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UNITED STATES ATOMIC ENERGY COMMISSION

Annual Report to Congress

OF THE

ATOMIC ENERGY COMMISSION

FOR

1960

January 1961

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LETTER OF SUBMITTAL

WASHINGTON, D.C.,
20 January 1961.

SIRS: We have the honor to submit herewith the Annual Report of the United States Atomic Energy Commission for 1960 as required by the Atomic Energy Act of 1954.

Respectfully,

UNITED STATES ATOMIC ENERGY COMMISSION,
JOHN S. GRAHAM.
LOREN K. OLSON.
ROBERT E. WILSON.
JOHN A. MCCONE, *Chairman.*

The Honorable
The President of the Senate.

The Honorable
The Speaker of the House of Representatives.

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FOREWORD

The record of 1960 shows that atomic energy continues its vital role in our national defense effort. The growth of the atomic power segment of the atomic energy industry has kept pace with the technological progress achieved. Commercial services and supplies of materials are adequate for industry and Government requirements.

Experience is being gained in operating major power reactors. Until now, the principal experience in operating reactors has been either from naval propulsion reactors, or from the Shippingport Atomic Power Station. This year, two more nuclear plants produced electricity—plants with a capacity of 290,000 kilowatts. Within the next 2 years, 648,000 additional kilowatts of nuclear capacity will be completed. By the end of 1962, the installed nuclear capacity will be more than 1,000,000 kilowatts. Operation of these plants will help increase efficiency of design and operation and cut costs.

We are exploring new and radical concepts for power reactors with the objective of reducing further the cost of power from nuclear sources. Construction and operation of reactor experiments and prototypes is deepening and widening our technology. We are applying the know-how of national laboratories and industrial organizations to the tasks of simplifying equipment, improving safety, and cutting fuel cycle costs.

This broad effort will steadily increase our technical competence. However, we cannot predict exactly when we will achieve costs for nuclear power that can be considered competitive with fossil-fueled conventional plants. Three utility organizations advise us that they are considering building large nuclear power plants mainly on the basis of economic considerations. These developments indicate that this country is at least close to the point where investment in large nuclear power plants in certain areas may be considered economical over the life of the plants.

In other countries, the Atoms for Peace program has helped to stimulate interest in putting atomic energy to work in beneficial applications.

Several nuclear power plants should be operating in Western Europe by 1965; one of 150,000 kilowatts by 1963. The Western European nuclear power program has progressed less rapidly than originally expected. The costs of fossil fuels there took a sharp downward turn, so that Western Europe's conventional power costs, formerly much higher, have declined sharply and, in some countries

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or areas, now are nearly as low as power costs in some areas of the United States.

Recent actions of India and Japan indicate their firm interest in putting nuclear power to work.

Obstacles to further progress in nuclear power for the free world are being eliminated or lessened through the work of international atomic energy organizations with which we cooperate. Safeguards against diversion of nuclear materials from peaceful uses have been approved by the International Atomic Energy Agency. Some progress has been made on provision of indemnification against nuclear accidents. The IAEA and other international agencies expect ultimately to take over many of the responsibilities and functions that now come under bilateral agreements on peaceful uses of atomic energy between the United States and other countries.

The use of radioisotopes continues to expand, and we hope to accelerate this expansion by developmental research to find new uses and techniques. We are exploring new ways of putting radiation to work—in the preservation of foodstuffs and sterilization of medical supplies, or in the production of improved materials with new applications.

Research and development are making broad and continuous contributions to the advancement of scientific knowledge and to the progress of technology for peaceful applications. Some developments contribute promptly to our welfare—for example, the use of radioisotopes in biology and medicine and industry; other benefits are for the long term.

Production of nuclear materials, from mines to fuel elements and nuclear weapons, has continued with steadily improved efficiency and economy, and at rates consistent with national needs.

The domestic mining and milling industry has been placed on a stable basis with production being brought into balance with current military needs and civilian requirements. There is a potential for prompt expansion whenever needed. Domestic sources now supply slightly more than half the total amount of uranium we require annually.

The Commission continues to place firm emphasis upon strengthening safety precautions on uses of radiation in its own operations and those of licensed users of atomic energy. The standards limiting radiation exposures of workers in the industry have been reviewed, established, and promulgated. To assist public understanding of radiation problems, the Commission has initiated full periodic reports to the public on radiation levels in the vicinity of its installations

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sites for land burial of wastes have been designated on Federal property.

Considerable groundwork has been laid with the States under Public Law 86-373 so that the States may know the steps to be taken to qualify for taking over responsibility for certain areas of radiation regulation and enforcement.

In the field of national defense, the Commission can take satisfaction in having developed and manufactured a variety of nuclear weapons and warheads in ample quantities to meet the current requirements of the Department of Defense. Nuclear weapons have been made available for strategic and tactical air forces and for missile batteries. During 1960, the first submarine armed with nuclear missiles as well as powered with a nuclear reactor—the Polaris missile-carrying U.S.S. *George Washington*—undertook its first routine mission. The world knows we have an ample store of a variety of nuclear weapons—an armament that represents a powerful deterrent against aggression.

