly in the field of neutron cross sections, as needed in the weapons and reactor programs.
4. To improve existing and to develop new devices such as accelerators and computers that will be of use in the overall AEC program.
5. To devise new methods of treating mathematical problems that arise in connection with AEC programs.

Chemistry

1. To advance basic knowledge in those fields of chemical science related to atomic energy.
2. Where the state of knowledge permits, and the need exists, to orient this knowledge toward, and development of it for the practical operations of the atomic energy program.

Metallurgy and materials

1. To evolve a true, coherent concept of the basic structures and mechanisms which govern the properties and behavior of materials related to the atomic energy program.
2. To apply the basic knowledge evolved to the development of materials technology in order to alleviate materials-related problems of the atomic energy program.

Controlled thermonuclear

1. To heat and confine a plasma at a particle-energy sufficient to yield significant amounts of thermonuclear energy during the time of confinement.
2. To study such plasma, and, if it be found feasible, to design and build a pilot thermonuclear plant yielding net power.
3. To produce economically competitive fusion power.

The increase of $40,022,000 in fiscal year 1963 over the level of $175,978,000 estimated for fiscal year 1962 is summarized as follows:

1. An increase of $17,234,000 in high energy physics applied to the following:	
Major AEC sites	$15,071,000
University programs	2,163,000
Total	17,234,000
2. An increase of $5,397,000 in nuclear structure consisting of—	
Research and equipment	2,597,000
Low energy machines	2,800,000
Total	5,397,000
3. An increase in all other physics and mathematics programs of	1,246,000
4. An increase in chemistry programs of	8,000,000
5. An increase in metallurgy and materials programs of	4,237,000
6. An increase in controlled thermonuclear programs of	500,000
7. An increase in all other capital equipment of	3,408,000

An estimated $2,750,000 of this increase is related to procurement of a high speed computer for the Brookhaven National Laboratory.

Summary of estimates by category

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Physics and mathematics research	$79,830,531	$90,888,000	$114,765,000
2. Chemistry research	34,918,788	39,675,000	47,675,000
3. Metallurgy and materials research	15,267,922	18,823,000	23,060,000
4. Controlled thermonuclear research	29,998,652	26,000,000	26,500,000
5. All other capital equipment	982,409	592,000	4,000,000
Total, physical research program	160,998,302	175,978,000	216,000,000

JUSTIFICATION BY CATEGORIES

1. Physical and Mathematics Research, $114,765,000

There are included within the physics and mathematics program estimates for the following activities:

[Costs in thousands]

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
A. High energy physics	$53,192	$63,931	$81,165
B. Nuclear structure and neutron physics (low energy physics)	20,107	21,188	26,585
C. Extra nuclear properties of matter	919	930	1,115
D. Physical methods of isotope separation	1,246	1,446	1,600
E. Mathematics and computer research	4,366	3,393	4,300
Total, physics and mathematics research	79,830	90,888	114,765

JUSTIFICATION OF CATEGORIES

A. High energy physics, $81,165,000

High energy physics continues to be one of the most active fields in contemporary science, with a great deal of the research pressing the very frontiers of scientific thought. Through research in this field, we learn about the fundamental properties of the basic particles which constitute matter, e.g., mesons and strange particles, antinucleons, and hyperons, with primary interest centering on the forces that hold nuclear matter together. In order to bring about the high energy reactions required to create these elementary particles under controlled laboratory conditions, it is necessary to use high energy (multi-Bev.) particle accelerators. An example of advancement in this field is the discovery of the omega particle, recently announced by scientists of the Lawrence Radiation Laboratory. As our knowledge of elementary particle physics has increased, it has been found necessary continually to go to higher energies. Research with each new accelerator has posed questions which experimentation with newer and high energy machines has answered. Experience in this field shows, however, that for every question answered, several new questions arise. As new machines come into operation, the older lower energy machines are applied to increasingly accurate and detailed experimentation with the recently discovered particles.

It is necessary to support continued research with lower energy machines, since many details must still be examined which the higher energy facilities cannot afford to investigate. The properties of the mu and pi mesons, for example, although discovered more than a decade ago, are still subject to intense investigation. This task has led to improving and updating existing machines to carry out tasks which previously were not feasible. The recent installation of a new linac injector for the California Institute of Technology synchrotron will give that accelerator not only a beam of much higher intensity but also will permit it to operate at the higher energy of 1.5 Bev. This renovation will permit further studies in pion physics which would be uneconomical

with high energy machines such as the alternating gradient synchrotron (AGS) at Brookhaven and the Cambridge Electron Accelerator.

In addition to higher energy machines, improvements in detecting devices such as bubble chambers, filamentary scintillation chambers, hodoscopes, and data-analyzing equipment have contributed to advancements in this field. The recently developed spark chamber is proving to be a very useful detector for the study of high energy events, in part due to its ability to be triggered so as to respond only to suitable selected events. Present experiments require elaborate apparatus, such as chains of bending and focussing magnets in order to provide intense and monoenergetic beams of particles, complicated beam separators for removing unwanted particles from the beam, and complex detection devices such as those mentioned above.

The programs in this category support the operations, including research and advanced technology, relating to the 30 Bev. alternating gradient proton synchroton and cosmotron at the Brookhaven National Laboratory, the 6 Bev. bevatron at the Lawrence Radiation Laboratory, and several electron synchrotrons and proton synchrocyclotrons of lesser energies. The beam of the AGS at BNL has now been built up to 3×10^{11} protons per pulse, and energies as high as 33 Bev. have been obtained. This machine thus may be regarded as the best accelerator in the world and it is highly desirable that sufficient funds be provided to permit its effective use by U.S. scientists. Two additional machines began operation in fiscal year 1962. These are the 3 Bev. Princeton-Pennsylvania synchrotron, which will produce a high intensity proton beam, and the Cambridge Electron Accelerator, which will produce 6 Bev. electrons. A third accelerator under construction is the 12.5 Bev. proton sychrotron, (ZGS) at the Argonne National Laboratory. This machine is scheduled to become operational in fiscal year 1964, and should produce beams of exceptional intensity to permit research with intense beams of selected secondary particles. Provision is also made under this category for research and development required in connection with the Stanford Linear Accelerator. Provision for the operation of these circular machines, including associated research and development work; for research and development related to the Stanford Linear Accelerator; for pre-operational buildup of the Argonne ZGS group; and for associated general theoretical work will require an increase of $15,071,000 in fiscal year 1963. This increase reflects not only the necessary increased costs of performing more sophisticated experiments, with more elaborate instrumentation and methods of data analysis, but in large measure also reflects the scheduled transfer of activities at major sites from a construction to an operating phase.

This activity also supports high energy research efforts at universities through the contract research program. These "machine user groups," which include some of the best scientific minds in high-energy physics, must be considered as an integral part of the high-energy physics program. The contract research program is strong in its support of theoretical studies in the area of particle physics. Many experiments at the national laboratories are carried out in close collaboration with university scientists. In fact, many contributions toward new discoveries originate within the university programs.

As experimental measurements become more accurate, complex, and detailed, there results a corresponding increase in costs for instrumentation and recording analysis. An increase of $2,163,000 reflects the growing needs of the contract research program as the U.S. capacity for high energy experimentation increases, and also provides for initiation of studies of advanced concepts in accelerator technology.

There follows a tabulation of estimates for high-energy physics program by major machine or location, including a breakdown of general research and development activities.

[In thousands]

Category and laboratory	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Penn-Princeton accelerator	$3,166	$3,648	$4,600
1. Research	1,111	1,165	1,300
2. Advanced accelerator technology	707	877	900
3. Operations	1,348	1,606	2,400

[In thousands]

Category and laboratory	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Cambridge accelerator	$1,719	$4,383	$5,350
1. Research	1,053	2,550	2,920
2. Advanced accelerator technology	196	253	600
3. Operations	470	1,580	1,830
AGS	4,192	5,885	9,550
1. Research	1,372	2,770	4,900
2. Advanced accelerator technology	1,632	1,685	2,000
3. Operations	1,188	1,430	2,650
Cosmotron	4,669	4,730	4,950
1. Research	2,906	2,835	2,900
2. Advanced accelerator technology	610	710	750
3. Operations	1,153	1,185	1,300
ZGS	2,791	3,137	6,900
1. Research	166	196	2,100
2. Advanced accelerator technology	2,625	2,814	3,300
3. Operations	0	127	1,500
Bevatron	10,586	11,217	10,600
1. Research	7,408	7,897	8,600
2. Advanced accelerator technology	0	0	0
3. Operations	3,178	3,320	2,000
184-inch cyclotron	1,544	2,265	2,900
1. Research	1,484	1,663	2,200
2. Advanced accelerator technology	0	0	0
3. Operations	60	602	700
California Institute of Technology accelerator	675	850	1,175
1. Research	0	595	850
2. Advanced accelerator technology	0	0	0
3. Operations	675	255	325
Stanford accelerator	2,902	4,100	5,600
1. Research	0	0	0
2. Advanced accelerator technology	2,902	4,100	5,600
3. Operations	0	0	0
MURA accelerator	1,843	1,553	1,180
1. Research	0	0	0
2. Advanced accelerator technology	1,843	1,553	1,180
3. Operations	0	0	0
ORNL high energy physics	423	529	840
1. Research	72	94	168
2. Advanced accelerator technology	0	435	672
3. Operations	351	0	0
General research and development	9,253	11,570	13,050
AMU	24	30	70
Ames	146	167	265
ANL	584	1,764	200
BNL	133	205	280
LRL	2,142	2,288	2,750
Other	6,224	7,116	9,485
Related capital equipment	9,429	10,064	14,470
Ames	23	15	0
ANL	1,020	1,404	3,400
BNL	3,561	4,575	4,720
CEA	1,402	812	2,700
California Institute of Technology	41	250	190
LRL	1,500	1,690	1,250
MURA	104	77	100
ORNL	173	5	10
PPA	1,046	370	1,200
Stanford	338	400	400
General research and development	221	466	500
Total, high-energy physics	53,192	63,931	81,165

B. Nuclear structure and neutron physics, $26,585,000

Neutron physics involves research relating to low energy nuclear processes and to the study of nuclear structure. This activity also covers work directed toward the design and development of devices for low energy nuclear physics research including new types of low energy accelerators, accelerator systems, and improvements in components of present systems.

It is in this program that measurements are performed and theories developed which are both of interest to basic nuclear physics and of direct interest to the Commission's mission in reactor development and nuclear weapons. In this regard, work involving nuclear cross sections is conducted at both the national laboratories and the universities, coordination is achieved on a national and international scale. The availability of such new machines, as the tandem Van de Graaff at Rice University, Argonne National Laboratory, and Oak Ridge National Laboratory, the 3 Mev. Van de Graaff at Duke University, the linear accelerator at General Atomic, and the high-current electron linear accelerator at Yale University are all instrumental in the increased activity in the cross section measurement program. A host of new research samples for use in these measurements are being made available through the expanded stable isotope production program at the Oak Ridge National Laboratory.

Major activities in nuclear structure and neutron physics are carried out at the Argonne National Laboratory, the Brookhaven National Laboratory, and the Oak Ridge National Laboratory. Programs in this field are also carried out at Ames Laboratory, Lawrence Radiation Laboratory, and at approximately 50 university research laboratories. This work is usually centered around low energy particle accelerators such as linear accelerators, Van de Graaff accelerators, or cyclotrons, or a major piece of experimental apparatus such as a magnetic spectrometer. Studies include research in fast neutron reaction studies, beta and gamma ray spectroscopy, energy level studies, charged particle reactions, photonuclear studies, production of polarized ion sources, and nuclear theory.

An increase of $5,397,000 is required for this activity. Of this increase, $120,000 is needed at Ames Laboratory to provide for development of the research activities to be centered around the newly established Ames research reactor and to provide for the procurment of a mass isotope separator for the preparation of radioactive sources of single, short-lived isotopes. The increase of $425,000 at Argonne National Laboratory is required to exploit the capabilities of the Van de Graaffs, to continue vigorous programs at the cyclotron and reactor, and to continue theoretical nuclear studies. At Brookhaven National Laboratory, the extension of work in gamma-ray studies, polarized neutrons, etc., utilizing the Van de Graaff, 60-inch cyclotron, and start up experiments with the high flux beam research reactor requires an increase of $464,000. The increase of $250,000 at the Oak Ridge National Laboratory represents the growth, maturing, and replacement to the existing diversified research program in nuclear structure and neutron physics with full utilization of the Oak Ridge isochronous cyclotron and the new tandem Van de Graff. A major part ($2,800,000) of the $4,138,000 increase in this activity for contractors other than those already mentioned results from the critical need for new and replacement low energy accelerators at university centers. These machines are urgently required if the United States is to keep in the forefront of that area of research which is most central to a number of the major activities of the Commission. With the slow growth rate in providing support for this area of research, critical situations have developed in certain Commission programs such that they will not be able to maintain their excellence in research if new facilities are not provided, and existing facilities modified. The balance of $1,338,000 in research, design, and development, and equipment costs in this program is necessary if studies are to be conducted with renewed vigor and if the new directions of researches which are continually opened up by discoveries of new phenomena, by major improvements in instrumentation, and by availability of new facilities are to be exploited.

C. Extra nuclear properties of matter, $1,115,000

Programs in extra nuclear properties of matter at Argonne National Laboratory, Oak Ridge National Laboratory, and six universities are supported under this activity. The research concerns those phenomena which are intimately related to the nuclear energy program, but which do not have a nuclear origin per se. This includes studies in mass spectroscopy research, optical spectroscopy of uranium salts and molecules containing tritium, spectroscopic methods

for isotope analysis, electric and magnetic resonance absorption, low temperature physics, and penetration in matter of charged particles.

The increase of $185,000 is required for undertaking several new developments such as work on cryogenic coils and to permit a more intensive effort on several of the continuing studies. Of this increase, $51,000 is for a more intensive effort in the program at Argonne National Laboratory, particularly in studies using a pulsed molecular beam in conjunction with a mass spectrometer for various measurements in high temperature physics and in molecular beam research.

The increase of $134,000 at Oak Ridge National Laboratory, as well as the projected increase in contract research, is aimed at expansion of effort in several areas, but primarily involves the development of cryogenic coils.

D. Physical methods of isotope separation, $1,600,000

Samples of elements that are required for Commission research programs, especially in the cross sections measurement program, fundamental physics research, and reactor physics studies, are obtained through the isotope separation program conducted under this activity. The major effort on isotope separation is conducted at the Oak Ridge National Laboratory, where work is carried out in programs of mass spectrometry development, thermal diffusion research and development, stable isotope process improvement, and the electromagnetic separations of the isotopes of thorium, uranium, and plutonium.

The increase of $154,000 in this activity is required as follows:

(*a*) An increase of $31,000 at the Oak Ridge National Laboratory for a modest expansion in the various isotope separation programs. Thermal diffusion development work will continue to be directed toward separation of isotopes of elements not yet attempted and the enhancement of different isotopes of elements now in production. In the heavy element electromagnetic separations program, the separations will be repeated as needed to satisfy research requirements. During the period of modification to this facility to provide suitable containment, the inventory on a number of isotopes has been depleted. It will be necessary to increase the effort in this program if present sample requirements are to be met in a reasonable period of time.

(*b*) The program at MOUND Laboratory will increase by $83,000 reflecting expanded research and development studies on the thermal diffusion process. Separations by this process will be required to meet important research needs for materials, such as carbon 13, and the stable isotopes of Xenon.

(*c*) A modest increase ($40,000) to permit the exploration of new or alternate methods of isotope separation.

E. Mathematics and computer research, $4,300,000

This activity includes research in mathematics as applied to physical processes and the development of advanced components and systems for use in various areas of AEC concern, including nuclear research, the design of accelerators, and reactors, and other applied activities. This activity encompasses development of components, computers, data-handling devices and systems, including their logical design, and the conceptual studies of information systems. There is also included in this activity the numerical analysis, programing, coding, and actual running of the mathematical problems associated with other parts of the physics and mathematics programs. In addition, mathematics and programing theory is developed as a discipline in differentiation from its use as a tool in carrying out other AEC programs.

Of the total increase in this activity ($907,000), $100,000 is for the design and development of the floating indexed point (FLIP) arithmetic unit to be used in conjunction with the GEORGE computer at Argonne National Laboratory. At Brookhaven National Laboratory an increase of $100,000 is required for the continued improvement of the MERLIN computer and expansion into other areas such as digitizing equipment and pattern recognition. In addition, an increase of $30,000 will be needed there for mathematics and programing research including applications of operator theory to partial differential equations, magnetohydrodynamics, feasibility study of programing Feynmen diagram calculations in quantum electrodynamics, and programing of calculations on nucleon and hyperon form factors. An increase of about $5,000 will also be required for modest equipment needs at Brookhaven.

At New York University plans for theoretical and experimental investigations into high-speed serial memories and arithmetic units, a program of computer simulation of a character recognition machine, along with associated developmental fabrication requires an increase of $380,000. The increase of $110,000

at Oak Ridge National Laboratory covers the extensive machine experiments that are contemplated for constructing, testing, and analyzing computational error in codes for solving differential equations and performing matrix computations, and for testing techniques for translating and programing. Other mathematics and computer research will increase by $182,000 primarily for initiation of research on "post-stretch" computer concepts.

2. Chemistry Research, $47,675,000

There are included within the chemistry program estimates for the following activities:

[In thousands]

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
A. Chemical properties and reactions	$23,415	$27,150	$31,410
B. Systems and materials chemistry	4,766	4,941	5,445
C. Chemical isotope separation studies	799	810	900
D. Special projects	2,009	2,316	2,670
E. Preparation and purification of special isotopes for research	1,404	1,789	3,450
F. Related capital equipment	2,526	2,669	3,800
Total chemistry research	34,919	39,675	47,675

A. Chemical properties and reactions, $31,410,000

Work performed in this activity is of fundamental nature, pertinent to many interests of the AEC. Some studies may be directly related to immediate programs or problems; others are of a long-range nature, searching for new information and techniques which may be the basis of new scientific discoveries or future chemical technology. Investigations carried out under this activity may be grouped in the following general areas: nuclear chemistry, heavy element research, radiation chemistry, high-temperature chemistry, theoretical and structural chemistry, and physical and inorganic chemistry.

Nuclear chemistry is the general area of science in which chemists investigate the properties and reactions of nuclides, usually radioactive. The kinds of investigations undertaken may involve the synthesis of a nuclide by bombardment of an element in an accelerator or nuclear reactor, followed by chemical separations of the products from the starting material. The chemist then ascertains the radioactive properties of the nuclide, e.g., the kinds of radiation present, the half-life, and the decay scheme into stable or other radioactive products. Other studies in this area are directed toward the details of the process of induced and spontaneous fission, about which much is still being learned.

Other nuclear reactions under investigation, include studies of reactions of nuclides with a wide variety of charged particles of various energies, including pions and K-mesons. This promising new field of high-energy nuclear chemistry is just beginning to develop. Expectations are that significant additional information on the forces which hold nuclei together will be uncovered.

An interesting and productive new field is the nuclear chemistry of meteorites: Studies of the isotopic contents and ratios in meteorites, providing clues regarding their history and exposure to radiation through wide dimensions of space and time. Similar investigations on components of satellites have also yielded valuable results.

An important aspect of this program is the development of more sensitive and more precise instruments to measure radiation under a wide variety of experimental conditions. New solid state detectors for alpha particles and fission products have proved to be useful in a variety of applications. Measurements of the lifetimes of nuclear excited states as short as 5×10^{-10} seconds combined with gamma-ray spectrometry and angular correlation measurements have served to elucidate nuclear decay schemes. Polarization or radiation from oriented nuclei (such as californium-249) enables new estimates to be made of the size and shape of the nucleus.

Heavy element research includes the preparation of the heaviest nuclides by a variety of nuclear reactions including bombardment of heavy nuclei with neutrons, alpha particles, or more massive particles such as boron-11 or carbon-12 nuclei. Because of the intense radioactivity of the products, many of which

undergo rapid spontaneous fission, special facilities and techniques are necessary for safe handling of these materials. However, microgram amounts and more of these materials have become available and chemical and physical measurements, such as absorption spectroscopy, have been carried out to study the electronic structure and reactivities and chemical properties of these higher synthetic elements. Much also remains to be learned of the fundamental chemical properties of the more common actinide elements such as neptunium and plutonium.

Radiation chemistry involves the study and interpretation of the chemical effects and reactions resulting when energetic radiations or particles interact with matter. Such studies form the basis for the understanding of this aspect of nuclear energy which is important to a large portion of the AEC program. Present activities involve studies with various forms of radiation including gamma and X-rays, beta particles, heavy charged particles (ranging from protons to fission recoils), ultraviolet rays (particularly in the vacuum region), and neutrons. Extensive attention is being paid to understanding and correlating the similarities and differences in the effects produced by different types of radiation. Systems being studied are aqueous, organic, and inorganic, in the gaseous, liquid, and solid states. Examples of research receiving increased attention at present are: energy transfer phenomena, effect of the state or form of the substance on radiolysis products (particularly for solids), the use of very high-intensity short pulses of radiation, the comparisons of effects of ultraviolet radiation with those of ionizing radiation, the use of fission recoil energy for producing chemical change, and new approaches to theoretical and experimental studies of the early stages of radiation effects.

One area of research closely related to radiation chemistry is "hot-atom" chemistry; this has been described as "the chemical consequences of nuclear transformations," and is restricted to a study of the chemical fate of the atoms which have recoil energy as a result of a nuclear decay. Although only a very few of these highly energetic atoms are present in a system, they can be followed through various chemical transformations by means of measuring the radioactivity of various constituents of the system.

High-temperature chemistry is the area of research which contributes to the knowledge and understanding of chemical behavior of substances at temperatures above those at which they have been normally studied. A major portion of the effort is devoted to the acquisition of both thermodynamic and kinetic data for many substances and their reactions, by use of techniques especially devised for the attainment, control, and observation at elevated temperatures. Such studies include investigation of structures by high-temperature X-ray diffraction and other techniques, as well as the study of reaction phenomena, preparation, chemical stability, and physical properties of these materials. In addition to the investigation of metals and oxides there is an increasing interest in carbides, nitrides, phosphides, borides, and sulfides, not only from the point of view of their importance to fundamental science, but also from their present and potential use in modern technology. One of the new research techniques which is becoming increasingly useful is that which uses special high-temperature mass spectrometers for determining vapor pressures and identifying the evaporating species. Many insoluble materials dissolve in water at high temperatures and pressures, and otherwise show unexpected and interesting properties. Much work remains to be done in this relatively unexplored field. Fused salt may also be used as solvents for chemical reactions and separations at high temperatures. Study in this area includes: the structure of molten electrolytes, chemical reactions in such media, the behavior of metals in molten salts, the formation of complex ions, the electrochemistry of such systems, and the mechanism of electrical conductance. Use is also being made of recent developments in high-pressure technology which permit pressures of up to 100,000 atmospheres (or 1,500,000 pounds per square inch) and temperatures up to 2500°C. to be attained. Under these conditions, other new materials and reactions of fundamental interest to the AEC are being investigated. Basic research in this area will also extend our knowledge of the properties of matter under extreme conditions.

Studies in the area of theoretical and structural chemistry make use of a wide range of tools and techniques, ranging from high-speed computers to liquid helium cryostats. The general purpose is to solve problems about the structures of matter, and to correlate and extend our understanding of the general unifying principles of chemistry. Studies are being made of the structures of a wide variety of inorganic and organic compounds related to the AEC pro-

gram, using methods such as nuclear magnetic resonance, ultraviolet, infrared, microwave and emission spectroscopy, and X–ray and neutron diffraction. Paramagnetic resonance spectroscopy gives useful information on electronic structures such as free radicals, excited molecules, radiation-damaged crystals, etc., and so gives information useful in radiation chemistry studies. Nuclear magnetic resonance techniques are being used to measure the details of the reactions taking place when electrolytes dissolve in water, or when complex ions are being formed. Theoretical investigations using statistical thermodynamics, quantum chemistry, ligand field theory, and other approaches correlate the results obtained by experimental scientists and attempt to construct general theories to increase our understanding and extend our ability, to predict new phenomena and properties of matter.

Physical and inorganic chemistry covers the other areas of fundamental chemical research of long-range interest to the AEC, excluding those specifically discussed above. Typical examples include the following: the mechanisms and kinetics of reactions in aqueous and nonaqueous solutions; electrochemistry, surface chemistry, formation and properties of complex ions, low-temperature calorimetry, isotope effects, biochemical synthesis of completely deuterated organic compounds, and applications of radioactive tracers and stable isotopes to the study of chemical reactions. Some research is carried out so that the AEC will be able to cope more effectively with the many analytical problems with which it is faced, not only in its manufacturing programs but in its basic and applied research programs. Requirements, for analyzing for very minute amounts of material, and for analyzing highly radioactive mixtures, cause very difficult but unavoidable problems, which are being attacked by a variety of chemical and instrumental techniques.

An increase of $4,260,600 will be required for this activity in fiscal year 1963. Of this increase, $434,000 is designated for preoperational costs of the Ames Research Reactor, and $1,807,000 is designated for increased operational costs of the LRL heavy ion linear accelerator, the 88-inch LRL cyclotron, and additional service and instrumentation support for the LRL chemistry effort. An additional $800,000 is required for nuclear chemistry research, particularly in conjunction with high energy accelerators. The importance of heavy element research requires an increase of $300,000 for studies of the nuclear and chemical properties of actinide isotopes. Additional funds are required as follows: radiation chemistry, $250,000; high-temperature chemistry, $250,000; theoretical and structural chemistry, which requires a special effort to bring it into more favorable balance within the program, $300,000; and other physical and inorganic chemistry, $119,000.

B. Systems and materials chemistry, $5,445,000

One of the main goals of the chemistry research program is the development of fundamental information for the practical operations of the atomic energy program. Studies aimed at the attainment of this goal are carried out primarily in this activity. Some of the investigations consist of rather fundamental studies of chemical behavior and properties, but are directed at systems, operations, and materials of direct Atomic Energy Commission interest; others represent attempts to adapt or apply existing information to specific areas or operations of Atomic Energy Commission interest. Several areas of study are included in this activity: separations chemistry (aqueous and nonaqueous), reactor and materials chemistry, chemical engineering, and geochemistry.

Chemical separation operations are required in many aspects of the Atomic Energy Commission's program; and requirements for new separations procedures, or improvements to existing procedures, will continue to arise in the future. Examples of present or future application of chemical separation techniques in the atomic energy program, in addition to the "main line" chain of raw materials—feed materials—spent fuel processing, include feed preparation and product isolation steps for the large-scale isotope separation processes; large-scale fission product isolations; transplutonium production program; waste treatment; processing and isolation for the radioisotope distribution program; analytical chemistry for the "main line" and other operations; preparation of pure materials samples for research purposes; target and source preparations for cross-section and other nuclear research programs, and isolation of special isotopes, such as neptunium, americium, uranium 232, etc. The separations chemistry investigations carried out in this activity are designed to provide a better fundamental understanding of existing methods of chemical separations and processing, and to provide a foundation upon which new developments can

be based. The aqueous separations chemistry investigations consist mainly of studies of the mechanisms of the reactions and the chemical species involved in the separation of elements by solvent extraction, ion exchange, and precipitation methods. New organic extractants and ion exchange materials are prepared and studied, and the effects of radiation on them are investigated. Mechanisms of precipitate formation and impurity inclusion are being studied. The potentialities of new methods that are suggested by such work are explored with respect to their usefulness in separating and purifying, under a variety of conditions, heavy elements, fission product elements, and other elements of interest to the Atomic Energy Commission.

Although aqueous methods will always be preferred for many types of operations, it seems certain that situations will arise for which nonaqueous procedures will be more advantageous, or will, in fact, be the only type that can be used. For example, volatility or pyrometallurgical methods may very well prove to be more economical for certain types of spent fuel processing than aqueous methods. Also, certain separations involving the very heavy and extremely radioactive elements may have to be carried out in nonaqueous systems because of the extensive radiation damage that might be suffered by water, organic solvents, and ion exchange resins. It is clear that a fund of information basic to nonaqueous seperations methods, which normally involve high-temperature conditions, must be developed. Studies are therefore being conducted on methods of converting uranium and other elements to volatile compounds and on the adaptation of such methods and compounds to separation schemes. The basic properties of the volatilizing agents (usually halogen-containing compounds or mixtures) and of the volatile compounds are being investigated. Distillation procedures are also considered with regard to their possible applications as separations schemes. Pyrometallurgical separation methods, such as those based on fractionation of metals between two immiscible liquid metals or between a liquid metal and fused salt, require fundamental information on liquid metal and fused salt systems, on the solubility of uranium, plutonium, thorium, fission product elements, etc., in them, and on chemical species and reactions in such systems. Such studies are carried out in this activity, and information resulting from them is evaluated and developed in terms of possible new separations methods.

The reactor and materials chemistry studies conducted within this activity are devoted to the chemistry of reactor systems and materials of interest and importance to the Atomic Energy Commission program. The detailed content of these investigations is best illustrated by mention of several typical areas now under study: high-temperature, high-pressure chemitry of aqueous salutions of uranium, plutonium, and fission products; surface chemistry and the preparation of stable suspensions of thorium dioxide; properties of slurries of heavy element compounds in liquid metals; properties and radiation chemistry of fluorocarbons; thermodynamic properties of refractory compounds of uranium and thorium, radiation chemistry or organic compounds of possible interest as reactor moderators; and the chemical properties and behavior of protactinium. It is intended that such studies will provide the required background of information for the efficient future development of nuclear technology.

The chemical engineering investigations are aimed at an improved understanding of chemical engineering principles, and at the development of new apparatus and techniques potentially applicable to atomic energy operations. Typical areas of investigation now being studied include theories and mechanisms of mass transfer across an interface under various conditions of contacting; studies of heat transfer in different types of systems; basic studies of the fluidization operation; new methods of decontamination of equipment; liquid metal-fused salt contactors for extraction column use; new methods of rapid and efficient contacting of two immiscible phases; etc. In view of the importance of large-scale chemical engineering operations within the atomic energy program, such studies have a high degree of potential payoff.

The geochemistry investigations are contributing to a better understanding of the geologic history and behavior of uranium, thorium, and other radioactive materials, and of isotope discrimination processes in nature. Specific studies are devoted to understanding, development, and application of geochronological methods; fractionation of carbon, oxygen, and nitrogen isotopes in nature; properties and synthesis of uranium and thorium minerals; thermoluminescence induced by natural radioactivity; studies of very low grade thorium-containing materials; and laboratory studies of uranium-oxygen compounds of geologic

interest. Such research, even though its motivation is geologic, often contributed significant fundamental information regarding nuclear and chemical properties and reactions of Atomic Energy Commission interest.

An increase of $504,000 is required for research in reactor and materials chemistry, particularly for obtaining thermodynamic data on materials of special interest and for examination of chemistry problems related to use of fission fragment energy in chemical processes. A major portion of this increase will be required for fundamental chemical engineering studies and in particular for problems of mass transfer.

C. Chemical isotope separation studies, $900,000

This activity includes costs incurred for the development of chemical methods of stable isotope enrichment and for the investigation of the effects of isotope substitution on the physical and chemical properties of chemical compounds. Since the isotopic substitution of an atom in a chemically reacting molecule affects such properties as the rates and equilibriums of its chemical reactions, the investigation of these properties and their application to isotope separation is an important facet of this research activity. In order to gain a greater theoretical and practical understanding of the principles of isotope separation and to apply them to the solution of isotope enrichment problems relevant to Commission programs, studies are made of the rate of exchange of isotopic species in multicomponent systems, solubility and distribution of elements of interest in multiphase systems, the magnitude of isotope separation factors, methods of refluxing each of the species, ion exchange systems, and other related problems. These separation studies are supplemented by research on thermodynamic, kinetic, spectroscopic, and chemical properties of isotopically substituted compounds. In addition to such well-known methods of isotope enrichment as ion exchange and chemical exchange, other techniques such as selective adsorption, distillation, photoexcitation, and chromatographic methods are investigated. Typical investigations include the enrichment of lithium isotopes by ion-exchange chromatography; the separation of boron isotopes by exchange in the methylsulfide-BF_3 systems; the effect of azeotropism on the separation of oxygen isotopes by distillation; the enrichment of nitrogen 15 by exchange in nitric oxide-nitrate systems, and the separation of the orthomodification and paramodification of hydrogen and deuterium by selective adsorption. The principles and methods developed for the separation of stable isotopes are often applicable to the chemical separation of different elements with similar chemical behavior. Thus, much of this research relates to problems involved in the separation of the rare earth elements and of the actinide elements.

An increase of $90,000 is required in this activity to study new concepts in isotope separation and to extend research on the effects of isotope substitution on chemical reaction equilibriums.

D. Special projects, $2,670,000

The narrative for this category is contained on classified page 266.

E. Preparation and purification of special isotopes for research, $3,450,000

This activity is devoted to the recovery, purification, and concentration of radioactive and stable isotopes, either naturally occurring or produced in nuclear reactors and accelerators, which are not available through other AEC programs for the routine production and distribution of isotopes, and which are required for Commission research programs in the physical and life sciences. Examples include stable isotopes, other than those produced by the electormagnetic process; special radioisotopes, generally of elements with atomic number greater than 84; and particularly the transplutonium isotopes. Because of the increasing importance and greater scope of the transplutonium elements production program, that project is discussed separately below.

The transplutonium production program is aimed at providing research quantities of americium, curium, berkelium, californium, einsteinium, and fermium for the purpose of conducting research on their chemical and nuclear properties, and for target materials for obtaining new elements and isotopes. Gram quantities of heavy-element isotopes up to californium 252 and smaller quanities of elements above californium are to be produced by a series of neutron irradiations starting with plutonium 239. Because of the large amount of heat released by fission of plutonium 239 during the early stages of this irradiation, the initial irradiation is best accomplished at a moderate flux until most of the fissionable plutonium (plutonium 239 and plutonium 241) is consumed. The plutonium

242, americium 243, and curium 244 formed in the initial irradiation in a Savannah River reactor will be separated from fission products and refabricated into targets for irradiation in the Oak Ridge National Laboratory high flux isotope reactor (HFIR) at 3×10^{15} neutrons per square centimeter per second. After irradiation the targets will be processed for recovery of curium, berkelium, californium, and small quantities of einsteinium and fermium. Some of the curium and other heavy isotopes will be recycled to the HFIR for further irradiation. Work directed toward meeting these objectives includes development of chemical processes and HFIR target fabrication techniques and the design of process equipment. The transuranium processing plant that will house the actual operations is being designed. Work to be done in fiscal year 1963 is coordinated with schedules for the construction and operations of the high flux isotope reactor and transuranium processing plant. Preoperational costs of the HFIR will be charged to this activity, and, for fiscal year 1963, will include charges for initial reactor fuel elements and control plates, training of operating personnel, preoperational tests for both the HFIR mockup and the reactor, and hazards evaluation. Transuranium process studies will include studies of variables in processes for the recovery of elements americium through fermium, mockup of the transuranium processing plant, and the fabrication of the first 350 grams of plutonium 242 targets for the HFIR.

Projects in the general category of preparing other special isotopes for research include those for obtaining high-purity isotopes of the heavy elements (such as thorium 229 and thorium 230, protactinium 231, uranium 232, and uranium 234, plutonium 236, plutonium 238, and plutonium 239) and any radioactive or stable isotope not otherwise available in the quantity and purity required (for example, technetium 99; low-tritium deuterium, high-purity uranium 233 freshly processed to be free of decay products). Work in this activity includes the preparation of new nuclides by bombardment of enriched targets in nuclear reactors and accelerators. Tritium-induced reactions are being studied in the search for undiscovered isotopes (for example: calcium 50, titanium 52, neodymium 152, and others) which might be made by (t, p) and (t, n) reactions. A target preparation center has been established for making targets of normal and isotopically enriched materials (rare earths, stable isotopes, heavy elements) for research use. Charges are made for costs involved in fabricating a particular target; however, this budget activity includes costs of development of methods and techniques for preparing targets such as chemical processing, reduction of compounds to metal, tests to determine stability, thickness, density and uniformity of thin-film targets. Incidental costs of setting up research pools, providing facilities for storage, preparation and distribution of samples, are also included in this activity.

The increase requested for fiscal year 1963 totals $1,661,000 and is needed for the following purposes: $960,000 for preoperational costs of the high flux isotope reactor at ORNL (tests in reactor mockup, tests at the reactor, preparation of operational manual, hazards evaluation, fuel and special materials, training of personnel); $355,000 for studies of variables in processes for the recovery of elements americium through fermium and fabrication of the first 300-gram Pu^{242} target for the HFIR; $286,000 for research and development on the fabrication of thin film targets, for development of transuranium separation and purification processes and target fabrication methods, and for obtaining special isotopes for replenishment of research pools, such as thorium 229 and 230, uranium 234, plutonium 236 and plutonium 238; and $60,000 for conducting experiments regarding the application of the new high flux beam research reactor at Brookhaven National Laboratory to the preparation of isotopes.

F. Related chemistry equipment, $3,800,000

The research described in the preceding five chemistry activities requires the use of a wide variety of capital equipment. In all of these fields of chemical research, maximum progress can be achieved only by taking advantage of the significant advances and developments that are continually being made in chemical and nuclear instrumentation. Some of these developments, such as solid state detectors, nuclear magnetic resonance spectrometers, and mass separators, have enabled chemists to take completely new approaches to problems in areas of great interest to the AEC, approaches leading to information which cannot be obtained in any other way. Other developments of less dramatic individual impact contribute collectively in a major fashion to the solution of the problems faced by the chemistry research program. In addition to the need for taking advantage of new equipment developments, a continuing require-

ment exists for the standard and well-proved items, either as replacements or to provide the additional capacity needed by new or expanded research programs. Some of the conditions which much of the research must be carried out, such as high radiation intensities and high temperatures, impose difficult requirements on the design and operation of the equipment, even the more or less conventional items, leading to increased complexity and cost. For efficient and productive utilization, major new research tools, such as the Ames reactor and the 88-inch cyclotron at the Lawrence Radiation Laboratory must have associated with them the instruments required by the research they make possible.

Equipment requirements costing $100,000 or more include: Neutron diffraction apparatus for the Ames reactor, extension of the Argonne National Laboratory linac to 28 million electron volts, an alpha spectrometer, a wide-range mass spectrometer, a computer controlled diffractometer, equipment for the LRL 88-inch cyclotron, counting equipment, a mass separator, a linac and two mass spectrometers for high temperature chemistry.

Other sizable items include a spark-source mass spectrometer, multichannel pulse-height analyzers, nuclear magnetic resonance spectrometers, neutron generators, atomic beam equipment, cobalt sources, spectrophotometers, and low-level counting equipment.

The increase in requirements over fiscal year 1962 is due to the increasing complexity of the research program, and to the need for instrumenting programs utilizing new research tools.

3. Metallurgy and Materials Research, $23,060,000

There are included within the metallurgy and materials program estimates for the following activities:

[In thousands]

	Actual fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
A. Production, treatment, and properties of materials	$3,180	$3,464	$4,021
B. Alloy theory and the nature of solids	7,916	10,371	12,435
C. Effects of irradiation on materials	2,901	3,506	4,179
D. Related capital equipment	1,271	1,482	2,425
Total metallurgy and materials research	15,268	18,823	23,060

A. Production, treatment, and properties of materials, $4,021,000

In this activity, fundamental and applied research is conducted on methods for producing, on properties, and on factors affecting the properties of materials of foreseeable interest to the Atomic Energy Commission. The ultimate objectives of such research are to improve methods of production of materials for Atomic Energy Commission uses, to develop new materials for Atomic Energy Commission purposes, and to increase the usefulness of materials through closer control of their properties.

Within this program, effort has been made to improve our understanding of materials having immediate or potential importance in nuclear technology such as: graphite, plutonium, uranium, uranium-oxide$_2$, and alloys of niobium and zirconium. Because properties of materials may be greatly influenced by small impurity contents and by the nature of their microstructure, attention is given to the source and control of impurities, to methods of altering microstructure, and to analysis of the influence of these variables on properties. Examples of specific areas of study are: Development of techniques for growth of crystals with strictly defined purity and perfections; the relationship of microstructure of alloys to heat treatment; and the nature of the corrosive attack of special environments on structural materials.

The increase of ($557,000) planned for fiscal year 1963 provides for increasing ability to produce and evaluate materials of controlled structure and purity ($194,000), for more intensive study of plutonium metallurgy ($88,000) and the corrosion of nuclear materials ($125,000), for increased effort in the study of deformation behavior and mechanical properties of structural materials, and in the study of microstructural-dependent properties ($150,000).

B. Alloy theory and the nature of solids, $12,435,000

Fundamental research in the materials-related sciences of metallurgy, ceramics, and solid-state physics is supported in this activity. The principal objectives of the program are to understand the behavior of materials under various conditions and to define the laws which govern this behavior. The program is subdivided into research on the atomic and electric structure, and related phenomena; research on the transport properties of solids; investigations of liquids and liquid-solid systems; and general solid state physics and physical metallurgy.

An increase of ($2,064,000) is requested in this research area. New funds will be applied as follows: For increased work on X-ray and neutron diffraction studies, alloy theory of the transition elements, and studies of magnetic materials ($504,000); for intensified research on the theory and properties of liquids ($120,000); for expanded solid state research with particular emphasis on electronic properties and behavior of semiconductors and insulators ($527,000); for research in superconductivity for the production of high magnetic fields at low temperatures ($180,000); for additional support of the research program of the inorganic materials laboratory at Lawrence Radiation Laboratory, a major portion of which will be required to continue research support currently provided by other agencies ($240,000); for greater work in physical metallurgy and ceramics, including studies of diffusion and the behavior of point defects ($241,000); for increased research in the general area of solid state physics, predominantly theory ($252,000).

C. Effects of irradiation on materials, $4,179,000

An area of materials research of prime practical importance to the AEC is that of the interaction of radiation and matter. Radiation has been shown to cause a marked change in the properties of materials and to alter kinetics of reactions. Research directed toward increasing our understanding of the processes of transfer of energy from electromagnetic and particulate radiation to liquids and solids, and the resultant change in properties thereby brought about is supported under this category. This is not a program of data collection, but of inquiry and interpretation. The type, energy, and flux density of radiation is considered together with the environmental and chronological factors in the study of the effect of radiation on characteristic solids or reactions.

An increase of $673,000 is requested to permit additional studies of radiation effects on metals and alloy particularly at low temperatures ($346,000), on superconducting materials ($111,000), on the fundamentals of the brittle-ductile transition in body-centered cubic metals ($54,000) and on alkali halides and high temperature materials ($112,000), and to permit increased studies of the scintillation process ($50,000).

D. Related capital equipment, $2,425,000

This category provides for the necessary equipment to carry out the program discussed above. These funds are required for replacement of wornout or outmoded equipment for the ongoing programs as well as providing the new equipment required because of the evolutionary nature of the programs. This latter factor not only requires that, for new experiments, instruments must be purchased which are usually progressively more costly because of necessary increases in intricacy and sensitivity, but which in many cases must be designed and developed for the specific purpose intended. Old equipment is reused when possible but it is often less expensive to purchase new equipment than to rework or alter old equipment for a new purpose.

The requested increase for metallurgy equipment reflects the increasing complexity of the metallurgy and materials research program. Specific items to be purchased or built estimated to cost $100,000 or more are: Low temperature irradiation facility ($170,000), inelastic scattering apparatus ($125,000), double focusing mass spectrometer ($100,000), and 2- to 3-million-electron-volt electron accelerator for radiation damage studies ($150,000).

4. Controlled Thermonuclear Research, $26,500,000

Research and development in the quest for the controlled production of power from the fusion of heavy hydrogen nuclei is being conducted at four major laboratories: Los Alamos Scientific Laboratory (LASL); Oak Ridge National Laboratory (ORNL); Plasma Physics Laboratory, Princeton University (PPPL); and the Lawrence Radiation Laboratory at Berkeley and Livermore, Calif. (LRL). Supporting work on specialized aspects of the program is carried on at

New York University, the Naval Research Laboratory, the National Bureau of Standards, and several universities and industrial organizations.

The controlled production of power from nuclear fusion requires that deuterium gas be heated to a temperature of the order of 400 million degrees centigrade, or that a deuterium-tritium mixture be heated to a temperature of about 50 million degrees. Furthermore, the ionized gas (plasma) must be confined long enough to permit an appreciable fraction of the fusionable nuclei to collide and liberate nuclear energy. In all cases under active investigation, magnetic fields are used to confine the plasma within an otherwise evacuated chamber and to prevent hot plasma particles from hitting the walls of the chamber.

In attempting to create or establish the very hot plasma, several different methods show promise. Similarly, there are several types of magnetic field configurations which can be employed for confinement. Consequently, the Commission's program is fairly broad.

Recent achievements and advances in capabilities

A. Higher temperature and longer confinement times:

1. The achievement of near-thermonuclear ion temperatures of 35 million degrees centigrade in a stable plasma in the multiple-stage compression mirror machine, Toy Top III, at Livermore.

2. Construction and operation of a new magnetic shock compression device, Scylla III, which achieved temperatures of 23 million degrees centigrade, neutron yields, of 10^8 per burst and stable confinement for approximately 3 microseconds.

3. The confinement time of very energetic trapped protons in DCX–1 has been increased from a few thousandths of a second to several seconds. Under some conditions this time is over 30 seconds.

4. Two cusp devices at LASL having provided a great increase in the confinement time of dense injected plasmas.

B. New experinmental equipment:

1. Initial operation of the model C stellarator with plasma—thus the first experimental use of what is undobutedly the most versatile facility in the world for study of plasma under quasi-steady state conditions in endless tubes.

2. Completion of a new molecular-ion injection machine, DCX–2, for multiple-pass trapping by dissociation of H_2^+, H_3^+, or D_2^+.

3. A neutral-injection device called Alice, at LRL, is in operation.

4. A powerful magnetic compression device called Pharos has been completed at the Naval Research Laboratory, under joint Navy and AEC support.

C. New approaches and increased understanding:

1. Successful demonstration in Scylla III of a new means of injecting hot plasmas by having two plasmas collide inside a fusion device.

2. An increased understanding of diffusion of plasma through magnetic field lines experiments in the B–3 stellarator and a cesium plasma device.

3. Significant experimental information on the trapping of plasma in magnetic cusp geometries, which show promise of providing stable high-density confinement and low electron cyclotron radiation losses, although they are inherently leakier than certain other forms of magnetic bottle.

D. Supporting areas:

1. Significant advances in the potentiality of normal cryogenic and superconducting coils for fusion devices—thus promising to reduce greatly the electric power required to maintain the large magnetic fields needed for plasma confinement.

2. Increased capabilities for plasma diagnostics, for obtaining ultrahigh vacuums, and for injection of energetic particle beams—both neutral beams and ion beams.

There are included within the controlled thermonuclear program estimates for the following activities and approaches:

[Costs in thousands]

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
A. General research and development	$3,894	$4,724	$5,153
B. Stellarator approach	11,160	7,289	7,075
C. Magnetic mirror approach	3,288	3,250	3,377
D. DCX approach	6,429	5,880	5,460
E. Relativistic electron approach	735	1,300	570
F. Pinch, shock compression, cusp, and rotating plasma approaches	4,493	3,557	4,865
Total controlled thermonuclear research	29,999	26,000	26,500

A. General research and development

Actual, fiscal year 1961	$3,894,396
Estimate, fiscal year 1962	4,724,000
Estimate, fiscal year 1963	5,153,000

Research and development of a general nature in support of the controlled thermonuclear program is provided for under this activity. Included are the theoretical and machine computations programs, basic plasma physics research, general engineering development at Lawrence Radiation Laboratory, the comprehensive theoretical plasma physics studies at Princeton, and the contract research program carried out at educational institutions and industrial laboratories. The contract research work consists chiefly of theoretical and experimental studies on plasma confinement, stability, oscillations, and turbulence; high energy ionization, electric field dissociation, and excitation cross sections; the effects of radiation and particle bombardment on reactor wall materials; improved detection methods; ultrahigh vacuum techniques; and the development of cryogenically cooled magnet coils.

The increase of $429,000 under this activity reflects: (*a*) Normal program adjustments at LRL consisting principally of increased study of atomic collision processes that may be encountered in the attempts to develop high temperature plasma devices and injuection systems; (*b*) greater utilization of machine computation on complex theoretical problems and magnetic field design; and (*c*) an augmentation of the contract research program for continued development of research efforts, mostly at university sites.

B. Stellarator approach

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Total stellerator approach	$11,160,223	$7,289,000	$7,075,000
C-stellerator fabrication	6,159,132	2,021,000	0
C-stellerator operation and modifications	153,391	1,226,000	3,650,000
Stellerator research and development	4,468,699	3,742,000	2,900,000
Related capital equipment	379,001	300,000	525,000

Stellarator research is pursued at the Plasma Physics Laboratory of Princeton University. In the stellarator approach, plasma is confined in an evacuated endless tube by an externally imposed longitudinal magnetic field. The strong field is produced by current-carrying coils surrounding the tube. A relatively complex coil configuration is required to produce stability and counteract, the adverse effects of the tube curvature. Initial heating is accomplished by comparatively weak currents passed longitudinally through the plasma; further heating is produced through the application of strong radiofrequency magnetic fields.