Testing of nuclear weapons has been suspended by the United States for more than 2 years. During this period, the United States has participated in negotiations among the nuclear powers with the objective of achieving a treaty on cessation of nuclear weapons tests which would provide adequate safeguards against clandestine testing. These negotiations, and the United States research program to improve the capability of detecting and identifying nuclear tests, are reviewed in the body of this report.

The Commission recognizes that radioactivity from nuclear tests is a source of concern in the minds of many people—regardless of whether or not the fears of fallout radiation are scientifically valid. Accordingly, the Commission would propose that future tests, if any, be conducted underground, or in space beyond the earth's atmosphere, in such a way as not to cause fallout.

This Commission is fully in accord with the national policy of attaining cessation of nuclear weapons tests under a treaty that would establish international controls adequate to assure compliance with its provisions. The Commission, however, also feels a strong sense of responsibility to point out the risks to free world supremacy in nuclear weapons—and the resultant threat to the free world—that are implicit in a continued unpoliced moratorium on weapons testing.

Nuclear weapons development is not a static science. Important advances in weapons design are possible—advances which would have great military significance. They could include improvements in many fields, such as new "battlefield" weapons and improvement of the weight-to-yield ratio of a variety of bombs and warheads. Our

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weapons scientists are convinced that further nuclear testing would achieve major advances in weapons design.

We must not assume that the United States is the only nation which could achieve dramatic advances in nuclear weapons technology. It is technically possible at present to conduct nuclear tests underground in a clandestine manner, with little or no possibility of detection and identification. Methods also could be developed for conducting tests in outer space—tests that would be extremely difficult to detect and identify. Improved methods of detecting and verifying nuclear explosions, and installation of a control system with provision for an adequate number of inspections of localities where suspicious events have been detected, are necessary if an international agreement is to be adequately monitored.

The military advantages to be gained from clandestine nuclear testing are great, and the probabilities of detecting and identifying clandestine tests are very small. This will be the free world's situation so long as there is an unpoliced *de facto* moratorium on nuclear weapons testing.

The Commission recognizes that a treaty to refrain from nuclear weapons tests under conditions of adequate control might be a significant step toward better international relations. Such a treaty might well point the way toward agreements and controls in important areas of disarmament. The United States has expressed its willingness to forgo weapons development which could be achieved through testing if a treaty were attained that provides adequate means of detecting violations. It would be quite another matter, however, to continue indefinitely a self-imposed moratorium on the testing of nuclear weapons while the means of detecting violations does not exist.

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Part One

The Atomic Energy Industry in 1960 and Related Activities

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Industry And Commission Activities

In this first part of this Annual Report to Congress for the year ended December 31, 1960, the Atomic Energy Commission presents a summary of the present state of the atomic energy industry and developments affecting the industry. Progress under the Commission's program for development of economic nuclear power reactors is reviewed, and activities in the programs through which the Commission supports and assists the industry are described. Part Two reports on progress in other major programs of the Commission and provides details of activities summarized in Part One.

The Nuclear Reactor Industry

Sixty-six civilian and military reactors were under active design or construction in the United States as of mid-1960 with a total estimated cost of $1,328 million exclusive of reactors for propulsion of naval vessels and aircraft and space reactor work.[1] These mid-1960 figures compared with $1,234 million estimated cost of 59 reactors in the same categories as of mid-1959. The estimates are based on surveys conducted each quarter by the Atomic Energy Commission and regularly published as available. The latest figures assembled as of the time of this report were for the quarter ended June 30, 1960.

The Commission estimated that the costs incurred for the year ended June 30, 1960 totaled about $641 million for the entire reactor field exclusive of naval propulsion reactors. This figure included $289 million for reactors under active design or construction during the year, some $127 million for aircraft and space reactor work, and about $225 million for other reactor research and development.

Costs for naval propulsion reactors apparently continued to be incurred at about the same levels as last year with 36 reactors authorized or under construction as of June 30, 1960, compared with 40 at an equivalent time the previous year. Nuclear propulsion plants under construction or authorized for installation in naval vessels as of June 30, 1960, had a total estimated cost of $402 million compared with $418 million as of June 30, 1959. By the end of December 1960, an addi-

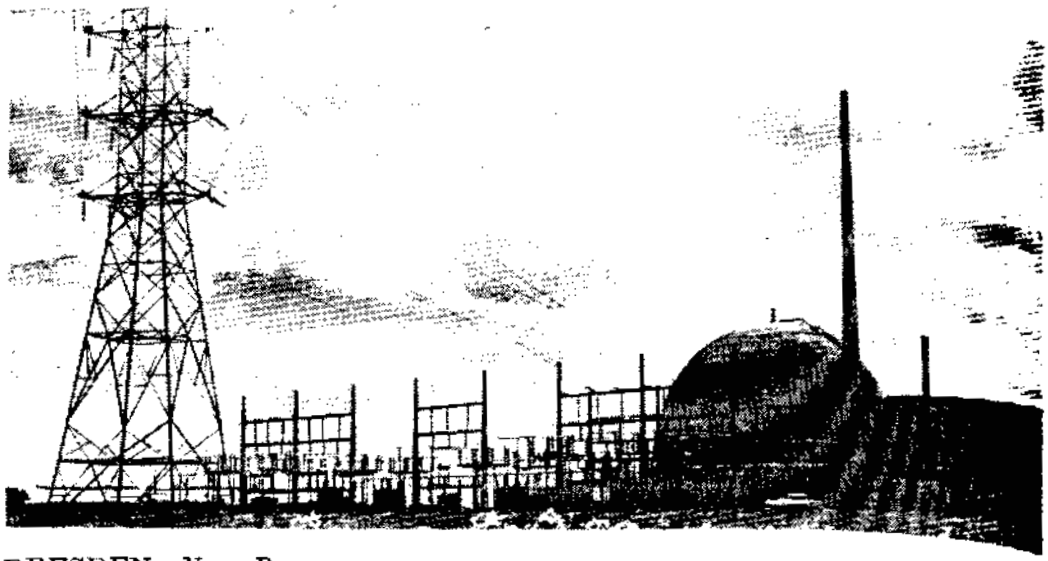
(Continued on p. 6.)