The stellarator approach remains at substantially the same level in fiscal year 1963. The completion and prospective closeout of the Allis-Chal-

mers/RCA subcontract for the fabrication of the model C stellarator results in a reduction of $2,021,000. Concomitant with this reduction, however, is the need for an increase of $2,424,000 to provide for vigorous utilization of the model C. This increase includes the funds necessary for modifications to add heating equipment more powerful than the ohmic heating methods used initially. The equipment could include low-modulation magnetic pumping, ion cyclotron resonance heating, or perhaps even plasma injection. In line with full-scale operation of the C device, the stellarator research and development program, concerned with experimentation with smaller devices decreases by $842,000. The increase of $225,000 in related capital equipment is required in connection with the modifications to model C heating equipment mentioned above.

C. Magnetic mirror approach

Actual, fiscal year 1961	$3,287,565
Estimate, fiscal year 1962	3,250,000
Estimate, fiscal year 1963	3,377,000

In the mirror devices the plasma is confined in an evacuated cylindrical tube or chamber by an externally imposed magnetic field. The strong field is produced by current-carrying coils surrounding the tube; the coils at both ends of the tube are larger and the greater magnetic field they generate causes the axial magnetic field lines to converge. The magnetic mirrors thus formed reflect the electrically charged plasma particles back into the central region of the tube. A high-temperature plasma is obtained by (*a*) injecting a low-temperature plasma into the chamber and compressing it by increasing the strength of the confining magnetic field or (*b*) injecting high energy neutral atoms into the chamber which become ionized, are trapped and result in a high temperature plasma. The problem is to contain the ions long enough for the plasma density to build up. Work on these two methods is accomplished at the Livermore site of Lawrence Radiation Laboratory. There have been continuous improvements in the capabilities of the mirror machines, particularly Toy Top, a multiple stage compression device which has yielded particle energies approaching the thermonuclear range. Preliminary experiments with the energetic neutral injection device, Alice, have been encouraging. Both devices are being developed further to provide increased capabilities.

Since the present Toy Top machine is approaching the end of its useful life, a larger multiple-stage magnetic compression machine is being built. This is the principal reason for the slight increase in funding for the magnetic mirror program.

D. DCX approach

Actual, fiscal year 1961	$6,429,434
Estimate, fiscal year 1962	5,880,000
Estimate, fiscal year 1963	5,460,000

The DCX program is carried out at the Oak Ridge National Laboratory. In this approach, high energy molecular ions are injected into an evacuated cylindrical chamber where they are broken into atomic ions by a high-current vacuum arc or by collisions with residual gas atoms. Current-carrying coils surrounding the chamber produce a strong d.c. magnetic mirror field. Since the atomic ions formed travel in an orbit of smaller radius they will not return to hit the injector. Thus, high energy atomic ions can be trapped and confined, forming a high temperature plasma. The problem is to contain the ions long enough for the plasma density to build up. Energetic particle injection is a method of obtaining hot plasmas which is probably not confined to mirror geometries.

The DCX program drops below the fiscal year 1962 level because of nonrecurring costs associated with completion of DCX–2 in fiscal year 1962. This is partially offset by minor increases in the experimental program as follows: Increased effort in fiscal year 1963 on dense space-charge-neutralized beams, H_3^+ injection into DCX–2 (which will require additional high voltage d.c. power supply equipment), and cyclotron resonance heating of electrons.

E. Relativistic electron approach

Actual, fiscal year 1961	$734,527
Estimate, fiscal year 1962	1,300,000
Estimate, fiscal year 1963	570,000

The Astron program is being conducted at the Livermore site of the Lawrence Radiation Laboratory. In the Astron, very high energy electrons are injected into the end of an evacuated cylindrical chamber. The high energy electrons form into a cyclindrical electron layer. The magnet field created by this current layer, aided by an external field, is expected to form a pattern of magnetic field lines which are closed onto themselves and create a magnetic "bottle" for confining the plasma. A plasma is formed in this "bottle" by the interactions of neutral atoms with the electron layer and then heated by successive collisions with the high-energy electrons.

The soundness of the Astron concept is being explored on a step-by-step basis. The first step will use a 4-million-electron-volt high-current electron accelerator and will provide a test of the new accelerator principle and useful information concerning electron injection into the high energy electron layer. The construction of the 4-million-electron-volt accelerator is to be completed early in fiscal year 1963. The second step in the Astron project will require a 5-million-electron-volt accelerator and will provide information concerning field reversal and stability of the high energy electron layer. The fiscal year 1963 funds provide for operation of the Astron at 4-million-electron-volt, and reflected a decrease as a result of completion of major fabrication of the Astron device in fiscal year 1962.

F. Pinch, shock compression, cusp, and rotating plasma approaches

Actual fiscal year 1961	$4,492,507
Estimate fiscal year 1962	3,557,000
Estimate fiscal year 1963	4,865,000

In the pinch approach, a strong electric current is caused to flow in a plasma contained in an evacuated cyclindrical tube or torus. The current produces an encircling magnetic field about the plasma which acts to confine, compress and thus heat it. The original simple pinch devices produced very unstable plasmas and have been replaced by much more sophisticated apparatus, notably Livermore's linear and toroidal (Levitron) hard-core pinch devices, which have interesting stability properties.

In the magnetic shock compression approach large currents are caused to flow in a single-turn coil surrounding an evacuated tube. The coil is enlarged at both ends, thus making a mirror configuration. The magnetic field produced by a rapidly rising current in the coil, as well as by currents induced in the plasma itself, compresses and heats the plasma. This work is being pursued at the Los Alamos Scientific Laboratory, using the Scylla and orthogonal pinch devices, and at the Naval Research Laboratory.

Theory predicts that a plasma can be stably confined by a magnetic field if the field lines are everywhere convex toward the plasma. Such a configuration, known as a cusp geometry, can be produced by two coils in which the current flows in opposite directions. If these coils surround an evacuated cylindrical tube, plasma can be injected and its confinement properties studied. Los Alamos is conducting a strong effort to evaluate the capabilities of these so-called stable geometries.

In the rotating-plasma studies a plasma is caused to rotate by being subjected to the action of crossed electric and magnetic fields. It may be possible to use such a technique either for plasma heating or for enhanced mirror confinement. Devices now under study include the homopolar device and ion magnetron at Lawrence Research Laboratory, Berkeley.

The additional $1,308,000 in fiscal year 1963 is the net effect of a decrease of $100,000 in AEC participation in the shock-compression work at the Naval Research Laboratory, a $607,000 increase at Los Alamos Scientific Laboratory and an increase of $801,000 at Lawrence Research Laboratory. The additional funds required at Lawrence Research Laboratory reflect a general increase in the scale and complexity of experiments with dense transient plasma. The efforts on hard-core pinch, the Levitron, homopolar IV, and hydromagnetic waves have all met with success in the last year, leading to increased attention to these efforts. A shifting of emphasis at Los Alamos from pinch to cusp geometries has provided successes with cusp plasmas which call for vigorous efforts in this field.

5. Other Capital Equipment, $4,000,000

Equipment requested in this category includes scientific equipment used by the service divisions of the national laboratories as well as the general or multipur-

pose type of equipment which cannot be identified with any specific research category or activity. In order to effectively support a research program of the magnitude described above, there exists a continuing requirement for replacement of obsolete as well as procurement of new and additional equipment in support of an expanding research effort. The estimate is based on normal requirements as indicated by past experience and on the needs of the program planned for fiscal year 1963.

A total increase of $3,408,000 is required for other capital equipment. Of this total, $2,750,000 is related to procurement of an IBM 7090 computer for the Brookhaven National Laboratory. The computer will be obtained on a purchase option rental basis is fiscal year 1962 with the option to purchase being exercised in fiscal year 1963. Cost analysis of rental versus purchase alternates indicates that for a period of retention in excess of 3 years, smaller costs will be incurred by the Government under the outright purchase plan. Approximately 65 percent of the fiscal year 1962 rental would be applicable toward the purchase price. The balance required in fiscal year 1963 approximates $2,750,000. The remaining increase of $658,000 is related to the needs of the Ames Laboratory, the Brookhaven Laboratory and the Lawrence Radiation Laboratory for both service-type scientific and general-purpose equipment. It has become abundantly clearly that with the increasing sophistication of scientific experimentation that equipment components have become more complicated and engineering and machine tool requirements more complex. The continued expansion of the research programs being supported at these laboratories requires an increase in the amount requested above.

EXHIBIT A

PLANT ACQUISITION AND CONSTRUCTION

PHYSICAL RESEARCH PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations fiscal year 1963	$132, 200, 000
Estimated obligations fiscal year 1962	78, 343, 000
Actual obligations fiscal year 1961	42, 588, 021

Obligations for the physical research program for fiscal year 1963 are estimated at $132,200,000 for the projects listed below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations, fiscal year 1963
63–g–1	Accelerator improvements, Lawrence Radiation Laboratory, California	$750, 000	0	$750, 000
63–g–2	Accelerator improvements, Cambridge and Princeton Accelerators	800, 000	0	800, 000
63–g–3	Accelerator improvements, Argonne National Laboratory, Illinois	500, 000	0	500, 000
63–g–4	Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York	1, 250, 000	0	1, 250, 000
63–h–1	Low level radiochemistry laboratory, Hanford, Washington	1, 200, 000	0	1, 200, 000
63–h–2	Inorganic materials laboratory, Lawrence Radiation Laboratory, California	2, 500, 000	0	2, 500, 000
63–h–3	Corporation yard, Lawrence Radiation Laboratory, California	1, 500, 000	0	1, 500, 000
63–h–4	Mathematics and computer building, Argonne National Laboratory, Illinois	2, 300, 000	0	2, 300, 000
63–h–5	Building addition for physics and mathematics, Brookhaven National Laboratory, New York	5, 000, 000	0	5, 000, 000
63–h–6	Water treatment plant, Brookhaven National Laboratory, New York	1, 000, 000	0	1, 000, 000
63–1	General plant projects	3, 400, 000	0	3, 400, 000
61–f–2	Princeton-Penn accelerator addition, Princeton, N.J.	10, 820, 000	6, 820, 000	4, 000, 000
61–f–6	Major bevatron improvements, Lawrence Radiation Laboratory, California	9, 600, 000	7, 100, 000	2, 500, 000
61–f–7	Linear electron accelerator	114, 000, 000	19, 000, 000	95, 000, 000
60–g–3	Transuranium processing plant, Oak Ridge National Laboratory, Tennessee	8, 700, 000	1, 200, 000	7, 500, 000
57–d–1	Zero gradient synchrotron, Argonne National Laboratory, Illinois	47, 000, 000	44, 000, 000	3, 000, 000
	Total	210, 320, 000	78, 120, 000	132, 200, 000

EXPLANATION OF PROJECTS ABOVE

1. Project 63–g–1—Accelerator improvements, Lawrence Radiation Laboratory, California, $750,000

This project is required to modify and improve the 184-inch cyclotron and the heavy ion linear accelerator as part of a continuing effort to sustain the performance capabilities of these machines in accordance with the technical advances of the programs they support. The requested improvements are related to programs that are experimental in nature. They involve a varied application of engineering design and equipment usage that includes equipment installation for varying periods of time.

The $750,000 requested in fiscal year 1963 is tentatively planned as follows:

1. 184-inch cyclotron	$250,000
2. Heavy ion linear accelerator	500,000
Total	750,000

Items enumerated represent current planning and are subject to revision as programmatic activity develops. Priorities are determined by experimental needs. Overall planning for accelerator improvements is based on a logical progression of modification and refinement of the instruments consistent with program requirements.

2. Project 63–g–2—Accelerator improvements, Cambridge and Princeton Accelerators, $800,000

This project provides for modifications and improvements to the Princeton-Pennsylvania Accelerator (PPA) at Princeton, N.J., and the Cambridge Electron Accelerator (CEA) at Cambridge, Mass. These improvements reflect a continuing effort to sustain the pace of physical and technological advancements by maintaining the effectiveness of the accelerators at their full scientific potential. General requirements for modifications and improvements occur in the near-term following completion of construction or major modifications. Thus it is clear that substantial funds will be required for these two machines over the next several years. It is considered more desirable to request these funds annually based on program developments since many of the changes cannot be established in all details in advance.

The $800,000 requested in fiscal year 1963 is tentatively planned as follows:

1. Princeton-Pennsylvania Accelerator	$500,000
2. Cambridge Electron Accelerator	300,000
Total	800,000

3. Project 63–g–3—Accelerator improvements, Argonne National Laboratory, Illinois, $500,000

This projcet provides for modifications and improvements to the Argonne zero gradient synchrontron (ZGS). The items listed below are examples of the projects that are under active consideration, however, the assignment of priorities will be determined in accordance with experimental needs.

The requirements requested under this project for fiscal year 1963 are tentatively outlined as follows:

1. Additions to A-C distribution system.
2. Hydrogen safety apparatus.
3. Ring magnet power supply improvements.
4. Improvements to linear accelerator.

As the frontiers of science advance it has been found necessary continually to alter and improve the Commission's major operating accelerators. From experience gained through the operation of high energy machines, it is clear that their effectiveness cannot be realized to the fullest scientific potential without continuous modification to maintain the pace of physical and technological advancements.

This project has been limited to the most urgent improvements required for the ZGS facility. The improvements are of considerable importance to the effective utilization of the ZGS and should be accomplished as soon as possible.

4. Project 63–g–4—Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, $1,250,000

Accelerator and reactor additions and modifications depend to some degree on the extension of existing techniques that cannot be established in all details in advance. It is, however, possible to list those projects which are presently planned and are under active consideration for fiscal year 1963. In all likelihood most of these projects will be realized. The cost estimates are by necessity of a preliminary nature. The improvements proposed are based on a logical progression of modification and refinement of the instruments consistent with program requirements.

The $1,250,000 requested in fiscal year 1963 is tentatively programed as follows:

1. Reactor	$160,000
2. Cosmotron	400,000
3. Alternating gradient synchrotron	690,000
Total	1,250,000

5. Project 63–h–1—Low level radiochemistry laboratory, Hanford, Wash., $1,200,000

This project provides for construction of a new laboratory building at Hanford equipped to provide an atmosphere free from environmental contamination. The building is to be a reinforced concrete structure with concrete built-up roofing. As currently planned, the laboratory will be designed and constructed to assure an internal atmosphere that will not contribute more than one-tenth of the contaminants found in the samples to be processed. The laboratory will be approximately an 11,000 gross square foot single story building plus about 5,000 gross square feet of counting room, mass spectrometer laboratory, and instrument calibration facilities in the basement.

An increase in the analytical capacity of Hanford facilities of approximately 100 percent is required in support of the radiochemical analysis and isotopic analysis research and development programs. It has been determined that the maximum increase of capacity possible in the present laboratory space is about 25 percent, this being achieved by resorting to two-shift operations. The proposed new laboratory is required to provide facilities and space for the necessary expansion requested, in addition to providing a means of meeting the exacting analytical requirements discussed above.

Current facilities limit the attainment of foreseeable required detection levels of radioanalysis and will become more and more limiting as improved analytical methods and equipment are developed. In addition, there is a continuously growing need for facilities in which very sensitive measurements of radionuclides can be performed. A need for facilities of this type will exist for years to come even if current programs change.

6. Project 63–h–2—Inorganic materials laboratory, Lawrence Radiation Laboratory, California, $2,500,000

This laboratory will provide the research area, the experimental facilities, and research in inorganic materials, involving the investigation of novel materials subjected to unusual temperatures and pressures. The laboratory will be of industrial-type design; the structure will be of steel frame with curtain walls, flooring will be stressed concrete to carry the load of laboratory, shop, and office space.

This laboratory will provide the resarch area, the experimental facilities, and the specialized equipment that is essential to an expanded inorganic materials research program at the Lawrence Radiation Laboratory. The program embraces such endeavors as high temperature chemistry, inorganic chemistry, metallurgy, and ceramics. It is of utmost importance that these different scientific disciplines be brought together in one facility to encourage maximum communication and interchange of ideas. The laboratory is to house the specialized, necessarily complex equipment and instrumentation required for the experimental work to be conducted. Facilities will be designed to meet the environmental requirements of the research activities. Support of projects such as this has been recommended by the Federal Council for Science and Technology recognizing that one of the major limitations in the Nation's research effort is the need for expansion in metallurgy and materials research.

7. Project 63–h–3—Corporation yard, Lawrence Radiation Laboratory, California, $1,500,000

This project relocates and expands scattered crafts shops and other support functions and consolidates them in one building. The facility will include a craft shop building, materials storage, decontamination facilities, health chemistry radioisotope handling facilities, access road, perimeter fencing, and utilities.

A centralized facility is needed for the following reasons: (*a*) Space now occupied by these support activities interferes with experimental programs connected with the 184-inch cyclotron. This space will better be used for direct support of the major instruments; (*b*) existing facilities are small, separate structures clustered about the 184-inch cyclotron. Expansion of individual facilities is required but precluded by the building congestion; (*c*) storage facilities are inadequate. Currently, passage between buildings is impaired as a result of essential storage in the present crafts shops area; (*d*) traffic congestion in the area is extreme because of the encroachment of add-on facilities; (*e*) the advantage of centralization of similar functions is an additional consideration.

8. Project 63–h–4—Mathematics and computer building, Argonne National Laboratory, Illinois, $2,300,000

This project provides for construction of a building addition to be attached to the east end of wing A of the present physics building. The first and second floor of the facility will provide space for 150 employees and for 2 major digital computers and an analog computer installation. The service floor area will be devoted to mechanical and electrical equipment, storage, building, maintenance, maintenance personnel, and a fallout shelter for a maximum of 150 persons. Office space must be adequate to permit scientists and engineers to carry on discussions with the Applied Mathematics Division staff members. In addition, space must be provided for computer maintenance, data preparation and storage, lectures and conferences, and materials and supplies storage.

The future programs of research and development at the Argonne National Laboratory will place an increasingly greater emphasis on the role of mathematics and computers. This greater emphasis will manifest itself in greater demands for mathematics and computer services as well as in a pressing need for a vigorous research program in mathematics and the computer sciences. Both the service work and the mathematics research and computer engineering work must develop together. Where service work is performed without a commensurate research program there is a great danger that the demands for computing capacity and programing staff will reach exaggerated proportions. In order to organize a corps of scientists in a manner to insure the greatest productivity of new ideas and to fully develop these ideas into useful concepts, it is essential that they be provided well equipped and efficient computing and data processing facilities, that they be provided a well-trained staff of professional programers, and that they receive the benefits of a closely interacting research program in mathematics and the computer sciences.

9. Project 63–h–5—Building addition for physics and mathematics, Brookhaven National Laboratory, New York, $5 million

The physics and mathematics addition will be an extension of the physics building, which will be occupied early in 1962. This project includes (*a*) additional physics laboratories and research offices and an extension of the works area; (*b*) space to house electronic computers, and supporting offices for the computer and mathematics research staffs.

This building will be connected to the south end of the physics building. Physics laboratories and research offices will be contained in two 3-story wings. One wing will house the laboratories and about one-fourth of the offices; the other wing will house the remaining three-fourths of the offices. Offices for applied mathematics will be located in an adjacent 2-story wing as well as in the principal office wing, while computer space will be in a 1-story construction.

A physics building was authorized for construction at Brookhaven National Laboratory (BNL) in 1957. It represented minimum space requirements for Brookhaven physicists whe were previously located in temporary barracks and other buildings scattered over the Laboratory site. It was already realized at that time that this proposed structure would be insufficient to accommodate all of the BNL physics effort. It has now become clear that a major extension to the physics building is urgently needed to provide essential laboratory and office space for not only those scientific activities which could not be scheduled for inclusion in the physics building, but also to accommodate an expansion in the

high energy physics program which has been considerably larger than could be foreseen several years ago. In addition to the space requirements of the physics program, it is evident that the growth of the Laboratory's relatively young applied mathematics effort will require space to house several digital computers, as well as a relatively large new staff which will be needed to satisfy the requirement of practically all the Laboratory's departments for extensive mathematical services.

It is presently planned that the new physics addition will house all of the Laboratory's high energy physics effort which can be located away from the high energy particle accelerators. This move will free sufficient space in the existing physics building to accommodate those scientific groups of the physics department which still have to be housed for the next few years in temporary and scattered locations.

10. Project 63–h–6—Water treatment plant, Brookhaven National Laboratory, New York, $1,000,000

This project provides for construction of a water treatment plant having a hydraulic capacity of 4,500 gallons per minute (6.5 million gallons per day). The treatment will consist of aeration, lime neutralization, settling, and filtration. The plant will be located in the northwest quadrant of the BNL site on Upton Road and will consist of the following structures: sludge pumphouse, filter building, main building, clear well, lagoon, setting tanks, reclamation tanks, and service building.

The quality of the water from the wells at Brookhaven National Laboratory has deteriorated markedly. Evidence of the corrosiveness of the water and its high iron content is mounting. Operational difficulties, caused by the iron content of the water, are being experienced at the large research machines and their experimental research equipment. At both the AGS and the cosmotron, deposition of iron in the cooling coils of the experimental magnets is causing serious difficulties. Troubles are developing in both open and closed cooling systems; cooling towers, depending on evaporation for their cooling effect, tend to augment the concentration of iron in the systems with an increase in sedimentation rate, thus causing more frequent cleaning and higher maintenance costs.

It is now apparent that the Laboratory is faced with an urgent situation, and that none of the partial water treatment steps that have been tried or proposed will be adequate.

11. Project 63–1—General plant projects, $3,400,000

This project provides for the minor and often individually unpredictable capital improvements, modifications, and additions that are required each year in conjunction with the research and development programs at certain of the AEC's research centers and for the contract research program.

The funds requested for fiscal year 1963 provide for the following:

1. Brookhaven National Laboratory	$1,200,000
2. Argonne National Laboratory	1,700,000
3. Ames Laboratory	150,000
4. Princeton Sherwood	150,000
5. Contract research programs	200,000
Total	3,400,000

12. Project 61–f–2—Princeton-Pennsylvania accelerator addition, Princeton, N.J., $4 million

This project provides for construction of a new administrative, maintenance, and laboratory wing, new storage building, an external beam room with necessary facilities, and of an extension to the meson experimental area.

A new wing is needed because the present office and laboratory building is already 100 percent occupied by accelerator engineering staff, administrative staff, and supporting functions. Part of the accelerator staff is housed 3 miles away on the main campus and should be moved over to the accelerator building as soon as possible. A new storage building is needed since at the present time there is no storage area available of sufficient size to store bulk materials and auxiliary equipment temporarily not in use. The original Princeton-Pennsylvania proposal of December 1955 discusses the future need for an external beam facility. This facility could not be adequately defined in 1955, but can now be specified. Certain classes of experiments cannot be performed with the presently planned

internal proton beam. Experiments such as proton scattering, study of direct proton interactions using bubble chambers, and detection of very short-lived particles would be practicable only with a well shielded external proton beam. Extension of the meson area also is needed because recent developments in high energy physics show that the presently planned meson area is inadequate to carry out the types of experiments the state of the art now permits.

This project was authorized in fiscal year 1961 at an estimated cost of $10,820,000. A total of $6,820,000 is expected to be obligated through fiscal year 1962 for work on the new wing and storage building, the external beam room with supporting facilities, and the meson area extension. The balance of $4 million will be needed in fiscal year 1963 primarily for completion of work on the external beam facilities.

13. Project 61–f–6—Major bevatron improvements, Lawrence Radiation Laboratory, California, $2,500,000

The effectiveness of the present bevatron research program is limited by three shortcomings of the facility; limited beam intensity, restriction in the number of experiments which can be performed simultaneously, and reliability in the overall operation of the facility. This project will provide for increased beam intensity, increased bevatron experimental facilities, new external beams, both primary and secondary, and increased reliability and flexibility of bevatron operation.

The total estimate of $9,600,000 is considered to be of the correct order of magnitude, and only the details are expected to be subject to appreciable variance. The basic concepts of increasing the beam intensity, expanding the experimental facilities and insuring greater facility reliability are not expected to change. The improvements program is justified in terms of an increase in the amount of scientific research which will be done at the bevatron. Each item in the program is directed toward this end.

This project was authorized in fiscal year 1961 at $9,600,000. Of this amount, $7,100,000 is expected to be obligated by the end of fiscal year 1962 for additional shielding work on the new injector, improvements to the control system, redesign and rebuilding of the present MG sets and work on the external beam facilities. The balance of $2,500,000 is required for obligation in fiscal year 1963 for completion of this work.

14. Project 61–f–7—Linear-electron accelerator, $95 million

This project provides for the design and construction of a high energy electron accelerator at Stanford University. The machine will be of linear design, approximately 2 miles in length, and also in the initial stages will achieve an energy of 10 to 20 Bev. The average current delivered to the target will be approximately 15 microamperes; 240 klystrons, operating at a frequency of 2,856 megacycles per second, will power the accelerator. The accelerating tube is to be contained in a housing 12 feet wide which will be deep enough in the ground to provide the necessary radiation shielding. A parallel, surface-level housing 20 feet in width will contain the klystrons and associated equipment. The two housings are to be separated by 35 feet of earth so that personnel can service the equipment while the accelerator is in operation.

This project was authorized in fiscal year 1962 at a total estimated cost of $114 million. Approximately $19 million is expected to be obligated through fiscal year 1962 for design and engineering effort on laboratories, shops, klystron modulators; standard accelerator sections; power components; and the power distribution system. Construction will be initiated on the laboratories. The balance of $95 million is being requested in fiscal year 1963 to provide the total funding necessary for this project.

25. Project 60–g–3—Transuranium processing plant, Oak Ridge National Laboratory, Tennessee, $7,500,000

This project provides for a reinforced concrete, structural steel and masonry processing plant consisting of shielded hot cells, alpha laboratories, operating areas, equipment makeup and transfer areas, offices, change rooms and storage areas.

The project will provide facilities needed for the development of processes to isolate chemically the higher transuranium elements that will be discharged from the high flux isotope reactor and the preparation of significant quantities of these elements through the reconstitution of the parent material into target elements for reirradiation by the high flux isotope reactor.

The AEC transuranium program has as its objective the production of significant quantities of the heavier transuranium elements americium, curium, berkelium, and californium. The production of transuranium elements of this proposed scale will permit the extension of heavy element research into many many areas requiring milligram to gram amounts of material. Among these areas are the precision measurement of neutron cross sections and fission parameters of importance to the power reactor program, new and more reliable measurements of the chemical and metallurgical behavior of the actinide elements, and the production of cyclotron and reactor targets for the further preparation of a wide range of transuranium isotopes, especially of elements above californium, whose nuclear properties are of interest and importance.

The original authorization (Public Law 86–50) for this project and the appropriation amounting to $1,200,000 contemplated a development facility capable of processing only small quantities of americium and curium irradiated in the materials testing reactor (MTR). The facility was proposed as an addition to the existing Isolation Laboratory prior to approval of Project 61–f–4, high flux isotope reactor (HFIR). As a result of approval of the HFIR and its subsequent relocation to the Melton Valley, further consideration of containment problems, and the realization that the specific neutron, alpha, and gamma activity of material to be handled in the facility would be considerably greater than assumed previously, the estimated cost of this plant has increased by $7.5 million, resulting in this additional fund request.

16. Project 75–d–1—Zero gradient synchrotron, Argonne National Laboratory, Illinois, $3 million

This project provides for the design and construction at Argonne National Laboratory of a proton synchrotron, known as the zero gradient synchrotron (ZGS), operating in the energy range from 10 to 15 Bev, plus extensive ancillary buildings, power supplies and experimental facilities.

This project was reauthorized in fiscal year 1961 increasing the total estimated cost from $29 million to $42 million. Beginning in September 1961, when serious slippages in the delivery schedule for ring blocks were first indicated, a continuous review and sequence of ameliorative measures has been underway. As a result, it is now estimated that the completion date for this project must be extended 12 months beyond the date previously estimated (June 1962 to July 1963), and the total estimated cost increased to $47 million, primarily as a result of the extension of the completion date and increased engineering and procurement costs. Of the total increase in cost, $2 million has been funded through savings or deferrals of other projects, leaving a balance of $3 million which is requested for appropriation in fiscal year 1963.

PROGRAM ACCOMPLISHMENTS

Mr. CANNON. What major accomplishments were realized on this program in the last year?

Dr. MCDANIEL. I think the completion of the major accelerators at Princeton, Penn, and Cambridge may be earmarked as some of the major accomplishments. The discovery of several new elementary particles has excited the scientific world. One of our contract employees won the Nobel Prize for his outstanding theoretical work in physics.

HIGH-ENERGY ACCELERATORS

Mr. CANNON. We take for granted, Doctor, that much of your increase in high-energy physics results from the availability of more accelerator time? Are these machines operated on a 24-hour basis? How is the time allocated for use of these machines?

Dr. MCDANIEL. I will take them up one by one, and give you a measure of the time they are actually being utilized.

The alternating gradient synchrotron at Brookhaven now operates on line about 120 hours a week. There are 168 available hours in every week. This machine is on and operating about 120 of those hours.

Mr. CANNON. You feel that you are getting the most out of these machines?

Dr. MCDANIEL. Yes. We have as our objective that of making efficient and economical operation of them and we believe we are utilizing them to the best of our ability at the moment. As we learn more and more how the machines may be used more effectively, we may be able to accomplish even greater things.

Mr. CANNON. It is our understanding that the immediate product in acceleration is principally photographs. Explain just how these machines work and what processing is necessary to secure the end result.

Dr. MCDANIEL. The accelerators themselves, sir, are large physical pieces of apparatus and do produce as their output large numbers of small individual entities, called particles. These particles cannot be seen by the naked eye and must be observed through special techniques. One of the techniques is to allow these particles to impinge upon the emulsion of a photographic plate. After the particle passes through the photographic emulsion, the emulsion can be developed and the tracks may be observed under a microscope.

Another technique which is commonly used is that of a bubble chamber. If one has a liquid like, for example, liquid hydrogen, and holds that liquid at a temperature below its boiling point, if one of the highly energetic particles passes through the chamber, there will be a short moment during which a series of bubbles appear along the track of the elementary particle. This series of bubbles may be photographed showing where the particles were at the time the bubbles were formed.

The experiments consist of various physical arrangements and the photographing of large numbers of tracks. This year we probably will photograph of the order of 6 million individual photographs which must be looked at by trained individuals and sorted out into the various interesting events. This large number of photographs requires, of course, extensive data-handling equipment to measure the angle of divergence of the many tracks that appear in the process.

Mr. CANNON. Is this processing work incident to the use of these accelerator operations current?

Dr. MCDANIEL. When one takes as many photographs as 6 million a year, there will be some backlog of work to be done.

Mr. CANNON. There is no work being done that can't be utilized?

Dr. MCDANIEL. Absolutely no, sir. For example, at Berkeley we are in the process now of remodeling the machine in accordance with the congressional authorization of last year.

During the time that the bevatron is not in operation the scientific people are able to continue to do some work on some of the backlog of photographs which have been accumulated.

Mr. CANNON. If you should drop back to an 8-hour operating schedule until this backlog was reduced, what effect would this have on your budget request?

Dr. MCDANIEL. It would reduce the budget request in dollars, but would probably result in a rather inefficient operation of the machine due to the rather large and continuing expenses of such a big installation.

Mr. CANNON. Would that be obviated by reducing the operating schedule to say 100 hours a week? Would you still get all the data required?

Dr. MCDANIEL. It is necessary in some of the complex experiments to maintain continuous operation around the clock for as long as 2 or 3 days, sometimes, to accumulate the statistics that are necessary in order to achieve the results of the experiment.

Mr. CANNON. That is not exceptional?

Dr. MCDANIEL. It does not occur in every experiment. Many experiments can be conducted with a shorter period of operation of the accelerator. But some experiments must be carried out over a long period of time.

RELATIONSHIP BETWEEN HIGH-TEMPERATURE CHEMISTRY PROGRAM AND HIGH-TEMPERATURE MATERIALS RESEARCH PROGRAM

Mr. CANNON. What is the difference between your high-temperature chemistry program and your high-temperature materials research program under reactor development?

Dr. MCDANIEL. The basic difference between the two programs—they are coordinated, I might say, between individuals exchanging their information and working together in the analysis of the proposal—generally the work which we in the physical research program supervise is that of fundamental studies. Generally the type of studies conducted under the nuclear technology group of the Reactor Development Division is more directly related to practical reactor problems.

HIGH-ENERGY ACCELERATORS

Mr. CANNON. We shall be glad if you will put in the record some examples of the use of the accelerators and their respective programs, including information on the status of the processing of photographs from each machine.

Dr. MCDANIEL. We will be very glad to furnish such a statement for the record on each accelerator.

I might say, sir, that the photographs are placed in libraries after they have been examined initially, because they do become valuable material for future examination for additional screening for other interesting events which might have occurred.

Mr. CANNON. Could you let us know the size of the backlog on these machines.

Dr. MCDANIEL. We will furnish that for the record.

(The information follows:)

The accelerator activities which form a major and essential part of the AEC high-energy physics program at present are, in several instances, in a state of transition to a phase wherein full operational use will be made of these accelerators for experimental research. A productive research program has been underway for several years with the cosmotron at the Brookhaven National Laboratory (BNL), the 184-inch cyclotron and the bevatron at the Lawrence Radiation Laboratory (LRL), the Cal Tech electron synchrotron, and several other university accelerators; modifications to the bevatron and to the Cal Tech synchrotron are now required to modernize these facilities, however, and less extensive improvements are proposed for one or more of the university synchrotrons. The alternating gradient synchrotron (AGS) at BNL requires a substantial addition to its ancillary equipment in order that this accelerator, which at 33 Bev. reaches the highest energy at present attainable in the world, can effectively and efficiently permit well-controlled experiments to be conducted; the Cambridge elec-

tron accelerator (CEA) has only recently come into operation and will require an initial period for the development of effective utilization procedures; and preparations are underway or planned for the eventual use of the Princeton-Penn accelerator (PPA), zero gradient synchrotron (ZGS), and Stanford accelerator, which still are in the course of construction.

Experiments performed with high-energy accelerators require quite extensive equipment to provide beams which contain particles which not only are carefully selected with respect to momentum but which also are selected to be of a particular type (mass selection). Data are obtained by use of a variety of types of counters, correlated by rather elaborate and precise electronic networks; by bubble chambers; and by spark chambers, often associated with and controlled by ancillary counter arrays. The provision of strong magnetic fields through the sensitive region of the bubble or spark chambers is frequently an essential feature of an experiment in which the identity and character of the observed particles must be determined. The photographic recording of data from the spark chambers, in particular, is frequently selectively controlled by an auxiliary configuration of counters, and the results, therefore, in each case pertain only to a single planned experiment. The bubble chamber exposures, however, in the past have been less selective, and hence constitute runs on the results of which analyses may be made in more than one way. The experimental conditions controlling the incident beam in such cases, of course, will be changed from run to run, guided in part by the results of previous work and in part by new concepts or questions for which experimental results are required. In the case of the fast-cycling bubble chamber which is under development for use with the Princeton-Penn accelerator (PPA), it is planned to make a counter selection of the events which will be recorded photographically.

The use of bubble chambers, and to a lesser extent of spark chambers, has led to the acquisition of a considerable volume of photographic records. The analyses which have been made of these records, both in the accelerator laboratories and at universities throughout the country, already have been fruitful in regard to the new information which they have provided concerning elementary particles. The information contained in these records in a number of instances can be profitably reanalyzed in new ways to provide additional information, but new runs under modified experimental conditions are also required to build on the earlier experimental results and current theoretical developments.

The backlog of unanalyzed film at the major accelerator laboratories has recently been surveyed. As the following summary table shows, the backlog has been substantial only in connection with the bevatron operations and, despite an anticipated increase in the number of photographs taken in successive years, the backlog of unanalyzed records is seen to be steadily decreasing. An appreciable backlog of bevatron records is, in fact, particularly desirable at this time in view of the planned shutdown for the authorized bevatron improvement program. The analysis facilities at the Brookhaven National Laboratory and those planned for the Lawrence Radiation Laboratory are scheduled to permit analysis of the film at the expected processing rate of these new records.

Processing of bubble chamber photographs by major high-energy physics machine

	1961	1962	1963
1. Alternating gradient synchrotron:			
(*a*) Photographs taken	0	800,000	2,500,000
(*b*) Unanalyzed at end of year	0	[1] 0	[1] 0
2. Bevatron:			
(*a*) Photographs taken	1,960,000	1,000,000	480,000
(*b*) Unanalyzed at end of year	2,700,000	2,300,000	1,500,000
3. Cambridge electron accelerator:			
(*a*) Photographs taken	[2]	0	100,000
(*b*) Unanalyzed at end of year	[2]	0	0
4 Cosmotron:			
(*a*) Photographs taken	1,300,000	460,000	500,000
(*b*) Unanalyzed at end of year	0	[1] 0	[1] 0
5. 184-inch cyclotron: [3]			
(*a*) Photographs taken			
(*b*) Unanalyzed at end of year			
6. Princeton-Penn accelerator:			
(*a*) Photographs taken	[2]	[2]	1,000.000
(*b*) Unanalyzed at end of year	[2]	[2]	540,000

[1] Essentially no backlog has been developed. At any given time some films may be on hand, usually in an amount just sufficient to occupy analysts until next run is made.
[2] Not operating.
[3] Bubble chambers not used with this machine.

A backlog of some magnitude has proven desirable, in that it permits analysis to proceed at universities where accelerators are not available and at major accelerator laboratories whenever the facilities are unavailable for such research during extended periods. It clearly would be imprudent, however, to permit the backlog to build up steadily for an indefinite time. For this reason, and in recognition of the need to process a much larger volume of data to obtain definitive and statistically significant information concerning narrow resonances or rare events, the scientific community has been devoting much thought and a great deal of development effort to the design and fabrication of automatic data processing equipment. This development now appears to have reached a turning point where a much larger volume of film records can be measured efficiently and accurately and the resulting data analyzed quickly with the aid of electronic digital computing equipment.

The measuring and analyzing equipment now becoming available assumes different forms, some suited to use in a large laboratory—perhaps with on-line computing facilities—and others more appropriate for smaller laboratories or for less routine exploratory work. The flying spot digitizer and the scanning measurement projector systems developed at the Lawrence Radiation Laboratory (LRL) are examples of this type of instrumentation, and the second of these methods is being adopted for a data analysis program at the University of Illinois. Automatic pattern recognition constitutes a further step of development. Methods for this important part of a complete analysis program are being given serious attention by physicists and applied mathematicians in several laboratories, and progress with the precision encoding and pattern recognition (PEPR) development at the Massachusetts Institute of Technology (MIT) appears to be highly encouraging.

Highlights of the new experimental results obtained from the high-energy physics program have been reported at appropriate times to the Joint Committee on Atomic Energy and to the General Advisory Committee of the AEC as well as in professional journals. Of particular note was the recent discovery, by a Brookhaven National Laboratory-Yale University team, of the anti-xi-minus hyperon, observed in a liquid hydrogen bubble chamber exposed to a 3.3 Bev/c beam of antiprotons from the alternating gradient synchrotron (AGS). This discovery, confirmed at the European Organization for Nuclear Research (CERN), supports the belief that for every existing particle there is a corresponding antiparticle. A very considerable interest is justifiably developing in the results which are emerging from another experiment, employing a large spark chamber, which now is nearing completion at the AGS. This latter experiment was designed to determine whether the neutrinos which result from pi-meson decay differ from those associated with the process of beta disintegration. The present (as yet unpublished) indication that there are two kinds of neutrinos will be of great significance in guiding the theoretical interpretation of interparticle forces, and undoubtedly will suggest additional significant experiments designed to pursue further the implications of this result.

The two experiments just mentioned were concerned with relatively rare events, and consequently did not involve as much routine data analysis as is typical for the use of bubble chambers although 34,000 photographs were scanned in the process of detecting the anti-xi-minus particle. Of comparable basic significance, however, is the continuing study of interparticle forces through the determination of "resonances" observed in reactions which give birth to mesons or to heavier elementary particles. A notable example of such a resonance is afforded by the discovery of the "omega meson," with a mass of about 790 Mev or a little over 1,500 times the mass of the electron, which is revealed by a kinematical analysis of the three pions which emerge from the breakup of this resonant state. The determination of the many resonant systems which exist—involving mesons, nucleons, or hyperons—requires the acquisition and analysis of a sufficiently large volume of data as will lead to results of statistical significance. Analysis of such data is being understaken with increasing emphasis not only in the large national laboratories but also by many university groups (John Hopkins, Northwestern, Wisconsin, etc.). We regard the increasing entry of university groups into this analysis program as not only useful for making effective use of the photographically recorded data, by the aid of the newer types of analyzing equipment, but also as desirable in returning to university campuses a significant part of the high-energy research program to stimulate the graduate student research activities on which the professional development of future scientists depends. The university programs also benefit

from the operation of smaller accelerators on campus, where specialized experiments can be undertaken and preparations made for use of the tightly scheduled accelerators at the major centers. An illustration of the research associated with a university accelerator is provided by the ingenious experiments conducted at the California Institute of Technology to determine the means life of the short-lived neutral pi meson (approx. 2.2×10^{-16} sec).

Accelerators in the 50–1,000 Mev range are also being used to an increasing extent to provide space-motivated irradiations.

It is fully expected that the demand for experimental time on all high-energy accelerators will continue to significantly exceed machine availability despite the oncoming operation of new machines.

CONTROLLED THERMONUCLEAR RESEARCH

Mr. CANNON. We have heard some encouraging comments about your progress in controlled thermonuclear research. Will you explain briefly the progress being made and the approaches you are following, including which of them seems to have the greatest promise, and which of them seem to have the least promise?

Dr. MCDANIAL. That is a big order, but I will attempt it, sir. There are four major sites where the controlled thermonuclear research is carried out, Princeton University, Oak Ridge National Laboratory, the Berkeley-Livermore group at the University of California, and the Los Alamos Scientific Laboratory.

In addition, we have about 20 smaller contracts for smaller pieces of work.

The size of the four major groups range from around $3 to $7 million each. The total program incurs an expenditure of about $26 million.

At Princeton University, the model C Stellarator has just been completed and has just started operation. This machine, I am proud to say, was fabricated within the funds originally planned, $26 million, and we did not overrun in the fabrication of this facility.

Since the facility has just started operation, we cannot really give you a prognosis of what will be coming out of it. We expect in the next year or so to find out what this concept holds for us. Certainly the initial operation of it has been satisfying. No major breakthroughs have occurred and no major experiments are noteworthy at the moment.

At the Oak Ridge National Laboratory, we have completed the fabrication of the so-called DCX2 apparatus. This consists of an apparatus in which positive ions are injected from a 600-kilovolt Cockcroft-Walton accelerator. The confinement times of the circulating beam have been very satisfactory. They have reached several seconds, but the temperatures of random motion do not indicate at the moment that sufficient temperatures have been reached to cause ignition. We are quite interested in what is going on but, again I will have to say, there are no breakthroughs in the sense of accomplishing something today that we thought we could not accomplish last year. The work should continue for another year or so before we can make a real effective evaluation of where we stand.

The experiments at Los Alamos have been more interesting and could border on what I define as a breakthrough, although not the breakthrough that would create excitement. The CUSP devices have been operating at temperatures that certainly indicate to the scientific community that chain reactions are occurring within the plasma and

that these are occurring at confinement times that are interesting. They are quite long containment times. Again I would have to say that these devices are not prototypes of a power machine, but they have certainly put us in the thermonuclear domain in terms of an operating plasma.

Mr. CANNON. That is at Los Alamos?

Dr. MCDANIEL. That is at Los Alamos.

DISPOSAL OF COMMUNITY FACILITIES AT LOS ALAMOS

Mr. CANNON. What is the significance of your proposal to sell the community facilities at Los Alamos as indicated in this morning's papers?

General LUEDECKE. Our proposal, Mr. Chairman, is to convert Los Alamos to a community, to turn the community back to the people. It is a Government community.

Mr. CANNON. It will not affect your program?

General LUEDECKE. No, sir.

Mr. CANNON. It is the last one you have left, I believe.

General LUEDECKE. It is. We would try to accomplish the same thing at Los Alamos that we have now been able to accomplish at Oak Ridge and at Hanford.

Mr. CANNON. You took quite a while to liquidate Oak Ridge.

General LUEDECKE. Yes, sir, we did. As a matter of fact, the law provides for assistance for 10 years to the community.

Mr. CANNON. This will not be on such a large scale at Los Alamos, or would it?

General LUEDECKE. It will not be on such a large scale in the sense that there are not as many people there, and the community is not as large. Otherwise, it is essentially the same.

CONTROLLED THERMONUCLEAR RESEARCH

Mr. CANNON. On page 259, you propose to get an answer to the same question through five different avenues, A, B, C, D, and E, each of which are expensive. It would not be advisable to limit work on two of the least promising and concentrate your research on the other three?

Dr. MCDANIEL. I had described, up until you asked the question about Los Alamos, the work at Los Alamos, Princeton, and Oak Ridge. The other two approaches are essentially carried out at the University of California, at Livermore and Berkeley, the relativistic electron approach and the mirror approach. The relativistic electron approach is sometimes called the Astron. The machine is now being fabricated and will not be operable for several months more. Therefore, we cannot really say that this machine has reached its output performance or that it has failed in its output performance. Again, it will require a year or so before we can answer your question categorically, which we do intend to answer.

Mr. CANNON. But if it develops that you would possibly secure an adequate answer through the three, you would drop the two least promising?

Dr. McDaniel. We would so recommend immediately, if there were a major understanding that one or more processes had distinct advantages over another that we reexamine.

Mr. Cannon. That would result in savings?

Dr. McDaniel. Yes, sir. At the present time we are completely reexamining the entire program by having a full-scale scientific review. That review will not be completed for several months. But if we ever did reach the stage where we could say this, or that approach were the best it would certainly eliminate expenditures on the others, but it would undoubtedly require additional effort behind the more successful ones.

RESEARCH IN COLLEGES AND UNIVERSITIES

Mr. Cannon. In connection with the table which we have asked you to include in the record, will you also prepare for the record a tabulation showing the amount of AEC appropriated funds for 1962 for all programs allotted to each college in support of research work?

Colleges and universities participating in AEC physical research program—University contracts

	1962 obligation (estimated)
Adelphi College	$9,000
Alabama, University of	5,424
Arizona State University	114,242
Arizona, University of	190,615
Arkansas, University of	190,287
Boston University	30,775
Brandeis University	70,176
Brigham Young University	15,383
Brooklyn, Polytechnic Institute of	80,780
Brown University	402,450
Buffalo, University of	71,200
California Institute of Technology	1,691,980
California, University of	1,539,206
Carnegie Institute of Technology	1,183,794
Case Institute of Technology	709,410
Catholic University of America	83,018
Chicago, University of	1,221,991
Cincinnati, University of	14,734
Clark University	33,500
Clarkson College of Technology	37,050
Colorado School of Mines	16,918
Colorado, University of	325,425
Columbia University	2,364,715
Connecticut, University of	57,300
Cornell University	558,262
Delaware, University of	63,973
Duke University	380,181
Duquesne University	16,990
Emmanuel Missionary College	9,500
Emory University	26,225
Fisk University	$13,750
Florida State University	142,017
Florida University	139,234
Fordham University	30,000
Georgetown University	29,592
Georgia Institute of Technology	133,415
Georgia, University of	14,118
Georgian Court College	5,586
Harvard University	680,743
Haverford College	13,008
Houston, University of	81,785
Idaho State College	11,620
Illinois Institute of Technology	142,900
Illinois, University of	2,422,524
Indiana University	170,120
Iowa, State University of	18,782
Johns Hopkins University	281,979
Juniata College	14,150
Kansas State University	42,499
Kansas, University of	485,749
Kentucky Research Foundation	79,737
Lehigh University	13,316
Louisiana State University	16,738
Louisville, University of	46,706
Maine, University of	20,676
Maryland, University of	531,069
Massachusetts Institute of Technology	1,307,782
Massachusetts, University of	12,480
Miami, University of	91,437
Michigan College of Mining and Technology	26,248
Michigan State University	178,995

Colleges and universities participating in AEC physical research program—University contracts—Continued

	1962 obligation (estimated)
Michigan University	$1,431,267
Minnesota, University of	700,841
Mississippi, University of	47,149
Missouri, University of	11,000
Nebraska, University of	75,480
New Hampshire, University of	41,686
New Mexico, University of	18,345
New York, State University of	5,518
New York University	519,568
North Carolina State College	17,407
North Carolina, University of	84,869
Northwestern University	194,377
Notre Dame, University of	379,232
Ohio State University	251,481
Ohio University	—3,493
Oklahoma State University	60,828
Oklahoma, University of	40,908
Oregon State University	61,247
Oregon, University of	37,643
Pennsylvania State University	582,189
Pennsylvania, University of	1,016,617
Pittsburgh, University of	138,656
Princeton University	1,657,339
Purdue University	627,293
Rensselaer Polytechnic Institute	263,505
Rice University	455,690
Rochester, University of	1,297,788
Rutgers University	77,004
St. John Fisher College	4,150
San Diego State College	22,800
South Carolina, University of	$10,280
Southern California, University of	423,090
Stanford University	291,548
Stevens Institute of Technology	197,644
Syracuse University	51,270
Temple University	65,629
Tennessee, University of	45,986
Texas A. & M. College	20,000
Texas Technological College	12,943
Texas, University of	171,085
Toledo, University of	6,564
Tufts University	195,349
Utah, University of	64,520
Vanderbilt University	80,435
Vermont, University of	37,257
Virginia Polytechnic Institute	67,279
Virginia, University of	173,437
Wake Forest College	16,137
Washington State University	46,317
Washington University	79,935
Washington, University of	525,762
Wayne State University	32,194
Western Reserve University	109,490
Western State College of Colorado	—8,629
Wisconsin, University of	927,443
Worcester Polytechnic Institute	19,763
Yale University	2,115,413
Total	[1] 34,609,784

[1] Excludes costs of major research centers as follows:

New York University	$1,120,000
Princeton University	7,810,000
Massachusetts Institute of Technology	785,000
Stanford University	4,500,000
Princeton-Pennsylvania accelerator	2,853,000
Cambridge electron accelerator	3,225,000
Total estimated fiscal year 1962 cost	20,293,000

SALINE WATER PROGRAM

Mr. CANNON. The committee understands that you may be undertaking some research in the saline water program. Can you give us some information on that?