[1] Dollar amounts used are for complete reactor projects including, for example, reactor components and construction, research and development on each specific project, waiver of fee charges, nonnuclear portions of central station electric power plants, land for sites, and training of operators. An exception is the N.S. *Savannah* on which only the nuclear plant costs are included.

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Reactors in 1960



DRESDEN—*New Power*

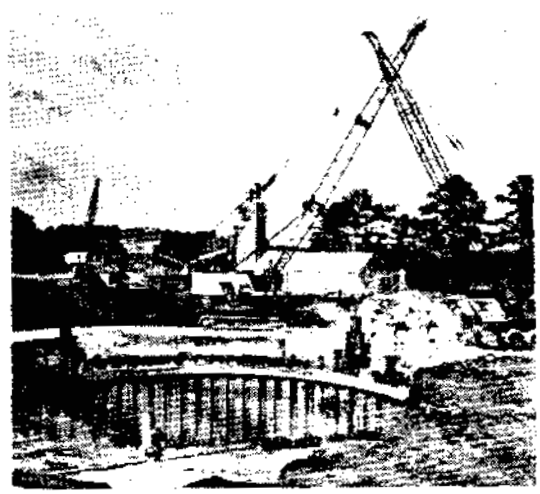


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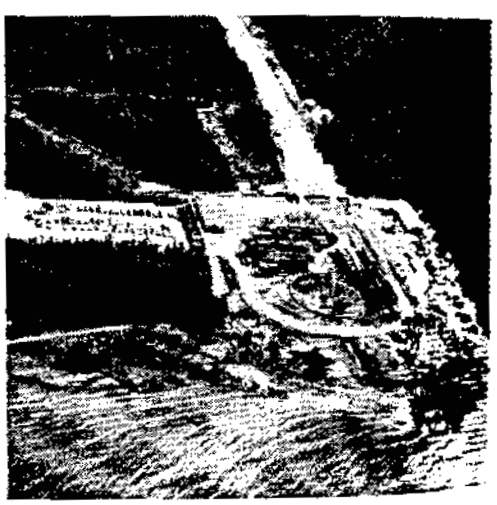
Operating experience and firm cost data based on routine operations of nuclear central power stations, plus constantly advancing technology, are the keys to the national effort to achieve competitive costs for nuclear power. Two new large nuclear stations started producing power during 1960. (See upper photos) During the next two years, new nuclear stations will add 648,000 kilowatts to the

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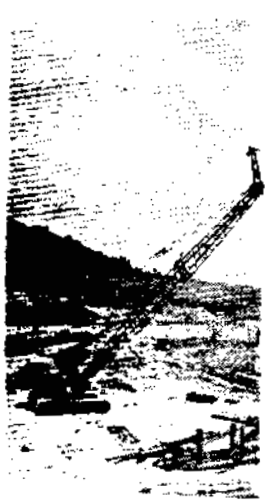
CAROLINAS-VIRGINIA—*New Start*



CONSUMERS—*New Start*

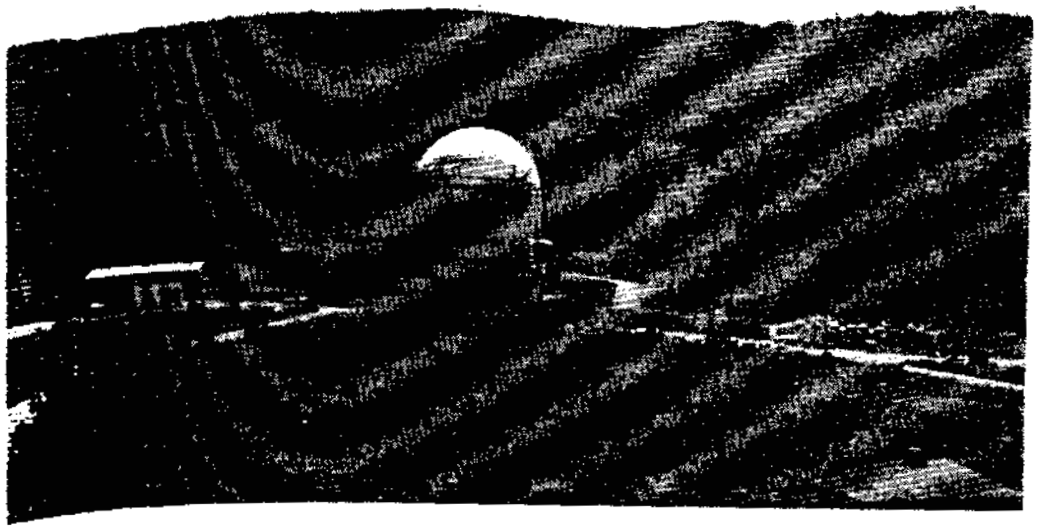


BONUS—*New Start*



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New Power—New Starts



ANKEE—*New Power*

tine operations
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United States' electrical capacity. While operating experience is being gained with these plants, the United States is pushing ahead with the development of other basic reactor concepts. Construction started this year on six prototype and experimental reactors, four of which are pictured below.