Dr. MCDANIEL. Yes, sir. Under directly budgeted funds, my division is not conducting research in saline water. Under a transfer of funds, in an arrangement with the Department of Interior, the Oak Ridge National Laboratory is carrying out a program with Department of the Interior budget funds, in this fiscal year of about $350,000. Next year, it will be somewhere around $700,000.

Mr. CANNON. What personnel will be employed in this, and what has that personnel been doing heretofore? In other words, it is not possible that you are trying to find places for some of your superfluous Oak Ridge personnel?

Dr. MCDANIEL. First of all, it does not have many bodies associated with it. I don't have the exact number but it is not a large number. These people were previously employed in some chemical processing type work at Oak Ridge, and I believe that was cut back some time earlier, and therefore they were available.

Mr. CANNON. This is not made work for that purpose then?

Dr. MCDANIEL. My understanding, although I am not an authority, my understanding is that this is important work to the Department of the Interior and the Commission is doing it essentially at their urging.

General LUEDECKE. This is correct. We had the peculiarly qualified personnel in the laboratory to undertake this kind of program for the Department of Interior and we could do it without any substantial expansion in the laboratory by reducing the other programs.

Mr. PILLION. Mr. Chairman.

Mr. CANNON. The gentleman from New York.

Mr. PILLION. What is your approach on this saline water research?

Dr. ENGLISH. Mr. Pillion, the work we are doing for the Department of the Interior at the Oak Ridge National Laboratory is not designed, and it is not part of the Interior Department program, to explore specific practical approaches such as to develop a process, for example, but it is more to understand the fundamental properties of dilute aqueous solution. The problem of water desalinization basically, of course, is one of removing salt content from water which is not potable. Obviously, one knows how to do this. You can simply evaporate it. But it is an expensive process to make water on a sufficiently large scale to supply populations and for irrigation purposes.

So what one is looking for in the end is the cheapest possible process. The people at the Oak Ridge National Laboratory have, by virtue of having worked on AEC programs for years, become very expert in the properties of dilute aqueous solutions. It is in the fundamental chemistry of these dilute aqueous solutions that these people will be working.

In the rest of the program, the Department of the Interior is actively developing pilot plant methods of several sorts for water desalinization.

Mr. PILLION. Isn't this a matter of basic chemistry? Why should it be in the Atomic Energy Commission? It is experimental and theoretical chemistry.

Dr. ENGLISH. It is experimental and theoretical chemistry.

Mr. PILLION. There are now many successful processes for converting salt water to potable water. What value will this new work be?

Dr. ENGLISH. This is directed toward finding more economical methods.

Mr. PILLION. There have been hundreds of studies made by different groups on this subject.

Dr. ENGLISH. The reason that the AEC is doing this is that the Department of the Interior is conducting research in universities and industrial concerns. By virtue of the AEC having very expert people in this field, they asked the AEC to undertake this research for them.

Mr. PILLION. What is the end result?

Dr. ENGLISH. This program has only been in existence for 3 months. I think it is far too early to tell you what will come out of Oak Ridge.

Mr. PILLION. There have been hundreds and literally thousands of studies made by universities, by various experimental people on this same subject. How is yours different from all the others that have been studied by chemists, by physicists, by economists, and by everyone else? How is your study different?

Dr. ENGLISH. The people at Oak Ridge certainly will review all the literature that has been prepared in terms of the basic research in the water field, and will try to explore avenues that have not been explored.

HIGH ENERGY ACCELERATORS

Mr. PILLION. Just general talk. It is just a general situation. Now, may I ask another question? How many high energy accelerators do we have in this country?

Dr. MCDANIEL. I would have to furnish a list. There is a large number of them.

Mr. CANNON. Yes, and include a list of the personnel involved in this work.

(The information follows:)

U.S. high energy accelerators

Machine	Particle	Energy (Bev.)	Source of Federal support	Location	Estimated personnel, 1962
Operating:					
Synchrocyclotron	Proton	0.240	AEC	University of Rochester	7
Synchrotron	Electron	.300	AEC	Massachusetts Institute of Technology.	4
Do	do	.300	AEC	Purdue University	3
Betatron	do	.300	ONR	University of Illinois	(1)
Synchrocyclotron	Proton	.400	ONR	Columbia University	(1)
Do	do	.440	AEC	Carnegie Institute of Technology.	10
Do	do	.450	ONR	University of Chicago	(1)
Synchrocyclotron (184 inch).	do	.740	AEC	University of California, Lawrence Radiation Laboratory.	[2] 91
Linear accelerator	Electron	1	ONR	Stanford University	(1)
Synchrotron	do	1.2	ONR	Cornell University	(1)
Do	do	1.2	AEC	California Institute of Technology.	11
Synchrotron (cosmotron).	Proton	3.2	AEC	Brookhaven National Laboratory.	288
Synchrotron (CEA)	Electron	6.0	AEC	Harvard-MIT-Cambridge	79
Synchrotron (bevatron)	Proton	6.2	AEC	University of California, Lawrence Radiation Laboratory.	[2] 438
Alternating gradient synchrotron (AGS).	do	25–30	AEC	Brookhaven National Laboratory.	243
Under construction:					
Synchrotron (PPA)	do	3.0	AEC	Princeton-Pennsylvania (New Jersey).	106
Synchrotron (ZGS)	do	12.5	AEC	Argonne National Laboratory.	75
Linear accelerator	Electron	10–20	AEC	Stanford University	53

[1] Not available.

[2] Direct man-years including technicians and others. All other numbers shown represent scientific man-years.

HIGH ENERGY PHYSICS

Mr. PILLION. Here you have $42 million in 1961 for physical research program. You jumped to $78 million in 1962. Now you have $132 million for 1963, tripling the amount in the space of 3 years. Now, can you tell me outside of the theoretical knowledge that you have of the particles that you have photographed from these accelerators, what practical application you have been able to give to any of the knowledge that you have obtained for the past 2 years?

Dr. MCDANIEL. I have to say that these studies are theoretical and experimental studies aimed at understanding nature.

Mr. PILLION. What economic and military use have we obtained from any of this knowledge that you have obtained from the millions of photographs that you have made of these particles?

Dr. MCDANIEL. The high-energy physics program is not designed to produce practical knowledge for the weapons program.

Mr. PILLION. I understand, but we do have a $10 billion deficit this year. We do have a 10 or 15 billion dollar deficit facing us next year. Now, I could take this piece of paper and spend $10 million studying that piece of paper, its various properties, its activities, its actions. Would that be worth while? Nice to put up on the shelf somewhere, nice to send somewhere. But would you consider that to be a wise decision? Now, you don't have an end result that is going to have some economic or some worthwhile result. Why all this money? Just for the purpose of making 6 million photographs? Where is the end result here?

Dr. MCDANIEL. The end result is knowledge.

Mr. PILLION. Well, there is knowledge of this, too. I could be knowledgeable to the extent of $10 million worth of research about this one piece of paper. It is like the expert who knows more and more about less and less. We only have a certain amount of resources, a certain amount of money. We have to allocate that to things that will bring in the greatest end result for the community and for our fellow citizens.

Dr. MCDANIEL. Therefore, in the programs which are designed to increase human knowledge, one must cut its program to fit the cloth. This is what we are doing. We are making the most effective use of the dollars which the Congress and the administration feels that the country should devote to long-range accumulation of fundamental knowledge.

CORPORATION YARD, LAWRENCE RADIATION LABORATORY, CALIFORNIA

Mr. CANNON. Coming on down to page 459, under construction, please explain the need for the item of $1,500,000 for the corporation yard at the Lawrence Radiation Laboratory.

Dr. MCDANIEL. This is required in order to consolidate the crafts work at the University of California into an efficient operation. The major facility that is required is for proper storage, for housing the craft shops, for decontamination facilities, for other support——

Mr. CANNON. It is in the nature of permanent construction?

Dr. MCDANIEL. It is, sir; a permanent group of buildings, a permanent area.

Mr. CANNON. This work has been in progress for some time. What is wrong with the present facilities? Why is there additional need?

Dr. MCDANIEL. The present facilities are crowded and the storage areas are overlapping into the roads. It is almost a hazardous situation simply to drive a vehicle on the property at the moment. It is necessary to relocate the shops and to provide the additional facilities required.

Mr. CANNON. You are certain that we have a permanent need for these new facilities? It will not be possible to discard some of these items without impairing the program?

Dr. MCDANIEL. No, sir; all of this is required.

Mr. CANNON. Let us have a breakdown on this.

Dr. MCDANIEL. We will provide you with a breakdown of the cost estimates and of the justification of the need, as well as a brief description of the project.

(The information follows:)

63-h-3 CORPORATION YARD, LAWRENCE RADIATION LABORATORY, CALIFORNIA, $1,500,000

This project relocates and expands scattered crafts shops and other support functions and consolidates them in one building. The facility will include a craft shop building, access road, perimeter fencing, and utilities.

The crafts shop building is to be a two-story, reinforced concrete structure with an area of 31,000 gross square feet. The first floor will house the carpenter shop, paint shop, maintenance machinists shop, a vehicle service shop, and a firehouse. On the second floor will be the plumbing shop, electrical shop, the laborers' dispatch room, safety offices, and a locker room containing a washroom and toilet facilities.

A centralized facility for the crafts shops is needed for the following reasons: (*a*) Space now occupied by these support activities interferes with experimental programs connected with the 184-inch cyclotron. This space will better be used for direct support of the major instruments; (*b*) existing facilities are small, separate structures clustered about the 184-inch cyclotron. Expansion of individual facilities is required but precluded by the building congestion; (*c*) storage facilities are inadequate. Currently, passage between buildings is impaired as a result of essential storage in the present crafts shops area; (*d*) traffic congestion in the area is extreme because of the encroachment of add-on facilities; (*e*) the advantage of centralization of similar functions is an additional consideration.

Details of cost estimate

1. Engineering design and inspection at 12 percent of construction costs			$146,000
2. Construction costs			1,214,000
a. Improvements to land		$70,000	
b. Buildings		894,000	
(1) Crafts shop, 31,000 square feet at $24.50	$760,000		
(2) Radioisotope service building, 3,500 square feet at $38.30	134,000		
c. Other structures 7,000 square feet at $7		49,000	
d. Utilities		50,000	
e. Equipment		151,000	
3. Contingency at 10 percent of other costs			140,000
Total project cost			1,500,000

MATHEMATICS AND COMPUTER BUILDING, ARGONNE NATIONAL LABORATORY, ILLINOIS

Mr. CANNON. Then under project 63–h–4, you are providing office space which you say must be adequate to permit scientists and engineers to carry on discussions. Is that something in the nature of an auditorium?

Dr. MCDANIEL. The auditorium at the Argonne National Laboratory is included in the building which the Congress authorized last year and is under construction. The facilities here will not provide for an auditorium.

Mr. CANNON. It would be conducive to conferences?

Dr. MCDANIEL. There would be small rooms of the order of the size of this room, perhaps a little larger, and it would provide for several people to be in the room but certainly would not qualify under the title of auditorium.

Mr. CANNON. Will you give us a breakdown of this item?

Dr. MCDANIEL. We will give you such a breakdown.

(The information follows:)

63–h–4 MATHEMATICS AND COMPUTER BUILDING, ARGONNE NATIONAL LABORATORY, ILL., $2,300,000

This project provides for construction of a building addition to be attached to the east end of wing A of the physics building at Argonne National Laboratory. The first and second floor of the facility will provide space for 150 employees and for 2 major digital computers and an analog computer installation. The service floor area will be devoted to mechanical and electrical equipment, storage, building maintenance, and maintenance personnel, and fallout shelter for a maximum of 150 persons. Office space must be adequate to permit scientists and engineers to carry on discussions with the Applied Mathematics Division staff members. In addition, space must be provided for computer maintenance, data preparation and storage, lectures and conferences, and materials and supplies storage.

The future programs of research and development at the Argonne National Laboratory will place an increasingly greater emphasis on the role of mathematics and computers. This greater emphasis will manifest itself in greater demands for mathematics and computer services as well as in a pressing need for a vigorous research program in mathematics and the computer sciences. Both the service work and the mathematics research and computer engineering work must develop together. Where service work is performed without a commensurate research program there is a great danger that the demands for computing capacity and programing staff will reach exaggerated proportions. In order to organize a corps of scientists in a manner to insure the greatest productivity of new ideas and to fully develop these ideas into useful concepts, it is essential that they be provided well equipped and efficient computing and data processing facilities, that they be provided a well-trained staff of professional programers, and that they receive the benefits of a closely interacting research program in mathematics and the computer sciences.

Details of cost estimate

1. Engineering, design, and inspection: at 12.5 percent of construction costs	$213,500
2. Construction costs	1,706,500
(*a*) Improvements to land	7,500
(*b*) Building, 53,230 square feet at $29.77	1,584,500
(*c*) Utilities	6,500
(*d*) Equipment	108,000
3. Contingency at 17 percent of other costs	330,000
Total estimated cost	2,250,000
4. Allowance for fallout shelter	50,000
Grand total	2,300,000

Biology and Medicine

Mr. Cannon. We will take up "Biology and medicine" next. Seventy-one million dollars is requested. How much was provided for this purpose in the current year?

Dr. Dunham. $61 million.

Mr. Cannon. An increase of $10 million. Why the increase?

Dr. Dunham. The reasons are to, one, keep up with the cost of living; two, get on with certain highly important projects, and three, expand certain activities which I would like to refer to when it is appropriate. I am talking about the ones associated with the current weapons test program.

Mr. Cannon. We will insert pages 267 through 292 and the associated construction justification.

(The justification follows:)

OPERATING EXPENSES

Biology and Medicine Program—Operating Expenses

Program statement

Estimate, fiscal year 1963	$71,353,000
Estimate, fiscal year 1962	61,077,000
Increase	10,276,000

As in prior years, the biomedical research program will place its principal emphasis on work directed toward a better understanding of the radiation hazards of atomic energy activities. The budget proposes an increase of $10,276,000 and covers planned initiation and expansion of activities in somatic and genetic effects of radiation, molecular and cellular level studies, environmental radiation studies, and other important areas.

The budget has been developed in recognition of the responsibilities of other agencies of the Government, particularly the Department of Health, Education, and Welfare, National Aeronautics and Space Administration, and the Department of Defense. There are in existence formal and informal arrangements for joint review and sponsorship of research projects both within facilities of the Atomic Energy Commission and those of the other agencies.

Increases are proposed in environmental radiation studies with greater emphasis on the biological effects of radioactivity in the streams, lakes, and oceans, as well as on the effects of radiocontamination on soils and plants. The resumption of atmospheric testing of nuclear devices by the U.S.S.R. and the possible resumption by the United States underscores the necessity for an increase in research in the atmospheric radioactivity and fallout area, including studies on high-level air sampling by means of rockets.

Important research programs designed to define and interpret the low-level, long-term chronic effects of radiation will be approaching full operational levels during fiscal year 1963. These involve large-scale studies utilizing facilities now under construction at several Atomic Energy Commission laboratories.

The importance of understanding the basic phenomena associated with molecular and cellular changes on interaction with radiation is becoming increasingly apparent. Consequently, this area of the biomedical research program needs further strengthening and expansion.

The Commission's responsibilities in exploiting nuclear energy for beneficial applications will in some measure be met through a continuation of its research in the fields of cancer, medicine, and agriculture.

It is proposed to initiate design studies for a comprehensive biomedical complex at the Lawrence Radiation Laboratory, Berkeley, centered around a high-energy proton accelerator designed for medical and biological studies. It is anticipated that these design studies will define the capabilities which such a facility should provide for the extensive radiobiology and clinical research programs which can subsequently be undertaken at this laboratory.

The details of the biomedical research program appear in the narrative justification which follows.

Summary of estimates by category

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Somatic effects of radiation	$13,217,949	$15,099,000	$18,034,000
2. Radiation genetics	3,805,231	4,186,000	5,022,000
3. Combating detrimental effects of radiation	2,005,030	2,231,000	2,629,000
4. Molecular and cellular level studies	9,001,809	10,297,000	11,739,000
5. Environmental radiation studies	8,076,288	11,016,000	15,109,000
6. Radiological and health physics and instrumentation	4,000,127	4,471,000	5,035,000
7. Chemical toxicity	510,478	663,000	787,000
8. Nuclear energy civil effects	1,362,250	2,031,000	1,365,000
9. Cancer research	4,721,781	5,056,000	5,391,000
10. Selected beneficial applications	3,465,259	3,283,000	3,076,000
11. Radiation pasteurization of foods	82,158	216,000	200,000
12. Capital equipment	2,655,922	2,528,000	2,966,000
Total	52,904,282	61,077,000	71,353,000

JUSTIFICATION OF CATEGORIES

1. Somatic effects of radiation, fiscal year 1963, $18,034,000

a. Radiation effects, general:

Fiscal year 1961	$8,341,317
Fiscal year 1962	9,183,000
Fiscal year 1963	10,644,000

The research in this category is intended to supply information for predicting the effects on man of specific amounts and different kinds of radiations delivered at various rates. The investigations employ a wide variety of organisms, but the object of interest is man. The following areas will receive special attention in the expanding program: (1) acute and delayed effects of whole body irradiation; (2) biological effects of heavy particles and energetic radiations; and (3) response of the nervous system to radiation.

Determination of acute effects of irradiation on man and animals continues to be a major program. Knowledge of the response of the total organism, as well as the functioning of the separate organ system to radiation of various energies, types, intensities, and total amounts is a prerequisite to studies of procedures for counteracting the effects of irradiation on minimizing the biologic response to a given exposure. Use has been made of the data from accidental exposures of man, and maximum use has also been made from data of patients treated with whole body irradiation which have given promise of providing information. When this technique of using these data has been further refined it will be possible to make a more realistic comparison between the responses of man and those of experimental animals.

The chronic effects of irradiation on man and animals are much less well understood than acute effects since subjects must be observed throughout their entire

life span. Because many of the chronic effects may be similar to those seen in normal aging, it is often difficult to differentiate the exposed group from the unexposed population. The results thus far suggest that the animal exposed to radiation "ages" more rapidly than the normal. Such studies are distressingly slow and expensive, yet the nature of the reaction demands a balanced program which will identify specific responses to chronic tissue effects as well as define the statistical reduction of life span of large populations relative to dose. The size of radiation dose, its frequency of repetition and duration, and the dose rate all influence the chronic response. Simple shortening of life span is a potential basis for compensation, hazard pay, and other claims, which could effect the peaceful applications of nuclear energy. Long-term studies on exposed large animals (dogs, bovines) and epidemiological studies on man, including primarily the Japanese on the roster of the Atomic Bomb Casualty Commission, are typical examples of this type of research.

Most of our knowledge concerning the biological effects of radiation has been developed from research on small laboratory animals. Experience gained from these studies will continue to be applied to defining the pathological and physiological effects of radiation in larger domestic animals. Experimental data derived from larger animals can frequently be extrapolated more directly to man because of closer similarities in body sizes and organ systems.

During fiscal year 1962, a large-scale program has been initiated at Oak Ridge National Laboratory that will require support for at least 5 to 10 years. This program will attempt to define the biological effects of very low dose exposure to external radiations. A companion program at Argonne National Laboratory with internally deposited radionuclides such as strontium 90 and cesium 137 has been budgeted under toxicity of radioelements. Economic and statistical considerations require that small laboratory animals be used for these studies. Each may involve 100,000 or more animals. The two programs will be complementary and are expected to develop the theoretical data required for more precise extrapolation of radiation effects from high doses to low doses and from animals to man. In a sense, they are designed to evaluate the potential hazards associated with fallout radiation. During fiscal year 1962, the necessary animal holding facilities will be completed and the initial staff personnel will be selected. Specific biological responses that require quantitating are hematopoietic and gastrointestinal injury, carcinogenesis, cataractogenesis, effects on endocrine and immune systems, effects on fertility, life shortening and decrement in physiological performance.

The question of the biologic effects of heavy primary particles and high energy radiations has taken on added importance because of the accelerated pace of the man in space program. The radiations from the Van Allen belts, the heavy particles of galactic origin and the protons of solar origin, together with their reaction products, constitute radiations not normally encountered in any important quantities in man's environment and whose biological effects must be thoroughly evaluated. The laboratory research in this area is cooperative with the National Aeronautics and Space Administration and uses high energy machines including the HILAC, Cosmotron, and Bevatron of the AEC. This research will constitute a major field of effort yielding data of both practical and theoretical significance.

The physiological, pathological, and psychological reactions of the nervous systems to radiations have received considerable attention recently and will be the subject of still more intensive investigation during the next few years. It is particularly important to establish whether the Soviet claims of effects on the nervous system at less than one roentgen are correct and if theere is a threshold for effects. Adult nervous system tissues, which are mostly nonproliferative cells, manifest various types of bioelectric phenomena, thus differing from most other body cells. The nervous system, therefore, affords special opportunities for investigating the action of ionizing radiations in biologic systems; however, special techniques are required. The integrity of acquired information has much the same significance as the integrity of genetic information. The acquisition and use of acquired information involves the sense organs, nerves, spinal cord, and brain. The function of all such organs as affected by ionizing radiation is being studied by analyzing impulse conduction, learning rate, memory, discrimination and behavior. This research provides data not only about radiation as a hazard but also about the information processing organs in the body.

b. Toxicity of radioelements:

Fiscal year 1961	$4,876,632
Fiscal year 1962	5,916,000
Fiscal year 1963	7,390,000

The purpose of this research is to determine the biological behavior and toxicity of radioactive nuclides generated in atomic energy operations, especially uranium, transuranic nuclides, and those nuclides produced as fission products. Such studies are designed to provide more precise information for establishing permissible limits for these nuclides. The evidence supporting the induction of cancer by ingested or inhaled radioactivity in experimental animals is convincing, and there is evidence that this occurs in man. It is, therefore, urgent that we continue to study the effects of the internally deposited radioactive materials and that stringent environmental control measures be continued pending the completion of adequate studies.

Recent recommendations of the international and national committees on radiation protection have led to a 30-percent reduction in the permissible limit of uranium ore in mill air. Accordingly, a study of uranium ore aerosols has been initiated during fiscal year 1962 at the Hanford Laboratories and will be further expanded during fiscal year 1963. Employees of certain operating contractors who have been exposed to uranium dust during several years of employment are also being studied.

Research at other AEC installations or off site contracts during fiscal year 1963 include studies of approximately 1,500 people who have ingested varying amounts of radium or mesothorium in the course of employment or from medical treatment. Such studies are used to help extrapolate animal studies to man.

Studies on the possible biological effects of both acute and chronic exposure by inhalation to fission products administered both singly and in combination which were started during fiscal year 1962 will continue at an expanded rate, consistent with a planned buildup in personnel and facilities.

Existing studies of the metabolism and biological effects of ingested fission products, is being supplemented by another large program on chronic exposure to low levels of radiation from single and mixed radioactive isotopes beginning in fiscal year 1962 at Argonne National Laboratory. This study, which will be expanded during fiscal year 1963, is directed toward determining the damage from internal radiation from deposited radionuclides and is a companion study to that being initiated at Oak Ridge National Laboratory described in the section on Radiation Effects, General.

Additional emphasis will be directed toward studies of the acute and chronic biological effects that result from assimilation of fission products in animal and plant systems. These studies will be directed toward understanding the distribution and dynamics of movement of various radionuclides in both plant and animal systems which may be involved in the food chain. Since the larger farm animals are important factors in the food chain for man, studies with these animal species will be expanded. Specific attention to studies of the control and removal of Sr–90 and Cs–137 in milk and other foods will be continued.

2. Radiation genetics, fiscal year 1963, $5,022,000

The genetic materials are critical cellular components which are quite susceptible to ionizing radiation, and in which only a slight, often undetectable, change can be harmful or lethal. Major emphasis will continue on obtaining the data necessary for estimating the radiation genetic hazard to man. An expansion is planned for tracing and accumulation, manifestation and ultimate elimination of radiation induced mutations in populations using suitable laboratory species of plants, animals, and micro-organisms. Whenever feasible, human populations will be surveyed. New work is planned in population dynamics to aid in the interpretation of present human population data and to explore all alternative expectations for the expression of genetic damage in populations subject to an increased mutation rate. In particular, the effects of selection pressures on human populations in determining the incidence of detrimental mutations in man will be studied. Continued support and expansion of studies of children of consanguineous marriage is vital for estimations of the mutation load normally present in man. The increased use of high speed computers will permit full exploitation of extensive data obtained in both Japan and Hawaii where much effort has been expended on the careful collection of data on cousin marriages (Japan) and on interracial marriages (Hawaii).

Many mutations have a subtle detrimental effect; for example, they may reduce growth rate, increase disease susceptibility, reduce reproductive performance, or reduce the life expectancy. Existing programs, such as the Oak Ridge National Laboratory mouse genetics and the Iowa State University swine genetics programs, require continued support in order to contribute to our understanding of these less tangible forms of genetic injury.

Studies on the chemical nature of genetic material and on the structure and functioning of chromosomes and the manner in which radiation acts to change them, need expansion in order to reevaluate the dose-response relationships for mutation induction by radiations of widely different ionization densities and rates of delivery. These studies could lead to the means of preventing or ameliorating genetic injury.

It is well known that the ingestion of some radioactive materials causes biological damage. However, with elements such as phosphorus 32 and carbon 14 which are incorporated into the genetic materials it is not yet possible to evaluate the relative damage caused by radiation from the decaying nucleus as compared to the possible effects due to transmutation of the element. Studies in this area must be strengthened.

In the event of a nuclear accident or a nuclear war the amounts of radioactivity introduced into the food chain could increase tremendously. It is essential, therefore, to determine how the quantity of isotopes ingested by man can be decreased. One obvious way to try to reduce the quantity of radioactivity in the diet is to lower the quantity absorbed by plants, both from the soil and through their aerial portions. Preliminary research indicates that the uptake and transport of some nuclides is under genetic control, i.e., some plants have the genetic constitution favoring the exclusion of some elements. It is imperative that a vigorous program begin immediately to find and/or develop varities of food plants which will exclude particular nuclides or to develop by genetic means new varieties having this capacity.

It should also be possible to breed plants that will accumulate excessive quantities of radionuclides. Such accumulator plants could be particularly useful in the decontamination and rehabilitation of soils and, accordingly, lessen the risk to man when the areas are subsequently cropped with plants for human consumption. Modest expansion of research in these areas is anticipated.

3. Combating detrimental effects of radiation, fiscal year 1963, $2,629,000

Prophylaxis.—Progress on new prophylactic agents equivalent to or superior to beta mercapto ethanolamine has been slow and somewhat disappointing. Large screening programs designed to provide new drugs with protective action are quite empirical and expensive. Therefore, it is essential that studies which relate chemical structure to biological activity of the known drugs as well as chemical structure to toxicity, be continued and encouraged. When additional information is available regarding the active site for protection and the nature of the structure responsible for toxicity, it may be possible to prepare better protective agents. Efforts should be continued along these lines. Naturally occurring substances such as those found in the fetal spleen and liver appear to decrease radiosensitivity in some biological materials and deserve further study.

Therapy for radiation syndrome.—Improvement for postirradiation therapy demands continued study. Prophylactic measures, even in the event that a very effective agent were available, can be anticipated to be of only limited value to the general problem of radiation exposure. Radiation exposure from accidents or from other unforeseen sources cannot be anticipated and it is essential that all approaches to therapy be explored and evaluated.

(*a*) Studies will be continued in the use of compounds or methods which will either directly reverse alterations produced by radiation or else enhance the normal recovery mechanisms of the tissue involved. Wide variations in the sensitivity of organisms to radiation have been demonstrated.

Accordingly, studies of fundamental biochemical and biophysical mechanisms underlying this tolerance to radiation by some organisms will be continued and expanded in an effort to discover substances or cellular mechanisms which offer protection against radiation or enhance recovery from radiation damage. Advances in this approach to the problem should provide information leading to improved supportive therapy and eventually for definitive therapy.

This field of study can be strengthened by better methods for assessing radiation damage, and tissue culture techniques will be used at ORNL to learn more

about damage to cells. The use of white blood cells in evaluating immediate and residual radiation injury in man and animals will be further studied.

(*b*) Another therapeutic approach depends upon the replacement of damaged components by the implantation of material from unirradiated animals. Primarily, this work has concerned the blood-forming elements which are destroyed by radiation. In very special cases, replacement by transplantation of bone marrow has appeared promising. The practicality of bone marrow transplantation as a means of repopulating the empty marrow spaces of irradiated mice has been demonstrated by many laboratories, both in the United States and abroad. However, the projection of this technique to larger animals, dogs and monkeys, has been less than favorable, and in the present state of knowledge its application to man is not established. Nevertheless, bone marrow transplantation is a promising lead. In order to permit more extensive use of this technique, additional study is demanded in the area of research dealing with the immunological responses encountered during bone marrow transplantation and also in the general field of radiation induced changes in immunity to substances of biological importance.

In general, exposure to large doses of radiation suppresses the immune reactions against foreign tissues so that it is possible to implant foreign cells, which continue to live and multiply in the body of the recipient.

(*c*) One of the serious hazards of nuclear energy operations arises from the production of radionuclides which may be ingested or inhaled by man. This hazard may be decreased by preventing the absorption by promoting mobilization and removal of the nuclide from the body. Studies will continue on factors which affect the absorption of nuclides, especially strontium and cesium. It is anticipated that research on methods of removal of isotopes will be increased as more is learned about chelation and mobilization of various elements in the body.

4. Molecular and cellular level studies, fiscal year 1963, $11,739,000

A precise understanding of how radiation produces changes in living organisms depends almost wholly upon thorough knowledge of the complex series of events which occur between the primary physical absorption of the radiation energy and the appearance much later of a readily observable biological change. From studies to date it is known that this in-between period involves a series of reactions, both biophysical and bio-chemical.

There is an initial physical absorption of radiation by matter which occurs very rapidly and determines both the types of molecular changes which occur and the initial geometrical distribution of the damage. Once the radiant energy is absorbed by matter it is transformed and redistributed throughout the molecule. The final biophysical event probably occurs with the appearance of specific changes in biologically significant molecules. Studies in this important area are intensely difficult, and will continue to expand during fiscal year 1963.

Attempts to evaluate the changes in cell structure and metabolism which result from the purely biophysical events cited above were among the first Commission programs to be initiated in the Division of Biology and Medicine. Although much more is known now than previously about the general biochemical changes caused by radiation, relatively little is known yet about the initial radiation produced biochemical lesions which are later amplified into marked, readily observable biological effects. This disparity of knowledge is due, in part, to the difficulty of detecting the subtle initial changes induced by radiation, as well as to the incompleteness of our understanding of the normal biochemical functions of the cell. To overcome these difficulties, continuing and expanding programs are being developed on the effects of radiation on model systems of pure biochemicals and macromolecules which might be masked in more complex systems, and the effects of these on the more complex systems themselves.

Many of these effects studies are possible only by using costly instruments such as the electron microscope. Additional information concerning the radiation labile site within the cell is being gained by expanding studies on the use of histochemical and cytochemical techniques.

Many studies reveal that an early effect of radiation is modification of the cell membrane so that important biological molecules are lost from the cell. Little is yet known of the structure or properties of the cell membrane, or how radiation affects these parameters. Studies of this and the companion problems of invasion of irradiated organisms by infectious agents are being expanded as are studies on the metabolism of various sulfur compounds in the hope that better means of

radiation protection may be found. It is likely that significant results in this area will depend upon a better understanding of the role of various hormones, vitamins, coenzymes and metals in maintaining the integrity of the cell.

It must be emphasized that many of the questions that are being asked concerning the biological effects of irradiation cannot be answered until biochemical systems are better defined by basic research on normally metabolizing systems. The major expansion with both irradiation and nonirradiated systems is in that area of biochemistry dealing with the structure, biosynthesis and metabolism of macromolecular and particulate constituents of the cell.

While it seems likely that at least some of the somatic damage from radiation arises from injury of the cell particulates such as ribosomes, microsomes, mitochondria, and plastids which are responsible for carrying out the energy yielding and biosynthetic reactions of the cell, much more study is needed to establish the precise manner in which this injury is consummated. Of more long-range impact perhaps is the radiation injury to the chromosomes and the genetic materials of the cell. Our present knowledge indicates that a cell is particularly sensitive to radiation during certain phases of active growth when the nucleic acids are being rapidly formed in the chromosome and proteins are being synthesized. Considerable expansion is anticipated in these areas to establish clearly when and how changes are wrought in the genetic materials and how these changes are in turn transmitted to the cell to affect its metabolism.

5. Environmental radiation studies, fiscal year 1963, $15,109,000

(*a*) Terrestrial and fresh water ecology:

Fiscal year 1961	$2,696,447
Fiscal year 1962	3,329,000
Fiscal year 1963	4,006,000

Ecological studies will be conducted on communities and species in natural and man-influenced environments. Emphasis will be placed on the study of factors which influence population changes in order to determine whether changes in biological organization and development may reflect the effects of radiation in the environment. One essential phase of this expansion is the establishment of gamma sources in areas of natural vegetation in order to study radiation effects on individuals and communities, with primary emphasis on longtime effects of low-level radiation. Base ecological studies are to be made prior to irradiation. An expansion of research in mineral cycling and radiation effects is anticipated.

The reactions of radioisotopes with soils and soil constituents which affect their redistribution and their availability to plants will continue to be investigated. Field plot experiments will be utilized to establish the long-term cycling relationships of long-lived fission products and the effects of soil management factors on their uptake by plants. Methods of reduction of uptake such as addition of complexing compounds and physical land decontamination will continue to be studied. An expanded study of the mechanisms of absorption and losses of ions by plants will help explain and control the contamination of plants by radioisotopes. The complex microbiological processes in soil are important to its effective functioning as a balanced medium for plant growth, and investigation of the effects of ionizing radiation on important types of soil microorganisms therefore will be expanded.

Research projects in fresh water ecology are designed to study the potential hazard to man of radioisotopes which may be released in small or large quantities to the fresh water environment and which may enter biological food cycles. Emphasis will be placed on three major aspects of fresh water ecology; (1) determining rates of biological uptake and concentration of radioactive isotopes by fresh water organisms; (2) developing an ecological explanation of the mode of distribution of radioisotopes in fresh water; and (3) studying possible radiation effects on aquatic populations and individual species. Primary effort will be devoted to expanding studies of radiation effects in aquatic systems.

(*b*) Marine sciences:

Fiscal year 1961	$1,206,042
Fiscal year 1962	3,000,000
Fiscal year 1963	4,700,000

Marine sciences research will be further emphasized in anticipation of increased AEC operation in the oceans. The most significant expansion will be

to gather data to assist in the evaluation of effects of added radioactivity from the testing of nuclear vehicles in the ocean. Studies will continue in oceanic mixing and sedimentation processes. Diffusion studies utilizing dyes will be extended to include deep-sea tests of the diffusion of radioactivity. Nuclear reactor operating areas such as the Atlantic and Pacific Missile Ranges, the Columbia River and its estuary, and Pacific Gas & Electric Co.'s coastal reactor areas will be studied jointly with the Defense Department, Bureau of Commercial Fisheries, and industry, from the standpoint of potential hazards of such operations. Emphasis will be placed on projects that assess the long-term distribution of radioactivity in the marine environment. Studies will continue on the biological uptake, concentration and effects of radioactivity on organisms of actual and potential value to man.

(*c*) Atmospheric radioactivity and fallout:

Fiscal year 1961	$4,173,799
Fiscal year 1962	4,687,000
Fiscal year 1963	6,403,000

The research program in atmospheric radioactivity and fallout supports the reactor development, military application, operational safety and other programs of AEC by providing—

(1) A scientific basis for predicting the behavior and fate of contaminants released into the atmosphere;

(2) Working techniques for predicting the radiation dose from a given release;

(3) Sampling and analysis techniques and survey procedures for ascertaining the actual distribution and movement of contaminants.

Unclassified

The resumption of weapons testing by the U.S.S.R. in late 1961 has made it possible to obtain experimental data on the time and space distribution of fallout from injections of debris into regions of the upper atmosphere with which there has been no previous experience. It also provides a unique opportunity to check deductions and predictions based on the analysis of fallout following their 1958 tests. Any future U.S. atmospheric tests should also be exploited to obtain more complete experimental data on the nature and distribution of fallout by using more advanced sampling and analysis techniques than were available during previous tests, and to check and extend available information on the behavior of debris from detonations in new environments. The program will be aimed at improving the understanding of mechanisms and not at documenting fallout levels for health and safety purposes. It is being planned in close cooperation with other agencies including the Office of Civil Defense, Defense Atomic Support Agency, Air Force, Navy, Public Health Service, and Weather Bureau. A number of fission products as well as several distinctive induced activities will be used to identify various sources of debris. A large part of the program expansion will be for the collection of samples by balloons and rockets in order to determine distribution and composition of high-altitude debris with the first year, before obscure transport processes, mixing with large quantities of other debris, dilution, and decay degrade the value of the studies.

Research on global atmospheric processes will continue to involve the AEC Health and Safety Laboratory, several cooperating Federal agencies and private contractors in extensive, closely coordinated sampilng and analysis programs. Long-range redistribution of contaminants from past tests in soils, food, and man will continue to be studied. Micrometeorological research related to the fate of stack discharges will be continued principally at AEC sites, with slight increases to permit field studies employing more sensitive and more precise tracer techniques.

A new program has been established for the study and evaluation of the environmental and biological consequences of nuclear warfare. Research and evaluation of data will be conducted on such subjects as nuclear weapons characteristics, nuclear weapon effects, attack pattern as related to blast damage, heat damage, and radiation damage.

6. Radiological and health physics and instrumentation, fiscal year 1963, $5,035,000

(a) Radiological and health physics:

Fiscal year 1961	$2,472,965
Fiscal year 1962	2,460,000
Fiscal year 1963	2,800,000

Studies in radiological physics are directed toward understanding and quantitatively describing the fundamental physical processes by which ionizing radiation interacts with matter. Ultimately such studies should provide a key to the chain of events which take place between the deposition of energy in a system by radiation and the production of observable biological effects. In addition to having this long-term goal, research in radiological physics has led to the recognition of practical principles and techniques for radiation dosimetry, the development of concepts for the formulation of radiation protection standards, and to techniques and data used in operating health physics programs. Research in radiological physics covers a wide range of specific investigations in various stages of advancement, reflecting the Commission's health protection needs and research responsibilities.

The following areas of investigation will require increased effort in fiscal year 1963:

(1) *Neutron dosimetry.*—The purpose of neutron dosimetry research is the eventual development of systems for measuring the physical characteristics of neutron beams (e.g., flux and energy spectrum) in terms meaningful for biological experiments and for personnel radiation protection standards for neutrons. With the increasing operation of high-energy particle accelerators and the increased handling of transuranium elements, potential exposure of personnel to neutrons in Commission activities is increasing. In order to assure that personnel are not exposed to larger than maximum permissible amounts of neutrons, routine operations are limited by the extent to which the assessment of neutron dose is uncertain. Present uncertainties in neutron dosimetry are reflected as operating problems in many installations.

(2) *Theoretical and experimental radiological physics.*—Advances in recent years in the development of experimental techniques and in the theoretical interpretation of data from studies at the atomic and molecular level show very promising potential for increasing basic understanding of the interaction of radiation with matter. It is desirable to increase effort in these studies to explore these potentialities, which appear capable of providing information which can elucidate the physical processes of biological significance.

(3) *Fast burst reactor.*—Dosimetric studies will be initiated at Oak Ridge National Laboratory utilizing the fast burst reactor, following its field use in Nevada.

In addition to increased effort in the above programs, the following programs will be pursued with no major expansion in level of effort in fiscal year 1963 over fiscal year 1962: chemical dosimetry, theoretical dose calculation studies, analytical procedures, the internal dose program, mixed radiation (alpha, beta, gamma, and neutron) dosimetry, electron stopping power studies, and studies related to radiation protection standards.

It is also planned to augment the radiological physics program by encouraging the interest of competent investigators in universities. It is anticipated that recent, new offsite contracts in the areas of beta-ray energy dissipation, energy losses by slow moving heavy ions in gases, and thermoluminescence dosimetry will warrant continued support.

(b) Radiation instruments:

Fiscal year 1961	$1,527,162
Fiscal year 1962	2,011,000
Fiscal year 1963	2,235,000

Radiological protection of personnel and biomedical research present continuing demands for nuclear radiation measuring equipment. Each new or expanding program within AEC plants and laboratories tends to give rise to unique or varying problems in radiation hazards, the meaningful control of which requires instruments designed for the particular application. Similarly, the biomedical research program is pushing into new areas of research and demanding more precise measurement systems beyond the capabilities of existing equipment. In order that these latter demands may be met, as the problems arise,

the instrumentation program must anticipate them by initiating research and development of improved new detectors and data presentation systems capable of greater sensitivity, precision, and accuracy. The instrumentation program will receive increased emphasis in the following areas in fiscal year 1963:

(1) *Health physics instrumentation.*—Plant operations with material generating spontaneous neutrons mixed with gammas have created a serious problem in health physics requiring the development of entirely new detectors for measuring the fast neutron component from these exposures. This requirement applies equally to radiation control problems around high-energy accelerators.

(2) *Low-level radiation measurements.*—In assessing the effects of long-term, low-level chronic radiation occurring naturally or from fallout, including effects from both external sources and internal emitters, the development of highly sensitive radiation detection systems, for measuring not only the types of radiations, but also the energy distribution are essential.

(3) *Fluoroscopy.*—Recent developments have demonstrated the feasibility of imaging nuclear radiations. The development of image amplifiers will permit the visualization of individual radiations which in principle will make possible an increase in the sensitivity over present techniques by several orders of magnitude.

(4) *Absolute absorbed energy measurements.*—The definition of the rad, in terms of energy absorbed per gram of the irradiated material, required the development of calorimetric equipment which measures the temperature rise of the detecting element and, hence, the absorbed energy for use as primary standards. These calorimeters must be correlated with air ionization instruments to provide more practical and versatile methods for routine measurements.

(5) *Clinical instrumentation.*—Development efforts will continue at about the same level for clinical or diagnostic instruments for utilizing tracer techniques in the measurement and localization of selective uptake of radioactive materials in patients.

(6) *Solid state detectors.*—In recent years radiation physics has demonstrated that the effects of radiation on some solid state systems are both marked and quantitative. This is particularly so in the semiconductors such as silicon, germanium and cadmium sulfide, in which the electrical properties of the material are affected by radiation, and in the thermo-luminescent materials (lithium fluoride, calcium fluoride) in which the luminescent properties of the materials when heated are a measure of the radiation exposure. Greater emphasis will be placed on the refinement of these known solid state detectors and search for new ones will be initated.

7. Chemical toxicity, fiscal year 1963, $787,000

Many of the chemicals associated with atomic energy operations have both an associated chemical and radioactive toxicity, and in some cases the former is of more concern than the latter.

Accordingly, toxicity data must be gathered and evaluated to enable permissible levels to be set to protect individuals from harmful effects.

Some of the studies are as follows:

(1) A continuing study of the inhalation toxicity of the rare earth elements, cerium, lanthanum, praesodynium, and scandium.

(2) Long-term followup studies of chronic beryllium and mercury exposure cases.

(3) An extensive program to assess the hazards of neptunium ingestion and inhalation.

(4) A continued effort to develop and test chemical compounds such as ethylenediaminepentaacetic acid (EDPA) and diethylenetriaminepentaacetic acid (DTPA) for therapeutic applications in the removal of body burdens of toxic elements.

8. Nuclear civil effects, fiscal year 1963, $1,365,000

The AEC role in civil effects studies arises from its responsibility for information required for its own self-protection planning and from its standing commitment to use its skills, capabilities, and facilities to seek essential technical information related to the effects of nuclear reactions for general nonmilitary defense purposes. Nuclear detonations, laboratory work, and field experiments using nuclear effects simulants are employed.

Through the media of surveys, technical experiments in the field and laboratory work, the nuclear energy civil effects program seeks to fill out the framework of nuclear effects data with respect to both the basic scientific facts and practical applications of effects information to protective schemes.

In fiscal year 1963 the program will include studies aimed at estimating human exposures to nuclear effects; aerial radiological measurements and surveys; the Nevada Test Site effects and environmental program; and the AEC community civil effects studies.

Studies will include laboratory and field investigations of the prompt neutron and gamma radiation fields and the attenuation of these radiations by shielding materials. The results will be correlated with medical and shielding data developed by the ABCC in Japan through study of the cases of the scientifically important group of survivors who were subjected to the effects of nuclear radiation, thermal radiation, and blast by the wartime detonations. An analysis and evaluation of thermal biology and blast biology injuries received by individuals in this group will be made and correlated with the more advanced work being accomplished with respect to nuclear radiations.

In the field, aerial radiological measurements and surveys will continue the active program to make reliable measurements of radiation levels over land areas and around facilities of interest to the Atomic Energy Commission. Under the program there will be maintained a readiness capability for rapid aerial radiological survey of any areas where significant radiation may be released. Included are the development of methods to improve the manner in which measurements and surveys are made and reported.

The Nevada Test Site effects and environmental program includes studies of ionizing and thermal radiation shielding from various sources, deposition and measurement of radiation from simulated fallout particles, response of radiometric instruments and infinite plane contribution to radiation dose and shielding geometrics; biomedical studies of environmental conditions in closed structures; use of weapons effects simulants to obtain information for practical applications in casualty reduction measures; investigations on which to base plans for the reduction of thermal, blast, and radiation to acceptable levels for humans. The program also includes cooperation with and field support of ecological research in Nevada, including accumulated physical effects calculations around ground zero.

Input data will be developed for the AEC community civil effects studies at Oak Ridge. Supporting studies in the laboratory and field will be conducted to develop information which will improve the capability of personnel to deal successfully with nuclear hazards under emergency conditions.

9. Cancer research, fiscal year 1963, $5,391,000

The cancer research program is concerned primarily with the development of new therapeutic approaches utilizing radiation either from external or from internally implanted sources, and improvement in our ability to detect neoplasms and to locate them precisely. Attention has also been given to metabolic aberrations occurring in neoplastic disease and to the problem of radiation and chemical carcinogenesis.

Utilization of the immunological approach to the cancer problem has been slowed by unexpected complications but advances have been made, especially in methods improving diagnosis and specifically locating neoplasms. Work will be continued in this area. The possibility of utilizing immunological techniques to enhance some combined therapeutic methods justifies further study of this approach.

Off-site programs in cancer research leading toward better diagnostic and therapeutic methods will be encouraged as well as research on carcinogenesis, especially where radiation is involved. The role of radiation as a factor in inducing neoplastic change or predisposing tissue to such change remains poorly understood.

The onsite cancer program encompasses work in many phases of cancer research. At the Argonne Cancer Research Hospital, research on cancer therapy will continue and be expanded with greater use of the linear electron accelerator. Other high-energy sources such as the Van de Graaff and the cobalt source will also be used in therapy. Additional emphasis will be given to studies on the use of sensitizers to increase the effects of irradiation upon cancer cells. Argonne Cancer Research Hospital also has active programs in such areas as the use of C^{14} tracer methods to study metabolic changes, improvement of diagnostic procedures by selection of more appropriate isotopes, the effects of continuous, daily, low-intensity radiation on the skin and the implanting of sources of radiation in the treatment of certain malignancies or for the management of pain.

Patient treatment will be continued at the University of California Medical School using the high-energy X-ray beam from a 70-million electron volt

synchrotron. In this continuing study, the methodology of this mode of therapy is being developed and the beneficial effects of high-energy X-rays are being evaluated in the treatment of selected types of tumors. By the end of fiscal year 1963 it will be possible to evaluate the 5-year survival of the first 40 patients treated.

The Oak Ridge Institute of Nuclear Studies will continue to evaluate the therapeutic efficacy of cesium and cobalt sources. Work will continue on the program of whole-body irradiation of patients with leukemia and the subsequent administration of bone marrow. In addition to an increase in the therapeutic program, studies on long-lived radioisotope retention will increase and work on diagnostic methods will be continued. Changes in lipid and amino acid metabolism which may be associated with therapeutic procedures or accidental exposure to radiation are being studied.

At the Brookhaven National Laboratory, the medical reactor offers a unique opportunity to study the beneficial effects of radiation in the treatment of certain malignancies. Some increase is anticipated in this research on neutron capture therapy. Studies of amino acid metabolism in neoplastic disease will be expanded.

Another rather unique application of high-energy sources is being pursued at the Lawrence Radiation Laboratory. The proton beam of the 184-inch cyclotron is being used to irradiate the pituitary gland of patients suffering from advanced breast cancer and other hormone dependent cancer. In addition to these studies, this group will increase its use of heavy particles at high-energy ranges in exploratory investigations in the use of heavy particle radiation in treating deep-seated tumors.

10. Selected beneficial applications, fiscal year 1963, $3,076,000

Some of the most significant research projects of the entire program are under this heading. They are carefully selected for their actual or potential contribution to knowledge, and for providing systems or devices which will improve the lot of mankind; it is from this group of projects that the exhibits and papers for the next Atoms for Peace Conference will be drawn. For example, studies on the toxicology of nickel have resulted in an effective method for treating the pulmonary damage resulting from inhaling aerosols of nickel and related metals.

The scope of projects ranges broadly and the projects tend to be one of a kind. These projects regularly develop byproduct data of definite value to furthering research projects in the preceding categories. Similarly, some of the above categories, e.g., "Cancer" could be classed with "Beneficial applications," and certain projects in each category result in and contribute in one or another way to "Beneficial applications." These projects include using isotope labels to find new and better methods of using fertilizers and there are studies on the uses of isotopes for the diagnosis and treatment of diseases; there is also a practical use for radiation in eradicating insect pests. In some instances, the aim is to improve existing methods or to devise substitute systems by capitalizing on a special property of a radioisotype or a particular kind of radiation; in other cases, the isotope provides a unique approach to understanding a complex biomedical problem. All such projects are assisted to the fullest extent possible. Whenever a procedure or system becomes generally accepted and in effect, "routine" support is terminated or transferred to other agencies.

The use of I^{131} as a diagnostic agent for diseases of the thyroid gland is one such generally accepted use no longer supported by the AEC. On the other hand, the value of other radioisotopes of iodine in diagnosis is being actively explored. Study of the movement of the iodine ion and materials labeled with I^{131} throughout the body in health and disease, however, continues to yield important biomedical data in addition to helping develop better radiation protection guides for man. A byproduct of one such project was proof that the I^{131} content of the thyroid gland of grazing animals is probably the most sensitive detector of I^{131} released from weapons and chemical-processing plants.

Similarly, radioactive isotopes of carbon, hydrogen, iron, manganese, magnesium, cobalt, copper, zinc, arsenic, argon, gold, promethium, cesium, cerium, sodium, potassium, phosphorous, sulfur, chlorine, and others are being employed in a variety of biomedical experiments on animals and plants in an effort to gain insight into normal and abnormal physiologic and biochemical processes and so arrive at data which can be crystallized into a practical beneficial use.

As radioisotope tracer experiments become more complex and sophisticated it is necessary to develop high-speed analysis, storage, recorder, and computer

systems in order to develop the desired quantitative relationships. Adaptation of such equipment from other sciences and the application of information theory to experimental and clinical procedures using radioisotopes for complex rate and volume experiments on diffusion, transport, compartment, and turnover processes in animals and man is encouraged.

The use of neutrons for study of movement of water through soils is proving to be the means of attracting soils and agricultural chemists to the uses of radiations. One experiment which demonstrated that it is possible to sterilize soil without altering its material structures, as occurs when a soil is autoclaved or baked, has opened a new area of investigation. The role of soils as ion exchangers is developing rapidly; this owes its origin to experiments on the removal of SR^{90} and Cs^{137} from agricultural land. Similarly the utility of isotopes and radiations in measuring various life processes in trees promises to convert arborculture into a quantitative science, although progress may be slow due to the scarcity of suitably trained scientists.

11. Radiation pasteurization of foods, fiscal year 1963, $200,000

The Atomic Energy Commission is continuing a minimum program in radiation processing of foods. The Department of the Army research in radiation sterilization of foods is recognized, and close liaison with the Army on these studies will be continued to insure coordination of the respective programs. The Atomic Energy program is concerned only with substerilization levels of radiation (less than 1 million rads) and hence will not duplicate any work already accomplished by the Department of the Army. The program planned for fiscal year 1963 will provide funds for continuing those studies in food chemistry, microbiology, and wholesomeness which are being conducted during fiscal year 1962.

12. Capital equipment, fiscal year 1963, $2,966,000

As research in the life sciences increasingly involves physical measurements of biological phenomena, there is a need for acquiring new techniques and equipment for detecting varying levels and types of radiation, for biochemical and biophysical studies, for unique irradiation equipment and other applications. Additional funds are required to correspond to the overall increases in the biomedical research program.

In addition to the normal requirements for new and replacement equipment, the following major items will be provided in fiscal year 1963:

(*a*) Germ-free animal system for studies of infectious disease, immunochemistry, and other related fields at Argonne National Laboratory.

(*b*) Recording spectrophotometer for general use at the Brookhaven National Laboratory.

(*c*) Infrared spectrophotometer and 512 channel analyzer for molecular level studies at Hanford Laboratories.

(*d*) Electron microscope for aerosol and other studies at the Health and Safety Laboratory.

(*e*) Airborne radiation measurement and data printout system for the ARMS program.

(*f*) Protein analyzer and high-speed zone electrophoresis equipment for research in radiation genetics at Oak Ridge National Laboratory.

(*g*) Superspeed density gradient ultracentrifuge for cellular biology studies at Oak Ridge National Laboratory.

(*h*) Direct reading emission spectrograph for analysis in environmental radiation, biochemistry, and trace metal studies at the University of California at Los Angeles.

(*i*) Spectrophotometer for research in radiation biology at the Lawrence Radiation Laboratory.

(*j*) Additional equipment for research projects in university and other private laboratories.

The following tabulation indicates the amounts estimated for equipment compared to the other operating costs at each major installation:

[In thousands]

Installation	Other operating costs	Equipment costs
Argonne Cancer Research Hospital	$2,400	$120
Argonne National Laboratory	5,548	235
Atomic Bomb Casualty Commission	2,600	140
Brookhaven National Laboratory	5,903	350
California, University of, at Los Angeles	2,351	180
General Electric, Hanford	3,072	260
Health and Safety Laboratory	1,711	131
Lawrence Radiation Laboratory	3,475	175
Los Alamos Scientific Laboratory	1,265	50
Oak Ridge Institute of Nuclear Studies	1,336	100
Oak Ridge National Laboratory	7,688	583
Rochester, University of	2,171	129
Tennessee, University of	782	100
All other	28,085	413
Total	68,387	2,966

PLANT ACQUISITION AND CONSTRUCTION

Biology and Medicine Program—Construction Obligations

Program statement

Estimated obligation fiscal year 1963	$4,810,000
Estimated obligations fiscal year 1962	3,623,000
Actual obligations fiscal year 1961	4,784,411

Obligations for biology and medicine program for fiscal year 1963 are estimated at $4,810,000 for the projects listed below.

Project number	Title	Estimated cost	Funded through fiscal year 1962	Estimated obligations, fiscal year 1963
63-i-1	Biological Research Laboratory additions, Oak Ridge National Laboratory, Tennessee.	$930,000	0	$930,000
63-1	General plant projects	600,000	0	600,000
62-h-1	Laboratory for mixed fission product inhalation studies, Lovelace Foundation, Albuquerque, N. Mex.	2,000,000	$1,500,000	500,000
62-i-3	Controlled Environment Laboratory, Brookhaven National Laboratory, New York.	1,800,000	0	1,800,000
62-i-4	Animal Bioradiological Laboratory, Lawrence Radiation Laboratory, California.	980,000	0	980,000
	Total	6,310,000	1,500,000	4,810,000

Explanation of Projects Above

1. Project 63–i–1. Biological Research Laboratory additions, Oak Ridge National Laboratory, Tennessee, $930,000

This project consists of two new laboratory areas in presently unused portions of the Biology Research Building 9207. Laboratories for mammalian tissue culture and plant physiology will occupy a portion of the fifth floor, and pathology and physiology laboratories and offices will occupy a portion of the fourth floor.

Mammalian tissue culture techniques are becoming increasingly important in studies of radiosensitivity of mammalian and especially human cells and human leucocyte tissue cultures may be one of the most valuable tools in studies of the potential dangers of ambient space radiations. This work has heretofore been on a modest scale in poorly adapted facilities at ORNL. The facilities planned permit a necessary expansion of effort in laboratories designed specifically to provide the carefully controlled, contamination minimizing conditions required.

The plant physiology program requires laboratory space and some controlled growth equipment to permit a modest expansion of effort. Biochemical, cyto-

logical, and anatomical approaches to basic problems of growth and differentiation as influenced by radiation will be expedited by the new laboratories. Location on the same floor as the Mammalian Tissue Culture Laboratories is advantageous in that several interests and techniques, e.g., microtechnique, cytology, autoradiography, and tissue culture, are common to both groups.

The Pathology and Physiology Laboratories will complete the development of the fourth floor for studies of the long-term effects of external radiation in mice, an integral part of the multimouse program. The expanded facilities are required for the thousands of animals necessary to detect the possible consequences of low doses of radiation.

2. Project 63–1. General plant projects, $600,000

The purpose of this project is to provide for miscellaneous alterations, improvements, and minor additions to general plant and research installations of the biomedical research program necessary to improve efficiency of operation, correct actual or potential operating hazards, and facilitate advances in research. The estimate, based on past experience as to requirements, will cover the necessary improvements at Commission-operated laboratories in the life sciences, as well as minor construction or alterations required by biology and medicine Commission-supported research at universities and other research institutions.

3. Project 62–h–1. Laboratory for mixed fission product inhalation studies, Lovelace Foundation, Albuquerque, N. Mex., $500,000

This project was authorized (Public Law 87–315) at $2 million, and $1,500,000 was appropriated for fiscal year 1962 obligations to provide for the aerosol generating and inhalation laboratory, dog breeding facilities, and initial supporting facilities. Completion of title I design indicates that the balance of $500,000 will be required in fiscal year 1963 for a dog metabolism building, animal holding facilities, and associated utilities.

This project will provide an inhalation laboratory containing aerosol generators and inhalation chambers for animal exposures, a hot lab and isotope storage area, and facilities for animal holding and metabolic studies of small and large animals.

The purpose of this project is to evaluate the short, intermediate, and long-term biological hazards that may result from a release of fission products to the environment resulting from the use of nuclear reactors, both as sources of power for industrial, military and space exploration purposes and as sources for large neutron fluxes for experimental purposes. This hazard arises mainly from the deposition of inhaled or ingested fission products in humans.

4. Project 62–i–3. Controlled environment laboratory, Brookhaven National Laboratory, New York, $1,800,000

This project was authorized in the fiscal year 1962 authorization act (Public Law 87–315) in the amount of $1 million. However, no funds were appropriated for the project. Subsequent to the authorization of this project at an estimate of $1 million, discussions with the laboratory program director and staff concerning the research program in the plant sciences area were held, and it was determined that the minimum facilities required to conduct the programed research would require a total of $1,800,000. Consequently, an increase in the authorized amount from $1 million to $1,800,000 has been requested in the fiscal year 1963 authorization bill.

The proposed laboratory will be an addition comprising 32,500 square feet to the west end of the present biology laboratory at Brookhaven, and will provide a plant growth and irradiation area and a general research laboratory area. Included within the plant growth and irradiation area will be controlled environment growth rooms, some of which will be shielded for growing plants under chronic gamma irradiation utilizing a 500-curie cobalt 60 source. The laboratory will include research laboratories for work in cytology, genetics, plant physiology and plant biochemistry, as well as special rooms for autoradiography, chromatography, cold temperatures, tissue culture, and counting instruments.

Research in plant sciences requires precisely controlled conditions for growing experimental plants. Growth areas must be flexible to provide a range of environmental conditions and of controlled gamma radiation which can be reproduced precisely. These requirements are particularly crucial in radiobotanical research. For example, mutation rate varies greatly depending on the environmental conditions under which the plant is grown. Further, and change in the environment during growth will alter all the physiological reactions of

plants. Biochemical studies of various cellular fractions can be applied to the same plants repeatedly only under identical conditions. The associated laboratory areas are required for the biochemical and physiological studies planned.

Present facilities are completely inadequate for studies needed to define radiation effects on biological systems utilizing plants as the experimental material.

5. Project 62–i–4. Animal bioradiological laboratory, Lawrence Radiation Laboratory, Calif., $980,000

This project was authorized in the fiscal year 1962 authorization act (Public Law 87–315) in the amount of $700,000. However, no funds were appropriated for the project. The current estimate of cost is $980,000, the increase being based primarily on a comparison of actual bids received on a similar first increment animal bioradiological laboratory now under construction, reflecting more accurately local construction conditions and cost factors rather than any change in the size of facility. Consequently, an increase in the authorized amount from $700,000 to $980,000 has been requested in the fiscal year 1963 authorization bill.

The proposed laboratory will be a two-story addition, comprising 17,000 square feet to the animal bioradiological laboratory at Berkeley, Calif. Approximately 11,000 square feet will be used as animal rooms, animal isolation rooms, surgery rooms, cold rooms, X-ray room, and a cobalt room. About 6,000 square feet will be used as office and general laboratory space. Outside dog runs will be provided for animals under treatment.

The first increment of the animal bioradiological laboratory provided program requirements associated with research involving colonies of small animals only (rats and mice). The addition will permit research on the larger animals and provide the necessary associated laboratory space.

This additional space is required to further the on-going research effort in long-term effects of small doses of irradiation; lifespan studies under simulated space conditions; i.e., heavy ion bombardment; effects of low doses of radiation to larger animals, and related physiological studies. As increasing numbers of animals are being held under longer termed experiments, space becomes critical in assuring that these studies are concluded successfully, with statistically valid results.

INCREASE IN FISCAL YEAR 1963 OVER FISCAL YEAR 1962

Mr. CANNON. Your principal activity increase in this program involves your normal routine?

Dr. DUNHAM. No; the principal increase is in the environmental radiation studies which include fallout studies relating to predicting what happens when radioactive materials are released in the atmosphere at various altitudes, and in various parts of the earth, also studies in oceanography and marine biology relating to what happens if a nuclear-propelled rocket or something of that sort lands in the ocean. What is the hazard associated with these events from the standpoint of getting into the food chain?

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

PROGRAM ACCOMPLISHMENTS

What have you had in the way of major accomplishments in cancer research, Doctor?

Dr. DUNHAM. In the field of cancer research, which is for us a relatively small effort, we have not had any dramatic accomplishments. I mentioned in the past that we have been working with the University of Rochester trying to localize radioactive materials in cancers. Last year a number of experiments were done in dogs that had cancers and many of these cancers were destroyed.

A few months ago a patient with a cancer which had spread to the brain was treated with this approach at the M. D. Anderson Hospital in Texas. A few weeks after the treatment the patient had a stroke and died. At autopsy the tumor was no longer there. This does not mean that it is always going to work, but it is hopeful. It looks like we have something useful.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

How long have we been studying cancer, Doctor?

Dr. DUNHAM. Cancer has been a problem for many, many years. It goes back to the Greeks who gave it the name of cancer.

Mr. CANNON. We have spent vast sums of money.

Dr. DUNHAM. Right.

Mr. CANNON. Nothing has been overlooked and nothing has been denied in our efforts to promote every field of research on this terrible disease, and we yet do not even know the cause of cancer.

Dr. DUNHAM. That is right.

Mr. CANNON. We yet have not found a cure for cancer.

Dr. DUNHAM. Well, we have found cures——

Mr. CANNON. Except the surgeon's knife. If we get it in time.

Dr. DUNHAM. Or destroy it by radiation.

Mr. CANNON. But that is not an alleviation.

Dr. DUNHAM. That is correct, and it does not control cancer in the sense of preventing it.

Mr. CANNON. Doctor, we have been working all these years with unlimited funds and every possible facility that could be supplied. Will we ever solve the problem of cancer?

Dr. DUNHAM. I think it will come about. I can't say when. I don't think it will come about from finding one cause or one cure. There are many kinds of cancers as there are many kinds of infectious diseases. As you recall, we controlled smallpox first with vaccination, and then diphtheria with antitoxin and diphtheria immunization and immunization against a whole variety of diseases that used to kill hundreds of thousands of people a year in this country.

Mr. CANNON. The principal breakthroughs have not been achieved through the expenditure of Government funds. Penicillin, for example, was discovered by some obscure doctor quite by accident. Henry Ford, working in a shed, made effective use of the internal combustion engine. Such things have come about largely through individuals working on their own with very limited equipment. Do you still think it is advisable for us to go ahead at this rate, providing such vast funds for cancer research and invariably with negative returns?

Dr. DUNHAM. First, I would like to correct the record. I believe that the discoverers of penicillin were working with British Government funds. It was not a large amount of money in the sense that we talk about it today, but it still was public funds of a different country.

Mr. CANNON. Dr. Fleming discovered penicillin quite by accident in a bread mold.

Dr. DUNHAM. That is right, but he was working with British Medical Council funds. I don't think unlimited funds should be available for anything. I think things can be very much out of balance.

Mr. CANNON. Doctor, as long as the situation has promised success we have never denied a dollar. I would say we have been dealing with unlimited funds.

Dr. DUNHAM. I think they should always be looked at just as you look at my budget.

Mr. CANNON. Yet, after all these years of study and research, we know nothing about the cause or the cure of cancer.

Dr. DUNHAM. This is not so. We know a great deal more about the cause of cancer than we did 10 or 15 years ago.

Mr. CANNON. What is the cause, Doctor?

Dr. DUNHAM. We don't know the precise cause, but we know a great deal more about how it is caused. For instance, some work that was done, not with AEC funds but done with radiation, has shown that, in certain types of cancer in mice, it takes a large dose of radiation which destroys certain cells, then in the process of these cells trying to recover rapidly cancer appears. It is not an effect of the radiation producing cancer directly in individual cells. Now, this is quite an important thing. This has to do with the whole field of viruses in relation to cancer. Under these circumstances, the virus of cancer in these mouse cancers can begin to grow. We think as we learn this type of information we can assume that, certainly before this century is out, we will be able to understand what is going on and be able to develop control measures.

Mr. CANNON. I wish I could be as optimistic as you are. But past performances have not given us much cause for encouragement.

FOOD IRRADIATION PROGRAM

Now, under the food irradiation program, which seems to promise far-reaching results, we would like to know what are you doing in this field and what the Army is doing? Is there any correlation of your work?

Dr. DUNHAM. Definitely. I think Dr. Aebersold is better qualified to speak to it. We do have an aspect of the program in my budget. The Army program is concerned primarily with sterilizing food, getting totally rid of bacteria. What we are working at is something which will perhaps not sterilize but will increase the shelf life of food.

Mr. CANNON. Does sterilization impair the food values?

Dr. DUNHAM. Only to a limited extent. There was considerable concern a few years ago on the basis of some incomplete experiments that there might be problems, but it is my understanding, and the joint committee had hearings on this a few months ago, that there are no serious harmful materials produced in the food by this high level radiation. People worried, feared it would become something that would produce cancer. This has not proved to be the case.

Mr. CANNON. You are in touch with each other?

Dr. DUNHAM. Definitely. There is an interagency committee which coordinates this work.

Mr. CANNON. How much money will be put into this program in the fiscal year 1963 from both sources?

Dr. DUNHAM. I don't have the Army figures.

Mr. CANNON. You may include that in the record.

Dr. DUNHAM. Fine.

(The information follows:)

Food irradiation budget for fiscal year 1962

Atomic Energy Commission:	
Biology and medicine	$200,000
Isotopes development	300,000
Total, Atomic Energy Commission	500,000
Army	1,070,000
Total	1,570,000

Mr. CANNON. Mr. Evins.

INCREASE IN FISCAL YEAR 1963 OVER FISCAL YEAR 1962

Mr. EVINS. I just noticed the good doctor is requesting $71,353,000 in operating funds, and $4,810,000 for construction. I wish the doctor would briefly tell us what he is going to do with these funds next year that he has not done in the past.

Dr. DUNHAM. I have already touched on one thing—the very important studies related to the hazards of nuclear weapons testing and the hazards of radiation in space programs. During this last year we have shown conclusively that the genetic effects of fallout radiation—that is, the estimates made 5 years ago by the experts—were high by a factor of 6. They were six times too high. We feel that the same thing probably holds for the effects in terms of cancer and leukemia, and about a quarter of these funds will go to expand our studies in this general area of trying to find out how much less than the original estimates the true hazards are from fallout and from exposure in day-to-day atomic energy operations. This would be a very important thing in terms of people's peace of mind, as well as in terms of medical problems.

Mr. EVINS. Doctor, I hope you come up with the answer and report it to us next year.

Dr. DUNHAM. I am afraid it won't be next year, because most of the facilities have just been completed this year.

Mr. CANNON. Before you leave that, if the gentleman will permit, and off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

FISCAL YEAR 1963 CONSTRUCTION PROGRAM

Mr. EVINS. I have one question for the general manager, Mr. Luedecke, there is a large request for funds for numerous new construction items, none of which were carried in 1962. Maybe there are a few exceptions. I wanted to ask the general question as to why the great acceleration in the construction program?

General LUEDECKE. I would like to check it with the year before.

Mr. EVINS. Most of them were not in any fund carried for the current year.

Mr. MCCARTHY. I think you are referring to previous years where we showed projects with funding carried over? Is this your question?

Mr. EVINS. I am talking about the many large construction items projected for next year for which you had no construction for the current year.

Mr. McCarthy. I think during the current year we have many of the same type of construction projects, but at different locations. There are mostly new projects to be authorized this year, and each year, of course, we do have a number of new construction items coming along, replacement of laboratories and things of that type. The biggest single amount in here this year, as you will see, is $95 million, which is the balance of funding on the Stanford accelerator. Last year the committee appropriated the first part of the total amount required for the Stanford accelerator, which has an estimated cost of $114 million. In prior years, as you will note on page 454, the committee appropriated a portion of the funds required for this project.

Then of course we have $43 million for the NPR which is the amount of overrun on the new production reactor. Those are the two biggest single items in here. If you take them away, I think comparisons of the totals in 1962 and 1961 are about the same, insofar as the dollar totals requested for funding.

LINEAR STANFORD ACCELERATOR

Mr. Pillion. Is it possible to spend $95 million in 1 year for that Stanford accelerator?

Mr. McCarthy. No, sir, it is not. We went to the Bureau of the Budget for a lesser amount for obligation in 1963. The Bureau's policy is to fully fund all construction projects. That is the reason the $95 million is provided here. It will not all be obligated in 1963. We estimate that our obligations on this project in 1963 will be some $34.5 million. The balance will not be obligated until after fiscal year 1963.

Mr. Pillion. Is that standard procedure now to fund the full amount?

Mr. McCarthy. To fully fund the construction.

Mr. Cannon. We may wish to keep them on that basis.

General Luedecke. I believe when those two items are taken out, that construction is about the same as in the previous year.

Mr. Cannon. The committee will stand adjourned until 2 o'clock this afternoon.

Mr. Evins (presiding). The committee will come to order.

Training, Education, and Information

This afternoon we will take up the Atomic Energy Commission budget request for education and training and information. I notice for 1963, you are requesting funds of $15,165,000, or an increase of $932,000 over the previous year.

Mr. Reporter, will you place in the record pages 293 through 331, of the justification and the associated construction page.

(The justification follows:)

OPERATING EXPENSES

Training, Education, and Information—Operating Costs

Program statement

Estimate, fiscal year 1963	$15,165,000
Estimate, fiscal year 1962	14,233,000
Increase	932,000

The training, education, information program is designed to broaden the base of nuclear knowledge and technology at home and abroad. Program efforts are directed toward providing assistance to colleges and universities in establishing nuclear curriculums; operating schools and conducting specialized courses under contract; offering graduate fellowships in the nuclear energy field; providing special assistance to States for training in radiation control; presenting international conferences, studies, and exhibits; and organizing and disseminating technical information.

The program of assistance to regular academic institutions through the provision of special training opportunities for qualified faculty will be expanded. The provision of materials and teaching aids for use in classrooms will be continued in an effort to meet the long-range needs of the atomic era by providing a foundation for increasing the numbers of technical manpower adequately prepared in the field of fundamental nuclear energy technology. The program of assistance to educational institutions through financial grants for the purchase of nuclear laboratory equipment for physical sciences and engineering is oriented to grants useful in general nuclear education in colleges of arts and sciences in addition to engineering colleges.

The Commission continues to provide special nuclear training opportunities for foreign nationals, both in Commission and American college and university facilities and at the Puerto Rico Nuclear Center where Spanish-speaking students receive nuclear training in their own language, and to provide advisory and consultant services to regional groups of countries such as the Organization for European Economic Cooperation, Euratom, etc. In addition, programs involving support of nuclear topical conferences and special conferences and the presentation of oversea nuclear energy exhibits are being continued.

In carrying out its responsibilities for the dissemination of scientific and technical information, the Commission provides a nuclear science information service; prepares books, technical reviews, and information releases; translates foreign language scientific materials; produces and purchases audiovisual and pictorial materials; and carries on a domestic exhibits program.

Summary of estimates by activity

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Training and education in reactor technology	$51,499	$31,000	$30,000
2. Training and education in the physical sciences and engineering	3,783,819	3,344,000	3,235,000
3. Training and education in radiobiology and the life sciences	2,822,449	2,851,000	2,985,000
4. Training and education of foreign nationals in nuclear science and technology	1,851,811	2,358,000	2,705,000
5. Training and education in radioisotope technology	244,582	330,000	325,000
6. Training assistance to States in radiation control	49,702	69,000	155,000
7. Technical information services	3,228,761	4,085,000	4,355,000
8. Public information services	128,085	165,000	175,000
9. International conferences and exhibits	1,044,037	,000,000	1,200,000
Total, training, education, and information program	13,204,745	14,233,000	15,165,000

1. TRAINING AND EDUCATION IN REACTOR TECHNOLOGY, $30,000

Reactor supervisors training course

Actual, fiscal year	$51,499
Estimate, fiscal year 1962	31,000
Estimate, fiscal year 1963	30,000

The Duquesne Light Co. operates a training course for the Commission at Shippingport to provide supervisor training to employees of other organizations in the operation of a central reactor power station. The tuition rate of $2,000 per student is based on recovering the cost of operating the school. The fiscal year 1962 and fiscal year 1963 budget estimates are based on the anticipated number of students in these years.

2. TRAINING AND EDUCATION IN THE PHYSICAL SCIENCES AND ENGINEERING, $3,235,000

The primary purpose of this program is to assist in developing an adequate undergraduate and graduate level of teaching capability in nuclear science and engineering in order to meet the estimated needs for scientists and engineers trained in these areas. This purpose is accomplished through four general activities: (1) providing intensive course training for selected high school science teachers followed by subsequent visitations to various high schools to stimulate interest and competence in nuclear science teaching, (2) providing nuclear equipment and materials assistance to undergraduate and graduate schools for their laboratories, (3) providing training opportunities to faculty members and students at the undergraduate and graduate levels, and (4) sponsoring a reasonable number of outstanding nuclear scientists and engineers through graduate fellowships and assignments to national laboratories. Funds requested for fiscal year 1963 are for the continuation of programs directed toward (1) increasing the supply of technical manpower in the atomic energy fields, and (2) for general orientation of students of science and engineering in nuclear phenomena.

Summary of estimates by activity

Training and education in the physical sciences and engineering	Actual, fiscal year 1961	Estimated, fiscal year 1962	Estimated, fiscal year 1963
a. Operation of courses	$17,465	$54,000	$115,000
b. Fellowships	634,986	659,000	800,000
c. Assistance to schools	3,073,337	2,559,000	2,220,000
d. Other training, education, and information activities	58,031	72,000	100,000
Total training and education in physical sciences and engineering	3,783,819	3,344,000	3,235,000

a. Operation of courses, $115,000

Actual fiscal year 1961	$17,465
Estimated fiscal year 1962	54,000
Estimated fiscal year 1963	115,000

The science demonstration program is the only activity carried out under this budget category. This program is designed to stimulate interest and competence in nuclear science among high school students, teachers, educational consultants, and supervisors. Selected high school teachers throughout the country are brought to Oak Ridge to receive 3 months of intensive training. Subsequent to this training they visit and demonstrate to high schools in their respective States and then return to their regular teaching posts at the end of 1-year appointments. The National Science Foundation will continue partial support of this program; however, for fiscal year 1963, it is estimated that the NSF support will decrease to approximately 50 percent of the total cost as compared to approximately 80 percent NSF support for prior years. The increase in AEC's estimate provides for maintaining this essential activity at about its past level.

b. Fellowships, $800,000

Actual fiscal year 1961	$634,986
Estimated fiscal year 1962	659,000
Estimated fiscal year 1963	800,000

In order to promote the maximum utilization of peaceful uses of the atom in such areas as nuclear powerplants, research reactors, industrial and other uses of radioisotopes, there is a continuing need for encouraging able students to pursue nuclear science and engineering education. This fellowship program enables these students to enroll for programs leading to M.S. and Ph. D. degrees, thus fitting them for significant roles in research, development, and industrial nuclear applications. As a secondary benefit, existence of this program encourages universities to continue to strengthen their graduate nuclear education programs. The increase in funds requested for fiscal year 1963 covers an increase in the funds paid to universities over and above tuition as a partial recognition of the high costs of graduate education, and a modest increase in

number of fellowships, primarily to permit a broadening of the program in the area of radiation chemistry and radioisotope applications.

c. Assistance to schools, $2,220,000

Actual, fiscal year 1961	$3,073,337
Estimated, fiscal year 1962	2,559,000
Estimated, fiscal year 1963	2,220,000

The AEC maintains a series of programs aimed at encouraging and assisting educational institutions to establish or expand curriculums in nuclear science and engineering. This assistance is in the form of (1) equipment grants, (2) provision of nuclear materials and services, (3) sponsorship of courses of instruction for university and technical institute faculty, (4) provision of on-the-job training opportunities for faculty and students, study groups, and general university use of national laboratory facilities. The programs are interrelated and institutions may participate in all these activities.

A summary of the items in this category follows:

	Actual, fiscal year 1961	Estimated, fiscal year 1962	Estimated, fiscal year 1963
Physical sciences and engineering equipment grants (including isotope equipment)	$2,522,442	$1,567,000	$1,070,000
Nuclear materials and services	79,915	430,000	440,000
Temporary faculty appointments at AEC sites	65,758	68,000	150,000
Institutes for science and engineering faculty	318,222	284,000	350,000
University-National Laboratory cooperative programs	87,000	210,000	210,000
Total assistance to schools	3,073,337	2,559,000	2,220,000

Under the equipment grants program, educational institutions at the college level are provided funds to acquire nuclear equipment for teaching students. The institutions receiving such equipment must assure the AEC that the equipment will be used in lecture demonstrations and in formal laboratory courses, as distinct from sponsored research projects. Scientific disciplines eligible for these grants include chemistry, physics, metallurgy, and the engineering disciplines such as chemical, electrical, mechanical, and civil engineering. Assistance is given both to establishing new courses and improving existing courses in subjects such as radiochemistry, isotope technology, nuclear and reactor physics, metallurgy, nuclear energy technology, instrumentation, heat transfer and fluid flow, radiological safety, and fuel processing. Support is granted for both undergraduate and graduate laboratories, with undergraduate support primarily limited to those institutions which can demonstrate that significant portions of their engineering and science majors go on for graduate study.

Under the program for provision of nuclear materials and services, funds are provided to (1) assist institutions to acquire the various nuclear materials needed for their nuclear science and engineering educational programs and (2) provide fuel-cycle assistance for university reactors. For educational purposes, materials such as normal and enriched uranium, graphite, heavy water, and neutron sources are either loaned without charge or dollar grants are provided for their purchase if the materials are commercially available. In addition, the Commission reprocesses, without charge, materials such as reactor-spent fuel elements returned by universities.

Under the faculty assistance programs, colleges and universities are assisted in increasing the level of competence and knowledge of their instructional staff members in the nuclear field. Since the AEC national laboratories have unique facilities and expert staffs not available on most university campuses, the AEC encourages university faculty members to accept temporary appointments at AEC sites to work on nuclear science and engineering projects designed to enhance the faculty member's scientific background and thereby improve his university's nuclear education program. These temporary appointments,

together with study groups, seminars, and short-term university use of special AEC facilities, enable university people to keep abreast of advances in nuclear technology and also provides AEC programs with a constant infusion of new ideas.

Faculty education is also enhanced at the college level by a program of AEC-sponsored institutes in nuclear technology, nuclear physics, reactor physics, reactor design, thermonuclear processes, reactor operation, and metallurgy. To date the major portion of this effort has been devoted to training faculty associated with engineering schools, through summer institutes operated in cooperation with the American Society of Engineering Education. Over 600 faculty members from engineering insitutions have attended summer institutes. The emphasis in the institute program is now being shifted to the nuclear aspects of chemistry and physics for the faculty of colleges of arts and sciences. These latter insitutes will be cosponsored with the National Science Foundation with AEC paying the operating expenses of the institutes and the Foundation responsible for the stipends and travel expenses. The institutes for chemistry and physics faculty will primarily cover nuclear and reactor physics, isotope technology, and nuclear radiation chemistry.

Masters and doctoral thesis students are encouraged to use national laboratory facilities when such equipment is not available to their own campuses, with university and national laboratory staff providing cooperative thesis supervision. The laboratories and the universities exchange seminar speakers, enhancing the scientific backgrounds of both groups. On occasions, university faculty and students visit the laboratories for periods up to a week in duration to perform experiments on the more sophisticated equipment.

(d) Other training, education, and information activities, $100,000

Actual fiscal year 1961	$58,031
Estimated fiscal year 1962	72,000
Estimated fiscal year 1963	100,000

In addition to the activities just described, there are a number of other activities essential to the total program in order to fulfill the varied nuclear needs of Government, educational institutions, and industrial organizations. Items presently programed include short courses in specialized nuclear subjects, lecture films on nuclear education, nuclear education newsletter and brochure, nuclear curricula development, preparation of nuclear texts and laboratory teaching manuals, and meetings and conferences with educators covering technical areas of nuclear education.

3. TRAINING AND EDUCATION IN RADIOBIOLOGY AND THE LIFE SCIENCES, $2,985,000

Costs incurred in this section of the training, education, and information program are classified into five general areas: (1) Operation of courses by the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn., primarily for the training of individuals in the use and handling of radioactive materials; (2) special fellowships offered in health physics, industrial hygiene, industrial medicine, and advanced radiological physics; (3) assistance to schools by means of financial grants for the purchase of specialized equipment to be used in training courses in the application of nuclear technology in the life sciences, radiobiology teacher training institutes, and lecture series for high school and college teachers; (4) other expenses of training; and (5) other capital equipment.

The education activities in the life sciences are conducted in recognition of the need for fellowships and courses in educational curricula from high school through postdoctoral levels to demonstrate the relation of the life sciences to the nuclear sciences in general. In order to include such courses, educational systems at all levels must obtain special and often costly equipment, specially trained teaching staffs, and in some instances augmentation of course work by visiting lecturers, teachers, exhibits, etc. The activities listed below are planned to meet these general requirements in the participating schools.

Summary of estimates by activity

Training and education in radiobiology and the life sciences	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Operation of courses	$213,693	$213,000	$216,000
(b) Fellowships	673,469	796,000	950,000
(c) Assistance to schools	1,803,890	1,665,000	1,646,000
(d)) Other expenses of training	99,819	139,000	130,000
(e Other capital equipment	31,578	38,000	43,000
Total training and education in radiobiology and the life sciences	2,822,449	2,851,000	2,985,000

(*a*) Operation of courses:

Fiscal year 1961	$213,693
Fiscal year 1962	213,000
Fiscal year 1963	216,000

The following activities are included under this budget category:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Special training courses (radioisotopes)	$160,977	$159,000	$157,000
2. Mobile isotope training program	33,962	41,000	44,000
3. Related capital equipment	18,754	13,000	15,000
Total operation of courses	213,693	213,000	216,000

1. *Special radioisotope training program.*—This program is conducted at Oak Ridge by the Special Training Division of the Oak Ridge Institute of Nuclear Studies primarily for the training of scientific workers in the use of radioactive materials. Five basic courses and one or more special courses will continue to be offered during a fiscal year, the course content emphasizing instrumentation, radiation detection, and the safe handling of radioisotopes. The average attendance per course is 48 students, or a total of 240 participants for recent fiscal years. It is proposed in fiscal year 1963 to continue these courses at the fiscal year 1962 level.

2. *Mobile isotope training program.*—This training has the same objective as the courses offered by the special radioisotope training program described above, but is conducted by the use of a mobile unit (35-foot bus) fully equipped as a modern laboratory, including electronic equipment. A 2-week course covering the basic principles, techniques, and applications of radioisotopes will be conducted at approximately 12 small colleges. Each course will have approximately 12 participants comprised of faculty members and selected students majoring in a natural science. The estimate of cost provides for personal services, travel, vehicle operation and maintenance, materials and supplies, and university administration.

The operation of the mobile isotope laboratory has been largely confined to the Southeastern States because of scheduling limitations. However, as a result of its extremely successful performance, efforts will be made to expand the program within funding availability.

3. *Related capital equipment.*—Funds are required in the ORINS Special Training Division for two specific equipment items: (1) a transistorized tricarb unit and (2) an automatic sample changer. These two items are estimated to cost $10,000. In addition, some replacements and additions of minor laboratory equipment are necessary.

(*b*) Fellowships $950,000

The types of fellowships and their cost by years are as follows:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Health physics	$292,225	$318,000	$385,000
Industrial hygiene	31,625	51,000	55,000
Industrial medicine	57,834	73,000	120,000
Advanced radiological physics fellowships	64,388	110,000	130,000
On-the-job training of fellows	205,349	234,000	240,000
Related capital equipment	22,048	10,000	20,000
Total, fellowships	673,469	796,000	950,000

In the field of nuclear sciences, as related to the life sciences, there is an increasing need to control the degrees of radioactivity to which man and his environment are exposed from reactors, high-energy accelerators, and the now common use of radioisotopes. These sources of radioactivity pose potential hazards, not only to the workers themselves but also to the population as a whole should the environment become unduly contaminated. Thus, there is a need for persons who understand these hazards; how to control them, and who are sufficiently trained in atomic developments in order that they can initiate and effectuate adequate safety programs. In fiscal year 1963 the AEC is endeavoring to continue to fulfill this need by offering fellowships in the major areas explained on the following pages. The estimates propose approximately the same number of new fellows in fiscal year 1963, but additional funds are required for increase in the institutional allowance fee.

Health physics fellowships offer 1 year of university graduate-level training in health physics to selected college graduates with degrees in basic science and engineering. Fellows take formal courses at participating universities for 9 months and then transfer to cooperating AEC installations for approximately 3 months' laboratory training in applied health physics. A second 9-month period of course work is available for outstanding students.

Industrial hygiene is a specialized science within the field of industrial health and includes the study and control of the more common occupational hazards and other environmental factors affecting the health of atomic energy industry employees. The industrial hygiene fellowship program offers 1 academic year of graduate training at one of the selected colleges leading to a masters degree in industrial hygiene.

As advances continue to be made in the development of atomic power and other peacetime uses of atomic energy, an increasing number of adequately trained industrial hygienists are needed to fill positions in AEC installations and industry. These fellowships help to fulfill this need.

Industrial medicine fellowships provides industrial physicians with either 1 or 2 years' training in industrial medicine including special instruction relating to the hazards of radioactive materials and other health problems encountered by the Commission in its operations. The training is received at universities offering approved graduate courses in industrial medicine. This program continues to provide suitable trained personnel for the medical and health needs of the atomic energy industry.

Advanced radiological physics fellowships are designed to train individuals at the doctoral level capable of directing programs for protection of workers and populations involved in the atomic energy industries. The fiscal year 1963 estimate provides for the training of 15 fellows. This number of appointments is intended to alleviate as quickly as practical a shortage in this area of the nuclear industry.

On-the-job training of fellows: This activity provides for the summer on-the-job training and laboratory experience for the health physics fellows after they have completed their 9-month course work at one of the sponsoring universities.

Related capital equipment is for laboratory equipment needed for the training programs offered at the University of Rochester.

(c) Assistance to schools:

Fiscal year 1961	$1,803,890
Fiscal year 1962	1,665,000
Fiscal year 1963	1,646,000

This category consists of (1) a program of grants providing funds to educational institutions for special equipment to be used in training courses in the application of nuclear technology in the life sciences, and (2) faculty training which includes radiobiology training institutes for high school and college faculty, and visits by prominent biologists to lecture at small colleges, universities, and high schools.

The cost estimates for these programs are listed below:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Nuclear training equipment in the life sciences	$998,504	$850,000	$430,000
Faculty training:			
Radiobiology training institutes	781,653	772,000	1,162,000
Radiobiology lecture series	23,733	43,000	54,000
Total, assistance to schools	1,803,890	1,665,000	1,646,000

Financial grants for the acquisition of special equipment and demonstration apparatus needed for courses in radiation technology in the biological sciences are intended to be responsive to publicly recognized national goals for strengthening education in the United States. These grants in the life sciences were begun in fiscal year 1958, for the purpose of assisting nonprofit educational institutions by offering funds for the acquisition of materials, apparatus, and equipment for instruction in radiation biology, and the use of radioisotopes in biology and medicine. Grants are available to medical schools, schools of pharmacy, schools of veterinary medicine, agricultural colleges, biological divisions of liberal arts colleges and universities, and schools of public health to acquire the various items of equipment which are needed to implement laboratory courses in nuclear technology as applied to the life sciences.

Since its inception late in 1957 through June 1961, 416 grants totaling $4,298,409 were awarded to 274 institutions. Schools receiving grants have reported an increasing interest in nuclear technology as related to these fields. As a result, in recipient schools science courses have been expanded to include nuclear technology education, with enrollment in such courses increasing more than 35 percent, and in addition new nuclear science courses have been initiated. Institutions receiving grants have enlarged the laboratories and/or general teaching facilities for the most effective use of grant equipment and have added or assigned new faculty members to the subsequent program. The funds requested will allow for a very modest continuation of the program through fiscal year 1963.

Radiobiology training institutes for high school and college teachers of science now have completed their pilot years. The result of this training has been to stimulate the teachers and through them their students in the desire to learn more about the meaning of nuclear energy and its applications to biology. Furthermore, a significant step toward education of the general public has been accomplished by the fact that these teachers, returning to their own communities with a real understanding of nuclear technology (control of hazards, safety measures, peaceful applications, etc.) participate in many extracurricular activities such as voluntary demonstrations to their fellow faculty members, and lectures and demonstrations to various civic groups and organizations. The program will continue to be administered jointly with the National Science Foundation, under the already established arrangement by which the foundation provides stipends, family allowances, travel costs to the teachers who attend; the Commission provides to the host universities the operational and indirect costs of conducting the institutes. Upon completion of the course, the Commission provides basic demonstration equipment to teachers for use in teaching upon returning to their schools. The institutes are available for attendance by high school and college teachers of science (specifically biology in the case of college teachers) and are offered in three sessions; that is, (*a*) summer sessions of 8 weeks, for high school and college teachers; (*b*) inservice, or school year sessions nights and/or Saturdays for high school teachers only; and (*c*) full academic year session of 36 weeks for college teachers. Moderate expansion in this program is proposed for fiscal year 1963.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Summer sessions	24	24	26
Inservice (school year)	3	3	7
Academic year	1	1	3
Total	28	28	36

Through the radiobiology lecture program, biologists actively engaged in research projects at universities and AEC installations in various areas of radiation biology visit high schools, small colleges, and universities. At these schools, where research programs are either small or nonexistent, they offer formal lectures to the students and faculty, advise faculty on their teaching and/or research programs, and spend some of their time in conferences with students, individually and in groups, discussing possible careers in radiation biology, courses of study in that area, etc. The program provides a practical and efficient broadening of biology teaching to encompass the impact of nuclear technology upon the life sciences. This program is administered by the Oak Ridge Institute of Nuclear Studies and the American Institute of Biological Sciences; the lecturers from ORINS offer their talks in overall fields of nuclear technology, and those from OIBS in the areas specific to the life sciences and radiation.

(*d*) Other expenses of training:

Fiscal year 1961	$99,819
Fiscal year 1962	139,000
Fiscal year 1963	130,000

These funds provide costs of general activities in support of those programs described in the preceding categories. Such activities include visual and pictorial aids such as teaching films; development of curriculums, manuals, and special textbooks; and domestic conferences and symposia required for the program.

(*e*) Other capital equipment:

Fiscal year 1961	$31,578
Fiscal year 1962	38,000
Fiscal year 1963	43,000

Items are needed for general support operations for all training programs and activities conducted by the Oak Ridge Institute of Nuclear Studies. These support operations include the technical shops, general administration, technical library, maintenance, and automotive fleet.

4. TRAINING AND EDUCATION OF FOREIGN NATIONALS IN NUCLEAR SCIENCE AND TECHNOLOGY, $2,705,000

The formal training opportunities in nuclear science and technoolgy offered by the Commission at AEC facilities are among the most significant and successful aspects of the atoms-for-peace program. The unique facilities and the experienced staff at the Commission installations contribute importantly to international cooperation in the physical, medical, biological, and agricultural areas of nuclear science and technology.

By making educational opportunities available to the free world, the United States strengthens its influence in the international scientific community. It is important that the United States continue this training so long as foreign nationals must seek it outside their own countries.

No substantial changes in the nature of this program are contemplated, although operating costs for fiscal year 1963 will increase over fiscal year 1962 in the amount of $347,000. This increase results primarily from increased staffing requirements and additional operating costs at both the Puerto Rico Nuclear Center and the International Institute of Nuclear Science and Engineering.

Summary of estimates by category

Training and education of foreign nationals in nuclear science and technology	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(*a*) Operation of schools	$1,654,815	$2,090,000	$2,440,000
(*b*) Operation of courses	159,053	190,000	165,000
(*c*) Advisory and consultant services	37,943	78,000	100,000
Total training and education of foreign nationals in nuclear science and technology	1,851,811	2,358,000	2,705,000

(*a*) Operation of schools:

Fiscal year 1961	$1,654,815
Fiscal year 1962	2,090,000
Fiscal year 1963	2,440,000

Two schools are operated by the Commission—the International Institute of Nuclear Science and Engineering, and the Puerto Rico Nuclear Center.

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. International Institute:			
Operating costs	$680,830	$775,000	$925,000
Related capital equipment	26,234	15,000	15,000
2. Puerto Rico Nuclear Center:			
Operating costs	761,610	1,100,000	1,300,000
Related capital equipment	186,141	200,000	200,000
Total operation of schools	1,654,815	2,090,000	2,440,000

A breakdown of operating costs, student enrollments, and revenues for the two schools follows:

(*1*) *The International Institute of Nuclear Science and Engineering*

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Operating costs	$680,830	$775,000	$925,000
Related capital equipment	26,234	15,000	15,000
Total	707,064	790,000	940,000
Student enrollments	[1] 199	140	160
Participants	131	100	100
Affiliates	68	40	60
Revenues	102,994	100,000	90,000

[1] Includes 50 students enrolled in 1960 summer session.

The International Institute of Nuclear Science and Engineering located at Argonne National Laboratory, provides advanced training in nuclear science and technology in the areas of (1) reactor science and technology, (2) engineering research and development, (3) physical science research, (4) life science research, and (5) engineering, administration, and operation of nuclear facilities.

Two types of programs are provided: (1) Classroom-laboratory type instruction in which the students are designated as "participants" and (2) a more advanced research-study type of program designed to meet the objectives of the individual students who are designated "affiliates."

To qualify as a participant a student must have the equivalent of the master's degree in science and engineering given in the United States and a background in nuclear studies. Participants follow a more formal program than affiliates.

Their training covers one or two semesters, during which they attend scheduled lectures and laboratory experiments and undertake special study projects of a theoretical nature, culminating in a final project report. Tuition is $1,000 per semester.