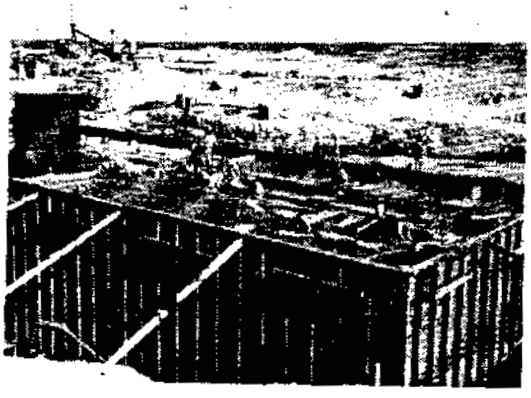
Start



BONUS—*New Start*



ORGANIC-COOLED—*New Start*



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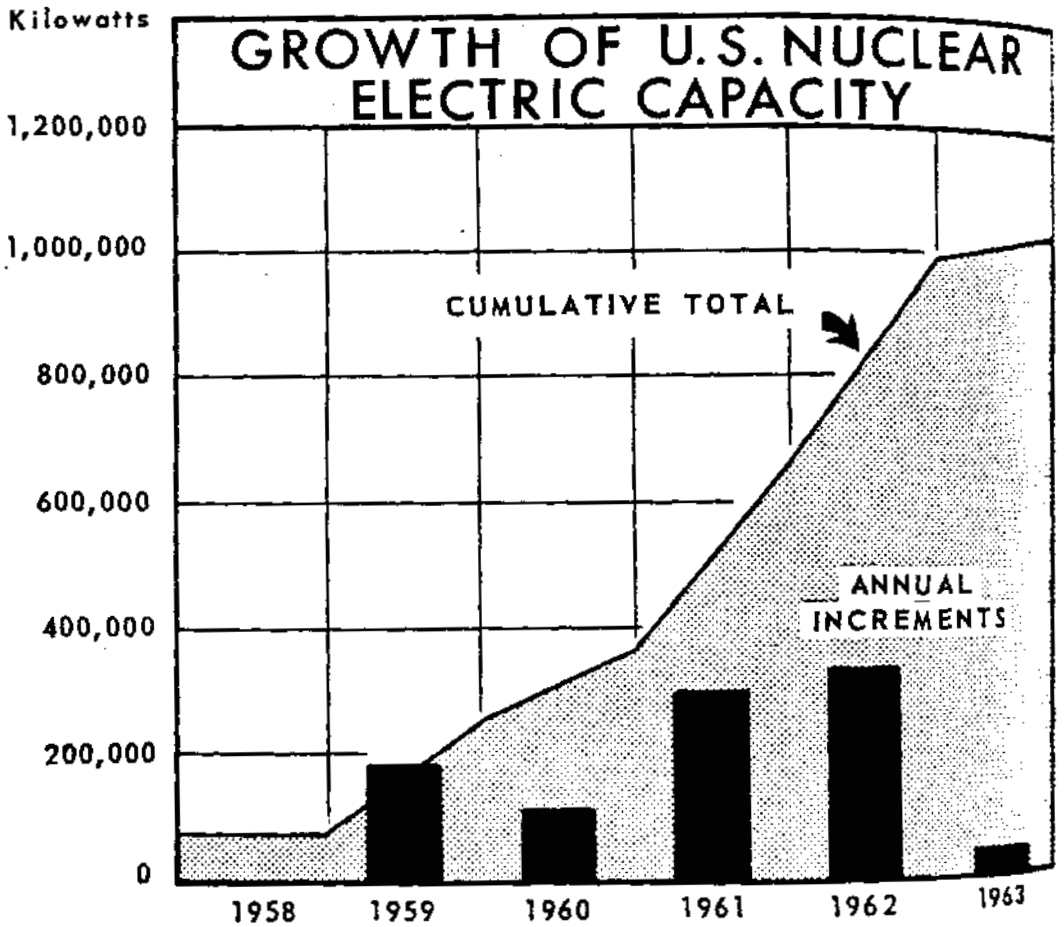
tional 6 propulsion reactors costing about $50 million had been authorized. Records were not available to show the rate at which costs were incurred against these estimated amounts. Orders for replacement fuel elements for naval propulsion reactors obviously will increase with 14 submarines now operating and 8 other nuclear vessels launched during 1960.

Reactors included in these totals are all those under active design or construction which are listed in Appendix 12, Part I, Civilian Reactors, Part II, Military Reactors, and Part III, Production reactors. Certain reactors listed as "planned" in Appendix 12 are excluded from charts and tables because they were not under active design or construction as of June 30, 1960.[2]

During the latter part of 1960, two more nuclear power plants began producing electricity, adding 290,000 kilowatts to the national nuclear electrical capacity—the Dresden Nuclear Power Station in Illinois, and the Yankee Atomic Electric plant in Massachusetts.