The affiliate level is the more advanced and is intended for highly experienced applicants with doctoral or postdoctoral experience who have established themselves in research careers in nuclear science or related fields. They are normally assigned for a period of two semesters to a scientific or engineering division of the Laboratory and are provided course work pertinent to participation in specific unclassified research and development work. They neither pay tuition nor receive a salary; it is expected that they will contribute significantly to the overall Argonne Laboratory research program.

It is estimated that operating costs for the International Institute will increase $150,000 in fiscal year 1963 over the fiscal year 1962 level. These increased costs result primarily from the addition to the Institute's staff of temporary appointees (4.5 man-years) who will be using Laboratory facilities for special work considered in support of the Institute's programs.

Related capital equipment, International Institute of Nuclear Science and Engineering:

Fiscal year 1961	$26,234
Fiscal year 1962	15,000
Fiscal year 1963	15,000

The acquisition of a modest amount of equipment is required to enable the Institute to maintain and enhance the effectiveness of its training program.

A summary of the operating costs, student enrollments, and revenues for the Puerto Rico Nuclear Center follows:

(2) The Puerto Rico Nuclear Center

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Operating costs	$761,610	$1,100,000	$1,300,000
Related capital equipment	186,141	200,000	200,000
Total	947,751	1,300,000	1,500,000
Student enrollments	96	190	207
Revenues	$1,624	$4,000	$9,000

The Puerto Rico Nuclear Center, operated by the University of Puerto Rico under contract with the AEC, provides nuclear training and research programs in agricultural, biological, medical, and physical sciences.

Facilities now in operation at the Puerto Rico Nuclear Center include a swimming pool reactor at the Mayaguez campus, with characteristics and auxiliary equipment which make it an excellent training and research facility, and the biomedical building at the new medical center at Rio Piedras, containing laboratories for work in radiochemistry, radiobiology, biochemistry, biophysics, and other related facilities. Staffing is proceeding satisfactorily and will be essentially completed by the end of fiscal year 1963.

Activities of the center are generally bilingual and participation by students from the Latin American States is facilitated as a result of the center's Hispanic environment and by reliance predominantly upon the Spanish language in formal instruction; however, qualified students from countries other than the Latin American community are accepted at the center.

The Puerto Rico Nuclear Center conducts M.S. degree programs in health physics and in nuclear science and technology. In addition, the facilities of the center are available to UPR graduate students who wish to take specialized courses in the application of nuclear energy in their fields of study. Long-term training courses, i.e., of 1 year or more, are offered in radiotherapy and cancer and in clinical uses of radioisotopes. Short-term courses are available in radioisotopes techniques, radiobiology, radiotherapy and cancer, radiation health protection, medicine, and agriculture.

Operating costs for fiscal year 1963 increase $200,000 over the previous fiscal year. This increase provides for the addition of approximately 10 scientific

personnel in fiscal year 1963, and reflects expanding programs in the areas of nuclear science and technology, reactor operations, radiotherapy and cancer, radiobiology and medical sciences.

Tuition charges at the center are comparable to those of the University of Puerto Rico.

Related capital equipment, PRNC $200,000

The projected equipment requirements for the PRNC for fiscal year 1963 are necessary to enable continued efficient operation of the center's training and research programs.

(*b*) Operation of courses:

Fiscal year 1961	$159,053
Fiscal year 1962	190,000
Fiscal year 1963	165,000

The following activities are included under this budget category:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Nuclear reactor operations supervision course	$78,036	$95,000	$82,000
2. Nuclear reactor hazards evaluation course	78,035	95,000	83,000
3. Radiochemical and counting procedure course	2,982	0	0
Total operation of courses	159,053	190,000	165,000

Two highly specialized courses are offered by the Oak Ridge National Laboratory to a limited number of qualified students. A summary of costs, student enrollments, and estimated revenues for these two courses follows:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(1) Nuclear reactor operations supervision course:			
Operating costs	$78,036	$95,000	$82,000
Student enrollments	24	22	28
Revenues	$26,000	$12,000	$16,000
(2) Nuclear reactor hazards evaluation course:			
Operating costs	$78,035	$95,000	$83,000
Student enrollments	36	20	27
Revenues	$14,000	$12,000	$14,000

These programs are for 12 months' duration.

The operations supervision program is intended to prepare an engineer or scientist to superintend the operation of a reactor efficiently and safely. The hazards evaluation program is to develop the individual's ability to evaluate the hazards involved in reactor operation including accidents possible from a chance conjunction of unlikely technical events and human mistakes—taking into account the geographical and geological environment.

The first 9 months of both courses are devoted to classroom and laboratory instructions on such matters as reactor operations, health physics, instrumentation, and control. In the final 3 months the reactor operations supervision student participates in the operation of various ORNL reactors, while the hazards evaluation student devotes further study to problems arising from potential reactor hazards.

These two courses are primarily for foreign nationals but U.S. nationals are accepted to the extent that facilities and the staff can accommodate them. Tuition fees for each course are $2,000. The estimates for fiscal year 1963 provide for the continuation of these courses at approximately the same level as in fiscal year 1962. The fiscal year 1963 reduction in costs reflects an expected increase in the number of AEC and AEC-contractor employees attending these courses, for whom costs equivalent to established tuition charges are transferred to the programs funding their salaries.

A third course, in monitoring techniques and radiochemical counting procedures, was provided by the New York Operations Office Health and Safety

Laboratory during fiscal year 1961. This course was discontinued in fiscal year 1962.

(3) Radiochemical and counting procedure course:

Fiscal year 1961	$2,982
Fiscal year 1962	0
Fiscal year 1963	0

c. International conferences, exhibits, services and other assistance:

(1) Advisory and consultant services:

Fiscal year 1961	$37,943
Fiscal year 1962	78,000
Fiscal year 1963	100,000

The estimate for this activity provides for advisory and consultant services, and attendance at meetings, conferences, and symposia for the purpose of assisting in the evaluation and development of atomic energy programs to regional groups of countries such as OECD and Euratom (excluding, however, IAEA, and the U.N.) and economically developed countries under bilateral agreements.

5. TRAINING AND EDUCATION IN RADIOISOTOPES AND RADIATION TECHNOLOGY, $325,000

The radioisotopes and radiation technology training program has three major objectives: (1) To strengthen the physical and engineering science curriculums in colleges and universities in radioisotopes and radiation techniques, and safe handling procedures; (2) to train physical scientists and engineers in the safe and effective use of radiation techniques; and (3) to combat fear of radiation and the general lack of knowledge and appreciation of the impact of radioisotopes on the national economy.

These objectives are accomplished through establishment of short courses in the basic and specialized applications of radioisotopes; and through development of educational tools for broad use throughout science and technology.

Summary of estimates by activity

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
a. Operation of courses	$95,676	$102,000	$100,000
b. Assistance to schools	75,229	100,000	100,000
c. Other T.E. & I. activities	73,677	128,000	125,000
Total	244,582	330,000	325,000

a. Operation of courses, $100,000

(1) The radioisotope training course at the Oak Ridge Institute of Nuclear Studies is designed primarily to meet the growing technical manpower requirements for the expanding use of radioisotope techniques in the sciences, engineering research, and applications. This training program is designed to give scientists and engineers from universities, research organizations, governmental agencies, and industry an introduction to the safe, routine use of radioisotope techniques. During fiscal year 1963, four courses in the physical sciences sequence will be offered, together with a special pilot course which will emphasize advanced radioisotope techniques. Estimated cost, $95,000.

(2) Related capital equipment: These equipment requirements provide for the acquisition of necessary repair and replacement items of laboratory instructional equipment for the Oak Ridge Institute of Nuclear Studies radioisotope technology training program. Estimated cost, fiscal year 1963, $5,000.

b. Assistance to schools, $100,000

Faculty training institutes.—In fiscal year 1960, a joint program was initiated with the National Science Foundation to increase the capability of small college faculties to teach the fundamentals of radioisotope and radiation principles, techniques of use, and safe handling procedures. Under joint sponsorship AEC provides funds for the operating costs of the institutes while the Science Foundation provides subsistence and travel costs of the faculty participants through

stipends. Five institutes accommodating 125 instructors were held in fiscal year 1962. Five institutes are also planned for fiscal year 1963.

c. Other training, education, and information activities, $125,000

A limited number of activities which support the key programs described are carried on to assure effective operation of both the university and industrial training efforts. A continuing survey is made of worldwide applications and new developments in the use of radioisotopes and radiation. Curriculums development studies, laboratory training systems, domestic symposia, and visual and pictorial aids are designed to extend the knowledge of isotopes, radiation, and their safe application throughout the educational, research, and engineering communities.

6. TRAINING ASSISTANCE TO STATES IN RADIATION CONTROL, $155,000

A continuing requirement exists for the Commission to provide a training and educational program adequate to meet the needs of State and local government personnel engaged in the functional areas of radiological health and radiation control. This training is a preparatory step in assisting the States toward assumption of certain regulatory responsibilities in certain phases of the nuclear energy industry. Specifically those regulatory functions being transferred, as a result of executing agreements between the States and the AEC, will include (1) byproduct materials, (2) source materials, and (3) special nuclear materials in quantities less than a critical mass. Authority for training assistance provided under this program is contained in section 274 of the Atomic Energy Act of 1954, as amended, entitled "Cooperation With States," Public Law 86–373.

a. Training program

Fiscal year 1961	$49,702
Fiscal year 1962	69,000
Fiscal year 1963	155,000
(1) University training program:	
Fiscal year 1961	3,150
Fiscal year 1962	0
Fiscal year 1963	0

This activity was discontinued in fiscal year 1961.

(2) Short courses:	
Fiscal year 1961	$46,552
Fiscal year 1962	64,000
Fiscal year 1963	150,000

(a) Operating costs

Fiscal year 1961	$43,653
Fiscal year 1962	61,000
Fiscal year 1963	148,000

These courses are designed to meet the needs of State and local employees engaged in health protection activities who need additional training in the evaluation of radiological hazards. The length of the course, hours of training, and course content will necessarily have to be designed to meet the current requirements of the State or group of States having need for training personnel under varying work conditions and degrees of individual competence. For these reasons it will be necessary to offer 10-week courses at AEC National Laboratories, universities, and colleges that provide such training. Further, extension courses of one and two semesters are planned for late afternoon and evening periods. Plans to include extension work under the short course program have been necessitated by the fact that many of the States have indicated their personnel cannot be spared from their work for extended periods, but the need to train such personnel is essential to their future competence in the radiation protection field.

(b) Related capital equipment

Fiscal year 1961	$2,899
Fiscal year 1962	3,000
Fiscal year 1963	2,000

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A requirement to provide a limited variety of radiation technology training equipment for laboratory instruction in health physics at the Health and Safety Laboratory, NYOO, will continue in fiscal year 1963.

(3) Other expenses of training:

Fiscal year 1961	0
Fiscal year 1962	$5,000
Fiscal year 1963	5,000

In addition to conventional classroom and laboratory training in health physics, there is concurrent need to exploit the use of educational television. This need exists not only for technical personnel engaged in inspection and enforcement but will provide information on nuclear energy to the general public. The estimate is primarily for the cost of television film rights.

7. TECHNICAL INFORMATION SERVICES, $4,355,000

The purposes of this program are to provide technical information services and materials throughout the AEC and among its contractors, and to provide for the dissemination of information concerning scientific and tehcnical developments in the national atomic energy program to meet the needs of the general public, particularly of educators, students, scientists, businessmen, and industrialists. These objectives are accomplished by the operation of a central AEC nuclear science information service center at the Division of Technical Information Extension, Oak Ridge, which provides classified and unclassified scientific and technical information and reference services; the preparation of monographs and books; publication of periodic technical reviews summarizing the developments in important areas of nuclear science and technology; translation of foreign language scientific materials; provision of collections of AEC informational materials to libraries in the United States and abroad; and the provision of educational packets, exhibits, manned demonstration projects, and special reference services to the lay public and secondary schools.

Summary of estimates by category

Technical information Services	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
a. Domestic exhibits	$606,606	$737,000	$825,000
b. Technical information services and materials	2,622,155	3,348,000	3,530,000
Total, technical information	3,228,761	4,085,000	4,355,000

JUSTIFICATION OF CATEGORIES

a. Domestic exhibits, $825,000

The domestic exhibits program is designed to assist in fulfilling the Commission's responsibility under the Atomic Energy Act of 1954 to disseminate unclassified scientific and technical information. The various exhibits include complex displays requiring several thousand square feet of presentation area, mobile walk-through van exhibits, high school lecture demonstrations, films, and small package units. The museum exhibit operated at Oak Ridge by the Oak Ridge Institute of Nuclear Studies serves as a comprehensive information and education center as well as an operating training base for the traveling exhibits program, also operated by ORINS for the Commission. In fiscal year 1963 major repair and maintenance of the museum will be required. In the traveling exhibits program displays are being updated to show the Nation's progress in developing nuclear technology and increasing applications of atomic energy, and reoriented to reach greater numbers of people. Exhibits are presented to large audiences at State, local, and county fairs, civic gatherings, and to students at high school and college levels. They foster public understanding of the Commission's atomic energy program and stimulate student interest in further study of science as it applies to atomic energy. More specialized exhibits are used at technical and industrial conferences, business meetings, trade fairs, and special ceremonies where Federal, State, and local government officials and civic leaders request presentations of informational displays on atomic energy. These

exhibits encourage greater industrial utilization and development of atomic energy by familiarizing industrial, scientific, engineering, and management personnel with the Commission's technical progress and developments. The equipment estimate provides for vehicles and related equipment required for the traveling exhibits program. There follows a summary of the activities in this category:

Domestic exhibits

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Museum exhibits	$93,494	$127,000	$150,000
Traveling exhibits program	490,249	574,000	650,000
Industrial information and other special exhibits	1,618	20,000	20,000
Related capital equipment	21,245	16,000	5,000
Total domestic exhibits	606,606	737,000	825,000

b. Technical information services and materials, $3,530,000

The Commission's technical information program provides information materials and services to AEC offices and contractors, the scientific and industrial communities and, in addition, implements agreements for international cooperation by furnishing technical information services under the atoms for peace and bilateral agreements programs.

The estimate of $3,530,000 covers the cost of activities required to fill the needs of the AEC and its contractors and of science and industry generally for scientific and technical information materials originated within the AEC program. These activities include the operation of the Division of Technical Information Extension at Oak Ridge which provides (*a*) centralized classified and unclassified publishing, reference, abstracting, and document collection and distribution services for the AEC, its contractors and other governmental agencies, (*b*) classified and unclassified technical information services to the Commission's access permit holders under the civilian application program, and (*c*) unclassified technical information services to domestic depository and educational libraries and to libraries established in foreign countries under the atoms for peace and bilateral agreements programs. Necessary additions and replacements of filing, printing, binding, and composing equipment for the extension are provided for. The estimate also covers the preparation under contract of unclassified monographs and books compiling technical data essential for peacetime applications of atomic energy; the writing under contract of technical progress reveiws to keep the industrial and scientific communities abreast of current developments in the atomic energy field; the translation of technical data from Russian and other foreign language materials; the printing of materials published and distributed under the industrial participation activities of the Commission; and the continuation under contract of surveys and analyses of new and improved methods for collecting, processing, controlling and disseminating scientific and technical information. This estimate also includes a provision for AEC support of Science Information Exchange (SIE), a centralized organization for compilation and dissemination of research and development project information for use of participating Federal agencies in coordinating research and development programs. A summary of activities under this category is as follows:

Technical information services and materials

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Technical monograph and book program	$209,389	$360,000	$300,000
Technical progress reviews	148,171	169,000	175,000
Translations	67,723	120,000	120,000
Printing	145,604	210,000	210,000
Division of technical information extension, Oak Ridge	1,899,380	2,269,000	2,455,000
Related capital equipment	62,347	75,000	60,000
Other	89,541	145,000	210,000
Total technical information services and materials	2,622,155	3,348,000	3,530,000

8. PUBLIC INFORMATION SERVICES, $175,000

The costs incurred in this portion of the training, education and information program classify into two general areas: (1) the duplication for distribution of material designed to keep specialized business and industrial publications and representatives of business concerns informed about AEC policies and programs of interest to them, and (2) the production of motion pictures, securing of stock film footage, purchase of motion picture prints, procurement of duplicating, editing, and laboratory services, etc., for the purpose of maintaining the Commission's still picture libraries located at headquarters and at the New York office, of providing films for distribution through the Commission's 14 motion picture libraries in the United States and overseas, of offering film footage at laboratory costs to private producers and AEC contractors to encourage production of informational motion pictures on atomic energy, and of providing materials for use on educational and commercial TV and radio nationwide.

Summary of estimates by activity

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Printing	$25,192	$30,000	$40,000
(b) Pictorial materials	102,893	135,000	135,000
Total public information	128,085	165,000	175,000

(a) Printing:

Fiscal year 1961	$25,192
Fiscal year 1962	30,000
Fiscal year 1963	40,000

This estimate provides for the duplication by industrial contractor of news releases covering areas of particular interest to business and industry, such as regulatory hearings, licensing actions, staff studies on the economic impact of certain Commission activities, fact sheets on Commission invitations for industrial participation in specific programs, etc. The number and cost of releases planned for fiscal year 1963 as compared with fiscal year 1962 are as follows:

	Fiscal year 1962	Fiscal year 1963
Approximate number of releases	330	340
Average number of pages	6	6-7
Average copies per release	2,450	2,600
Cost per 100 pages	$0.62	$0.62

(b) Pictorial materials:

Fiscal year 1961	$102,893
Fiscal year 1962	135,000
Fiscal year 1963	135,000

(1) Film footage and film production:

Fiscal year 1961	$25,324
Fiscal year 1962	57,000
Fiscal year 1963	57,000

The estimate of $57,000 provides for the production of a limited number of films on various subjects to meet AEC program needs, including at least one on the broad, overall aspects of the national atomic energy program such as public understanding of radiation, or one on the Commission's licensing and regulatory program to provide a better public understanding of how radioactive materials are used safely; the securing of stock film footage of research and development activities to be offered at laboratory costs to private producers and AEC contractors to encourage production of informational motion pictures on atomic energy for use by the Commission, its contractors and other Govern-

ment agencies; and the obtaining of laboratory services for duplicating and editing film negative material.

(2) Motion picture prints:

Fiscal year 1961	$73,343
Fiscal year 1962	75,000
Fiscal year 1963	75,000

Approximately $75,000 will be required to purchase new and replacement prints of motion pictures on atomic energy subjects for distribution through the Commission's 14 motion picture libraries in the United States and overseas. They are loaned within reasonable limits at no cost, to the general public, other Government agencies, Commission and contractor personnel, industrial organizations, professional societies, universities, and other requestors for information and orientation purposes. They are selected for their usefulness in broadening the base of nuclear knowledge at home and abroad, and range from presentation of relatively elementary nuclear energy principles to semitechnical and technical summaries of the U.S. effort in peacetime nuclear research and application. To the extent possible, the funds will also be used to purchase prints and telecasting rights for atomic energy films to be used on the 56 educational TV stations nationwide, for which arrangements are now being made at the request of the Commission with the National Educational Television and Radio Center, and for prints for special educational TV for the State-AEC relations program.

(3) Still photographic laboratory services:

Fiscal year 1961	$4,226
Fiscal year 1962	3,000
Fiscal year 1963	3,000

Specialized laboratory services will continue to be needed in connection with maintaining the Commission's still picture libraries located at headquarters and at the New York Office.

9. INTERNATIONAL CONFERENCES AND EXHIBITS, $1,200,000

The costs estimated for fiscal year 1963 under this category include support of international conferences on nuclear science, and the preparation and presentation of oversea exhibits on the peaceful uses of the atom.

Summary of estimates by activity

International conferences and exhibits	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(*a*) Assistance for international conferences	$110,605	$200,000	$200,000
(*b*) International nuclear energy exhibits	933,432	800,000	1,000,000
Total, international conferences and exhibits	1,044,037	1,000,000	1,200,000

(*a*) Assistance for international conferences:

Fiscal year 1961	$110,605
Fiscal year 1962	200,000
Fiscal year 1963	200,000

An amount of $200,000 is requested to support the requirements for international scientific conferences on atomic energy and related subjects during fiscal year 1963. Since the program of conference support began, there has been an increase in the number of scientific conferences which merit AEC financial support from a programmatic viewpoint. AEC support of these conferences and symposia, as indicated below, averages $9,000 to $10,000 per conference:

	Total number of conferences supported	Amount of support	Average amount per conference
Fiscal year 1958	7	$77,000	$11,000
Fiscal year 1959	11	99,495	9,045
Fiscal year 1960	15	131,444	8,763
Fiscal year 1961	13	110,605	8,505
Total number supported through fiscal year 1961			46
Total amount of support			$418,544
Overall average support per conference			$9,098

Approximately 20 conferences were approved for support in fiscal year 1962. It is estimated that during fiscal year 1963 fund requirements for conference support will remain at the fiscal year 1962 level.

(*b*) International nuclear energy exhibits:

Fiscal year 1961	$933,432
Fiscal year 1962	800,000
Fiscal year 1963	1,000,000

Requirements to support the Commission's nuclear energy exhibits activity during fiscal year 1963 are estimated at $1 million. The two exhibits which are currently touring Latin America and the Middle East were fabricated in 1959 and 1960; each will have been shown four times by the end of fiscal year 1962. Extensive refurbishing, renovating, and probable changes in components will be required to update and repair these exhibits before they can be mounted at further sites. Funds will also be needed during fiscal year 1963 to design specialized smaller exhibits which can be shown more frequently than the two comprehensive exhibits now being presented. During fiscal years 1961 and 1962, AEC exhibits were mounted at the following sites:

Site	*Fiscal year 1961*
Lahore, Pakistan	Nov. 6 to Dec. 2, 1960
Buenos Aires, Argentina	Nov. 1 to Dec. 15, 1960
Rio de Janeiro, Brazil	May 3 to June 4, 1961
	Fiscal year 1962
Lima, Peru	Oct. 7 to Nov. 7, 1961
Beirut, Lebanon	Oct. 8 to Nov. 8, 1961
Mexico City, Mexico	Apr. 2 to May 2, 1962
Athens, Greece	May 6 to June 4, 1962

Exhibits are scheduled as indicated below for fiscal year 1963:

Site	*Fiscal year 1963*
Santiago, Chile	Oct. 20 to Nov. 20, 1962
Bangkok, Thailand	November 1962[1]
Bogotá, Colombia	April 1963[1]
The Philippines or South East Asia	April 1963[1]

[1] Tentative date.

The fiscal year 1963 estimate is based on formal requests from the foreign ministries of Chile, Colombia, and Thailand.

PLANT ACQUISITION AND CONSTRUCTION

TRAINING, EDUCATION, AND INFORMATION PROGRAM—CONSTRUCTION OBLIGATIONS

Program Statement

Estimated obligations, fiscal year 1963	$225,000
Estimated obligations, fiscal year 1962	411,000
Actual obligations, fiscal year 1961	51,884

Obligations for the training, education, and information program for fiscal year 1963 are estimated at $225,000 for the project listed below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations fiscal year 1962
63-1	General plant projects	$225,000	0	$225,000

Explanation of project above:

1. Project 63-1. General plant projects, $225,000

The project provides for capital construction items that are not of sufficient magnitude to constitute separate line item construction projects. These items include improvements, alterations, and additions to the reactor and training facilities at Mayaguez and the biomedical facilities at San Juan, as needed to meet requirements resulting from the conduct of the programs of the Puerto Rico Nuclear Center.

In order to advance the program of nuclear science and technology, it is anticipated that a small, heavily shielded or underground laboratory for counting at low background levels of radioactivity will be provided at Mayaguez. A whole-body counter laboratory, of great value in medical diagnosis, is planned at Rio Piedras. Other miscellaneous improvements, alterations, and additions to PRNC facilities will be provided to meet the requirements resulting from the conduct of the center's programs.

Mr. EVINS. Dr. English, tell us why you need this $932,000 increase, what your programs are and what you expect to accomplish?

Dr. ENGLISH. Thank you, Mr. Chairman. The increase in the training and education program is, we feel, quite modest this year. As the Chairman indicated in his opening statement, the training and education program of the Commission is one which we feel and the Commission feels is very important. It is a way in which the Commission can contribute in some small but significant way to the training of young scientists as they are coming along, not only to supply the need for technical talent for Atomic Energy Commission programs in future years, but since atomic energy will certainly thread its way through many aspects of our life, in all respects radiation is here with us, the early training of promising people is very important.

In the physical and biological sciences where the training program is devoted to the provision of fellowships, operations of some courses, faculty in training in institutes and the provision of equipment grants, the program is essentially at the same level as it was last year. The increases are in two areas, the major increases are in two areas outside those. One is in the training and education of foreign nationals in nuclear science and technology, and the other is increase in information services.

I would like to ask Mr. Kratzer of the Division of International Affairs to speak to that program.

Mr. KRATZER. The increase in our foreign training program is a rather modest one in our view. It is approximately $350,000. It consists of two increases, $200,000 at the Puerto Rico Nuclear Center which, as the committee knows, was set up to provide training for students of Latin American origin at the University of Puerto Rico, and an increase of $150,000 in the program of the International Institute of Nuclear Science and Engineering located at Argonne National Laboratory.

Both of these increases represent increased financing primarily for personnel but no basic change in the program. At Puerto Rico our program is finally getting up to approximately its full initially contemplated staffing level. That $200,000 represents the requirements for increased staff.

At Argonne National Laboratory, the increase is for a few additional temporary staff members to provide instruction in new and broader fields in response to the demands we have had. There are some minor adjustments in other items consisting of the funds which we have for consulting and advisory services but the overall net result is approximately a $350,000 increase.

Mr. EVINS. How large is the Institute in Puerto Rico, including the facilities, laboratories, and equipment?

Mr. KRATZER. The Institute consists of facilities at two separate locations, sir. The major location in terms of investment is at the Mayaguez campus of the University of Puerto Rico located at the west end of the island where their School of Agriculture and Engineering is. At that location we have a research reactor and associated radioisotope labs and also certain facilities that are important in the agricultural use of radioisotopes, greenhouses, gamma radiation sources for the radiation of seeds and so forth.

The other facilties of the Puerto Rico Nuclear Center are located at the Rio Piedras campus of the university, the medical school in the suburbs of San Juan. At that location we have essentially a laboratory building with provisions for the use of radioisotopes in medicine, including teletherapy units. All of these are closely connected and integrated with the new medical facilities of the University of Puerto Rico.

Mr. EVINS. How much is the investment?

Mr. KRATZER. Our overall investment is of the order of $5 million.

Mr. EVINS. Besides this Institute, how many more institutes do you have in the Atomic Energy Commission? The one at Argonne Laboratory?

Mr. KRATZER. The other which has the status of an institute or school is the International Institute of Nuclear Science and Engineering at Argonne. In addition to that we operate courses at the Oak Ridge National Laboratory.

Mr. EVINS. How many students are you training in Puerto Rico?

Mr. KRATZER. We have this year projected to the end of the fiscal year a total of 190 students.

Mr. EVINS. How many are you training at the institutes in this country?

Mr. KRATZER. At Argonne our enrollment is very close to the capacity figure of about 70 per semester or 140 for the school year.

At our two courses, both of which are located at Oak Ridge, one in reactor hazards and one in reactor supervision, the total enrollment is about 25 to 30. I would have to check that figure. But only a portion of these, approximately six or eight in each course, are foreign students. This has proven to be a very useful——

Mr. EVINS. Really most of the training is going on in Puerto Rico outside the United States proper.

Mr. KRATZER. Pardon me, sir?

Mr. EVINS. Most of the training that is going on at the present time is outside the United States?

Mr. KRATZER. The Puerto Rico school is the biggest single operation in this program.

Mr. EVINS. It is bigger than the two in the United States.

Mr. KRATZER. I would say not in terms of student years. The figure which we indicated of 190 is not all full-time students. Many of these are Puerto Rico University students, taking only a few courses at the nuclear center.

Mr. EVINS. I recalled earlier that it was my position, and I still think there is some merit in it, if I do advance it, in bringing the foreign students to this country and let them rub elbows with our students here, and get another point of view and perspective in training here, rather than taking it to them.

Mr. KRATZER. We think this is very important, sir, and we don't look upon the Puerto Rico Nuclear Center in any way as a substitute for training foreign students in continental United States either in our own facilities or in universities in the country. But it does serve two very important purposes.

One, of course, is the Spanish language. Many of these Latin American students are not qualified in English sufficiently to gain anything from education here in the United States. Certainly one of the concepts, but by no means the only one, of the Puerto Rico Nuclear Center is to take those students, where they can absorb the training in the Spanish language up to the point—because they do learn English very quickly there—where they can go on for more advanced training in the United States.

The other importance of the Puerto Rico Nuclear Center is the fact that it constitutes a very fine opportunity to develop training and associated research around some of the special problems of the Tropics, tropical medicine, tropical agriculture, which has a very strong importance and relevance to many of the underdeveloped areas of the world. That is essentially what our goal is down there at this time. The goal of the director, Dr. John Bugher, is to build the center up, to make it a good and excellent center in these fields related to tropical environmental conditions which you really can't do here in the continental United States.

Mr. EVINS. We have all kinds of climates, all kinds of conditions in this country. I trust we are not diminishing our training in the United States.

Mr. KRATZER. No, sir. We find it very important.

REACTOR TRAINING COURSES

Mr. EVINS. The reactor training courses, are they given largely to employees of the Commission?

Dr. ENGLISH. The one in item 1 is given by the operating employees of the Duquesne Electric Power Co., the operator of the Shippingport reactor. They are contract employees.

Mr. EVINS. Are we paying for the training at their reactor?

Dr. ENGLISH. This is a self-financing program. The fees charged are sufficient to cover the cost of the program. In the case of training at the Oak Ridge Institute for Nuclear Studies, for example, the instructors are not AEC employees. They are employees of separate corporations at the Oak Ridge Institute.

TRAINING AND EDUCATION IN PHYSICAL SCIENCES AND ENGINEERING

Mr. EVINS. Please explain the $3,235,000 item for training and education in physical sciences and engineering, $3,235,000.

Dr. ENGLISH. I would like to have Mr. Cera, the Coordinator of Nuclear Education and Training, describe this. At this point let me explain that for the training and educational program in physical and engineering science and in isotopes, the Commission has recently established a new division called the Division of Nuclear Education and Training, which will encompass all these programs which previously had been in three divisions. The new Director of this Division is not here yet. He should report soon—he is Dr. Russell Poor, who is provost of the University of Florida.

Mr. CERA. The major items in that category represent equipment grants to the universities, faculty training through institutes, fellowship programs, and the development of curricula and training aids. The largest single item is the equipment grant program. That is the one shown on pages 298 and 299. Page 299 shows that of the total, about half of it is in the form of equipment grants to the institutions to help build their nuclear laboratory or to acquire nuclear laboratory facilities.

The second largest item is the nuclear materials. This involves the furnishing of neutron sources, graphite, and other forms of materials that they need in the laboratories along with their equipment.

The third largest item, the $350,000, is the program of training of the faculty in nuclear science and engineering.

Mr. EVINS. Tell us how these fellowships are arrived at. Are they made upon application? How are they selected?

Mr. CERA. The program is administered through the Oak Ridge Institute of Nuclear Studies, and the students apply down there, and we have a fellowship board that reviews the applications and makes the selection.

Mr. EVINS. Do they go to any school that they desire?

Mr. CERA. There are now 58 universities that are qualified to teach nuclear science and engineering at the master's and doctoral levels and they can choose any one of the 58 institutions.

Mr. EVINS. How many recipients of the fellowships are presently in training?

Mr. CERA. I think there are about 160. It varies between 150 and 170. Now we are speaking at this point only about the fellowship

program in the physical sciences and engineering. The Commission also has four other fellowship programs in the life sciences.

Mr. EVINS. How do you make selections of the schools to which the grants are made?

Mr. CERA. The schools apply or submit their proposals to Commission headquarters, and we twice a year accumulate the proposals and then through a selection committee go over the proposals and select the recipient institutions.

Mr. EVINS. What is the nature of the nuclear materials?

Mr. CERA. The nuclear materials include—and I might say that most of the materials that we furnish are loaned to the schools, natural uranium, U 235, heavy water and so on. The bulk of the materials that have been loaned to the institution are in the form of natural uranium. They are reject slugs from the Savannah River plant that go into subcritical assemblies on campus.

Dr. ENGLISH. I might point out, Mr. Chairman, if my numbers are correct, that at the present time AEC loans of materials of this sort go to our research reactors which are on university campuses. So there is training being given in all of these cases to young students coming on.

Mr. EVINS. How many colleges and universities at the college level have received grants from AEC?

Mr. CERA. The total is 502 institutions to date.

Mr. EVINS. How much in amount over the years?

Mr. CERA. $22.8 million total.

Mr. EVINS. What is the nature of the grants below college level? I know you have your summer institutes for teachers. How many teachers below college level have participated in your science training programs and how much has been expended?

Mr. CERA. You say below college level?

Mr. EVINS. Yes, high school.

Mr. CERA. There have been no grants made at the high school level. We do have in our life sciences a high school science teacher training program which includes the teaching of radiation biology and this program to give the students an opportunity to show their abilities and includes something like about 26 to 28 institutes for high school science teachers in radiation biology. When those teachers go back to their high schools to incorporate nuclear science into their courses, they are furnished a kit of equipment that has been loaned to them and they can take them back to their high schools to use in their training.

Dr. ENGLISH. So that the record will be complete, Mr. Cera mentioned the figure of $22.8 million as the accumulated total of grants. Now, this is the total in the physical and engineering sciences and the life sciences. The corresponding figure in the biological sciences alone is $4.3 million.

EDUCATION AND TRAINING IN RADIOBIOLOGY AND LIFE SCIENCES

Mr. EVINS. I notice you are asking for $2,985,000 for education and training in radiobiology and life sciences. Do you operate these courses? Do you send your own men there to do the training?

Mr. CERA. No, sir. These are all conducted by universities and colleges and the way they are selected, they submit proposals to the

Commission—and I might say that those are joint arrangements with the National Science Foundation—so that the AEC and NSF receive the proposals from the universities and colleges and then select the institution that will run the institute for the high school teachers in that particular area. AEC contributes about half the cost to that training.

Mr. EVINS. Since you are providing them with the nuclear material, you must give them instructions and information on caution and protection. I notice you have $216,000 budgeted for operation of courses. I was wondering if you operated the course, yourself.

Mr. CERA. Yes, those courses are run by the Oak Ridge Institute of Nuclear Studies and mainly in radioisotopes.

HIGH SCHOOL PROGRAM AND SCIENCE FAIRS

Mr. EVINS. Tell us about your science fairs and your high school programs, and what you are doing in this field?

Mr. CERA. As I indicated, the only high school program that we have is the one in the life sciences for the training of high school science teachers. We this year started a science fair project that I think Mr. Brunenkant might want to address himself to.

Mr. BRUNENKANT. We went into the science fair for the first time this year. Our participation was limited to awards at the National Science Fair, consisting of 10 awards to those students who had what we considered the outstanding exhibit related to nuclear energy. They are going to be given a workweek in science at Argonne National Laboratory some time later this summer.

Mr. JENSEN. Before you leave that, Mr. Chairman——

Mr. EVINS. Mr. Jensen.

(Discussion off the record.)

TRAINING FOR FUTURE SCIENTISTS

Mr. JENSEN. I realize, as I said yesterday, that you are giving these many colleges and universities an opportunity to participate in this program to give the students an opportunity to show their abilities relative to nuclear science and possibly even in some of the smaller colleges and universities you might get the best nuclear scientists.

Now, do you feel that it is paying off to scatter your allocations so widely?

Mr. CERA. Yes, sir. I think it is paying off tremendously in that about 40 percent of all the students that go into graduate work come from these smaller colleges. If they get a good grounding, especially in nuclear physics and radio-chemistry and so on, it will help them tremendously when they do get into graduate work.

Mr. JENSEN. Has this program which you enter into with colleges and universities produced up to this time some outstanding nuclear scientists after graduation? To date have you brought any of these students into the top echelon of the atomic energy activities here in Washington and elsewhere, or has the time element not yet permitted?

Mr. CERA. I think the time element does not really permit that yet, although I would like to say that many of these graduates of the programs that have been established through these educational assistance

activities of the Commission have produced some very high-caliber nuclear scientists and engineers as evidenced by the number of technical papers that they contribute to the American Nuclear Society Journal and other top nuclear energy publications and societies.

Mr. JENSEN. Have the private utilities who are building atomic reactor plants contracted for any of these students up to this time?

Mr. CERA. Yes, sir. I might say that in the last two graduating classes of the masters and doctors in nuclear science and engineering that each one of the graduates has had a minimum of four or five bona fide offers for employment in the atomic field. I might say that the Atomic Energy Commission and its contractors would also like to employ more of these outstanding graduates. In industry, of course, they get a little more money than they do in the Government, but in industry itself there is urgent need for more people.

Dr. ENGLISH. I think it might be well to have Dr. Dunham, with respect to the biological and health physics and interests of the Commission, speak to the same point.

Mr. JENSEN. I am always glad to listen to Dr. Dunham. He is always welcome on board.

Dr. DUNHAM. As far as the radiobiology courses for high school science teachers, it is hard to get a fix on what has come of that yet. As far as our fellowship program that we have had over the years in health physics, industrial medicine, industrial hygiene, it has been very, very successful. Actually, two or three or those have come back to work for the Commission, itself.

Industry snaps them up as fast as they can because there is a shortage in these areas. We feel that it was a very wise decision back in 1949 to start these fellowship programs.

BIOLOGY AND MEDICINE

Mr. JENSEN. Dr. Dunham, I was otherwise engaged this forenoon. I am going to read all your testimony, of course. I would like to ask this question for my own satisfaction at this time. No doubt the other members heard you this morning.

Do you feel that you are making progress in your field in relation to finding cures for some of these human dread diseases?

Dr. DUNHAM. Yes, I feel we are making progress. I mentioned some of the things this morning; not spectacular progress. I mentioned particularly an approach of using radioisotopes in materials that would go to a tumor with the idea of destroying the tumor. This is work which has been underway for a number of years.

We have studied several tumors, spontaneous tumors in dogs, and as sometimes happens the first time it was tried in a human being, it seemed quite successful. A few weeks after it was used the individual died of a stroke which had nothing to do with the treatment for cancer and that particular tumor had disappeared.

Now the next one may be quite different but it gives us hope that we are on the right track in using some old conventional immunological techniques worked out years ago by bacteriologists in attracting to tumors some radioactive materials which will destroy the tissue.

Mr. JENSEN. Have you visited with Dr. Lawrence recently?

Dr. DUNHAM. I saw him a few months ago. I talked to him on the telephone a few weeks ago.

Mr. JENSEN. Is he satisfied with the progress being made at his institution?

Dr. DUNHAM. No, he is never satisfied.

Mr. JENSEN. I know that. He is a pusher. He is a great dedicated man and I have great regard for him.

Will you furnish for the record a statement on the progress that you feel has been made in finding the cause and the hoped for cure of this dread disease?

Dr. DUNHAM. I will be glad to.

(The data referred to follows:)

PROGRESS REPORT ON ATOMIC ENERGY RESEARCH IN MEDICINE

As I indicated this morning when the question is raised as to the cause of cancer it must be admitted that the problem is by no means solved. Nevertheless, considerable progress has been made. For example, viruses are now known to be involved in a number of animal neoplasms, and much has been learned about several factors which are related to the production of cancers. The relationship of radiation to the production of neoplasms is being studied in certain special programs supported by the Atomic Energy Commission and steady progress is being made. Much of this work is not specifically directed toward the overall cause of cancer but involves cancer production as one of the somatic effects of radiation. In some of our extensive small animal radiation effects, studies at our national laboratories leukemia production is one end point and its occurrence is being related to the dose of radiation. The role of viruses is being studied. The relationship of radiation from strontium 90 in bone-to-bone tumors, and the formation of skin cancers by radiation are also being investigated. The AEC also is studying human and animal populations, such as the program of the Atomic Bomb Casualty Commission in Japan, which among other objectives looks for the relationship of radiation to tumor formation.

CANCER DIAGNOSIS AND THERAPY

The Commission has continued to provide leadership in developing the uses of radiation and radioisotopes in medical diagnostic and therapeutic studies. The labeling of molecules with radioactive substances has opened up new techniques for tracing the pathways in the human body of metabolically active substances.

In cancer research, much of the Commission's work is concerned with improved means of applying radiation to destroy cancers, or devising detectors which can accurately locate and define hidden growths after injection of radioactive materials in minute amounts. Breakthroughs in this research, as in all scientific investigations, come rarely, but there is a steady accretion of knowledge and improvements in techniques.

Findings reported in this summary are those which give some indication of future usefulness in medicine. The few results set down are only a selection from the whole record of recent advances. They do, however, serve to indicate the range of events and findings in biomedical research carried out in Commission-owned and financed laboratories.

In both experimental and clinical work with cancer, it is frequently necessary to destroy small discrete volumes of tissue while avoiding damage to surrounding structures. This is particularly true in and about the central nervous system. The volume of destruction depends upon the radiation energy absorbed and on the strength of the radiation source. Nonradioactive materials are fabricated into sources and then are made radioactive by exposure to neutron bombardment. Sources of the pure beta-radiation emitters, palladium 109, yttrium 90 are two source materials that have been fabricated in this way and used extensively.

Palladium 109.—Palladium 109 in the form of a metallic wire has proved a suitable tool for destruction of localized areas of the brain in work at Argonne Cancer Research Hospital. This convenient metallic source can be placed accurately in deep cerebral tissues with the aid of a special needle and fluoroscopic image intensifiers. The fluoroscopic radiation exposure to the patient during insertion approximates that for a gastrointestinal examination. The 13.2 hour

halflife of the isotope and its virtual freedom from gama irradiation simplify handling.

Palladium 109 has been used in this manner with satisfactory results in treating selected patients with Parkinson's disease.

Yttrium 90.—The endocrine influence on the metabolism of certain neoplasms, notably those arising in the breast and prostate, has been well established. Since the pituitary gland controls other endocrine glands by hormones it produces, surgical removal of the pituitary has been used as an endocrinologic method for the control of breast cancer. There can be no doubt that this procedure will produce remissions in some cases.

Because of the difficulty of achieving complete surgical removal of the pituitary gland and because of the operative risk in patients with extensive metastatic disease, the method of implantation of the pituitary with discrete beta particle sources (yttrium 90) using the pernasal transsphenoidal route was developed.

Yttrium 90 oxide pellets are made by irradiation of yttrium 89 oxide pellets. These pellets will pass through a needle which has been incorporated into special instruments for implantation. Usually six such pellets, each with 1 microcurie yttrium 90, are placed in the hypophysis (pituitary). As a result, an average dose of 150,000 rads is delivered with resultant destruction of the gland. Based on autopsy findings the average destruction of the gland is 90 percent by this technique. Results in over 100 cases indicated that, as with other types of hypophysectomy for hormonal dependent tumors, control of the tumor is successful in just over 20 percent of the treated cases.

Diagnostic methods continue to be improved by the utilization of additional isotopes and specific compounds. Iodine 125 is being studied as a more appropriate nuclide than the well-established iodine 131 for certain uses.

Use of iodine 125.—The development of production methods for iodine 125 (thermal neutron activation of xenon), has made available half-curie quantities for clinical experimental studies. For diagnosis of metastatic cancer of the liver I^{125} labeled "Rose Bengal" has been administered and has been found to be distributed uniformly in the healthy liver whereas the cancerous tissue takes up lesser amounts of the label. Metastatic cancer nodules on accessible surfaces of the liver can be demonstrated because radiation originating in the underlying liver is attenuated in passing through the "cold nodule" giving a better scan than that obtained with I^{131} labeled "Rose Bengal."

BRAIN TUMOR LOCALIZATION

Testing a new dye.—The use of detectors or scanners in localization of tumors in the body may also depend on the fact that some radioactive isotopes tend to accumulate to a greater degree in tumor masses than in normal tissue. In a previous study in mice, scientists at Argonne Cancer Research Hospital found that octo-iodo-fluorescein dye labeled with iodine 131 was a suitable agent for localization of some tumors. The ratio of concentration of this dye in tumors as compared to normal tissue ranged from 3 to 1 to 10 to 1. It is eliminated slowly, and satisfactory scans can be made at any time between 2 and 48 hours after intravenous injection, the optimum time being from 5 to 24 hours. Biological properties of this substance appear superior to those of other agents now used.

Improving positron scanning.—The efforts of the neurosurgical groups at Massachusetts General Hospital and the Baltimore City hospitals are directed toward understanding and improved chemical and physical aspects of scanning with the use of positron emitters for brain tumor localization.

Evaluation of a series of copper compounds at Massachusetts General Hospital has aimed at substituting reactor-produced copper 64 for the more expensive cyclotron-produced arsenic 74 as a positron-emitting tracer material. The copper chelate of diethylenetriaminepentaacetic acid (DPTA) gives a higher tumor-to-brain ratio of concentration than does any previously tested copper-containing substance, and now is being evaluated in scanning. Solution of this problem would eliminate a major economic restriction on extension of present positron methods.

One major disadvantage of positron scanning is the relatively high radiation dosage required. An investigation at Baltimore City hospitals is directed to a clinical study of available positron emitters in an attempt to lower this factor. A technique that was developed permitting use of very small amounts of arsenic 74 as arsenate improved the clarity of the scanner's tumor images.

Another scanner system also has been used successfully with the same radioisotope to delineate persistent effusions beneath the brain covering in infants.

The preparation of labeled conjugates (paired compounds) and the concentration of these materials in tumors versus normal tissue is under study. Sodium arsenate and a variety of compounds labeled with copper 64, also are being measured in mice with transferred human tumors and other tissues. Preliminary results indicate that significantly higher concentrations of these conjugates may be found in tumors compared with sodium arsenate.

HIGH ENERGY RADIATION THERAPY

The properties of the linear electron accelerator at Argonne Cancer Research Hospital have suggested advantages in its use in a number of clinical conditions.

It is hoped that treatment by the linear accelerator may be substituted for surgery in certain malignancies of the head and neck where the electron beam would be less harmful to underlying structures in the base of the skull and spinal cord. In the case of carcinoma of the parotid gland, electron treatment can limit the resulting inflammation to the lateral portion of the oral and nasal cavity, thus allowing the patient to maintain adequate food intake during treatment. At the same time, the opposite parotid gland can continue to function. Similar results are noted in treatment of carcinoma of the tonsil.

One limiting factor to radiation teletherapy for tumors of the urinary bladder is the radiation effect on the nearby bowel. The linear accelerator is ideally suited for treatment in urinary bladder tumors because of the sharp falloff in dose beyond the focal point. A single anterior portal can be used, an adequate dose of radiation can be delivered to the tumor, and yet the dose to the bowel is kept to a level where serious complications do not arise. Several patients with bladder tumors have been treated with good early results, and the patients do not seem to have the extremely severe bladder reactions connected with use of other forms of radiation therapy.

Most patients so far treated had extremely extensive tumors or had had previous surgery. The results may warrant its use in treatment of smaller, unoperated tumors.

CESIUM 137 TELETHERAPY

At the University of Michigan Medical Center and at the Oak Ridge Institute of Nuclear Studies cesium 137 teletherapy has been studied for several years. Cesium 137 is a byproduct material of fission, and readily available. It has a half-life approximately six times that of cobalt 60. Cesium 137 radiation appears to be most promising as a replacement for standard high-voltage X-ray in the range of 200–250 kilovolts where cesium 137 allows increased depth dose and provides a decrease in skin reactions.

STUDIES OF ANTIBODY THERAPY

Research at the University of Rochester atomic energy project, directed toward use of fibrinogen and antibodies as radioisotope-labeled carriers to irradiate human cancer widely spread in the body, has shown that, in a variety of experimental animal cancers, the radioactive antibody to fibrin (the protein meshwork of a blood clot) will localize in tumor tissue. It is hoped that highly radioactive antibodies can be prepared with enough specificity for localizing in human cancer after intravenous injection so that cancer lesions too diffuse for treatment by other types of radiation or not surgically accessible can be effectively destroyed by the radiation carried by the antibody.

Many tumors have an appreciable fibrin content and this fibrin is able to bind the circulating radioactive antibody, so that tumor tissue anywhere in the body is selectively irradiated by the radioactive antibody. In treated animals, tumors disappeared and did not recur; most of the untreated animals died from extensive tumor growth.

A significant finding at Rochester is that epsilon aminocaproic acid (EACA), which slows down or prevents the natural dissolution of blood clots in the process of wound healing, also greatly augments the amount and duration of the radioactive antibody fixation in many animal tumors. Probably, after administration of EACA, the fibrin deposited in tumors stays there longer and furnishes more sites for antibody binding.

This research effort has been extended to experimental radiation therapy of spontaneous dog cancer, and to tracer studies of antibody localization in human cancer. Clinical work in cooperation with the National Institutes of Health has shown that the antibody to human fibrin localizes in some types of human brain cancer.