Fifteen power reactor projects now underway are scheduled for completion before the end of 1963. Nearly 300,000 kilowatts of electrical capacity watts in 1962, and Electrical Capacity 1960. Negotiation Commission reacto

[2] The excluded reactors in Part I, Appendix 12, are the Improved Cycle Boiling Water Reactor, the Organic Cooled Reactor Prototype, the Small Size Nuclear Power Plant, the Experimental Low Temperature Process Heat Reactor, and the Southern California Edison Co. power plant.



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TABLE A.—NUCLEAR

Prior to 1959: *
Experimental Boi
Shippingport At
Pa
Vallecitos Boiling
Sodium Reactor
Total:

1959:
Dresden Nuclear
Total:

1960:
Yankee Atomic E
Total:

1961:
Consolidated Edi
Enrico Fermi At
Rural Cooperativ
City of Piqua,
Experimental Br
Saxton Nuclear
Total:

1962:
Shippingport (PW
Hallam Nuclar E
Northern States
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Consumers Powe
Pacific Gas and
Carolinas-Virgini
Experimental Ga
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Boiling Reactor
Higuera, Puert
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Total:

1963:
High Temperatu
Total:

* Indicated years are
operating license.

TABLE A.—NUCLEAR ELECTRIC GENERATING PLANTS AND CAPACITIES

Prior to 1959:*	
Experimental Boiling Water Reactor (EBWR), Lemont, Ill	4,500 ekw
Shippingport Atomic Power Station (PWR), Shippingport, Pa	60,000 ekw
Vallecitos Boiling Water Reactor (VBWR), Pleasanton, Calif	5,000 ekw
Sodium Reactor Experiment (SRE), Santa Susana, Calif	6,000 ekw
Total:	75,500 ekw
1959:	
Dresden Nuclear Power Station, Morris, Ill	180,000 ekw
Total:	180,000 ekw
1960:	
Yankee Atomic Electric Plant, Rowe, Mass	110,000 ekw
Total:	110,000 ekw
1961:	
Consolidated Edison Thorium Reactor, Indian Point, N.Y	151,000 ekw
Enrico Fermi Atomic Power Plant, Lagoona Beach, Mich	94,000 ekw
Rural Cooperative Power Association plant, Elk River, Minn	17,500 ekw
City of Piqua, Ohio, plant	11,400 ekw
Experimental Breeder Reactor No. 2 (EBR–2), NRTS, Idaho	16,500 ekw
Saxton Nuclear Experimental Reactor Project, Saxton, Pa	3,250 ekw
Total:	293,650 ekw
1962:	
Shippingport (PWR) modification (added capacity)	40,000 ekw
Hallam Nuclar Power Facility, Hallam, Nebr	75,000 ekw
Northern States Power Co. (Pathfinder plant), Sioux Falls, S. Dak	62,000 ekw
Consumers Power Co., Big Rock Point, Mich	50,000 ekw
Pacific Gas and Electric Co., Humboldt Bay, Calif	48,500 ekw
Carolinas-Virginia Tube Reactor, Parr, S.C	15,000 ekw
Experimental Gas Cooled Reactor, Oak Ridge Natl. Lab., Tenn	22,300 ekw
Boiling Reactor Nuclear Superheat Project (BONUS), Punta Higuera, Puerto Rico	16,300 ekw
Yankee second core (added capacity)	26,000 ekw
Total:	355,100 ekw
1963:	
High Temperature Gas Cooled Reactor, Peach Bottom, Pa	40,000 ekw
Total:	40,000 ekw

*Indicated years are based on date of initial, or anticipated, criticality or issuance of operating license.

electrical capacity are to reach criticality in 1961, some 350,000 kilowatts in 1962, and 40,000 in 1963 (see Chart, Growth of U.S. Nuclear Electrical Capacity). Some new power projects were in sight in late 1960. Negotiations have begun on a contract for one Atomic Energy Commission reactor prototype; two other power prototypes have been

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authorized. A small process heat reactor has been authorized. The estimated total cost for the four reactors is $50 to $60 million. In addition, utilities are actively considering construction of three power reactors in the 300,000 kilowatt class.

The Industry in General

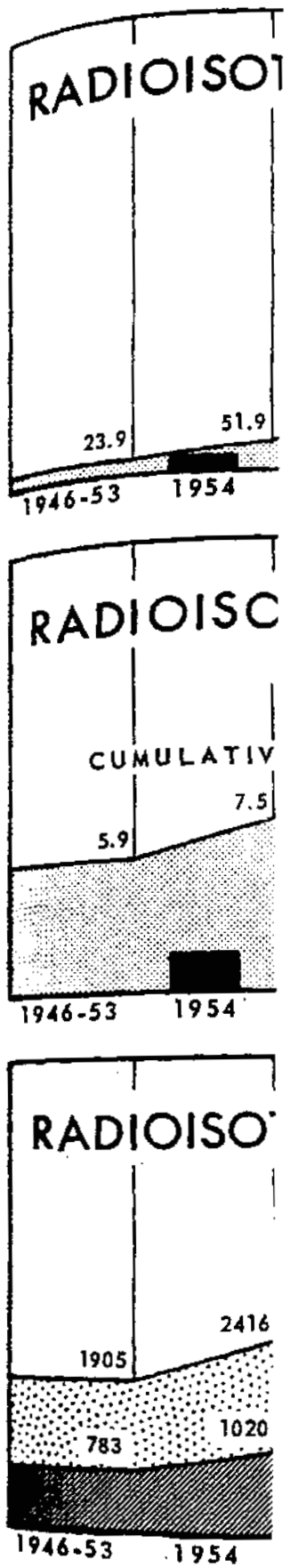
In the atomic energy industry as a whole, about the same number of companies continued to operate as in 1959. Two new companies are entering the uranium concentrate field. One firm, already in the atomic energy field, intends to broaden its activities to include commercial fabrication of fuel elements for nuclear reactors. Another firm was licensed to manufacture plutonium-beryllium neutron sources, a device used, among other purposes, in oil-well logging and previously available only from Commission-owned plants. The first private company initiated reactor production of a radioisotope for chemical use. One corporation curtailed its participation in reactor work and is concentrating upon gamma-irradiation facilities.

A useful measurement of atomic industrial activity is provided by the dollar volume of manufacturers' shipments as compiled annually by the Bureau of the Census. The latest figures available are for 1958, when total shipments were some $245 million, about 50 percent above 1958, and 145 percent above 1957.

Radioisotope Business

The radioisotope segment of the industry continued its steady growth during 1960. Licensed industrial users of radioisotopes increased 11 percent during 1960 after a 16 percent rise during 1959. Because isotope production facilities for fission products were shut down for some 9 months, (see chart), total curies shipped declined 14 percent after a 20 percent rise in 1959 and a 37 percent rise in 1958. The backlog of orders awaiting delivery was many times the total shipped during the previous year.

The continued rise in number of industrial licenses occurred after major manufacturers of gaging equipment began operating under the Commission regulation which permits sale of gages under general licenses, instead of under an individual license for each user. As a consequence, the new licenses usually cover industrial research, use of radiographic equipment, or manufacture of gages, and indicate increased purchases of radioisotope equipment for industrial use. These sales are in addition to equipment marketed to medical and research users.