In the few patients studied thus far, good localization of iodine 131 labeled fibrin antibody has been obtained after administration of EACA. The inhibitor drug was well tolerated with no apparent immediate or latent toxicity, and remissions have been obtained with marked clinical improvement. The investigators hope that these, and similar, techniques may give improved results in the treatment of advanced human cancer.

PITUITARY IRRADIATION

The 184-inch synchrocyclotron, which producers a 900-million-electron-volt beam of alpha particles, has been used at the Lawrence Radiation Laboratory, University of California, Berkeley, to destroy the pituitary gland selectively in patients with pituitary tumors and for palliative control of widespread breast cancer.

In patients with generalized breast cancer, remissions of from 12 to 18 months have been obtained. Reasons why the relief is temporary are being sought.

Pituitary irradiation has been observed to slow down a particular type of blindness sometimes occurring in certain patients with diabetes. In a study of patients, this type of blindness was arrested in more than half following pituitary irradiation. The work has indicated that the pituitary does not have to be destroyed entirely to produce this beneficial effect. In these patients it is also possible to cut down on their insulin requirements by 20 to 40 percent. Heavy particle irradiation is also being applied to other problems, and proton beams have elsewhere been used to advantage in certain inoperable brain tumors and in Parkinson's disease.

OTHER MEDICAL STUDIES

Role of manganese in central nervous system disease

Parkinson's disease is a slowly progressive, degenerative disease of the central nervous system occurring in adults; it results in rhythmic tremor of resting muscles and associated stiffness and slowing of movements. It may be induced in man by inhalation of manganese ore dusts and by the use of some tranquilizing drugs. Such induction of Parkinsonism does not imply that these materials are the sole causes, but the fact that the disease may be produced by manganese led to the present studies of this metal. Investigations at Brookhaven National Laboratory have centered on measurements of manganese metabolism in the body both before and after administration of drugs and hormones. The manganese pathway has been established in normal animals, and progress is being made in verifying this pathway in normal persons to form a basis for determining whether a distinct alteration or deviation in distribution and excretion occurs in patients with this disease.

Sugar metabolism and diabetes

Glucose labeled with radioactive carbon (carbon 14) has been used at Brookhaven National Laboratory to measure the degree of impairment of carbohydrate metabolism in diabetic patients and to test the efficacy of new oral compounds as replacements for injected insulin.

The general extent and metabolic pathways of formation of blood glucose have been studied in patients with different types of diabetes. This has been done by analyzing the total amount and molecular distribution of carbon 14 appearing in blood glucose within 2 hours after intravenous administration of precursors of glucose such as lactate and pyruvate labeled with carbon 14.

At times of maximum activity (about 1 hour after injection), the amount of carbon 14 in free body glucose ranged from 15 to 30 percent of the administered amount. These minimal figures for degree of conversion indicate that glucose formation may be a major product formed by blood lactate, at least in the diabetic. Both insulin and tolbutamide (in sensitive patients) reduced by 50 percent the apparent incorporation of carbon 14 into glucose when injected as the labeled lactate and pyruvate. These findings suggest the treatment has some early inhibitive effect on the production or release of glucose by the liver.

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Uric acid metabolism in gout

Using radioisotopes labeling of molecules, the metabolism of uric acid in normal subjects and in pathological conditions such as gout, polycythemia, and leukemia has been investigated at the Argonne Cancer Research Hospital.

By labeling uric acid components with carbon 14, and identifying and measuring it subsequently, it has been established that the intestinal tract is an important excretory pathway for uric acid in man. Normal persons appear to excrete one-third of their uric acid in digestive juices. In pathological conditions associated with a high concentration of uric acid in the blood, this type of excretion is still more important since it does not depend on the kidneys.

Studies of this type in gouty patients have indicated that primary gout can be divided into two types: (*a*) Primary metabolic gout characterized by an overproduction of uric acid, and (*b*) primary renal gout, characterized by normal production and reduced excretion, apparently due to dysfunction of the renal tubules. Three types of secondary gout were identified: (*a*) Secondary to blood dyscrasias (disorders) associated with an increased breakdown of nucleic acids in cellular destruction; (*b*) secondary to renal diseases in which there is a reduced glomerular filtration rate; and (*c*) drug-induced gout in which a drug (chlorothiazide, pyraxinoic acid) interferes in the renal excretion of uric acid.

Mr. EVINS. Mr. Pillion.

Mr. PILLION. Dr. Dunham, are you acquainted with the Roswell Park Memorial Institute in Buffalo?

Dr. DUNHAM. Yes.

Mr. PILLION. It is one of the large cancer institutes.

Dr. DUNHAM. Right; and a very good one.

Mr. PILLION. Thirty years ago they were using radium needles for cancer. So what is remarkable about your statement of someone using radium-treated or nuclear-treated instruments in placing it into a cancerous tissue? What is new about that? We can't support these terrific millions of dollars based upon an isolated little sticking of a needle into a tumorous area of the body. That has been going on for 30 or 40 years.

Dr. DUNHAM. Actually, this is not sticking a needle into the tumor. There was very nice work done at Roswell Park a few years ago which showed that brain tumors take up certain types of materials and it has now become a fairly standard method of diagnosing brain tumors and finding out where the tumor is.

Mr. PILLION. That is nothing new.

Dr. DUNHAM. This is simply one step further.

Mr. PILLION. It is not new at all. It does not justify these tremendous funds. It is an old, established medical situation going back 30 or 40 years.

Mr. JENSEN. This is a different technique that you hope will find the cause and eventually the cure for these human dread diseases.

BUDGET INCREASES

Mr. PILLION. I was surprised with the statement made by the witness, Doctor, saying that the increase of $932,000 in a $42 million budget was very modest. The gentleman who talked about foreign training said the $350,000 additional amount was also very modest.

Now I just don't think that such increases all through the budget are exactly modest, in view of the $9 billion deficit this year and probably $10 or $15 billion deficit next year. I am just wondering about the attitude of the gentlemen of the Atomic Energy Commission and

whether they relate any of this spending to the ability of this country to pay for it all.

It just seems to me that the spending here is wholly unrelated to practical objectives or the ability of this country to pay for all these very desirable but seemingly unnecessary expenditures.

I am concerned about the attitude that a 6½-percent increase, or $10 million or $15 million, are all modest figures. It just seems it is growing like Topsy with seemingly no control. We get explanations here of all this spending and so far as I can understand it, Mr. Chairman, every explanation I have heard has been in general, vague terms, generalities, with no specifics whatever.

You are talking a language here that is ephemeral; up in the clouds. Nowhere can you pin anything down as to what the practical result is to this country or economic value. Everything is generality and vagueness. I want to leave that on the record.

Mr. EVINS. Certain members of the Atomic Energy Commission have a different definition than members of this committee as to what is modest and relative.

Mr. PILLION. That is right.

ISOTOPE DEVELOPMENT

Mr. EVINS. We have Dr. Paul C. Aebersold, Director of the Division of Isotope Development. Please insert pages 332 through 343 and the associated construction pages.

(The data referred to follow:)

OPERATING EXPENSES

ISOTOPES DEVELOPMENT PROGRAM—OPERATING EXPENSES

Program statement

Estimate, fiscal year 1963	$7,462,000
Estimate, fiscal year 1962	5,884,000
Increase	1,578,000

The isotopes development program is designed to extend and accelerate the development of new technology for widespread use of radioisotopes and radiation in engineering, agriculture, medicine, and research. It recognizes that a timelag exists between the discovery through basic research of new radioisotope and radiation principles, and their practical, beneficial application throughout science, technology, and areas of public benefit. The research and development program being carried out is serving to bridge this gap.

Emphasis under this program is given to development of large-scale economic uses of fission product wastes arising from nuclear reactor operation. Principal research and development is also directed to developing solutions to longstanding national problems in meteorology, seismology, control of environmental pollution, and water resources development.

Major subdivisions of this program include radioisotope technology development, isotopic power fuels development, radioisotope production and separations technology, process radiation development, and radiation pasteurization of foods.

Summary of estimates by category

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Radioisotope technology development	$1,083,118	$1,400,000	$1,500,000
2. Isotopic power fuels development	605,071	1,284,000	1,922,000
3. Radioisotope production and separations technology	1,005,006	1,300,000	1,775,000
4. Process radiation development	1,126,243	1,500,000	1,965,000
5. Radiation pasteurization of foods	347,075	400,000	300,000
Total isotopes development program	4,166,513	5,884,000	7,462,000

JUSTIFICATION OF CATEGORIES

1. Radioisotope technology development, $1,500,000

The objective of this research and development is to create a broad base of new and improved technology required for extending and speeding up the application of radioisotopes in engineering, agriculture, medicine, and research. Emphasis is directed primarily at bridging "gaps acting as roadblocks" critical to advancing the use of radioisotopes. This objective is being pursued through sponsorship of numerous and varied research and development project with universities and colleges, private research organizations, and AEC national laboratories.

(*a*) Applications safety testing:

Fiscal year 1961	$156,432
Fiscal year 1962	250,000
Fiscal year 1963	300,000

This activity provides for the development of testing procedures and safety standards for radiosotope techniques, applications, and devices to assure that they meet the necessary requirements for public safety. Such a program will help to accelerate the peaceful uses of radioisotopes by (*a*) providing regulatory groups with technical guidance in establishing safe yet practical regulatory practices, (*b*) giving the public added assurance that radioisotope devices have met standard test procedures, and (*c*) giving manufacturers definite test goals to meet. The National Bureau of Standards, the AEC's national laboratories, the Underwriters' Laboratory, Inc., and other groups that have special competency in the testing field, will participate in this research.

(*b*) Isotope analytical technology:

Fiscal year 1961	$317,774
Fiscal year 1962	415,000
Fiscal year 1963	430,000

This activity provides for the establishment of a practical, reliable base for broad application of isotopic analytical techniques to areas important to the national interest. i.e.:

Water resources investigation
Stream pollution
Air pollution
Crime detection
Biological assay
Textile identification
Products and soils
Food contamination
Special chemical analysis

Practical development of neutron activation and radiometric methods of analysis, coupled with sensitive radiation measurement systems, will permit instantaneous analysis of a whole spectrum of materials not now possible by other methods. Importantly, these techniques will also increase the limits of sensitivity for many additional elements and afford the means to increase resolution by computer techniques.

(*c*) Low-level tracer technology:

Fiscal year 1961	$120,105
Fiscal year 1962	140,000
Fiscal year 1963	140,000

Low-level tracer techniques possess capabilities for making important technical, scientific measurements not permissible with higher levels of radioactivity not possible by conventional methods. Continued research and development will be conducted on environmental problems of public interest and on engineering problems. A long-range program to develop low-level tracer techniques for the investigation and removal of pesticide residues in food has recently been initiated and will be continued. Other potential applications include the development of techniques for testing quality control of cement in roadbuilding operations and control of waste effluents being discharged into streams. Research aimed at the development of techniques to measure the flow of water currents indicates real promise in the measurement of deep ocean currents.

(*d*) Isotopic measurement systems:

Fiscal year 1961	$180,563
Fiscal year 1962	190,000
Fiscal year 1963	215,000

Significant advances in developing the spectrum of radioisotope applications require continuing developments in radiation detection and measuring techniques. Sensors are needed to meet the environmental extremes of space and planetary exploration and for ruggedized isotope equipment used in diverse field applications. Development of more sensitive measurement systems are especially needed in measuring the extreme tracer dilutions required in water resource investigations, oceanographic current measurement, chemical process monitoring, and radiation safety monitoring. Additional emphasis is planned for detection systems to attain the ultimate in sensitivity for tracer and contamination monitoring. New developments in scintillation fiber optics, solid state sensors, and neutron sensors will be investigated for practical utility.

(*e*) Advanced methods technology:

Fiscal year 1961	$262,441
Fiscal year 1962	355,000
Fiscal year 1963	365,000

Basic research studies have identified several phenomena in the interaction of radiation with matter which may have unique capability for establishing the constituency and integrity of materials or components without damaging their utility. Development of advanced systems utilizing interaction phenomena, such as neutron absorption and Compton scatter, will permit, for example, predetermination of missile, aircraft, and high-speed machinery reliability. X-ray fluorescence, Rayleigh scatter, alpha, beta and neutron scatter, and neutron capture reactions promise to extend the capability for analysis of elemental constituents in oceanography, meteorology, air pollution, food handling, sanitation engineering, roadbuilding, and natural resource exploration and evaluation. Numerous other potential applications for radioisotopes exist which require long-range investigation. For example, the extreme sensitivity of the resonant absorption associated with the Mossbauer effect for sensing velocity, acceleration, and magnetic and gravitational fields may extend inertial navigation and space exploration capabilities. Work will also continue on the development and refinement of ionization technology and radioisotope-activated light sources.

(*f*) Related capital equipment:

Fiscal year 1961	$45,803
Fiscal year 1962	50,000
Fiscal year 1963	50,000

The nature of the research and development performed at times requires the use of unique and specialized equipment. Funds requested are primarily for the purchase of a 400 channel transisitorized analyzer for research applications in radioactivation analysis and low-level gamma counting, as well as other items of equipment.

2. Isotopic power fuels development, $1,922,000

This category is directed at the development and production of isotopic fuels and fuel forms for auxiliary power devices. Involved in the production of fuels for specifically planned SNAP and other applications as well as general research and development looking to new and improved fuels and fuel forms to satisfy future requirements. This category represents a reorganization and consolidation of efforts previously budgeted under the satellite and small power sources category of the reactor development program and the raidoisotope

technology development category of the isotopes development program. A comparative transfer of the fiscal year 1961 and fiscal year 1962 costs has been effected. Substantially increased funding is required in fiscal year 1963 to assure meeting NASA Surveyor flight schedules for fiscal year 1964 and subsequent years. The following activities constitute the planned effort and fund requirements for fiscal year 1963:

(*a*) Curium 242 power fuel development and production:

Fiscal year 1961	$583,000
Fiscal year 1962	1,194,000
Fiscal year 1963	1,487,000

Funds requested for this activity are to provide the curium 242 isotopic fuel for SNAP 11 (Surveyor) units being developed by the reactor development program for NASA. Included are costs of research and development necessary to develop suitable fuel forms and production capabilities. The estimates for fiscal year 1963 also include $225,000 for American targets for curium 242 production, as well as $130,000 for irradiation charges.

(*b*) Other isotope fuels technology development:

Fiscal year 1961	$22,071
Fiscal year 1962	90,000
Fiscal year 1963	435,000

This activity provides for a comprehensive research and development effort directed at the development of new and improved isotopic fuels for power generator utilization. A variety of fuels and fuel forms are needed to meet both known and anticipated requirements of the SNAP and other programs in the area of aerospace, military, scientific, and other applications. Specialized applications dictate the development of fuels with unique characteristics and power producing capabilities. Included are costs of producing experimental fuels for testing with test generators as well as developmental costs leading to such production.

3. Radioisotope production and separations technology, $1,775,000

This category is directed at fulfilling the Commission's responsibilities of insuring the overall availability and safety of radioisotopes and radiation sources required to meet the changing needs of the Nation's advancing science and technology. This research and development supports the Commission's radioisotope distribution program (Oak Ridge), which provides the principal domestic supply of radioisotopes for use in medical and agricultural research, educational and industrial applications.

(*a*) Process research:

Fiscal year 1961	$353,566
Fiscal year 1962	360,000
Fiscal year 1963	485,000

This activity provides for research and development activities designed to improve existing radioisotope production processes, create new radioisotopes and processes, and advance technology and production techniques related to the more than 100 radioisotopes distributed by the Commission. This includes development of processes to recover, separate, and purify fission product radioisotopes from both production and power reactor chemical reprocessing effluents. Also included are waste decontamination development of solvent extraction flowsheets, and studies of radiation effects on chemicals and recovery processes. Research will continue to be directed toward improvements of product purities and yields. Tests and experiments to develop reactor loops for continuous production of I–125 and C–14 will be increased. Development work in the preparation and purification of target materials related to the use of the 86-inch cyclotron for the production of special isotopes will also be included.

(*b*) Production and engineering development:

Fiscal year 1961	$259,009
Fiscal year 1962	230,000
Fiscal year 1963	365,000

This activity provides for design, engineering services, and chemical engineering development of unit process operations and equipment in support of radioisotope production activities. Included are equipment, research and development, and engineering services related to fission product recovery. Also in-

cluded is the research and development required to make available calcined waste or mixed fission product sources for beneficial use as heat and/or radiation sources. Subsequent to fiscal year 1962, it is expected that emphasis in activities at Oak Ridge National Laboratory will be placed on development programs such as equipment testing and evaluation, and/or pilot plant demonstration tests of new flowsheets and equipment for utilization by megacurie plants at other sites. In addition, included are support studies of beam characteristics and excitation functions to provide usable amounts of relatively rare neutron dificient isotopes to be produced with the 86-inch cyclotron, and a Brookhaven National Laboratory program in support of production development and distribution activities at that site.

(*c*) Source technology and safety development:

Fiscal year 1961	$130,234
Fiscal year 1962	210,000
Fiscal year 1963	385,000

This activity provides for development work on safe, stable forms of radioisotope compounds, source fabrication and encapsulation, and definition of chemical, physical, and nuclear source characteristics. This includes fabrication, evaluation, and testing of actual sources to develop standards and technology to assure safety. It also provides for development of technically sound safety testing criteria as a basis for establishing standards for radioisotope sources. Such standardized testing and safety procedures will assist in (*a*) development of safer sources; (*b*) revising as necessary the AEC and State scientific licensing criteria for several radioisotope applications; and (*c*) creating a better atmosphere of acceptance of radioisotopes by the general public, industrial management, and labor unions. The scope of research and development to assure safety will be enlarged to include development and testing of reliable and improved radioisotope source containers.

(*d*) Isotopic enrichment:

Fiscal year 1961	$20,199
Fiscal year 1962	50,000
Fiscal year 1963	90,000

This activity encompasses research and development of ultrapure high-specific activity radioisotopes for advanced medical, biological, agricultural, chemical, and physical research. It also provides for reactor research involving high flux reactors (HFIR) related to production of new radioisotopes by methods other than (n, γ) reaction. The level of effort will be modestly increased to permit demonstration of enrichment techniques and radioisotopic enrichment pilot plant tests.

(*e*) Related capital equipment:

Fiscal year 1961	$241,998
Fiscal year 1962	450,000
Fiscal year 1963	450,000

This activity provides for the equipment and nonconstruction items necessary to support production and research and development activities such as production tools and equipment, shipping casks and containers, laboratory instruments, and research prototype equipment.

4. Process radiation development, $1,965,000

This program is concerned with developing technology basic to productive utilization of the vast quantities of radiation energy available from fission products and other radiation sources. The program has two main aspects: (*a*) Radiation engineering (activities (*a*) through (*c*) below) which is concerned with design and engineering of radiation sources and facilities and the physical aspects of radiation interaction with matter; and (*b*) process feasibility (activities (*d*) and (*e*) below) which is concerned with the radiation chemistry of radiation reactions and development of the process technology for future practical utilization. Based upon past progress in the foregoing areas and the completion of the high intensity radiation development laboratory (HIRDL) at Brookhaven National Laboratory, a much-needed, intensified level of effort is planned for this program. The increase of $465,000 in fiscal year 1963 is attributable to these efforts and the cost of radiation sources for use in HIRDL experimentations.

(*a*) Source engineering:

Fiscal year 1961	$295,094
Fiscal year 1962	300,000
Fiscal year 1963	300,000

This activity is concerned with the various types, physical characteristics, and means of containment of radiation sources valuable for radiation processing. It is necessary to investigate geometrical configurations of radiation sources in relation to the material being irradiated. Similarly, present methods of source encapsulation are specific to the few isotopes now available in appreciable quantities. To provide greater versatility in radiation source utilization an increased variety of techniques of encapsulation must be developed and methods expanded to included a spectrum of gamma and beta emitting isotopes. A further deterrent to progress is the lack of standardized, flexible, simple, inexpensive materials which can be readily adapted to a variety of radiation processing situations. Research and development in this area will serve to overcome certain of the technological difficulties in radiation processing and will reduce costs. Additionally, promising processes, technically or economically unfeasible in terms of the present limited number of radiation sources which have been investigated for use, are likely to become practical if other types of sources are developed. Accordingly, it is essential that a large variety of radioisotopes be investigated to identify those which might be productively employed for radiation processing.

(*b*) Facility design:

Fiscal year 1961	$95,008
Fiscal year 1962	200,000
Fiscal year 1963	155,000

Along with radiation sources, safe, efficient, economical facilities are necessary if widespread productive utilization of radiation is to be achieved. Very little experience exists in this area. It is therefore essential that both general and specific radiation facility designs be developed. Included in design research must be study of safety problems such as self-heating of the radiation sources by radioactive decay to the point of melting, accelerated corrosion of critical components in the presence of intense radiation fields and warping and possible leakage of source capsules under thermal and radiation stress.

(*c*) Dosimetry systems:

Fiscal year 1961	0
Fiscal year 1962	100,000
Fiscal year 1963	110,000

Inadequate dosimetry systems have limited progress in the whole field of radiation processing. Dosimeters for liquid, solid, and gaseous systems must be developed. Wide differences in results among scientists working in the same area have resulted from poor dosimetric systems. Adequate systems must be developed and standardized and new materials and methods sought to fill gaps in dosimetry technology.

(*d*) Process radiation chemistry:

Fiscal year 1961	$441,015
Fiscal year 1962	350,000
Fiscal year 1963	510,000

This activity forms the heart of most potential radiation processes. Included in this category are studies of polymerization, graft copolymerization, radiation effects on colloidal systems, initiation of chemical reactions, and sterilization processes. These studies provide basic essential technical data for the development of practical radiation processes and also provide new ideas and concepts for future development.

(*e*) Process engineering research:

Fiscal year 1961	$228,055
Fiscal year 1962	300,000
Fiscal year 1963	510,000

This activity entails engineering research and development of promising radiation systems uncovered by process radiation chemistry research. It entails demonstration of the feasibility of translating laboratory results into practical processes. In conjunction with this work there must be carried out studies

which not only gage the useful potential of a particular process but also provide information on the technical and economic limitations inherent in the proposed system. These studies are the final stage of research and development before private industry carries out the necessary work for making specific processes commercially useful and feasible.

(*f*) Related capital equipment:

Fiscal year 1961	$67,071
Fiscal year 1962	250,000
Fiscal year 1963	380,000

Normal equipment requirements to support the process radiation development program at Brookhaven National Laboratory will require funds in the amount of $120,000 in fiscal year 1963. Procurement of radiation sources upon which research will be conducted in the high intensity radiation development laboratory will require funds in the amount of $260,000.

5. Radiation pasteurization of foods, $300,000

(*a*) Research and development:

Fiscal year 1961	$179,042
Fiscal year 1962	355,000
Fiscal year 1963	300,000

The Atomic Energy Commission is continuing a minimum program in radiation pasteurization of foods. During fiscal year 1962 the research and development program covered work on radiation pasteurization of selected fruits and vegetables. Experimentation was initiated to define radiation parameters on east, west, and gulf coast fishery products and west coast fruit products. The program planned for fiscal year 1963 will provide for continuation of the most essential contracts on both fish and fruit products at approximately the fiscal year 1962 level of effort.

(*b*) Related capital equipment:

Fiscal year 1961	$168,033
Fiscal year 1962	45,000
Fiscal year 1963	----------

Three food research irradiators were completed and placed in operation through fiscal year 1962. Existing equipment is sufficient to support the proposed level of research and development planned for fiscal year 1963.

PLANT ACQUISITION AND CONSTRUCTION

Isotopes Development Program—Construction Obligations

Program statement

Estimated obligations, fiscal year 1963	$390,000
Estimated obligations, fiscal year 1962	171,000
Actual obligations, fiscal year 1961	1,293,705

Obligations for the isotopes development program for fiscal year 1963 are estimated at $390,000 for the project listed below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations, fiscal year 1963
63-j-1	Isotopes technology laboratory, Oak Ridge National Laboratory, Tennessee.	$390,000	----------	$390,000

EXPLANATION OF PROJECTS ABOVE

1. Project 63–j–1—Isotopes technology laboratory, Oak Ridge National Laboratory, Tennessee, $390,000

This project provides for the construction of additional facilities at the Oak Ridge National Laboratory required to carry out research and development studies on radioisotope applications, isotopes technical information evaluation, on-the-job training in isotope applications, and production and development to advance the general field of isotopes technology in this country and abroad.

In fiscal year 1963 the scope of the radioisotope development program at ORNL will be increased. The present research program will be expanded and will be combined with related programs now administered by the Division of Isotopes Development as contracts with many different organizations. In addition to an increased effort in the existing ORNL radioisotope development programs in the fields of source technology, radioisotope enrichment, process chemistry, and production development, and the training of visiting scientists, additional programs of isotope technology development and radioisotope technical information evaluation will be initiated. Also the training of visiting scientists in radioisotope production techniques and radioisotope technology will be expanded to include a greater number of both domestic and foreign trainees and to provide a more formalized training program.

The proposed building will be a three-story structure designed to provide office, laboratory demonstration, and support facility housing for scientific personnel engaged in these activities. As such it will complement the newly constructed radioisotope development laboratory. The first floor will provide a demonstration hall, conference room, an office, a lobby and reception area, toilet facilities, and a room for building equipment. The second and third floors will provide a low-level practice laboratory, lunchroom, and offices for scientists and technicians.

Mr. EVINS. Doctor, will you tell us the need for the increase in the appropriation of $1,578,000, making a total of $7.462 million?

Mr. AEBERSOLD. As you know, Mr. Evins, in your State, at Oak Ridge, Tenn., we have the Oak Ridge National Laboratory, which has a major responsibility for isotope production and development. Our program has the objective of finding new use for isotopes; also producing new radioisotopes.

(The following additional information was provided:)

Most of the increase requested is to permit efficient utilization of AEC's newly completed isotope and radiation research laboratories at Oak Ridge National Laboratory and at Brookhaven National Laboratory. For example, $475,000 will be utilized at Oak Ridge to help support the AEC's Radioisotope Development Center, a coordinating activity for broad scope radioisotope research of national importance. Such research includes the development of new radioisotopes urgently needed to meet rapidly changing needs in science, medicine, and agriculture.

Similarly, $465,000 is needed to provide adequately for use of the just completed High Intensity Radiation Development Laboratory (HIRDL) at Brookhaven, and to support the newly established Radiation Development Center. This center has the objective of achieving efficient utilization of the vast energies potentially available from high level radiation created as a byproduct of atomic energy operations. Uses presently foreseen include practical methods of processing foods, pharmaceutical and surgical supplies, plastics and chemicals, valuable both in terms of our economy and of our national defense. Large radiation sources required for HIRDL account for $260,000 of the amount needed.

The isotopic power fuels development program is directed at development of radioisotopic heat sources in safe form for SNAP and other power unit needs. An increase of $638,000 is required to develop and provide curium 242 heat-power sources in support of the NASA "Surveyor" moon landings project, an important part of the national space program. Over half of this amount is required for the americium 241 target material and the necessary reactor irradiation charges.

Mr. EVINS. Doctor, you may submit the rest of your statement for the record. Please tell us how your $300,000 program for radiation and pasteurization of food, shown on page 343, relate to your $200,000 program for the same thing on page 290.

Dr. AEBERSOLD. As Dr. Dunham testified, there are two facets to this program: One is concerned with developing the practicality of this method of food preservation, such as the parameters of shelf life extension, the microbiological spoilage involved, the practical matters of shipping and shelf life extension, and so on. This is in our part of the program. We are also responsible for the development of radiation techniques and design of irradiators.

In Dr. Dunham's program they are concerned with the wholesomeness and nutritional value of the food. These are two separate, but related items.

Sir, I have a brief summary of progress in the isotopes development program which I would like to submit.

Mr. EVINS. You may include it in the record.

(The information referred to follows:)

BRIEF SUMMARY OF PROGRESS, ISOTOPES DEVELOPMENT PROGRAM, 1961

The Commission's isotopes development program made important strides in 1961 toward its objectives of—

1. Developing nonpower uses of atomic energy to help solve longstanding national problems, for example, in the control of environmental pollution, water resources management, weather determination and criminology, as well as for space exploration and the national defense and security.

2. Developing large-scale economic uses of fission product wastes created by nuclear power development in the United States. Fission products represent the largest, and potentially the most economical, source of radioactive energy to satisfy current and future demands for radiation sources and heat-power sources.

Particularly important is our progress over the past 12 months in the following areas.

PROJECTS RELATED TO NATIONAL DEFENSE AND SECURITY PROBLEMS

Missile performance.—A radioisotope quality control method is being developed to eliminate many costly failures in missile electronic systems.

Aircraft safety.—A cooperative project with FAA is now being undertaken to develop, fabricate, and test a nuclear system for detecting bombs hidden in aircraft luggage which will give increased assurance of safety to commercial airline travel. In wartime, the system could be very important to national defense.

Space environment analyzer.—A unique process has been developed for introducing inert radioactive gases into a variety of host materials. This principle is now being studied by the Air Force to sense poisonous missile exhaust, and by NASA to analyze planetary atmospheres.

Weather data from high altitudes.—A radioisotope technique is being developed in cooperation with the U.S. Weather Bureau for measuring those changes in upper atmosphere density having a profound influence on weather patterns. The Air Force is also adapting the technique for altimeters to be used on the X–15 aircraft and future manned space vehicles.

PROJECTS RELATED TO DIRECT GOVERNMENT PROBLEMS

Narcotics identification.—A nuclear activation analysis technique has been developed which may serve to identify geographical origin of opium and other narcotics. The U.S. Treasury Department is watching this project and, if successful, it will aid their policing of the narcotics traffic from various parts of the world.

Crime detection.—A neutron activation technique is being developed for positive identification of persons through determination of differing amounts of trace elements, such as selenium, copper, gold, and chromium, in hair, blood, and skin

samples. This can serve as another type of "fingerprint" of an individual. The technique can be of significant value to criminal investigatory bodies, such as the FBI.

Water resources management.—A radioisotope method for determining underground storage capacity of ground water has been successfully developed and used at Lake McMillan, N. Mex. The radioisotopes test method provides accurate knowledge of the quantity of stored water in natural underground reservoirs not possible through any other means. Accurate knowledge of underground water reserves will have a profound effect on water use and management, particularly in "water scarce areas." Estimated water losses due to evaporation in the 11 Western States amount to 10 percent of the total.

Water pollution control.—A deepwater isotopic current analyzer has been successfully demonstrated for accurately determining rate and direction of water currents in bays and estuaries. This isotopic device, tested in the Chesapeake Bay, is expected to have a significant impact on the control of water pollution and silt movement.

Hydroelectric turbine rating.—A radioisotopes method for rating of hydroelectric turbines with accuracies of 1 to 2 percent has been successfully developed and tested at TVA installations in Tennessee and Kentucky. The radioisotope turbine rating method is easier to perform, more accurate and cheaper than conventional techniques. Comparative cost between the isotope method and conventional methods is approximately $500 to $25,000. Over the next 3 years, the Bureau of Reclamation plans to use the isotope method for rating approximately 70 hydroelectric turbines.

Ocean bottom analyzers.—A nuclear activation device is under development for use on the floor of the ocean for mineral exploration.

Atmospheric pollution control.—A new type radioisotope analyzer has been developed to measure continuously the concentration (down to 0.1 part per million) of sulfur dioxide, a major pollutant of the atmosphere. The device is now undergoing field tests by the California Department of Health. If successful, it can contribute to the Nation's smog-abatement program.

Conservation of mineral resources.—A radioisotopes technique has been developed for improving and controlling mineral beneficiation processes. The technique is now being test-operated for processing of potash. Through better process control, marginal grade ores can be more economically processed.

OTHER PROGRAMS

Food preservation.—Further progress has been made over the past 12 months in developing the use of radiation for pasteurization of perishable foods such as fresh fruits and fish. It appears feasible to reduce spoilage and extend marketability.

Process radiation development.—Continuing progress has been made in the development of methods for the large-scale use of radiation in beneficial processing of materials. One particularly impressive result achieved during the past year has been the development of "wood plastic alloys" having substantially greater toughness, elasticity, and dimensional stability than the original wood. This radiation produced material could greatly improve the durability and weather resistance of wood and could contribute greatly to the utilization of soft woods for many new applications.

Isotopic power.—Newly developed strontium 90 titanate SNAP units are now powering weather stations in the Arctic and Antarctic, a light buoy, undersea electronic equipment and a barge-mounted weather station.

An important new fuel form of cesium 137 (polyglass) has been developed for isotopic power systems and will be first used in a deep sea generator to power a seismograph station being placed on the ocean floor.

Plutonium 238, the fuel used in the first space nuclear power generator launched last year, will also be used for the operational TRANSIT network, the Navy's maritime navigational satellite.

Curium 242 will be produced in quantity and used to fuel the generators powering SURVEYOR program devices. The SURVEYOR effort is an integral part of the Nation's manned lunar landing mission. The first large quantities of curium fuel will be produced during the next year.

Radioisotope and fission product production.—This program area serves to meet the requirements for radioisotopes and fission products established by all departments of the Government, as well as for science and industry in the United States. Emphasis over the past year has been on a campaign to develop processes

for separation of large quantities of fission products for use as isotopic power sources for space applications, as well as on new product development for medical development for medical and research purposes.

CIVILIAN APPLICATION OF NUCLEAR EXPLOSIVES

Mr. EVINS. The reporter will please insert pages 344 to 348 covering the program on civilian application of nuclear explosives.

(The data referred to follow:)

OPERATING EXPENSES

CIVILIAN APPLICATIONS OF NUCLEAR EXPLOSIVES—OPERATING EXPENSES

Program statement

Estimate, fiscal year 1963	$10,050,000
Estimate, fiscal year 1962	9,650,000
Increase	400,000

This program provides for research, development, and experimental testing necessary to develop peaceful uses for nuclear explosives and for the development and testing of special nuclear explosive devices for these purposes. The program is commonly known as Plowshare. The fiscal year 1963 program will include: (1) Research and development; (2) execution of one experimental project of a scientific nature; (3) execution, early in fiscal year 1963, of an experimental project of an engineering nature; and (4) preparations for future projects. The primary responsibility for the technical direction of the program is assigned to the Lawrence Radiation Laboratory at Livermore, Calif.

Summary of estimates by category

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(*a*) Research and development	$3,932,494	$3,030,000	$2,000,000
(*b*) Experimental and demonstration projects	3,534,123	6,620,000	8,050,000
Total, program	7,466,617	9,650,000	10,050,000

JUSTIFICATION OF CATEGORIES

(*a*) *Research and development, $2 million*

This amount will support research and development effort, primarily at the Livermore Laboratory, directed toward: (1) Developing and laboratory testing of theory relating to the effects of nuclear detonations for a wide variety of applications; (2) understanding and developing means to control the radioactivity and other potential hazards produced by nuclear detonations; (3) studying the feasibility and usefulness of proposed applications; and (4) developing concepts and detailed designs of nuclear explosives with characteristics specifically useful for peaceful purposes and supplying scientific support to the fabrication of experimental devices.

Theoretical understanding is needed on such things as rock mechanics, shock propagation, deposition and partitioning in different media of the different types of energies produced by nuclear explosions, and chemical reactions induced by high shocks and temperatures.

Safety studies relate primarily to controlling the potential hazards of radioactivity both as fallout and as a contaminant of ground water, and also cover the effects of blast and seismic shock.

Feasibility studies are made of potential applications to assess their cost and practicability. Among applications which have received study are: a sea level canal across the Central American Isthmus, production of oil from oil-bearing sands in Canada, mining ore from mineral deposits by block caving, and deep disposal of brine contaminates of fresh river water. Studies on other and similar applications will be conducted in fiscal year 1963.

The development of explosives with special characteristics is the key to a great many uses of this form of nuclear energy; final success in this development will greatly limit the hazards of contamination from radioactivity, will make possible scientific experiments of great value which will not otherwise be possible, will extend the range of usefulness of nuclear explosive techniques by lowering costs, and will save on very expensive nuclear materials.

Although a reduction is reflected in this category, the level of effort at the Livermore Laboratory will remain fairly constant, with scientific staff effort at the laboratory being applied to Project Coach (see below).

(*b*) *Experimental and demonstration projects, $6,800,000*

The activities which would be undertaken with these funds are designed to demonstrate applications for nuclear explosives and to develop technology and test theory by obtaining experimental data in the field.

Summary of experimental and demonstration projects

Project	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(1) Gnome	$1,626,574	$3,875,000	0
(2) Chariot	970,861	790,000	$300,000
(3) Coach	0	0	4,875,000
(4) Sedan	0	750,000	1,250,000
(5) Other	936,688	1,205,000	1,625,000
Subtotal, projects	3,534,123	6,620,000	8,050,000

(1) *Project Gnome.*—Project Gnome is an experimental project which was executed on December 10, 1961, and was the world's first known nuclear explosion for peaceful purposes. The detonation for Project Gnome took place in a salt formation, 1,200 feet underground, about 25 miles from Carlsbad, N. Mex. Project Gnome was judged a highly successful experiment and has provided an abundance of data of immediate use in the scientific fields of physics, chemistry, and radiochemistry, and concerning the physical effects of nuclear explosives in a different kind of earth media. It has also provided information needed for the assessment of the feasibility of the application of nuclear explosives to the production of isotopes and to the production of power from the heat generated by the explosion, and information important to the development of nuclear explosives with greater utility for peaceful purposes because of lower cost and reduced radioactivity. Field work for Project Gnome, itself, has been completed, although laboratory analysis of data will continue for the rest of fiscal year 1962. Thus, no costs will be incurred for Project Gnome in fiscal year 1963.

(2) *Project Chariot, $300,000.*—Project Chariot is a proposed demonstration project under study at a location on the northwest coast of Alaska. It would provide scientific, safety, and engineering information for the use of nuclear explosives in excavation. As now planned, the experiment would include the simultaneous detonation of a row of charges and would produce an elongated channel connecting a turning basis, in the form of a harbor. Scientific data which would be obtained from this experiment includes crater dimensions, especially the effects on these dimensions of simultaneous firing of inline charges; suppression of air blast; containment and distribution of radioactive debris; and effects on the ecology of the area. During fiscal year 1963, activities would be conducted at a minimal level to obtain additional bioenvironmental data, especially on weather and on recently deposited fallout from U.S.S.R. weapons test. Also, results of the bioenvironmental surveys which have been made of the area would be compiled. It is expected that a decision on the future of Project Chariot will be made in fiscal year 1963.

(3) *Project Coach, $4,875,000.*—Project Coach is a scientific experiment which is planned to be executed in the spring of calendar year 1963. The project would involve the underground detonation of a specially designed, several kiloton nuclear explosive providing a region of very high neutron flux to study the possibility of producing and recovering known transplutonic elements and elements heavier than those yet discovered. The results of the experiment may make a considerable contribution to the scientific theory underlying this field. Reuse of the Gnome site is being considered for this project.

(4) *Project Sedan, $1,250,000.*—This project would be a high-yield nuclear detonation buried several hundred feet in alluvium at the Nevada test site to produce a crater and to provide data relating to the excavation application. Principally, it would extend to higher yields, scaling laws which have been developed from low-yield detonations. The experiment would be executed early in fiscal year 1963.

(5) *Other, $1,625,000.*—The funds available in this activity in fiscal year 1963 will be used to prepare for the next excavation experiment which would probably be conducted at the Nevada test site in fiscal year 1964 and to begin site selection for subsequent experiments which, for geological reasons, would probably have to be conducted outside the Nevada test site.

In the past, funds in this activity have made possible exploratory experimentation with high-explosive detonations to develop cratering theory, association of Plowshare program research with projects carried out in other programs, and, in fiscal year 1962, postshot mining at the Project Gnome site. Such associated research allows data to be obtained without the need to duplicate detonations at a later date for Plowshare purposes. No specific work of this type is provided for in fiscal year 1963.

Mr. EVINS. Mr. Kelly, you are the Director of the Division of Civilian Application of Nuclear Explosives.

Mr. KELLY. Yes, sir.

INCREASE IN FISCAL YEAR 1963 OVER FISCAL YEAR 1962

Mr. EVINS. You are asking for an increase from $9.650 million to $10.050 million. We will ask you to explain the reason for this increase.

Mr. KELLY. Basically, the reason for the increase is to enable us to do two experiments in fiscal year 1963 where we only did one in fiscal 1962.

PROGRAM ACCOMPLISHMENTS

Mr. EVINS. What have been the accomplishments of your program to date?

Mr. KELLY. We have only had one major experiment, that is, one nuclear experiment. That was the project conducted near Carlsbad, N. Mex., last December in which we had several objectives and we got very excellent data in nearly all of these objectives. We got some interesting new data on neutron resonances which had never been measured before. We got an interesting and useful information on the physical effects of nuclear explosives underground, how it deforms the salt, breaks it up, how shock waves get transmitted. We got some information on the heat trapped underground and things that can lead to useful applications of nuclear explosives.

Mr. EVINS. We have been conducting a lot of explosions underground and in the atmosphere of all types. What new development can you report?

Mr. KELLY. We have this neutron information that I mention, the neutron resonance information which information had not been gotten by any means before.

Mr. BOLAND. What does this do for you?

Mr. KELLY. It helps us to understand the basic neutron physics. When you understand that better, you can design better reactors and weapons and all sort of those kinds of things.

Mr. JENSEN. Mr. Kelly, it is good to see you. I was with Mr. Kelly at Carlsbad during that underground detonation last fall. He

told me a good many things about this field of operation. I attended two extensive briefings in the auditorium. It was my privilege to hear Mr. Kelly make two very technical explanations of this whole field of underground detonation. I must say that there were many atomic scientists there from not only the United States but from nine foreign nations.

I saw the great respect that those people had for Mr. Kelly's knowledge of this field.

Now, let me ask this, Mr. Kelly. You have had some underground detonations since Carlsbad, have you not?

Mr. KELLY. Yes, in the weapons program.

Mr. JENSEN. There was some steam that escaped from the tunnel in which the load had been placed and exploded. I saw that with my own eyes. It gave me considerable concern. Have you learned since then just why your tunnel was not steamproof?

Mr. KELLY. No, sir. We hope to get that answer in the next week or so. As a matter of fact, we have dug back a parallel tunnel with crosscuts to the original tunnel. A group of us is going down there next week to make an onsite underground inspection to see if we can determine how the steam escaped.

Mr. JENSEN. You have been down in the tunnel since the explosion?

Mr. KELLY. Yes.

Mr. JENSEN. What happened to that tunnel? Now you expected that a great dome would be blown in the salt, in that restricted area where the load was placed? Has that area been inspected to date and just what happened?

Mr. KELLY. Well, the detonation did produce a cavity as we expected. The cavity persists. So far as I know it is the only cavity that is produced in this manner that does persist. We have drilled back through the cavity down into the bottom of it where the steam and salt collected. We have collected samples of that material and learned something about the distribution of heat and isotopes in that region. We have also gone back in the elevator shaft and dug a hole parallel to the original tunnel and are just about to attain physical reentry into the cavity so that people can go back there. This has not yet been done.

ECONOMIC VALUE OF PLOWSHARE PROGRAM

Mr. JENSEN. Now, will you tell the committee what knowledge you expect to receive which will be of economic value to this Nation by these underground atomic explosions in as few words as you can put together and still make it understood?

Mr. KELLY. Well, there are quite a number of them. In Nome, for instance, one of the things we learned is about the distribution of isotopes.

Basically, in the entire Plowshare program the nuclear explosive we consider to be a very large and in some conditions inexpensive source of energy. This energy is manifested basically in three forms: One, the mechanical energy which can be used for breaking rocks like in mining or for moving dirt and rocks such as excavation in civil engineering projects and we have some experiments in mind for that and a great reduction in cost as compared to conventional methods.

Also, another form of energy released by nuclear explosives is the very large number of neutrons compared to any other source of neutrons and these can be used in several ways. One, making of isotopes in less expensive form and also for making basic nuclear physics measurements such as we did at the experiment near Carlsbad.

The third form of energy is the heat for thermal energy which can be trapped underground and subsequently used in economical processes, perhaps in the production of electric power, perhaps in the melting of certain kinds of oil so that it decreases its viscosity so that it can be recovered, and things of that nature. Those are just examples.

KINDS OF ISOTOPES

Mr. JENSEN. How many different kinds of isotopes are there? Dr. Aebersold, that is your field.

Dr. AEBERSOLD. There are isotopes of every element—all the way from element 1, which is hydrogen, to element 103, Lawrencium which was discovered recently at Berkeley. There are now over 1,300 varieties of atoms known. Of these over 1,000 varieties can be made with reactors or accelerators. There are three times as many manmade atoms as there are the kinds of atoms ordinarily found in nature. These have properties that range from very low energy electron or beta emitters to very high energy gamma ray emitters.

CIVILIAN APPLICATION OF NUCLEAR EXPLOSIVES

Mr. JENSEN. You are expanding your Carlsbad experiments, as I understand, Mr. Kelly?

Mr. KELLY. Yes, sir; we hope to conduct another experiment near the site of the first one.

Mr. JENSEN. Have the geologists ascertained since the explosion last fall what effect the explosion had on the structure in that area, the salt and earth structure?

Mr. KELLY. It didn't have any beyond about 1,200 feet, some rather small distance like that.

Mr. JENSEN. What was the power of that explosion?

Mr. KELLY. It turned out to be 3 kilotons with some uncertainty, plus or minus 1 kiloton.

Mr. JENSEN. Three kilotons?

Mr. KELLY. Yes, sir.

Mr. JENSEN. Yet we stood 4 miles away and the earth trembled under our feet.

Mr. KELLY. Yes, sir.

Mr. JENSEN. It was a 3-kiloton explosion. How does that compare with the bombs that we have dropped and that Russia has dropped that contain many more times that power?

Mr. KELLY. I believe the Russians last fall detonated one alleged to have been around 50 megatons.

General LUEDECKE. Sixty megatons.

Mr. KELLY. Which was 20,000 times stronger.

Mr. JENSEN. You can imagine the power of that bomb when we stood 4 miles away from the 3-kiloton bomb explosion and the ground heaved upward. What were the number of inches that the ground raised right above the explosion?

Mr. KELLY. Right after the shot the ground above the shot point was heaved upward almost 6 feet. It was 176 centimeters. Of course, that fell back down with a permanent deformation of 19 inches.

Mr. JENSEN. That bomb was detonated how many feet in the earth?

Mr. KELLY. 1,184 feet.

Mr. JENSEN. About 700 feet of that was solid salt?

Mr. KELLY. That is correct.

Mr. EVINS. What specific detonations will be undertaken next year in fiscal 1963 and what do you expect to prove from them?

Mr. KELLY. There are two we hope to undertake in fiscal 1963. One is a project called Sedan. This is to get information on excavation, on moving dirt and rock for civil engineering types of construction work.

The second is the one that will take place near the site of the Gnome experiment near Carlsbad and in that we hope to use the neutron output of the nuclear explosive to produce some very heavy isotopes or isotopes of very heavy elements. These are isotopes that are very difficult to make by conventional means, by accelerators or reactors.

It may be possible that we will make some isotopes or elements that have never been made before. We hope so.

Mr. JENSEN. What do you expect to find from the Project Coach mentioned on page 347?

Mr. KELLY. Project Coach is the heavy element experiment I briefly mentioned.

Mr. JENSEN. That you did not find out from Project Gnome?

Mr. KELLY. We are using the data from Gnome, the isotopic distribution data from Gnome to help design Project Coach.

Mr. JENSEN. Does the AEC actually expect Project Chariot to dig a harbor in Alaska? Why will it take $300,000 to make the decision in 1963? Why can't you make it now?

Mr. KELLY. I don't know whether we will do the Chariot experiment or not. Several things have happened. As you know this one got started just prior to the test moratorium and we became involved in a rather detailed environmental survey of the area. This is nearing completion. We think whether or not we do the experiment, we ought to complete the bioenvironmental surveys so that we can document this part of the experiment.

It turned out that the Russians dumped some fallout on that area up there so we can even document the radiological effects, even if we don't actually conduct the experiment.

Mr. JENSEN. How far along have you gone with your Project Chariot?

Mr. KELLY. We have done nothing except conduct these biological surveys.

Mr. JENSEN. You haven't made the decision as to whether you are going forward with it or not.

Mr. KELLY. That is right. Chariot was designed back in 1958. Through a series of chemical explosive shots and through this Project Sedan that we hope to do in fiscal 1963 we feel we will have learned a goodly fraction of the information that we had originally planned to get from Chariot.

Mr. JENSEN. What can you find from your survey that you have not found from similar surveys or elsewhere?

Mr. KELLY. Well, the primary thing is the assessment of the biological effects of this Russian fallout. This was one of the original objectives of Chariot, was to evaluate the effects upon the biophore, of putting some fallout there.

The Russians put it last winter, last fall, so we are trying to evaluate its effect, if any.