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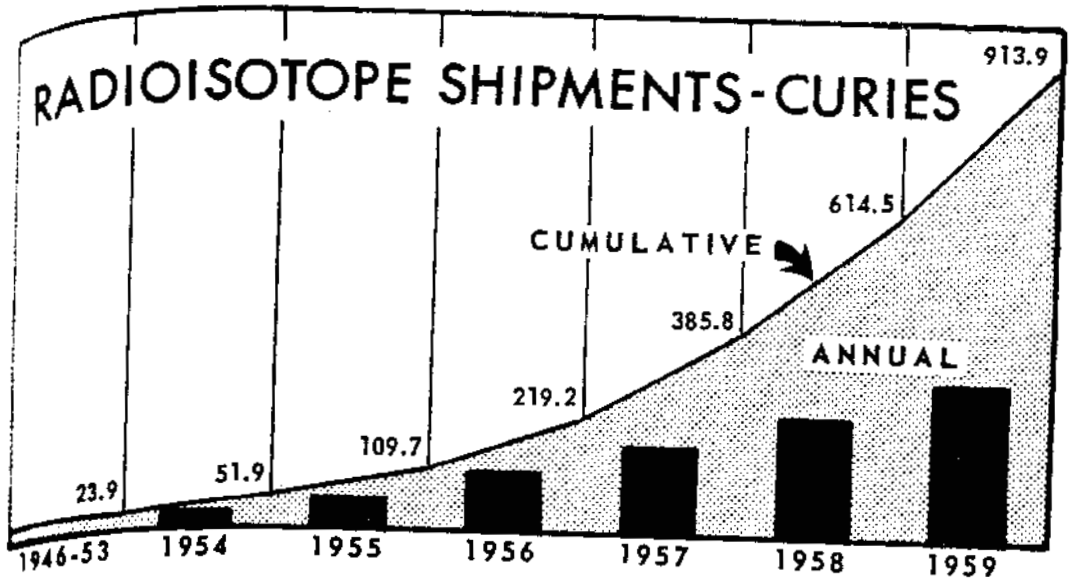
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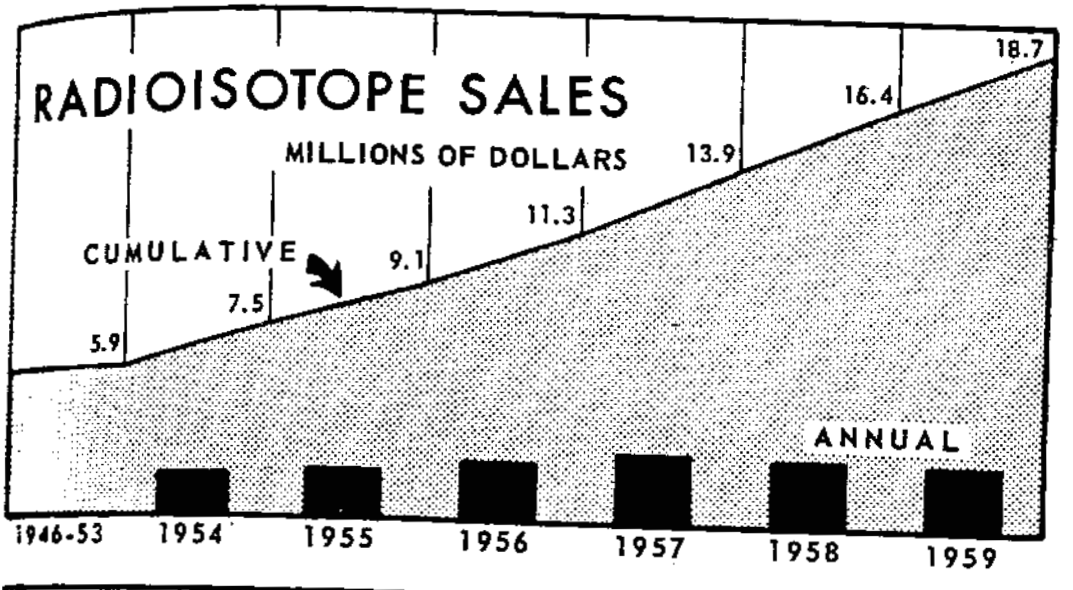
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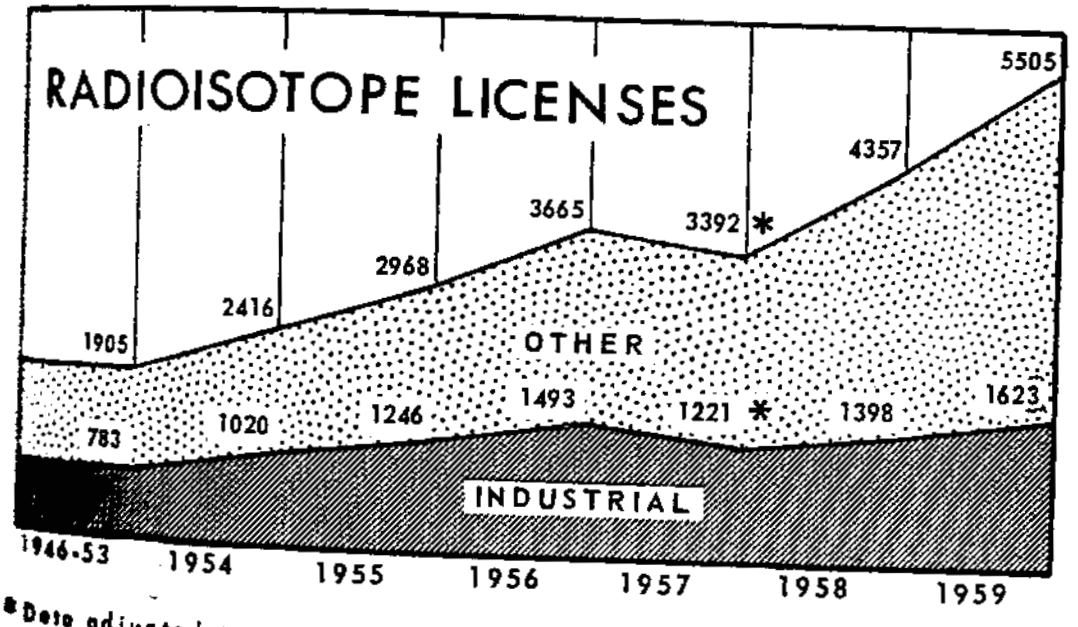
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As of February 10, 1959, when general licensing of gages controlled by a manufacturer's license first was authorized, about 4,000 gages were in use in industry. Use of the general license is at the option of the manufacturer, and not all manufacturers have taken advantage of this arrangement. Those that do use the general license will make regular reports to the Commission on sales. On the basis of these reports and other data, it is estimated that between 5,000 and 6,000 radioisotope gages now are in use, of which some 1,000 gages were marketed during 1960.

In addition, radioisotopes and equipment containing radioactive sources (such as teletherapy devices) are being imported into the United States. During 1959, the latest year compiled by the Bureau of the Census, these imports totaled $1,145,000, more than 80 percent from Canada.

The International Market

During 1960, one small power reactor was ordered from a United States corporation by Japan—a reactor that will use enriched fuel. Japan has not previously favored the use of enriched fuel; its one previous contract for a power reactor was with the United Kingdom for a design using natural uranium fuel.

At least one additional power reactor apparently is expected to be proposed under the European Atomic Energy Community's joint program with the United States in response to the Joint Board's invitation to be issued in 1961, covering reactors to be completed by the end of 1965. One large reactor is being built for completion in 1963.

The power reactor market has not developed in Europe as rapidly as expected in 1958 when Euratom programs first were authorized, chiefly because the greater availability and downward trend in prices of fossil fuels lessened the urgency for nuclear power development.

Foreign countries ordered 4 new research reactors from the United States during 1960. Radioisotopes exported during 1960 had a total value of $1.5 million. Seven research, training or testing reactors built in the United States went into operation abroad during 1960, as did two for production of power—at Kahl-am-Main in the Federal Republic of Germany and at Mol, Belgium.