General LUEDECKE. Funds are not provided in this budget to carry out this project.

Mr. JENSEN. Off the record.

(Discussion off the record.)

Mr. EVINS. If you have not made a decision to go forward with the project, why do you need funds at this time?

Mr. KELLY. This is just a phaseout or a completion of the studies that have been underway, the biological studies that have been underway.

Mr. EVINS. Thank you, Mr. Kelly. You are a very knowledgeable man in your field.

Off the record.

(Discussion off the record.)

COMMUNITY PROGRAM

Mr. EVINS. We will turn to the communities program.

Insert in the record 349 to 355 and the associated construction program justification.

(The documents referred to follow:)

OPERATING EXPENSES

COMMUNITY PROGRAM—OPERATING EXPENSES

Program statement

Estimate, fiscal year 1963	$9,114,000
Estimate, fiscal year 1962	8,583,000
Increase	531,000

The community program provides for:

1. Operation and administration of the AEC controlled and operated community of Los Alamos, N.M., including municipal services, utilities, hospital, housing, and commercial properties.

2. Assistance payments to the former AEC communities of Oak Ridge, Tenn., and Richland, Wash., in accordance with the Atomic Energy Community Act of 1955, as amended (Public Law 84–221).

The principal operations of the community of Los Alamos are carried out under a cost-type contract. Commercial facilities are generally operated by private enterprise through lease or concession agreement.

The estimates for assistance payments at Oak Ridge and Richland are based on Public Law 84–221 which provides that for a period of 10 years from the date of transfer of any municipal installations to a governmental or other entity, AEC shall make annual assistance payments of just and reasonable sums. In

determining the amount and recipient of such payments, the statute states that AEC shall consider:

(1) The approximate real property taxes and assessments for local improvements which would be paid to the governmental entity upon property within the community if such property were not exempt from taxation by reason of Federal ownership.

(2) The maintaining of municipal services at a level which will not impede the recruitment or retention of personnel essential to the atomic energy program.

(3) The fiscal problems peculiar to the governmental entity by reason of the construction of the community as a single-purpose national defense installation under emergency conditions.

(4) The municipal services and other burdens imposed on the governmental or other entities at the community by the United States in its operations in the project area.

The revenues from community operations are included under the program "revenues applied" as a reduction in the operating expenses appropriation. A summary comparison of community operating costs and revenues is shown in the table below. Estimates and justifications for Los Alamos, Oak Ridge, and Richland are shown in the pages following.

AEC has proposed that Public Law 84–221 be amended to provide for disposal of the community of Los Alamos. This legislation, however, would not have any significant effect on fiscal year 1963 estimates for the community program.

Summary of community costs and revenues

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Gross operating costs:			
1. Operation of communities:			
(a) Los Alamos	$5,730,277	$6,180,000	$6,767,000
(b) Oak Ridge	33,163	0	0
(c) Richland	103,942	75,000	0
(d) Monticello, Utah, and Grants, N. Mex.	11,262	12,000	0
(e) Sandia	25,180	0	0
Total, operation of communities	5,903,824	6,267,000	6,767,000
2. Assistance payments:			
(a) Oak Ridge	2,343,851	1,239,000	1,251,000
(b) Richland	898,540	1,077,000	1,096,000
Total, assistance payments	3,242,391	2,316,000	2,347,000
Total gross costs	9,146,215	8,583,000	9,114,000
Revenues (budgeted under "Revenues applied"):			
Los Alamos	5,324,123	5,510,000	5,767,000
Oak Ridge	15,432	0	0
Richland	278,761	116,000	0
Monticello, Utah, and Grants, N. Mex.	23,950	15,000	0
Sandia	37,999	0	0
Total revenues	5,680,265	5,641,000	5,767,000
Net operating costs:			
Los Alamos	406,154	670,000	1,000,000
Oak Ridge	2,361,582	1,239,000	1,251,000
Richland	723,721	1,036,000	1,096,000
Monticello, Utah, and Grants, N. Mex.	−12,688	−3,000	0
Sandia	−12,819	0	0
Total net operating costs	3,465,950	2,942,000	3,347,000

Summary of Los Alamos community estimates

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Gross costs:			
(a) Municipal:			
(1) Schools	$925,783	$1,036,000	$1,314,000
(2) Other	1,014,313	1,157,000	1,331,000
Subtotal, municipal	1,940,096	2,193,000	2,645,000
(b) Utilities	895,674	1,002,000	1,002,000
(c) Real estate operations	2,006,115	2,043,000	2,188,000
(d) Hospital	807,150	860,000	853,000
(e) Equipment	81,242	82,000	79,000
Total gross costs	5,730,277	6,180,000	6,767,000
2. Revenue (budgeted under "Revenues applied"):			
(a) Municipal	24,828	27,000	29,000
(b) Utilities	1,491,359	1,632,000	1,732,000
(c) Real estate operations	3,128,760	3,171,000	3,308,000
(d) Hospital	679,176	680,000	698,000
Total revenue	5,324,123	5,510,000	5,767,000
3. Net costs:			
(a) Municipal:			
(1) Schools	925,783	1,036,000	1,314,000
(2) Other	989,485	1,130,000	1,302,000
Subtotal, municipal	1,915,268	2,166,000	2,616,000
(b) Utilities	−595,685	−630,000	−730,000
(c) Real estate operations	−1,122,645	−1,128,000	−1,120,000
(d) Hospital	127,974	180,000	155,000
(e) Equipment	81,242	82,000	79,000
Total net costs	406,154	670,000	1,000,000

JUSTIFICATION OF LOS ALAMOS COMMUNITY OPERATING EXPENSES

The town of Los Alamos, N. Mex., represents a community of approximately 14,000 atomic-energy-project-connected personnel, their families, and a minimum of nonproject-connected citizens necessary in support of the town. It is estimated that the cost to operate the municipal and support functions of Los Alamos in fiscal year 1963 will be $6,767,000, or $587,000 more than fiscal year 1962. The major reasons for this increase are as follows: Increased school plant and enrollment, increased police and fire protection associated with the White Rock development, increased real estate requirements related to the aging of the community, special studies related to long-range community planning, and merit and wage increases.

The increased school requirements of $278,000 reflect the opening of the new Cumbres Junior High School and the new Barranca Mesa Elementary School, an increased total school enrollment from 4,519 in fiscal year 1962 to 5,071 in fiscal year 1963, and normal merit salary increases.

An increase of $174,000 is required for other municipal costs consisting of: (1) $50,000 to staff and equip the new police and fire groups at White Rock; and (2) $124,000 in connection with the further development of long-range plans for the Los Alamos Community, including special studies of the Los Alamos Medical Center, evaluations of present utility systems, and studies of the municipal functions. An increase of $145,000 is required for real estate operations to cover additional reroofing of houses as well as normal merit and wage increases. The increase of $587,000 in costs is partially offset by increased utility and real estate revenues, resulting in a net increase of $330,000 over fiscal year 1962.

Summary of Richland community estimates

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Assistance payments	$898,540	$1,077,000	$1,096,000
Other costs	103,942	75,000	0
Total gross costs	1,002,482	1,152,000	1,096,000
Revenues (budgeted under revenues applied)	278,761	116,000	0
Net costs	723,721	1,036,000	1,096,000

The fiscal year 1963 estimate is based on the assumption that all remaining apartments, lots, and commercial facilities will be sold by the end of fiscal year 1962. The estimated fiscal year 1963 assistance payment of $1,096,000 provides for continuation of essentially the fiscal year 1962 level of services. The fiscal year 1962 and fiscal year 1963 estimates include $30,000 for high school bond redemption. The increase of $19,000 in fiscal year 1963 assistance payments is due chiefly to additional requirements for schools.

Summary of Oak Ridge community estimates

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Assistance payments	$2,343,851	$1,239,000	$1,251,000
Other costs	33,163	0	0
Total gross costs	2,377,014	1,239,000	1,251,000
Revenues (budgeted under revenues applied)	15,432	0	0
Net costs	2,361,582	1,239,000	1,251,000

The estimated fiscal year 1963 assistance payment of $1,251,000 provides for continuation of essentially the current level of services. The entire payment is made to the city of Oak Ridge.

PLANT ACQUISITION AND CONSTRUCTION

Community Program—Construction Obligations

Program statement

Estimated obligations fiscal year 1963	$1,940,000
Estimated obligations fiscal year 1962	4,241,000
Actual obligations fiscal year 1961	1,532,056

Obligations for the community program for fiscal year 1963 are estimated at $1,940,000 for the projects listed below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations fiscal year 1963
63-k-1	White Rock Elementary School, Los Alamos, N. Mex.	$600,000	0	$600,000
63-k-2	Real estate development, Los Alamos, N. Mex.	600,000	0	600,000
63-k-3	Additional water well, Los Alamos, N. Mex.	165,000	0	165,000
63-1	General plant projects	575,000	0	575,000
	Total	1,940,000	0	1,940,000

EXPLANATION OF PROJECTS ABOVE

1. 63–k–1—White Rock Elementary School, Los Alamos, N. Mex., $600,000

This project provides for the construction of an elementary school at White Rock in Los Alamos County. The facility will consist of 10 classrooms plus a library, industrial arts room, art, music, and a combination auditorium-gymnasium with necessary administration space. Current school board enrollment forecasts based upon present construction schedules by the private developer at the subdivision of White Rock indicate a requirement for school facilities for 200 elementary grade students.

2. 63–k–2—Real estate development, Los Alamos, N. Mex., $600,000

This project provides for (*a*) the development of approximately 50 lots, and (*b*) the design and construction of support facilities to serve all the lots (approximately 400) which can be developed in future years on Barranca Mesa east of the existing 210 lots. The additional lots represent the continuation of a program to provide developed lots for sale to project connected personnel for private home construction. Inadequate quarters and the lack of housing have proved detriments to the normal recruitment of qualified staff personnel of the laboratory.

3. 63–k–3—Additional water well, Los Alamos, N. Mex., $165,000

This project provides for a new water well at Los Alamos, due to the continued growth in the White Rock and Barranca Mesa housing developments and the technical areas. The daily yield from the six existing wells cannot meet current peakloads, requiring drawdown from reserve storage tanks. Continued development of Los Alamos will further aggravate the present problem and create a dangerous situation where water reserves will be lowered at fire hydrants, reducing the capability to effectively fight fires in the community or technical areas.

4. 63–1—General plant projects, $575,000

This project provides for miscellaneous Los Alamos community improvements extensions, additions, alterations and/or new construction of streets, schools, sewage systems, utility systems, municipal sites, housing, business concessions, hospital, and other community facilities in order to adequately maintain the Los Alamos community. Based upon past experience, a continuing need for numerous capital items is evidenced each year in order that the community continue to operate as economically as possible.

Mr. EVINS. You are asking for $9,114 million.

General Betts, we are pleased to see you again. Please give us some of the details on this program and the disposition of the town of Los Alamos and why you need this amount of money.

General BETTS. The community program, as indicated in our program statement, includes not only the cost of operating Los Alamos as a community, but also certain assistance payments to the towns of Richland and Oak Ridge that are provided for by Public Law 84–221.

DISPOSAL OF COMMUNITY FACILITIES AT LOS ALAMOS

But to speak specifically to Los Alamos, we have made the proposal that the public law I have just mentioned be amended to include Los Alamos so that we can go ahead with the process of selling Los Alamos to the people of the community in order to make it a more normal community than the federally sponsored community it is now.

Mr. EVINS. When do you propose to move forward with this disposal work?

General BETTS. If that amending law is passed this year. we would hope to be able to have all of the necessary preparation, platting, appraisals done, so that the first unit could be sold in about 2 years and thereafter it would take another approximately 2 years to sell it all.

Mr. EVINS. What is the total investment in the town of Los Alamos?

General BETTS. I will have to supply that for the record, sir.

Mr. EVINS. You may do so.

(The information requested follows:)

The current estimated net book value of Government community property which would be involved in the community disposal program at Los Alamos is $65,193,000.

Mr. EVINS. How many residents are there, how many buildings are there?

Mr. BETTS. We will have to supply that, sir.

Mr. EVINS. You may do so.

(The data referred to follows:)

A 1960 census of Los Alamos showed a population of approximately 13,100. Some slight increase has occurred since that time with the expansion of White Rock and Barranca Mesa areas. These residents are living in domiciles broken down as follows:

	Number of buildings	Number of living units
Single homes	1,254	1,254
Duplex buildings	462	924
Apartments	225	1,450
Subtotal living quarters	[1] 1,941	[1] 3,628
Other major building types include:		
Lodge (hotel)	1	
Schools	[2] 13	
Medical center	1	
Library	1	
Post office	1	
Shopping centers	[3] 2	

[1] Excludes privately owned homes at Barranca Mesa and White Rock.
[2] 11 complete schools; 2 under construction.
[3] Includes 46 commercial concessions.

Mr. EVINS. How is the $9 million distributed?

General BETTS. Of that sum, $6.767 million is for Los Alamos. There are assistance payments of $1.251 million proposed for Oak Ridge and $1.096 million proposed for Richland.

Mr. EVINS. Those are fixed by statute?

General BETTS. The basis on which the judgment is reached is fixed by statute; that is right, sir.

Mr. EVINS. Off the record.

(Discussion off the record.)

PROGRAM DIRECTION AND ADMINISTRATION

Mr. EVINS. We will place in the record pages 356 to 375 and the associated page for construction.

(The data referred to follow:)

PROGRAM DIRECTION AND ADMINISTRATION—OPERATING COSTS

Program statement

Estimate, fiscal year 1963	$64, 111, 000
Estimate, fiscal year 1962	60, 631, 000
Increase	3, 480, 000

This program covers the salaries, travel and other costs associated with both program direction and administration of AEC operations, and the discharge of regulatory functions of the Commission. With respect to AEC operations, the following functions are performed by AEC employees budgeted under this

program: (1) Program planning and direction, (2) negotiation and administration of contracts, (3) accounting, auditing, property management, and other functions to assure adequate controls by AEC offices and contractors, (4) conducting a program of cooperation with other nations and international groups, and (5) normal management, administrative and supporting staff services required within the agency. The regulatory functions of the Commission are discharged directly by AEC employees budgeted under this program and include: (1) All regulatory and licensing matters including development of regulatory and licensing policies and procedures, and administering licenses and regulations applicable to licenses, (2) inspection of licensees for compliance with license requirements and rules of the Commission, (3) investigation of licensee incidents, (4) establishment of radiation safety standards, and (5) cooperation with States under section 274 of the Atomic Energy Act.

The fiscal year 1963 estimate is based on reaching a total employment of 5,314 employees by the end of fiscal year 1963, or an increase of 222 employees over the strength estimated at the end of fiscal year 1962. Of the total increase of 222 employees, 178 are for AEC operations and 44 are for regulatory functions.

A summary of the budget estimate by category appears on the next page.

Summary of estimates of category

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Personal services	$44,502,339	$45,111,000	$47,159,000
2. Personnel benefits	3,365,591	3,427,000	3,570,000
3. Travel and transportation of persons	2,703,453	3,412,000	3,795,000
4. Contractual services and supplies	7,549,597	8,111,000	8,617,000
5. Capital equipment	777,548	570,000	970,000
Total, program direction and administration	[1] 58,898,528	[1] 60,631,000	64,111,000

[1] Includes comparability adjustment of $1,814,994 in fiscal year 1961 and $1,706,000 in fiscal year 1962 for costs associated with personnel budgeted under "Program direction and administration" in fiscal year 1963 but budgeted and costed in prior years under the raw materials program.

The fiscal year 1963 estimate above includes $1,450,000 for costs associated with AEC employees budgeted in prior years under the raw materials program. For comparability, adjustments for similar costs have also been reflected in the fiscal year 1961 and fiscal year 1962 columns of the estimates. After fiscal year 1962, these employees will perform duties of a nature which makes them chargeable to program direction and administration.

The estimates include the following amounts for AEC operations and regulatory functions, respectively:

[In thousands]

Category	AEC operations			Regulatory functions		
	1961	1962	1963	1961	1962	1963
1. Personal services	$42,405	$42,796	$44,153	$2,097	$2,315	$3,006
2. Personnel benefits	3,212	3,254	3,346	154	173	224
3. Travel and transportation of persons	2,503	3,162	3,420	200	250	375
4. Contractual services and supplies	7,550	8,051	8,557	0	60	60
5. Capital equipment	778	570	965	0	0	5
Grand total	56,448	57,833	60,441	2,451	2,798	3,670

The estimated costs for regulatory functions include only the costs of personal services, personnel benefits and travel for personnel reporting to the Director of Regulation, and other costs clearly identified with specific activities of the regulatory function such as special contractual services and specialized equipment. The costs of general supplies and equipment and other usual housekeeping services provided to regulatory personnel are included in the estimates under AEC operations.

JUSTIFICATION OF CATEGORIES

1. Personal services, $47,159,000

This budget provides for an average employment of 5, 59 permanent full-time employees, plus a small number of professional and scientific consultants whose services are utilized intermittently for limited periods, and a small number of employees in temporary positions to meet special situations. A breakdown of total personal services costs under this program follows:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(*a*) Net cost of permanent full-time employees, including terminal leave costs	$43,437,561	$44,229,000	$46,227,000
(*b*) Costs of other employees	527,675	457,000	457,000
(*c*) Regular pay in excess of 52-week base	167,671	0	0
(*d*) Payment above basic rates	344,630	400,000	450,000
(*e*) Reimbursements to other agencies	24,802	25,000	25,000
Total, personal services	44,502,339	45,111,000	47,159,000

(*a*) Net costs of permanent full-time employees, including terminal leave costs:

Fiscal year 1961	$43,437,561
Fiscal year 1962	44,229,000
Fiscal year 1963	46,227,000

The estimates provide for employment at the beginning and end of the fiscal year as follows:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Starting employment	5,026	5,087	5,092
Ending employment	5,087	5,092	5,314
Computation of the dollar estimates:			
(1) Average employment	5,072	5,074	5,259
(2) Plus man-year equivalent or terminal leave costs	22	23	23
(3) Total permanent man-years	5,094	5,097	5,282
(4) Average man-year cost	$8,527	$8,677	$8,752
(5) Net cost of permanent full-time employees, including terminal leave costs (line 3 multiplied by line 4)	$43,437,561	$44,229,000	$46,227,000

As stated above, the estimates are based on reaching a strength of 5,314 permanent full-time employees by the end of fiscal year 1963, which is an increase of 222 employees over the strength of 5,092 estimated at the end of fiscal year 1962. Of the net increase of 222 employees, 178 are for AEC operations and 44 are for regulatory functions. The workload of the Commission is reaching such proportions that additional staff will be required to maintain an acceptable standard of performance. Every effort is being made to meet increasing needs for staff for new and expanding programs through various types of staffing economies including the maximum retrenchment in administrative functions and shifts of positions between offices and functional areas to meet priority requirements. Staffing for the current year is at a critical level, and the absorption of additional work without corresponding increases in staff is not believed to be feasible.

The increases requested are in the following major functional areas:

(1) *Regulatory functions, +44.*—Several factors contribute to the sharp increase in regulatory activities in fiscal year 1963. Substantial increases will occur in the numbers of license applications, and licensees; increased numbers of power reactors will be in operation; all regulatory activities will be affected by more advanced uses which are being made of radioisotopes; compliance requirements will be greater in the expanding scope of reactor technology; and a recent Presidential directive requires AEC concurrence in the safety evaluation of Department of defense reactors. The growth of responsibility and workload extends to each of the primary activities within the regulatory function.

(2) *Direction and administration of technical programs, +98.*—Substantial growth will occur in the scope and volume of research in the physical and life sciences. To provide necessary direction and administration and adequate surveillance of research contracts in these areas 19 additional employees will be

needed. New and expanded programs in the development of compact power systems, principally the SNAP series, and continued increases in workload under the power reactor programs, will require 25 additional employees. Indicative of the continued growth in administrative and surveillance responsibility is the fact that a significant number of reactors are scheduled to come into operation between now and the end of fiscal year 1963.

Acceleration of the ROVER program will require addition of 49 AEC employees. Of this number, it is planned that 29 will be assigned to the Joint National Aeronautics and Space Administration-AEC Space Nuclear Propulsion Office in Cleveland and 20 will be assigned to the joint office in Nevada. Operating costs in fiscal year 1963 are budgeted at about three times the fiscal year 1961 level. Both technical and administrative staff must be increased significantly to meet the established schedule.

Preparation for and conduct of field experiments within the Plowshare program, together with continuance of research and development will require five additional employees.

(3) *Operational nuclear safety, +38.*—The increased emphasis on and expanded scope of the AEC nuclear safety program will result in a greater devotion of time throughout the technical programs to safety engineering and testing, as well as to separate evaluation and surveillance. Overall direction and coordination will be strengthened with greater attention to safety in reactor operations, materials processing, nuclear research, and the transportation and use of radioactive and fissionable materials. To assure effectiveness of this program, 38 additional employees will be required.

(4) *Nevada Operations Office, +71.*—Effective March 6, 1962, the Commission established the Nevada Operations Office with responsibilities in the following areas:

(*a*) Managing the Nevada test site and other experimental nuclear explosive test sites outside of the Nevada test site;

(*b*) Providing site supporting services to the various users of the Nevada test site, concentrating on site-wide problems associated with construction, labor relations, transportation, housing, and other arrangements requiring increasing attention for the weapons, nuclear explosives, and reactor programs;

(*c*) Contract negotiation and administration, legal, information, construction, fiscal, personnel, labor relations, security, safety, and other administrative services.

Prior to establishment of the Nevada Operations Office, the above responsibilities were assigned to the Albuquerque Operations Office. In order to more effectively execute the complex responsibilities, the Office of Field Operations was established as a unit of the Albuquerque Operations Office, and was recently relocated from Albuquerque to Las Vegas. Because of the growth of activities now underway and contemplated at the national test site near Las Vegas, together with test activities at other places for which the Las Vegas organization would be responsible, it was determined that it was necessary to strengthen the Las Vegas organization and give it independent status reporting directly to the General Manager, rather than through another field office. It is pointed out that in addition to the Commission's programs, the National Aeronautics and Space Administration will have a large program at the national test site.

The gross staffing requirements by the end of fiscal year 1963 for the Nevada Operations Office, amount to 220 employees. It has been determined, however, that 149 of the total requirement can be met by a reduction under the Albuquerque Operations Office, leaving a net additional requirement in fiscal year 1963 of 71 positions.

(5) *Other areas requiring increases, +15.*—A total of seven additional employees will be required for increased workload in industrial participation, inspection, and public and technical information activities.

The workload in administrative and service functions in support of the overall higher staffing level will also require some increase in staff. It is estimated that total needs can be offset some by further economies, so as to reduce net requirements to eight additional employees.

(6) *Offsetting reductions in other areas, −44.*—The declining workload in activities performed by personnel assigned to the Headquarters Division of Raw Materials and the Grand Junction Office will permit a total reduction of 44 employees.

In view of the pressing need for additional staff, it will be necessary to expedite the recruitment of the additional employees and place them on the rolls as early in fiscal year 1963 as possible. For this reason, funds will be required to support an estimated average employment of 5,259 in fiscal year 1963. In this connection it is pointed out that the Commission has a continuing program for recruiting each year under internship programs outstanding college graduates for integration in the organization. These interns enter on duty shortly after graduation, and for the most part are placed on the rolls early in July.

The increase in the average salary results chiefly from a full year effect in fiscal year 1963 of action being taken in fiscal year 1962 to reduce the number of administrative and service positions to make available positions for the recruitment of professional and technical personnel in higher grades. In addition, the average salary of types of personnel to be added in fiscal year 1963 is expected to be above the overall current average salary in the program, which will also result in some increase in the overall average salary.

The table on the next page reflects by office the actual strength of permanent full-time employees as of June 30, 1961, and estimated requirements at June 30, 1962, and June 30, 1963. All personnel to be assigned to the Joint National Aeronautics Space Administration and Atomic Energy Commission Space Nuclear Propulsion Offices at Cleveland and Nevada and personnel performing regulatory functions are included in AEC headquarters.

Office	Actual strength, June 30, 1961	Estimated strength, June 30, 1962	Estimated strength, June 30, 1963
Albuquerque	758	794	645
Brookhaven	31	31	34
Chicago	295	298	305
Grand Junction	239	200	160
Hanford	263	265	265
Idaho	191	193	200
Lockland	53	0	0
Nevada	0	[1]	220
New York	202	209	209
Oak Ridge	631	605	605
Pittsburgh	104	104	104
San Francisco	184	203	205
Savannah River	208	200	195
Schenectady	91	92	92
Headquarters and extensions	1,837	1,898	2,075
Total	5,087	5,092	5,314

[1] Staffing for this office on June 30, 1962, included under Albuquerque.

(*b*) Costs of other employees:

Fiscal year 1961	$527,675
Fiscal year 1962	457,000
Fiscal year 1963	457,000

These costs cover salaries of temporary, part-time, and intermittent employees. The bulk of these costs in fiscal year 1963 is for salaries of personnel who are paid only when employed, such as members of the General Advisory Committee, the Patent Compensation Board, the Advisory Committee for Reactor Safeguards, other boards, committees, panels, and consultants and experts.

(*c*) Regular pay in excess of 52-week base:

Fiscal year 1961	$167,671
Fiscal year 1962	0
Fiscal year 1963	0

These costs cover salaries of permanent employees for days of pay in excess of 260 days of pay in one fiscal year. No extra days are involved in fiscal year 1963.

(*d*) Payment above basic rates:

Fiscal year 1961	$344,630
Fiscal year 1962	400,000
Fiscal year 1963	450,000

These costs cover payments for scheduled and emergency overtime, nightwork differential, and authorized salary differentials for certain AEC employees stationed overseas. The increase is estimated to meet requirements at the Nevada Operations Office.

(e) Reimbursement to other agencies:

Fiscal year 1961	$24, 802
Fiscal year 1962	25, 000
Fiscal year 1963	25, 000

These costs in fiscal year 1963 cover reimbursement to the Department of State for furnishing translation services in the Tokyo office; and payments to other agencies for reimbursable details.

2. Personnel benefits, $3,570,000

This category comprises payments to other funds for the benefit of employees, and certain cash allowances paid to employees. The items under this category are:

Item	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Payments to civil service retirement fund	$2, 828, 383	$2, 875, 000	$3, 005, 335
(b) Payments to employees health benefits fund	278, 331	290, 000	296, 000
(c) Payments to civil service employees life insurance fund	143, 870	150, 000	155, 000
(d) Payments to employees compensation fund	0	0	1, 665
(e) Agency's share of Federal Insurance Contributions Act taxes	11, 771	12, 000	12, 000
(f) Employee oversea allowances	64, 772	60, 000	60, 000
(g) Employee incentive awards	38, 464	40, 000	40, 000
Total, personnel benefits	3, 365, 591	3, 427, 000	3, 570, 000

(a) *Payments to Civil Service Commission retirement fund, $3,005,335.*—This covers the estimated amounts to be paid by the agency into the civil service retirement fund, equal to amounts withheld from the basic salary of employees to whom the Civil Service Retirement Act applies. In accordance with law, requirements are computed at 6½ percent of basic salaries of such employees.

(b) *Payments to employees health benefits fund, $296,000.*—This covers the estimated contribution required of the Government under the Federal Employees Health Benefits Act of 1959. The estimate is based on current experience as to the extent of employee participation in the health benefit plans provided.

(c) *Payments to Civil Service Commission employee's life insurance fund, $155,000.*—This covers the estimated amounts to be paid by the agency to the Civil Service Commission employees, life insurance fund, equal to one-half of the amounts withheld from salaries of participating employees, in accordance with the rate established by the Civil Service Commission under the Federal Employees Group Life Insurance Act of 1954.

(d) *Payments to employees' compensation fund, $1,665.*—This covers payments to the employees compensation fund which are required for the first time in fiscal year 1963 under the provisions of Public Law 86–767. The amount budgeted for fiscal year 1963 is the amount to be billed to AEC by the Bureau of Employees' Compensation for benefits paid by the Bureau in fiscal year 1961 on account of injury or death of AEC employees.

(e) *Agency's share of Federal Insurance Compensation Act taxes, $12,000.*—This covers the agency's share of taxes on salaries of employees subject to the Federal Insurance Contributions Act, as provided by the Social Security Amendments of 1958.

(f) *Employee oversea allowances, $60,000.*—This covers quarters allowances for employees stationed overseas, as authorized by law.

(g) *Employee incentive awards, $40,000.*—This covers cash awards to employees in recognition of suggestions, inventions, superior accomplishments, and other acts as authorized by the Government Employee's Incentive Awards Act.

3. Travel and transportation of persons, $3,795,000

This category consists of the following items:

Item	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Travel subject to travel regulations	$2,606,018	$3,307,000	$3,690,000
(b) Rental of passenger vehicles from interagency motor pools	58,667	67,000	67,000
(c) Contractual local transportation (headquarters only)	38,768	38,000	38,000
Total	2,703,453	3,412,000	3,795,000

(a) *Travel subject to travel regulations, $3,690,000.*—This estimate covers the cost of official domestic and foreign travel chargeable to program direction and administration. The travel costs under this program include the travel of three principal classes of personnel: (1) AEC permanent full-time employees; (2) AEC intermittent employees such as members of advisory groups and individual consultants; and (3) approximately 300 military personnel on duty with the AEC, whose salaries are paid by the Department of Defense, but whose duties require considerable travel on AEC business.

The major areas in which travel increases will be required are—

(1) The sharp increases in regulatory activities, which were previously discussed under the justification for personal services.

(2) Travel in connection with weapons testing.

(3) A higher level of travel for proper management and technical supervision of technical programs, for which a significant increase in staff is being requested.

(4) Travel necessitated by the increased emphasis on and expanded scope of the nuclear safety program for which additional staff is being requested.

(b) *Rental of passenger vehicles from interagency motor pools, $67,000.*—This estimate covers reimbursement to the General Services Administration for use of passenger-carrying vehicles secured from GSA motor pools. These vehicles are used principally for local transportation.

(c) *Contractual local transportation (headquarters only), $38,000.*—This estimate covers the net cost of shuttle bus operations between the Germantown headquarters and a terminal in downtown Washington, D.C. This bus operates on a regular schedule to transport employees on official business. Employees on personal business and the general public are authorized to use the bus by payment of a prescribed fare.

4. Contractual services and supplies, $8,617,000

This estimate covers all costs of operations at the headquarters and in the field chargeable to this program except personal services, personnel benefits, travel and transportation of persons, and capital equipment. A breakdown of requirements between field offices and headquarters is:

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Field	$3,747,332	$3,785,000	$3,985,000
Headquarters	3,802,265	4,326,000	4,632,000
Total	7,549,597	8,111,000	8,617,000

Field offices: Requirements for field offices are related rather directly to employment levels, except for special items required from time to time. Funds in the amount of $32,000 are included in the fiscal year 1963 estimates for rental of an additional 7,500 square feet of space to meet increased requirements of the San Francisco Operations Office. The General Services Administration will budget for such rental costs after fiscal year 1963. In addition, funds have been included to meet increased requirements of the Nevada Operations Office.

A breakdown of costs in field offices by activity for the 3 years follows:

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Transportation of things includes transportation of Government property and employees' household goods	$108,310	$130,000	$175,000
Communications services includes costs of telephone services, including equipment and circuit rental, and teletype service	951,237	920,000	935,000
Rents and utilities includes costs of rental of office and other administrative space and utilities	716,717	750,000	830,000
Printing and reproduction includes charges for printing, binding, photostating, and reproduction services	109,281	120,000	125,000
Other services covers costs of maintenance and operation of administrative buildings and equipment, guard services, and various services performed by other agencies and private contractors	1,429,427	1,435,000	1,480,000
Supplies and materials includes costs of general office supplies, technical and professional books, and gasoline, oil and parts for Commission-owned vehicles	432,360	430,000	440,000
Total, field offices	3,747,332	3,785,000	3,985,000

Headquarters: This estimate includes costs incurred by the headquarters, including maintenance of a small office on a permanent basis in the District of Columbia. The estimates have been developed by detailed analysis of needs under the various activities to provide the level of services and materials required for economical and efficient operations. The fiscal year 1963 estimates include funds for the rental of 25,100 square feet of space in the Washington area to house headquarters personnel who cannot be accommodated within available space, and a total of 6,000 square feet of space to house personnel of compliance regional offices at Atlanta, Ga., and Denver, Colo. The General Services Administration would budget for such rental costs after fiscal year 1963.

A breakdown of costs in the headquarters by activity follows:

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Transportation of things	$76,792	$168,000	$149,000

This estimate includes costs for transportation of Government property, and shipments of household goods and personal effects of employees in connection with domestic and foreign transfers. The estimate for fiscal year 1963 reflects a decrease due to a smaller number of foreign transfers.

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Communication services	$1,117,009	$1,211,000	$1,334,000

This estimate includes costs for the following:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(a) Telephone	$636,216	$658,000	$718,000
(b) Teletype	200,500	280,000	337,000
(c) AEC-wide postal services	235,500	240,000	241,000
(d) Other communications services	44,793	33,000	38,000

(a) *Telephone, $718,000.*—This item covers costs of telephone servicse, including equipment and circuit rental and installation costs, long-distance toll calls and tieline services. The increase in fiscal year 1963 is for: (1) Full year's costs of tielines for which costs were incurred for only a portion of fiscal year 1962; (2) full year's costs of communications requirements for the compliance regional offices at Denver and Atlanta which were established during fiscal year 1962; (3) costs

for the national warning system service to be furnished to our emergency relocation centers by the Department of Defense; and (4) costs associated with the additional staff required in fiscal year 1963.

(*b*) *Teletype, $337,000.*—This estimate covers costs of teletype services, including equipment and circuit rentals, and commercial message costs. The increase in fiscal year 1963 is to provide for full year's costs for equipment and circuit rental to extend the service over the Strategic Army Communications (Starcom) to three additional offices for which costs will be incurred for only a portion of fiscal year 1962 and the associated costs for messages to be refiled over commercial lines for the three new terminals.

(*c*) *AEC-wide postal services, $241,000.*—The estimates reflect payments to the Post Office Department for AEC-wide postal services. These estimates are developed by periodic sampling and estimated mailings.

(*d*) *Other communications services, $38,000.*—Included under this activity are costs for such items as communication services for foreign offices, telegrams, cablegrams, and lease of facsimile equipment and circuits.

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Rents and utilities	$140,779	$185,000	$337,000

This item includes costs of electric power, water and sewerage charges at Germantown, rental of specialized equipment, and rental of office space.

The fiscal year 1962 and fiscal year 1963 columns include the following amounts to be transferred to the General Services Administration for rental of additional space, for which GSA would budget after fiscal year 1963:

	Fiscal year 1962	Fiscal year 1963
Location and amount of space:		
Washington, D.C.—25,100 square feet at $5.50 per square foot to house headquarters employees who cannot be accommodated in presently available space	0	$138,000
Atlanta, Ga.—2,874 square feet at $3.18 per square foot to house the Atlanta Compliance Regional Office established in fiscal year 1962	$4,570	9,139
Denver, Colo.—3,070 square feet at $4.40 per square foot to house the Denver Compliance Regional Office established in fiscal year 1962	6,754	13,508

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Printing and reproduction	$329,573	$315,000	$323,000

This activity includes costs of printing forms, letterheads, routine reports, etc.; special printing and duplicating services performed by other agencies; and contractual duplicating services for press releases and informational materials. The increase is related to the higher level of workload and employment.

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Other services	$1,804,362	$2,107,000	$2,117,000

This activity includes costs for all contractual services not otherwise classified. These services which are performed by other Government agencies and private contractors are itemized below:

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(a) Services performed by other agencies:			
(1) Building operation and maintenance, General Services Administration	$834,000	$844,000	$884,000
(2) Guard service, GSA	395,921	407,000	415,000
(3) Administrative support, foreign offices, Department of State	112,814	100,000	100,000
(4) Other miscellaneous services	176,348	248,000	242,000
Total, services performed by other agencies	1,519,083	1,599,000	1,641,000

The increase in fiscal year 1963 is primarily for additional costs associated with the relocation of headquarters personnel.

	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
(b) Services performed by private contractors	$285,279	$508,000	$476,000

This item includes services contracted for with private contractors, such as repairs and maintenance of equipment; handling foreign patent matters; reporting services for conferences and hearings; outside training of employees; and official entertainment both at headquarters and field offices.

Activity	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963
Supplies and materials	$333,750	$340,000	$372,000

This item includes costs of supplies and materials, such as office supplies; cryptographic supplies; technical and professional books, gasoline, oil, and parts for Commission-owned vehicles; and subscriptions for newspapers and periodicals. The increase in fiscal year 1963 is related primarily to the higher level of employment projected for fiscal year 1963.

5. Capital equipment, $970,000

This category covers replacement and additional administrative equipment to meet regular operating requirements, such as office machines and furniture, reproduction equipment, motor vehicles, and library equipment, etc.; and highly specialized equipment for specific operational needs.

The principal items are:

Item	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
(a) Equipment for regular operating requirements	$354,493	$240,000	$460,000
(b) Special equipment for AEC-wide improved communications capability	423,055	305,000	110,000
(c) Automatic data processing equipment	0	25,000	400,000
Total	777,548	570,000	970,000

(a) *Equipment for regular operating requirements, $460,000.*—The bulk of these funds will be required for the normal replacement of equipment items which meet prescribed replacement criteria, or which have become unservicable, or on which further repairs would be uneconomical. It will be necessary to purchase some additional equipment, such as reproduction equipment, radiation survey instruments for use in the license inspection program, miscellaneous minor items for which needs normally develop, and some additional office furniture and machines

for staff increases. The estimate provides approximately $186,000 for purchase of additional equipment required for the staff increases requested for fiscal year 1963.

(*b*) *Special equipment for AEC-wide improved communications capability, $110,000.*—This estimate consists of the following:

(1) An amount of $80,000 for radio equipment, of which $20,000 is for improvements in range and reliability of the basic radio network by the addition of high-gain antennas and other features and $60,000 is to provide for procurement of the minimum test equipment and replacement components required for maintenance of the network.

(2) An amount of $30,000 for the procurement of portable cryptographic equipment with tape readers. In normal operation, the new cryptoequipment will backup the key-tape systems, encrypt most book and multiple-address messages and, for small volume centers, may replace the tape system. During simulated or actual emergencies, this equipment may be used for communication between cadres at normal comcenters and others at emergency relocation centers.

(*c*) *Automatic data processing equipment, $400,000.*—Extensive management analyses have been completed which indicate that substantial management improvements can be effected at the headquarters office through the establishment of an automatic data processing unit. The unit has been established and some of the required electric accounting machines are being procured in fiscal year 1962. Funds will be required in fiscal year 1963 for procurement of a computer which is planned for installation by January 1, 1963.

ADMINISTRATIVE PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations, fiscal year 1963	$100, 000
Estimated obligations, fiscal year 1962	200, 000
Actual obligations, fiscal year 1961	364, 333

Obligations for the administrative program for fiscal year 1963 are estimated at $100,000 for the project listed below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1962	Estimated obligations fiscal year 1963
63-1	General plant projects	$100, 000	0	$100, 000

EXPLANATION OF PROJECT ABOVE

1. Project 63-1. General plant projects, $100,000

This project provides for alterations, additions, replacements, and other general improvements of various types at the AEC headquarters in Germantown, Md., including shelter area improvements. Normal operating requirements create a need for numerous capital items each year, many of which are of a recurring nature for reasons of economy, safety, health protection, and efficient operation.

SECURITY INVESTIGATIONS

Mr. EVINS. If there are no questions we will turn to security investigations. We will place in the record pages 376 to 378; $6.019 million is requested for 1963. This is a decrease of $1.2 million over the previous year.

(The documents referred to follow:)

SECURITY INVESTIGATIONS PROGRAM—OPERATING COSTS

Program statement

Estimate, fiscal year 1963	$6, 019, 000
Estimate, fiscal year 1962	7, 215, 000
Decrease	1, 196, 000

This program covers cost of security investigations on individuals requiring security clearance or access authorization under the provisions of the Atomic Energy Act of 1954, as amended. Cost of investigations of individuals for whom access authorizations are required under the access permit program is not included. This is budgeted under "Cost of work for others."

The Atomic Energy Act of 1954, as amended, provides that no individual shall be permitted access to restricted data until the U.S. Civil Service Commission, another Federal agency which conducts personnel investigations, or, under certain conditions, the Federal Bureau of Investigation shall have made an investigation and report to the AEC on the character, associations, and loyalty of the person concerned, and the AEC shall have determined that permitting such individual access to restricted data will not endanger the common defense and security. Policies and procedures provide guidance in determining need for AEC security clearance or access authorization.

Pursuant to provision of section 145(f) of the Atomic Energy Act of 1954, as amended, distribution of total investigative caseload between CSC and FBI is based on Commission-approved criteria. Requests for investigation of persons who are to occupy positions of a "high degree of importance or sensitivity" are referred to the FBI, all others to CSC.

The Commission-approved program for selective reinvestigation of previously cleared personnel continues in order to assure that the program is protected from individuals whose clearance eligibility may have changed since the time of the last clearance action in their cases.

Clearance needs of AEC contractors account for about 79 percent of the 17,050 Q-type investigations budgeted for fiscal year 1963. Clearances of AEC personnel represent 6 percent of the total requirement; reinvestigations of persons previously cleared, 6 percent; and clearance of others, including suppliers and employees of other Government agencies, amount to 9 percent.

The following table shows the estimated number of new cases to be referred to the investigating agencies. Costs are expressed in the number of cases referred to the investigating agencies multiplied by the unit cost per investigation. Unit costs are those furnished by the investigating agencies.

Summary of estimates

Item	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Cost of investigations:			
Q clearances:			
Number referred to Federal Bureau of Investigation	3,725	3,600	3,550
Cost per investiation	[1] $349.53	$350.00	$350.00
Total cost, FBI	$1,301,500.00	$1,260,000.00	$1,243,000.00
Number referred to Civil Service Commission	15,087	16,800	13,500
Cost per investigation	[1] $339.50	$350.00	$350.00
Total cost, CSC	$5,122,060.00	$5,880,000.00	$4,725,000.00
Total cost of Q clearances	$6,423,560.00	$7,140,000.00	$5,968,000.00
L clearances:			
Number referred to Civil Service Commission	6,177	10,000	6,800
Cost per investigation	$7.00	$7.50	$7.50
Total cost of L clearances	$43,239.00	$75,000.00	$51,000.00
2. Total, security investigations program	$6,466,799.00	$7,215,000.00	$6,019,000.00

[1] Average cost.

JUSTIFICATION OF ESTIMATES

The estimated number of cases to be referred for full field investigation (item 1 of the preceding table) is summarized below:

Full field investigation (Q clearance)

Category	Actual, fiscal year 1961	Estimated, fiscal year 1962	Estimated, fiscal year 1963
AEC	1,009	1,040	1,050
Contractor:			
Construction	643	2,265	615
Operating	14,453	14,586	12,933
All others	1,510	1,509	1,502
Reinvestigations	1,197	1,000	950
Total	18,812	20,400	17,050

Cost of Work for Others

Mr. Evins. Mr. Reporter, insert pages 379 to 382 of the justifications.

(The data referred to follow:)

Cost of Work for Others

Program statement

Estimate fiscal year 1963	$4,100,000
Estimate fiscal year 1962	7,430,000
Decrease	3,330,000

Under the program "Cost of work for others" the Commission budgets for certain costs incurred in the manufacture of materials, which it sells to eligible purchasers and in rendering laboratory, research and other services to industrial and research organizations. The program estimates are presented in two categories in the "Summary of estimates by category" on the following page. The first category "Cost of products and services" consists of items for which the related revenues are included under the program "Revenues applied" and the second category "Cost of separation of irradiated SS material" consists of costs for which the related revenue has been included under the program "Revenues applied" in current or prior years. Reimbursements received by the Commission for the costs incurred in manufacturing products and rendering services are applied to reduce the Commission's fund requirements. These reimbursements constitute an offset against "Cost of work for others" and are shown under the program "Revenues applied." The decrease in estimated costs consists primarily of decreases in estimated sales of miscellaneous products and isotopes together with reduced levels of services rendered to others.

Summary of estimates by category

	Actual, 1961	Estimate, 1962	Estimate, 1963
1. Cost of products and services:			
(a) Cost of special reactor materials sold	$2,838,655	$1,668,000	$1,100,000
(b) Cost of isotopes sold	2,092,958	2,197,000	1,600,000
(c) Cost of other products sold	710,702	1,030,000	580,000
(d) Cost of services	778,375	2,285,000	595,000
(1) Use of AEC-owned facilities and equipment	107,069	1,620,000	60,000
(2) Irradiation services and test reactor experiments	182,921	150,000	50,000
(3) Processing and fabrication and conversion services	247,010	297,000	295,000
(4) Other services	241,375	218,000	190,000
(e) Cost of security investigations	107,767	85,000	60,000
(f) Total costs of products and services	6,528,457	7,265,000	3,935,000
2. Related revenue included under "Revenue applied"	9,898,162	10,064,000	5,732,000
3. Excess of revenues over related costs	3,369,705	2,799,000	1,797,000
4. Cost of separation of irradiated SS material (related revenue has been included under "Revenues applied" of current or prior years)	0	165,000	165,000
Total cost of work for others (line 1(f)+line 4)	6,528,457	7,430,000	4,100,000

JUSTIFICATION OF CATEGORIES

1(a) Cost of special reactor materials sold, $1,100,000

This estimate consists primarily of cost of heavy water sales to foreign countries. The decrease of $0.6 million from the fiscal year 1962 estimate is related to lower sales estimates in fiscal year 1963. Related revenue of $2.2 million for the sale of this material is included under the budget program "Revenues applied."

1(b) Cost of isotopes sold, $1,600,000

Includes cost of isotopes sold to research laboratories, industry, and educational institutions. This estimate is based on fiscal year 1963 sales projections which anticipate the availability of certain isotopes from commercial sources. Related revenue in the amount of $2 million is included under the budget program "Revenues applied."

1(c) Cost of other products sold, $580,000

Includes costs of miscellaneous products sold to the United Kingdom. The decrease of $0.5 million from the fiscal year 1962 estimate is related to lower sales levels for these products based on present projections. Related revenue of $0.7 million is included under the budget program "Revenues applied."

1(d) Cost of services, $595,000

Includes costs related to the use of AEC facilities and equipment, irradiation services, and test reactor experiments, processing, fabrication, and conversion of materials and other associated activities in the field of atomic energy. The decrease of approximately $1,690,000 from the fiscal year 1962 estimate is primarily related to the use of AEC facilities and equipment which in fiscal year 1962 include the use of test facilities through a special arrangement with the United Kingdom. Such use is not anticipated in the fiscal year 1963 estimate. Related revenue in the amount of $752,000 is included under the budget program "Revenues applied."

1 (e) Cost of security investigations, $60,000

Includes cost of security investigations obtained for access permit holders. As a means of encouraging American industry to participate more fully in the atomic energy program, the Commission initiated a program for release of selected classified nonmilitary information, after obtaining the necessary security clearance, to applicants who can demonstrate the need for this information in their business or profession. Due to recent declassifications of material the access permit program has tended to decline from the levels experienced previously. It is estimated that 260 limited security clearances and 166 full field investigations will be undertaken in fiscal year 1963 at a total cost of $60,000 from which the

Commission will derive $90,000 in revenues. These revenues have been included under the budget program "Revenues applied."

2. Related revenue included under program "Revenues applied," $5,732,000

The estimated total revenue related to the sale of products and services included under the budget program "Revenues applied" is $5,732,000 as compared to costs of the related products and services of $3,935,000 reflecting an excess of revenue over costs of $1,797,000 on the products and services included in the program "Cost of work for others."

4. Cost of separation of irradiated SS material, $165,000

Includes the cost of separation of irradiated SS material, presently scheduled for reprocessing, which has been, or will be, returned by domestic and foreign reactors. The estimate is subject to adjustment dependent upon the receipt of scheduled returns and accomplishment of planned schedules for reprocessing this material.

COMMUNITY PROGRAM

Mr. JENSEN. Are you leaving the community program?

Mr. EVINS. Yes. We passed it.

Mr. JENSEN. I would like to ask General Betts a question.

General, in the community where Federal installations have located, and some of them have been established now for many, many years—homes are built by the thousands and business establishments are there in every line one can imagine. Business prospers, they have good schools, property values are up. Yet we, Uncle Sam, all of us, continue to give those communities Federal aid. When is the time coming, do you anticipate, when no more Federal aid will be requested for those communities?

General BETTS. The kind of assistance payments now being made to the communities of Richland and Oak Ridge are proposed to be terminated at the end of 10 years from the time the disposal law was passed, which was 1955.

Mr. MCCARTHY. I think it is 10 years after disposal of the community. The assistance payments run 10 years after the transfer of municipal installations to the local governing body.

Mr. JENSEN. When does the time run out. When we will not have such a request before this committee?

General BETTS. For the town of Oak Ridge it would now be about 6 or 7 more years.

Mr. MCCARTHY. I think the first assistance payment at Oak Ridge was about 1960, after they had disposed of the community and a self-governing body had taken over. I think each of them have 6 or 7 years to run under the act.

Mr. JENSEN. Can we expect each year that there will be a reduction in the budget request for community assistance?

Mr. MCCARTHY. We would hope that there would be, as they get more taxable property in each of these towns. One of the great problems, I think——

Mr. JENSEN. I certainly would expect there would be. It should be materially reduced each year. I am sure this committee is going to take a good, long look at these community assistance requests for areas that are under discussion.

Mr. MCCARTHY. Under the Community Disposal Act we have to take into account the level and standards of community services in looking at the assistance payment during the 10 years. This is one of the things that was offered to the community people there, when we

sold the community—that, in effect, during this 10-year period, the rate of services which had been provided by the Government would not materially decrease. We did this, so disposal would not affect our program and the opportunity to attract people to our program.

Mr. JENSEN. I would recommend, and I think the committee will concur in this recommendation, that the Atomic Energy Commission and you, General Betts, take a personal interest in seeing that the budget request for such purposes is held to a minimum. I am sure that this committee looks at these huge budget requests for such purposes with a jaundiced eye. We may find it necessary to send an investigator into those areas to see that Uncle Sam is not getting too badly duped.

General BETTS. It is our policy to hold these to the minimum consistent with the law passed by Congress. We trim these to that minimum as well as we can.

Mr. JENSEN. I hope you do.

Now, I think, Mr. Chairman, I should make this statement at this time, and I will make it off the record.

Mr. EVINS. Off the record.

(Discussion off the record.)

ADDITIONAL CONSTRUCTION ITEMS INCLUDED IN AUTHORIZING LEGISLATION

Mr. EVINS. General Luedecke, in the event your legislative committee includes any additional items in your construction authorization bill for 1963, we would appreciate your indicating in this record whether or not the Commission intends to request the Bureau of the Budget to amend your budget estimates for fiscal year 1963. Oftentimes, we legislate and you don't like the program and you don't fund them. Lots of times we are interested in matters that the Commission is not interested in. It is not always that we get together.

(The requested information follows:)

NOTE.—Changes made by the legislative committee in the 1963 authorization bill for the Atomic Energy Commission, are as follows:

Increase amount for project 63–g–4, accelerator and reactor additions and modifications, Brookhaven National Laboratory from $1,250,000 to $2,250,000	$1,000,000
Add project 63–j–2, marine products development irradiator	600,000
Add project 63–j–3, two mobile irradiators	700,000
Add amount for cooperative power reactor program	3,000,000
Reduce project 63–d–6, improvement of U.S. Highway 95—Las Vegas, Nev., to the Nevada test site, from $10,000,000 to $9,000,000	−1,000,000

The Commission does not plan to request amendments to the President's budget for 1963.

SELECTED RESOURCES

Mr. EVINS. We would like to have an explanation of your selected resources, whoever wants to tell us about that. We will insert pages 383 to 394 in the record.

(The documents referred to follow:)

INCREASE OR DECREASE IN SELECTED RESOURCES

Program statement

Estimate, fiscal year 1963	$989, 108, 976
Estimate, fiscal year 1962	828, 434, 976
Increase	160, 674, 000

This program "Increase or decrease in selected resources" presents the net increase or decrease in levels of resources required to support the programs of the Commission. This program includes requirements for inventories, collateral funds and other deposits, and goods and services on order. The category "Goods and services on order" includes contracts for materials and services to be delivered after fiscal year 1963 and financing of contractors in accordance with Commission policy beyond the end of the fiscal year to insure continuity of operations. The contractor requirements included in the estimate provide for 3 months of forward financing. The levels of selected resources are assets that may be applied to program costs of future years' operations.

The increase of $160,674,000 for fiscal year 1963 consists of an increase of $732,000 in inventory levels and an increase of $159,942,000 in the level of goods and services on order:

The net increase in inventories of $732,000 consists of—

1. A decrease in stores inventory of $137,000.
2. A decrease in special reactor materials inventory of $424,000 resulting primarily from utilization for program requirements of inventories on hand.
3. A decrease in other special materials inventory of $1,969,000 primarily attributable to reduction in inventory levels of barrier items.
4. A net increase of $3,262,000 in isotopes inventory related primarily to increase in stable isotopes of $1.9 million to support higher levels of research in cross-section measurement activities and $1.3 million in radioisotopes based on projected program requirements.

The increase in level of goods and services on order is related to program cost levels at the end of fiscal year 1963.

Summary of estimates by category

	Actual, 1961	Estimate, 1962	Estimate, 1963	Increase or decrease (−)
Balances at end of year:				
1. Inventories:				
(*a*) Stores	$91, 664, 786	$91, 273, 000	$91, 136, 000	−$137, 000
(*b*) Special reactor materials	65, 407, 711	63, 883, 000	63, 459, 600	−424, 000
(*c*) Other special materials	17, 936, 395	15, 431, 000	13, 462, 000	−1, 969, 000
(*d*) Isotopes	11, 097, 807	13, 139, 000	16, 401, 000	3, 262, 000
Total inventories	186, 106, 699	183, 726, 000	184, 458, 000	732, 000
2. Collateral funds and other deposits	20, 256, 798	20, 257, 000	20, 257, 000	0
3. Goods and services on order	679, 193, 000	624, 451, 976	784, 393, 976	159, 942, 000
Total unapplied resources at end of year	885, 556, 497	828, 434, 976	989, 108, 976	160, 674, 000
Increase or decrease in selected resources	5, 711, 443	−57, 121, 521	160, 674, 000	

JUSTIFICATION BY CATEGORIES

1. Inventories (increase) $732,000

(*a*) *Stores inventory (decrease) $137,000.*—Stores inventories are supplies, materials, and parts normally used or consumed in the production of source and special nuclear materials; in the maintenance of production plants, buildings, and other facilities; or in the operation of laboratories and experimental projects, communities and administrative activities. Stores exclude source and special nuclear materials, weapons components, special reactor materials, and other special materials.

Decrease related principally to reduction in operating inventories of reactor development program contractors.

(b) *Special reactor materials inventory (decrease) $424,000.*—This inventory consists of selected materials used in the construction and operation of reactors for production and research purposes.

The decrease results primarily from reduction in heavy water as a result of sales and program usage.

A classified schedule of the inventory levels of special reactor materials is presented on classified p. 395.

(c) *Other special materials (decrease) $1,969,000.*—Other special materials inventory is made up of the following items, requiring special accounting controls: Radium, gold, silver, platinum, rhodium, palladium, iridium, osmium, gallium, americium 241, and barrier items.

The decrease is primarily attributable to a reduction in the inventory level for barrier items.

(d) *Isotopes (increase) $3,262,000.*—The increase in the inventory levels of isotopes is indicated below:

	Estimate, fiscal year 1962	Estimate, fiscal year 1963	Increase
Stable isotopes	$9,382,000	$11,313,000	$1,931,000
Radioisotopes	3,757,000	5,088,000	1,331,000
Total inventory	13,139,000	16,401,000	3,262,000

The increase of $1.9 million in the stable isotopes inventory is based on requirements to meet the specific needs of cross-section measurement activities. The increase of $1.3 million in the radioisotopes inventory is related to projected program requirements.

2. Collateral funds and other deposits (increase), none

No change is planned in fiscal year 1963 for collateral funds and other deposits. The fiscal year 1963 year-end balance includes $18,680,000 for collateral funds consisting of insurance collateral funds, employee benefit and annuity funds; and $1,577,000 in other deposits required by vendors on containers and other deposits of a miscellaneous nature. The collateral funds were established under contracts originally entered into by the War Department, and were designed to provide for various extraordinary contingencies in the activities of cost-type contractors. For the most part, collateral funds are held by trustees and invested in U.S. Government securities.

The following table indicates the balances of collateral funds and other deposits as of the end of fiscal years 1961, 1962, and 1963:

Yearend balances

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Collateral funds and other deposits:			
Collateral funds by office and contract:			
Hanford, Wash., General Electric insurance fund—Travelers Insurance Co	$10,500,000	$10,500,000	$10,500,000
Albuquerque, N. Mex., Los Alamos—University of California employees benefit fund	1,000,000	1,000,000	1,000,000
San Francisco, Calif., Berkeley—University of California employees benefit und	480,000	480,000	480,000
Chicago, Ill., University of Chicago employees benefit fund	500,000	500,000	500,000
New York, N.Y., Columbia University employees benefit fund	200,000	200,000	200,000
Washington, D.C., University of California, Los Alamos, and University of Chicago insurance fund—Royal & Globe Co	6,000,000	6,000,000	6,000,000
Total, collateral funds	18,680,000	18,680,000	18,680,000
Other deposits	1,576,798	1,577,000	1,577,000
Total, collateral funds and other deposits	20,256,798	20,257,000	20,257,000

3. Goods and Services on order (increase) $159,942,000

Estimates for fiscal year 1963 are based on Commission policy for 3 months forward financing for cost reimbursement type contractors and funding of commitment levels at the end of the contract period to insure continuity of operations. The funding requirements are related to the cost levels presented under program costs. A summary table of requirements by category is included on the following page.

Yearend balances

[In thousands]

Category	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963	Increase or decrease (—) in fiscal year 1963
Goods and services on order:				
A. Major long-term reimbursement contracts, over $1,000,000 annual operating level:				
(1) Contractors with prinicipal effort in production of source and special nuclear materials	$133,650	$100,552	$134,381	$33,829
(2) Contractors with principal effort in production of weapons and weapon components	113,423	72,394	118,165	45,771
(3) Contractors with principal effort in research and development	285,869	281,456	358,648	77,192
(4) Contractors with principal effort in supporting services	8,018	25,150	25,150	0
Total	540,960	479,552	636,344	156,792
B. Major material procurement contracts	43,077	50,542	29,740	—20,802
C. Research and development other than those contractors included under item A(3)	46,053	47,816	61,130	13,314
D. Cooperative arrangements program, civilian power reactors	23,476	19,641	30,313	10,672
E. Other cooperative power reactors (bonus)	434	319	0	—319
F. Utilities	2,180	1,932	1,682	—250
G. All other	23,013	24,650	25,185	535
Grand total, goods and services on order	679,193	624,452	784,394	159,942

Increases and decreases in the balances of goods and services on order follow:

A. Major long-term reimbursement contracts—over $1,000,000 annual operating level (increase) $156,792,000.—The estimates provide forward financing of 3 months in addition to financing the level of outstanding commitments at the end of this period. Increases or decreases by category of contracts are listed below.

	Increase
(1) Contractors with principal effort in production of source and special nuclear materials	$33, 829, 000
(2) Contractors with principal effort in production of weapons and weapon components	45, 771, 000
(3) Contractors with principal effort in research and development	77, 192, 000
(4) Contractors with principal effort in supporting services	0

B. Major material procurement contracts (decrease) $20,802,000.—Includes uncosted balances related to procurement of Canadian uranium concentrates, feed materials, and procurement of cores.

C. Research and development other than those contracts included under item A(3) (increase) $13,314,000.—Includes incosted balances related to procurement of: (1) A computer for the high energy physics program, (2) low energy physics accelerators, (3) aerospace safety launch vehicles; and also provides for uncosted balances related to research and development contracts other than major long-term reimbursement type.

D. Cooperative arrangements program—Civilian power reactors (increase) $10,672,000.—The following table reflects the level of uncosted balances at the end of the fiscal year under various contracts in the cooperative arrangements program for the advancement of civilian nuclear power:

Yearend balances

[In thousands]

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963	Increase or decrease (−) in fiscal year 1963
(1) Fiscal year 1958 cooperative power reactor demonstration program:				
Consumers public power district	$6,870	$5,086	$4,386	−$700
Fast reactor systems (PRDC)	140	848	598	−250
Elk River-Rural Cooperative Power Association	1,575	1,273	433	−840
City of Piqua, Ohio	1,360	626	125	−501
Northern States Power Co	2,432	1,221	506	−715
Carolinas-Virginia Nuclear Power Association, Inc	4,732	5,085	4,485	−600
East Central & Florida West-coast Nuclear Group	295	0	0	0
Unapplied R. & D. funds	0	0	3,268	3,268
Subtotal	17,404	14,139	13,801	−338
(2) Fiscal year 1960 cooperative power reactor demonstration program:				
Advanced high temperature reactor (Philadelphia Electric)	2,000	2,092	2,092	0
Consumers of Michigan	3,017	2,265	1,258	−1,007
R. & D. assistance for unsolicited proposals	0	0	1,513	1,513
LaCrosse boiling water reactor	0	1,145	945	−200
Intermediate organic reactor	1,052	0	0	0
Small size nuclear water reactor	3	0	0	0
Subtotal	6,072	5,502	5,808	306
(3) Additional unsolicited proposals	0	0	10,704	10,704
Grand total, cooperative power reactor demonstration program	23,476	19,641	30,313	10,672

E. Other cooperative power reactors (decrease), 319,000.—This activity provided for the uncosted balance related to the bonus reactor.

F. Utilities (decrease), 250,000.—Includes the unliquidated cancellation liability under the contract with the East Tennessee Natural Gas Co. for the supply of gas at Oak Ridge, Tenn.

G. All other (increase), $535,000.—Includes uncosted balances for miscellaneous contracts.

INCREASES REQUESTED

Mr. EVINS. Review the principal increases under this heading, other than the item of $159 million for further financing of your facility contractors.

Mr. MCCARTHY. Other than the $159 million there is an increase of $3,262,000 in the isotopes inventory. This inventory is made up of stable isotopes and radioisotopes which will be in the inventory at the end of fiscal year 1963. This increase is offset in large part by a decrease of $1.969 million in other special materials, a decrease of $424,000 in special reactor materials which includes heavy water, beryllium and other materials, and a $137,000 reduction in our stores inventory. These net out to a total increase of $732,000. The $159 million is tied into the level of contracts and, of course, $120 million is the 1962 supplemental which has been deferred

Mr. EVINS. I notice you have the Hanford, Wash., General Electric insurance fund, $10 million and other funds, $6 million, $1 million.

Mr. McCarthy. These are the collateral funds that are on deposit. The insurance companies hold the funds for the various insurance plans we have. Some years ago the committee suggested that we see if we could not recoup the collateral funds and buy the insurance outright. We examined this and we found it would be more costly. These funds are invested in Government bonds by these companies.

Mr. Evins. You are not big enough yet to be self-insurers?

Mr. McCarthy. Not in the case of these plants.

Revenues Applied

Mr. Evins. Tell us about your revenues applied.

Mr. McCarthy. For 1963 we are projecting a decrease of $4.769 million. In 1962 our estimate increased over what we came to the Congress with last year. Three items made up the increase. One was disposal of additional heavy water to Canada. We also carried out—off the record—

(Discussion off the record.)

Mr. McCarthy. Our estimated revenues in 1963 are $26.7 million.

Mr. Evins. Place in the record pages 396 through 405.

(The documents referred to follow:)

Program Statement

Estimate, fiscal year 1963	$26, 700, 000
Estimate, fiscal year 1962	31, 469, 000
Decrease	4, 769, 000

The program "Revenues applied" includes income from the sale and lease of products, materials, and services to eligible purchasers and other revenue from community operations, hospitals, schools and courses, collateral funds, and other miscellaneous sources. The program estimates are presented in three categories in the "Summary of estimates by category" on the following pages. The first category "Revenue from sale of products and services" consists of items for which the related costs are included under the program "Cost of work for others," the second category "Revenue from separation of irradiated SS material" reflects income accruing to the Commission for which the related costs will be included under the program "Cost of work for others" currently or in future years, and the third category, "Other revenue" consists of revenue items for which the costs are reflected under the related program costs, and other income of a miscellaneous nature.

Revenue from sale of products and services includes income from the sale of special reactor materials, isotopes, and other products as well as income from the use of AEC-owned facilities and equipment, irradiation and related test reactor services, services for processing and fabrication and conversion of materials, other miscellaneous services, and income from security investigations. Commission policy provides for full-cost recovery for products, materials, and services, with the exception of use charge waivers under the cooperative arrangements program as authorized by law, and other minor exceptions approved by the Commission.

The revenues generated from transactions involving source and special nuclear material reflect the reduced base charges for enriched and depleted uranium that became effective July 1, 1961 (fiscal year 1962), together with increased use charge rates which became effective at the same time.

The revenues received are applied in the budget to reduce the appropriation requirements of the Commission. The major changes in the fiscal year 1963 estimate which result in a net decrease of $4.8 million from the fiscal year 1962 estimate are:

Decreases in "Products and services," related costs for which are included under the program "Cost of work for others":

	Millions
Sale of special reactor materials	−$1.2
Sale of other products	−1.4
Income from services	−1.7
Subtotal	−4.3

Other changes:

Decreased sales of source and special nuclear materials	−3.2
Increase from charges for separation of irradiated SS material	+1.6
Miscellaneous increases (net)	+1.1
Total	−4.8

Summary of estimates by category

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
1. Revenue from sale of products and services:			
(a) Sale of special reactor materials	$5,671,779	$3,395,000	$2,200,000
(b) Sale of isotopes	2,339,552	2,698,000	2,000,000
(c) Sale of other products	903,638	1,365,000	690,000
(d) Income from services	778,780	2,473,000	752,000
(1) Use of AEC-owned facilities and equipment	121,022	1,630,000	70,000
(2) Irradiation services and test reactor experiments	197,206	200,000	70,000
(3) Processing and fabrication and conversion services	269,810	362,000	362,000
(4) Other services	250,742	281,000	250,000
(e) Income from security investigations	204,413	133,000	90,000
(f) Total revenue from sale of products and services	9,898,162	10,064,000	5,732,00
2. Related costs included under "Cost of work for others"	6,528,457	7,265,000	3,935,000
3. Excess of revenues over related costs	3,369,705	2,799,000	1,797,000
4. Revenue from separation of irradiated SS material (related costs will be included under "Cost of work for others" of current or future years)	0	190,000	1,800,000
5. Other revenue (related costs are included when applicable under program costs of current or prior years):			
(a) Sale of source and special nuclear material	3,015,093	4,014,000	800,000
(b) Income from charges for SS material consumed	2,657,041	3,572,000	4,500,000
(c) Income from lease of materials and interest from deferred sales of material	2,552,789	2,680,000	3,280,000
(d) Income from community operations	5,680,265	5,647,000	5,767,000
(e) Sale of steam	3,173,896	2,310,000	2,900,000
(f) Sale of vanadium pentoxide	208,504	944,000	0
(g) Income from research hospitals	401,620	375,000	375,000
(h) Income from operation of schools and courses	212,318	162,000	196,000
(i) Sale of publications and other fees	67,528	64,000	60,000
(j) Income from collateral funds	661,897	567,000	560,000
(k) Other miscellaneous income	965,811	880,000	730,000
(l) Total, other revenue	19,596,762	21,215,000	19,168,000
Total, revenues applied (line 1(f)+4+5(l)	29,494,924	31,469,000	26,700,000

JUSTIFICATION OF CATEGORIES

1. Revenue from sale of products and services, $5,732,000

The gross revenue from the sale of products and services in this category for fiscal year 1963 in the amount of $5,732,000 is applied as a reduction of the total appropriation requirement of the Commission; however, it is pertinent to point out that the related costs of these products and services amount to $3,935,000 (line 2), which is included as an appropriation requirement under the budget program "Cost of work for others." The net revenue after deduction of costs is $1,797,000 (line 3).

1a. Sale of special reactor materials, $2,200,000

This estimate consists primarily of revenue derived from the sale of heavy water to foreign countries for reactor use. It also includes the sale of minor quantities for research purposes. The decrease of $1.2 million from the fiscal year 1962 estimate is attributable to lower estimated foreign sales in fiscal year 1963. The related cost of the material is $1.1 million which is included under the budget program "Cost of work for others."

1b. Sale of isotopes, $2,000,000

This estimate consists of revenue derived from the sale of stable and radioisotopes to research laboratories, industry and educational institutions. It is based on projections of sales in fiscal year 1963 which anticipate the availability of certain isotopes from commerical sources. The related cost of the products is $1,600,000 which is included under the budget program "Cost of work for others."

1c. Sale of other products, $690,000

This estimate consists of revenue derived from the sale of miscellaneous products to the United Kingdom. The decrease of $675,000 from the fiscal year 1962 estimate is related to projections of currently known requirements. The related cost of the products is $580,000 which is included under the budget program "Cost of work for others."

1d. Income from services, $752,000

This estimate consists of income derived from the use of AEC-owned facilities and equipment and from the rendering of services, the purpose of which is to further research and other associated activities in the field of atomic energy. Related costs of $595,000 are included under the budget program "Cost of work for others." The major activities which produce this revenue together with the related costs are as follows:

1d. (1) Use of AEC-owned facilities and equipment, $70,000.

Reflects income derived principally from the use of Commission laboratory facilities for research work. The decrease of $1,560,000 from the fiscal year 1962 estimate is related to the use of test facilities through a special arrangement with the United Kingdom, such use is not anticipated in the fiscal year 1963 estimate.

1d. (2) Irradiation services and test reactor experiments, $70,000

Reflects income derived from performing irradiation services in Commission facilities and conducting test reactor experiments at the national reactor testing station for non-AEC users in connection with industrial applications and research activities. The decrease of $130,000 from the fiscal year 1962 estimate reflects the continued implementation of Commission policy to refer work of this type to commercial reactors where available. Related costs of $50,000 are included under the budget program "Cost of work for others."

1d. (3) Processing and fabrication and conversion of materials, $362,000

Reflects income derived from services performed for non-AEC users in connection with the processing and fabrication of materials and the conversion of returned materials into an acceptable form. Related costs of $295,000 are included under the budget program "Cost of work for others."

1d. (4) Other services, $250,000

Consists principally of income derived from miscellaneous laboratory services performed by Commission laboratories for non-AEC users. Related costs of $190,000 are included under the budget program "cost of work for others."

1e. Income from security investigations, $90,000

This estimate reflects income from authorized access permit holders for charges for security investigations. As a means of encouraging American industry to participate more fully in the atomic energy program, the Commission has instituted a program for release of selected classified nonmilitary information, after obtaining the necessary security clearances, to applicants who can demonstrate that the information is needed in their business or profession. Due to recent declassifications of material the access permit program has tended to decline from the levels experienced previously. The related costs of security investigations for access permit holders are $60,000 and are included under the budget program "Cost of work for others."

4. Revenue from separation of irradiated source and special material, $1,800,000

This estimate reflects income from charges, either estimated or actual, made for the separation of returned irradiated source and special material by domestic and foreign reactors. The estimate is based on scheduled returns and therefore is subject to adjustment dependent upon their receipt.

5. Other revenue, $19,168,000

5a. Sale of source and special nuclear material, $800,000

This estimate consists of income derived from the sale of normal and enriched uranium to foreign countries, and domestic sale of normal and depleted uranium for industrial and research usage. The fiscal year 1963 estimate represents the best projection of miscellaneous sales that can be obtained in the absence of firm requests at this time. Related costs of this material were included in program costs in prior years.

5b. Income from charges for source and special nuclear material consumed, $4,500,000

This estimate reflects income derived from charges made for material consumed, or "burned up," in the operation of private domestic power and test reactors, military reactors and some foreign reactors using fuel provided by the Commission. Current Commission policy requires that for such reactors, other than military or those for which the charges have been waived, material consumed be paid for periodically on a provisional basis subject to adjustment when the spent core is reprocessed and actual "burnup" is determined. These charges are billed currently from data submitted by the reactor operators. The fiscal year 1963 estimate reflects the "startup" and/or attainment of full power and normal operations by a number of new power reactors.

5c. Income from the lease of materials and interest from deferred sales of materials, $3,280,000

This estimate consists of revenue derived as follows:

Lease of source and special nuclear materials	$2,640,000
Lease of special reactor materials	320,000
Lease of stable isotopes	20,000
Subtotal	2,980,000
Interest from deferred sales of source and special nuclear materials	300,000
Total	3,280,000

Current Commission policy provides for a lease, or use, charge of 4.75 percent per annum on the sales value of material leased to qualified domestic and foreign users. The Commission has also established deferred payment plans for the purchase, by qualified foreign users, of enriched power reactor fuels, which provide for a 10-year deferral of the payment for the material purchased and equal annual installments over the next 10 years with interest to be charged on the unpaid balance of the purchase at rates set forth below. Purchases under the U.S.-Euratom joint program are subject to an interest charge of 4 percent per annum while purchases under the Commission's "limited deferred payment plan" are subject to an interest charge of 4.75 percent per annum. The bulk of the revenue from the lease of source and special nuclear materials is derived from the lease of enriched materials for domestic power reactors. Revenue from lease of special reactor materials is derived primarily from lease of heavy water by foreign users. Interest from deferred sales is related to material for the Senn reactor near Formia, Italy, which is being built under the U.S.-Euratom joint program. The above estimates are subject to adjustment dependent upon accomplishment of program scheduling by users of material.

5d. Income from community operations, $5,767,000

This estimate consists principally of income related to the operation of the AEC community at Los Alamos, N. Mex. This includes revenue from housing and commercial properties, hospital, utility operations, and other miscellaneous sources. Costs of $6,767,000 (exclusive of assistance payments of $2,797,000) which related to these revenues are included under the budget program "Community operations," together with schedules reflecting the revenues by community and category.

5e. Sale of steam, $2,900,000

This estimate reflects income derived from the sale of steam at the Shippingport pressurized water reactor, sodium reactor experiment (SRE) in Santa Susana, Calif., and the new cooperative power project at Piqua, Ohio. Under the cooperative arrangement for the Piqua project, the Commission owns and operates the reactor, the operating costs for which are included under the budget program "Reactor development," and sells the reactor-generated steam to the operating utility.

5f. Sale of vanadium pentoxide, none

No sales of vanadium pentoxide are anticipated in fiscal year 1963.

5g. Income from research hospitals, $375,000

This estimate consists of revenue derived from payments by patients at the Commission's research hospitals. Related costs for the operation of the hospitals as well as for the operation of the cancer research laboratories and other related facilities are included under the budget program "Biology and medicine."

5h. Income from operation of schools and courses, $196,000

This estimate reflects income from tuition charges for the following schools and courses:

Argonne International Institute of Nuclear Science and Engineering	$90,000
Puerto Rico Nuclear Center	9,000
Nuclear reactor operations supervision course	16,000
Nuclear reactor hazards evaluation course	14,000
Reactor supervisors training course	30,000
Special and industrial radioisotope courses	37,000
Total	196,000

Related costs for these schools and courses are included under the budget program "Training, education, and information."

5i. Sale of publications and other fees, $60,000

This estimate consists of revenue derived principally from the sale of pamphlets to museum visitors, sale of classified technical publications to access permit holders and sale of unclassified technical publications to the Department of Commerce for resale to the public. Related costs are included under other budget programs either currently or in prior years.

5j. Income from collateral funds, $560,000

This estimate reflects income from special funds held by the Commission or its contractors for insurance collateral, employee benefits and annuity purposes.

5k. Other miscellaneous income, $730,000

This estimate includes income derived from insurance indemnity fees, timber sales, and other miscellaneous sources of a general nature. The decrease of $150,000 from the fiscal year 1962 estimate is primarily in royalties from Commission-owned mines leased to independent producers, or milling contractors. These leases will expire by March 31, 1962, and will not be renewed.

Employment, Travel, and Motor Vehicle

Mr. Evins. We will insert pages 406 through 411 on employment, travel, and motor vehicles.

(The data referred to follows:)

All Programs—AEC Direct Employment

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Number of permanent full-time civilian employees at end of fiscal year	6,713	6,790	7,022
Average number of permanent full-time civilian employees	6,683	6,757	6,968
Total personal services costs	$55,936,117	$57,233,000	$59,526,000

It is the basic policy of the Commission to conduct the atomic energy program through contractors to the greatest practical extent. The following functions are performed by AEC employees within the basic policy: (1) Program planning and direction, contract negotiation, liaison with contractors, and inspection of contractor products; (2) administration of industrial development, regulatory and licensing, and international cooperation activities; (3) security measures including screening of personnel, protection of documents and property, guarding of security shipments and patrolling of sites where contractor guard service is not provided; (4) operation of the New Brunswick Laboratory and New York Health and Safety Laboratory; (5) operation and management of the Los Alamos communications facilities, and fire and police department; (6) operation of health and safety activities at the national reactor testing station in Idaho; (7) accounting, auditing, property management, and personnel services, assuring adequate controls by AEC offices and contractors; (8) control and dissemination of scientific and technical information; and (9) provision of supporting services at the AEC Headquarters and field offices.

The fiscal year 1963 estimate reflects an increase of 232 permanent full-time employees over the June 30, 1962, end strength of 6,790. Yearend strengths and average employment for permanent full-time employees and total personal services costs for each of the Commission's programs are shown in the following table:

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Program	Actual, fiscal year 1961			Estimate, fiscal year 1962			Estimate, fiscal year 1963		
	Employment		Cost (in thousands)	Employment		Cost (in thousands)	Employment		Cost (in thousands)
	End strength	Average full time		End strength	Average full time		End strength	Average full time	
Special nuclear materials	149	153	$1,201	157	155	$1,224	149	156	$1,242
Weapons	853	852	6,089	883	877	6,429	898	893	6,493
Reactor development	230	223	1,587	247	241	1,715	247	247	1,784
Biology and medicine	103	96	767	105	105	820	108	107	855
Training, education, and information	213	211	1,267	223	223	1,360	223	223	1,412
Community	78	76	523	83	82	574	83	83	581
Program direction and administration	5,087	5,072	44,502	5,092	5,074	45,111	5,314	5,259	47,159
Total	6,713	6,683	55,936	6,790	6,757	57,233	7,022	6,968	59,526

The basis for increases and decreases by program follows:

(*a*) Special nuclear materials program (anticipated reduction in volume and type of security shipments)	−8
(*b*) Weapons program (overall increase in programmatic workload)	+15
(*c*) Biology and medicine program (increased workload at the New York Health and Safety Laboratory)	+3
(*d*) Program direction and administration (increased workload as discussed in the narrative justification for this program)	+222

ALL PROGRAMS—TRAVEL

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Estimated number of travel days	92,701	109,369	115,454
Total estimated cost	$3,181,847	$4,165,000	$4,545,000

This estimate covers essentially the cost of official travel of Government employees while discharging assigned AEC duties away from official duty stations. It is pointed out that the number of travel days and the travel costs reflect the travel of three principal classes of personnel: (1) AEC permanent full-time employees; (2) AEC intermittent employees such as members of advisory groups and individual consultants; and (3) about 300 military personnel on duty with the AEC, whose salaries are paid by the Department of Defense, but whose duties require considerable travel on AEC business. Some employees of the Commission spend a large part of their duty time away from their official station, such as shipment security guards in the special nuclear materials, weapons, and reactor development programs. Extensive travel is required in connection with weapons production, quality assurance inspections and storage activities under the weapons program; inspection of licensed facilities; and international cooperation activities. Substantial travel is also required to maintain a satisfactory degree of technical and administrative supervision over Commission offices and projects and liaison with contractors, to provide for attendance of technical and scientific personnel at important domestic and foreign conferences and symposia, and to provide for coordination of and participation in oversea nuclear energy exhibits.

The fiscal year 1963 request represents the estimated requirements for travel essential to the proper discharge of Commission responsibilities in all areas. The estimates for the special nuclear materials and reactor development programs are related primarily to the volume of security shipments requiring escort personnel. The estimate for the weapons program is related to the projected level of operations which will necessitate a high volume of travel. The travel requested under the biology and medicine program is for required travel of personnel assigned to the New York Health and Safety Laboratory. A small amount of travel funds is required under the training, education, and information program by the Technical Information Service Extension at Oak Ridge. Under the community program limited travel will be performed by personnel engaged in community operations under the Albuquerque Operations Office. The estimate for program direction and administration was discussed in the justification for operating costs of that program.

The following table reflects a comparison of the estimated days of travel and estimated costs of the various programs:

[Costs in thousands]

Program	Actual, fiscal year 1961		Estimate, fiscal year 1962		Estimate, fiscal year 1963	
	Days	Cost	Days	Cost	Days	Cost
Special nuclear materials	3,573	$75	5,469	$130	5,469	$127
Weapons	20,669	402	26,995	595	26,995	595
Reactor development	1,877	45	2,602	67	2,602	67
Biology and medicine	1,100	40	1,140	50	1,140	50
Training, education, and information	250	9	250	10	250	10
Community	152	5	152	6	152	6
Program direction and administration	65,080	2,606	72,761	3,307	78,846	3,690
Total travel	92,701	3,182	109,369	4,165	115,454	4,545
Additional costs to account for the grand total of "Travel and transportation of persons":						
Rental of passenger vehicles from interagency motor pools	----------	59	----------	67	----------	67
Contractual local transportation (headquarters only)	----------	39	----------	38	----------	38
Grand total	----------	3,280	----------	4,270	----------	4,650

Statement of Passenger Motor Vehicles

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Net active fleet, end of fiscal year	1,983	2,101	[1] 2,496
Number of replacement vehicles	405	314	410
Number of additional vehicles	20	118	330
Gross cost of replacement vehicles	$897,912	$1,149,650	$2,003,450
Gross cost of additional vehicles	35,400	191,100	448,850
Total gross cost of vehicles	933,312	1,340,750	2,452,300

[1] Includes 65 vehicles to be transferred from the General Services Administration to AEC without reimbursement as discussed below.

Passenger motor vehicles are required by the AEC for security patrols of extensive plant and laboratory areas, inspection and audit of Commission and contractor operated facilities, and for other necessary official transportation of AEC and contractor personnel within and between project sites and areas in the management and operation of the programs conducted by the agency. The estimate includes requirements for both contractor operations and the AEC. The fiscal year 1963 estimate provides for procurement of 740 passenger motor vehicles of which 410 are for replacement and 330 are for additions. All vehicles to be replaced will meet or exceed the GSA replacement standards.

In fiscal year 1963 the operation of the General Services Administration interagency motor pool at Livermore, Calif., is to be terminated and 170 passenger vehicles are to be transferred to AEC. Sixty-five of these vehicles, representing the return of vehicles AEC furnished GSA when the motor pool was started in 1957, will be transferred without cost to AEC. The acquisition of the remaining 105 passenger vehicles from GSA requires congressional approval under 5 U.S.C. 78(e). The discontinuance of the motor pool has been mutually agreed to between GSA and AEC as being advantageous to the Government. Apart from those at Livermore, the additional vehicles requested include 222 automobiles and 3 station wagons for the following purposes: 200 automobiles for the Nevada test site to offset a like number of commercial rentals in view of the continuing programs at this location; 8 automobiles for the Atomic Bomb Casualty Commission to be substituted for 4-wheel drive truck-type vehicles used for passenger and patient transportation; 10 automobiles for activities at the national reactor testing station in Idaho; and 4 automobiles and 3 station wagons for Brookhaven National Laboratory to provide for increased staff and off-site service for official visitors.

Table A, below, shows the passenger motor vehicle requirements, by type, for fiscal year 1963. A breakdown of the AEC fleet by type of vehicle is shown in table B.

TABLE A.—*Passenger motor vehicle requirements*

	Actual, fiscal year 1961		Estimate, fiscal year 1962		Estimate, fiscal year 1963	
	Number	Cost	Number	Cost	Number	Cost
Automobiles	380	$558,301	376	$564,000	597	$871,000
Station wagons	24	48,755	17	33,150	86	123,050
Ambulances	4	44,348	8	45,250	9	44,900
Busses	17	281,908	31	698,350	48	1,413,350
Total requirements	425	933,312	432	1,340,750	[1] 740	2,452,300

[1] Includes 105 passenger vehicles to be transferred from the GSA motor pool with reimbursement to GSA as follows: 54 automobiles, 47 station wagons, and 4 ambulances.

TABLE B.—*Net active fleet of passenger motor vehicles at end of year*

	Actual, fiscal year 1961	Estimate, fiscal year 1962	Estimate, fiscal year 1963
Automobiles	1,446	1,561	1,902
Station wagons	139	139	186
Ambulances	44	45	49
Busses	354	356	359
Total	1,983	2,101	2,496

EMPLOYMENT

Mr. BOLAND. The budget calls for an overall increase of 122 positions from 5,100- to 5,300-odd positions in all of AEC. As I remember the chairman's opening statement he indicated that you were closing down some operations at Oak Ridge and Weldon Springs.

How many employees does this affect in those areas?

General LUEDECKE. No more than six AEC employees.

SUBMISSION OF BUDGET TO THE BUREAU OF THE BUDGET

Mr. BOLAND. What was your request of the Bureau of the Budget? You are asking for $2.8 billion here. What was your request of the Bureau of the Budget?

Mr. MCCARTHY. About $2.92 billion.

Mr. EVINS. Any further questions?

Off tne record.

(Discussion off the record.)

CHANGES IN APPROPRIATION LANGUAGE

Mr. EVINS. Please explain any language changes that the Commission may be proposing.

PURCHASE OF MOTOR VEHICLES

Mr. MCCARTHY. In our operating budget, Mr. Chairman, we are proposing one change relative to the purchase of motor vehicles. This would provide for authority to procure 740 vehicles in 1963 of

which 410 would be for replacement and 330 would be an increase to the pool. Of these, 105 would be purchased from GSA. The General Services Administration presently operates a motor pool at Livermore, Calif. They wrote to us on January 2 saying that they had determined it would be to the best interest of the Government to discontinue the pool. At the present time only our Livermore laboratory and the Veterans' Administration utilize the pool. They are presently operating some 170 vehicles of which we furnished 65 to GSA at the time they took the pool over. These they would return to us without cost, but the 105 which they have purchased in the meantime we will have to buy from them in order to keep their capital fund intact under their motor pool operations.

We will need 200 additional at Nevada because of the increase in activity out there. We have been renting a number of vehicles out there to take care of the peakload. We estimate that it would be economical for the Government to buy 200 more and replace rental vehicles. We need eight for the operation of the Atomic Bomb Casualty Commission in Japan. At the present time they are utilizing jeeps. We are now converting to passenger vehicles for them. The jeeps are not classified as passenger vehicles so in order to change over we need authority to procure the eight.

We need 10 additional at Idaho and 7 at Brookhaven laboratory, thereby making a total additional requirement of 330 motor vehicles.

Mr. EVINS. Are you using the motor pools where feasible or possible?

Mr. MCCARTHY. Everywhere that GSA has an established motor pool we are utilizing it.

Mr. EVINS. In how many instances?

Mr. MCCARTHY. I don't have the exact number, but I think we are utilizing about 20 in locations where GSA has a motor pool in being.

Mr. EVINS. All the cars you are turning in have reached the standards recommended by GSA for disposal?

Mr. MCCARTHY. They have met the requirement of 6 years or 60,000 miles; yes, sir. In fact, many of ours are beyond that. We try to keep them as long as we can, but they have met the minimum requirement of GSA for disposal.

Mr. EVINS. This applies to the 410 that you are replacing?

Mr. MCCARTHY. That is right.

Mr. JENSEN. Mr. Chairman.

Mr. EVINS. Mr. Jensen?

Mr. JENSEN. There was a time when automobiles that traveled 60,000 miles or were 6 years old were quite expensive to operate. Today most of these automobiles are so well built that they can run 120,000 miles with very little repair when properly taken care of. I think the old yardstick of 60,000 miles or 6 years should be abolished.

Mr. EVINS. Revised.

Mr. JENSEN. It should be revised, yes, upward to possibly 90,000 miles and 8 years. You know we learned during the war when new cars were not readily available that you could run the same car several years and still get good service with proper care.

Now, I am going to tell you frankly that I am not ready to appropriate money for 400 new automobiles, because I do not think it is necessary. I think it is poor business for Uncle Sam to dispose of a car just because it has been run 60,000 miles or is 6 years old. I think

it is very poor business. I hope that we can get every agency in the Government and the General Services Administration to revise their yardstick to at least 90,000 miles and 8 years.

Mr. EVINS. If we give authority just for the exchange of the old cars, that would be sufficient, would it not?

Mr. MCCARTHY. Instead of providing the additional 330?

Mr. EVINS. Yes.

Mr. MCCARTHY. If we don't get the additional 330, I am afraid we are going to spend more money in rental than purchasing would cost. That is our problem in trying to meet the demand. It is much more economical to buy than to rent.

Mr. EVINS. How many new ones did you buy last year?

Mr. MCCARTHY. Last year, I believe, our new procurement in addition to replacements was 118. We had authority for 432 of which 314 were replacements. I am referring to fiscal year 1962.

Mr. EVINS. Are there further questions?

(Discussion off the record.)

TRANSFER OF FUNDS TO THE BUREAU OF PUBLIC ROADS

Mr. MCCARTHY. There is one piece of language which is the authority to transfer $10 million to the public roads for the road we talked about at Nevada.

There is one additional thing. I think Commissioner Olson and Commissioner Graham would like to talk to before we adjourn.

Mr. EVINS. We will be pleased to hear you, Commissioner Olson.

SALARIES OF HEARING EXAMINERS

Commissioner OLSON. I am Commissioner Olson. This is Commissioner Graham.

The Chairman said in his opening statement the Commissioners for sometime have been concerned about the salaries of its three hearing examiners. Last year we thought this was going to be taken care of by general legislation and general statutory correction of the situation. It got right up to the wire and did not get passed primarily because of the differences in the levels of responsibility of examiners in the different agencies.

It has become rather clear to the Commission that if we are going to have a correction of this inequity, it will have to be done on an agency-by-agency basis. In early April the Commission authorized me to write to Fred Lawton of the Civil Service Commission to see if we could not make one last effort to fine some way to adjust the pay of these three hearing examiners.

You see, they are employed under the Administrative Procedure Act and they are under the Classification Act. Their salaries are set at grade 15 for the top. We have an organization of the Commission, the General Manager, who has been presenting the budget here, is head of the Operational Division. Mr. Price is head of the Regulatory Division, and the three examiners constitute our adjudicatory arm. They have our delegation in this area.

Mr. EVINS. How many examiners are involved?

Commissioner OLSON. Three. We are talking about 3 people out of 7,000 employees, more or less, of the Commission.

Mr. EVINS. You want supergrades for the three?

Commissioner OLSON. Yes, and it takes action because as the Civil Service Commission advised us, it takes a statutory action to authorize it. They favor it. They recommend it. They have been trying to get general legislation, as I said before, but they have been unable to. If I could read a short quotation from Fred Lawton's letter, I would like to do so. He says:

> We have no disagreement with those who believe that the compensation of hearing examiners should be increased. * * * At the last session of Congress we recommended that hearing examiners be excluded from the Classification Act and that Congress provide a statutory salary. In this way Congress could consider factors in setting pay which cannot be considered under the Classification Act. For example, it could consider the pay of judicial and other quasi-judicial positions compensated under statutory salaries such as Federal district judges and commissioners of the Court of Claims.
>
> It could consider the salaries set by statute for general counsels or it could consider what salaries should be set to attract and retain the caliber of hearing examiner Congress thought desirable. Our proposal failed of enactment but we still feel that a statutory salary is the most desirable solution to the problem of hearing examiners' pay.
>
> In the Atomic Energy Commission the problem is undoubtedly complicated by the fact that your hearing examiners are the only employees subject to the Classification Act. Our proposal to remove the examiners from the act would be particularly appropriate in your agency.

Mr. EVINS. What are the salaries of these three examiners?

Commissioner OLSON. Grade 15. I don't know what that amounts to but it is grade 15.

Mr. EVINS. What do other agencies pay grade 15 examiners?

Mr. TACKMAN. Our examiners are paid $14,380, $15,030 and $14,070.

Commissioner OLSON. The point is that there are differences in levels of work between the agencies. That is why the administration has been unable to get across-the-board relief from this situation.

Mr. EVINS. The most direct way would be either through the legislative committee, or the Civil Service Commission. You have come to the Appropriations Committee as a last resort. We are not supposed to write legislation in an appropriations bill.

Commissioner OLSON. We are aware of this, but as you say, it is a last ditch effort after struggle for several years to try to remedy this inequity.

Mr. EVINS. Have you talked with the legislative committee on this same matter?

Commissioner OLSON. No, sir; we have not.

Mr. EVINS. Off the record.

(Discussion off the record.)

Mr. JENSEN. I wonder if the Commissioner would give us an idea of the duties of these examiners.

Commissioner OLSON. Yes, sir. The hearing examiners hold all of the hearings that are required under the act. Hearings are mandatory, as you know, from our basic act, in the case of all licensing of special nuclear production facilities, powerplants, all of the nuclear powerplants, and also hearings are provided for in the case of any disciplinary action under our licensing procedure. We have some 12,000 licenses outstanding, so there are disciplinary proceedings.

In addition to that, we have assigned to our hearing examiners in the Atomic Energy Commission all the contract appeals work. This work is done in the Defense Department by a corps of about 25 men, a number of whom get grade 16 pay because they are not examiners under the Administrative Procedure Act. So, therefore, they do not suffer from the same Classification Act limitation that we do. Our examiners have both the licensing problems and the contract appeals matters.

In some of these licensing cases the record will go from 400 to, our largest record was 10,000 pages, in big cases. A number of them have gone on to the circuit court of appeals and to the Supreme Court.

Mr. EVINS. Off the record.

(Discussion off the record.)

Mr. EVINS. Commissioner Graham, is there anything you wish to say?

Commissioner GRAHAM. Only this, sir: I think we have been extremely fortunate in attracting high-grade, qualified examiners who take their work seriously and who try to stay on top of the work. I think there is a certain glamor to our agency and a certain newness which attracts people. It is a little bit difficult, if you are setting as an examiner and in effect as the trial judge, and the lawyers who appear before you are getting higher salaries than you are.

Mr. EVINS. That often happens in civil courts. You have high-paid lawyers and the judges are serving for honor.

Commissioner GRAHAM. Our attorneys representing the staff of the agency are getting more than the judge who is also representing the agency. However, I do not think these men would quite tomorrow, sir.

Mr. EVINS. Commissioner, we appreciate your situation and we will try to be helpful. I wish you would write a letter to the chairman giving the names of the three hearing examiners and their present grades and salaries. You did not give that specifically—and the salary to which you would like to have them advance.

Commissioner OLSON. I will give it right now on the record.

Mr. EVINS. Yes; and then you may confirm with a letter.

Commissioner OLSON. The three examiners, the chief examiner is Sam Jensch, grade 15, $14,380. The second examiner is Jay Bond, grade 15, $15,030. The third examiner is E. Riggs McConnell whose pay is grade 15, $14,705. We would propose that these three men be rasied to grade 16, which would be a range of $15,255 to $16,295. In terms of money it is not very significant. It is the grade and stature we feel is necessary to the positon.

Mr. EVINS. Mr. Jensen.

Mr. JENSEN. Do they keep their cases pretty well adjudicated?

Commissioner OLSON. Yes, sir. We are satisfied that they are satisfactory currently. There are no 2-year delays in our agency today. I think we are turning out cases in our agency faster than any other agency in the city. We are a newer agency and we don't have quite the volume, but we have been careful about preventing delay.

Off the record.

(Discussion off the record.)

(The following letter was subsequently submitted:)

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., June 9, 1962.

Hon. CLARENCE CANNON,
Chairman, Committee on Appropriations,
House of Representatives.

DEAR MR. CANNON: Pursuant to the request of your committee, the following information is furnished with respect to the testimony of Commissioners Olson and Graham and myself proposing that the Commission be authorized to establish the salaries of AEC hearing examiners.

Hearing examiners of the Atomic Energy Commission receive compensation prescribed by the Civil Service Commission in accordance with the Classification Act of 1949, as amended, pursuant to section 11 of the Administrative Procedure Act of 1946 (5 U.S.C. 1010) and under the same general schedule applying to hearing examiners in other regulatory agencies. The maximum grade now provided by CSC standards under the Classification Act is grade GS–15.

The names and present salaries of the Commission's three hearing examiners are:

Jensch, Samuel W., Chief, GS–15	$14, 380
Bond, Jay, GS–15	15, 030
McConnell, E. Riggs, GS–15	14, 705

As Commissioner Olson indicated in his testimony, it is proposed that the compensation for AEC hearing examiners be fixed by the Atomic Energy Commission without regard to the provisions of 5 U.S.C. 1010, but not in excess of the maximum for grade GS–16 under section 603(b) of the Classification Act of 1949 as amended (5 U.S.C. 1113(b)). The following insertion in the section dealing with operating expenses would accomplish the desired result: Insert immediately after "* * * (5 U.S.C. 55a);" "the payment of compensation to personnel employed pursuant to section 11 of the Administrative Procedure Act of 1946 (5 U.S.C. 1010) at rates to be fixed by the Atomic Energy Commission not in excess of the maximum rate provided for grade GS–16 under section 603(b) of the Classification Act of 1949, as amended, (5 U.S.C. 1113(b));"

Sincerely yours,

GLENN T. SEABORG, *Chairman.*

Mr. EVINS. If there is nothing further we will adjourn.

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