The vigorous advancement in arrangements for the exchange of information with other countries, particularly with Canada in connection with heavy water moderated power reactors and with the United Kingdom on high temperature gas cooled reactors; the authorization by the International Atomic Energy Agency of a study on sea disposal of radioactive wastes by the Oceanographic Museum in Monaco, the first such study undertaken on an international basis;

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[3] See pp. 5–6, and 353–
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progress in negotiations toward the acceptance of the N.S. *Savan-* in foreign ports; all were indicative of significant long-range ad- toward increased industrial applications of reactors throughout world.

Summary and Highlights

Taken together, these activities and accomplishments of 1960 pre- ted, in the view of the Atomic Energy Commission, a picture of a dily developing atomic energy industry.

Highlights of industrial development during 1960, and of Commis- supporting activities, included the following items:

• Twenty-three civilian power reactor prototypes and experiments imated to cost $858.4 million were under active design or construc- on as of June 30, 1960, compared with 18 valued at $747.1 million at same time the previous year.

• Construction started on 6 power reactor prototypes and experi- ents during 1960, the same number started during 1959. Three power reactors authorized by Congress were delayed: one by safety considerations affecting the choice of site; one because privately owned utilities did not submit proposals in response to a Commission invi- tion. Contract negotiations began in November on the third author- ed power reactor.

• At Camp Century, Greenland, the first field power plant installed for the military services began to supply power and heat for this Arctic outpost.

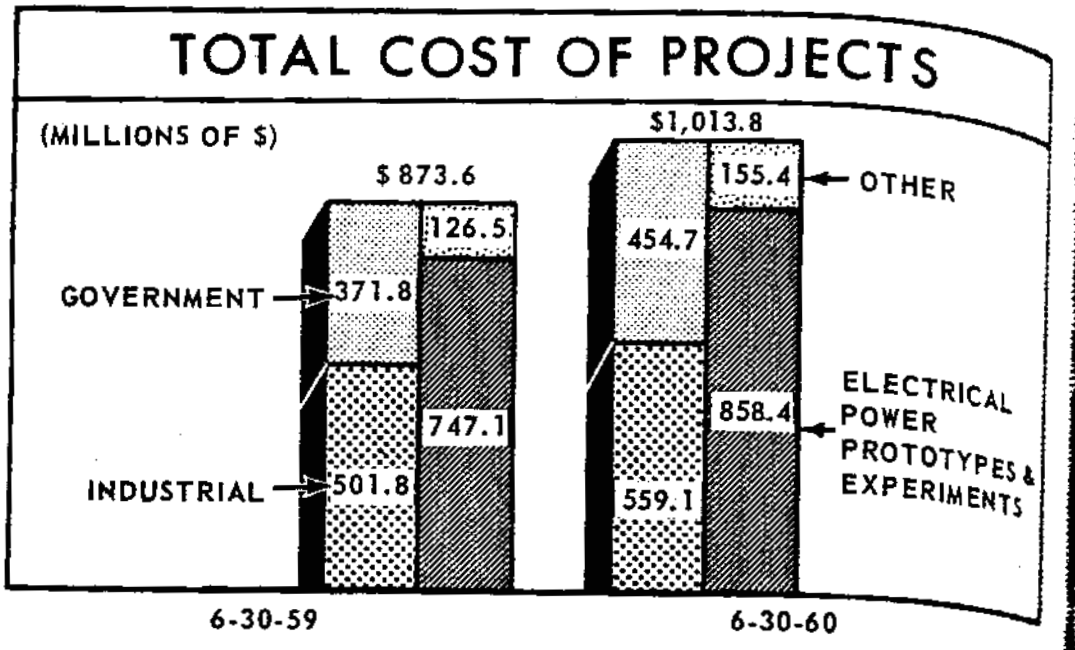
• Private industrial capacity continued during 1960 to meet or exceed the demands of the nuclear industry in the mining and milling of ores; in the conversion of uranium hexafluoride to forms needed in the production of fuels, and in the fabrication of fuel elements for private and Government reactors.

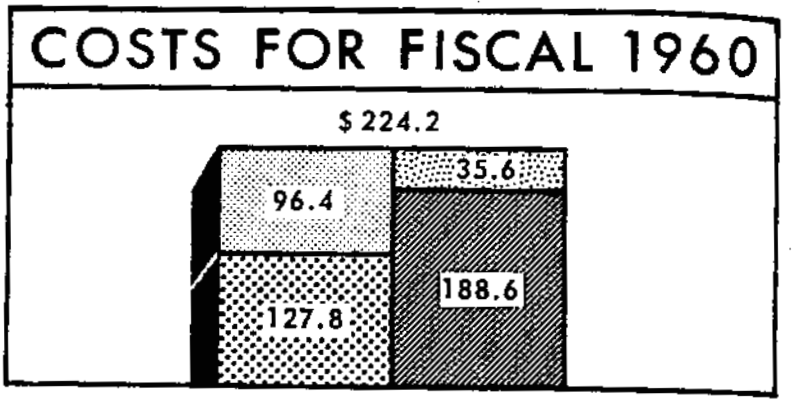
• Production of uranium oxide concentrates by United States mills rose 8 percent to 17,730 tons for the year ended December 31, com- pared with the previous 12 months. Domestic production repre- sented 52 percent of total receipts by the Commission compared with 49 percent the year before. Arrangements have been virtually com- pleted for mills to handle ore from developed reserves which had in- adequate outlets under the Commission program announced April 2, 1958.

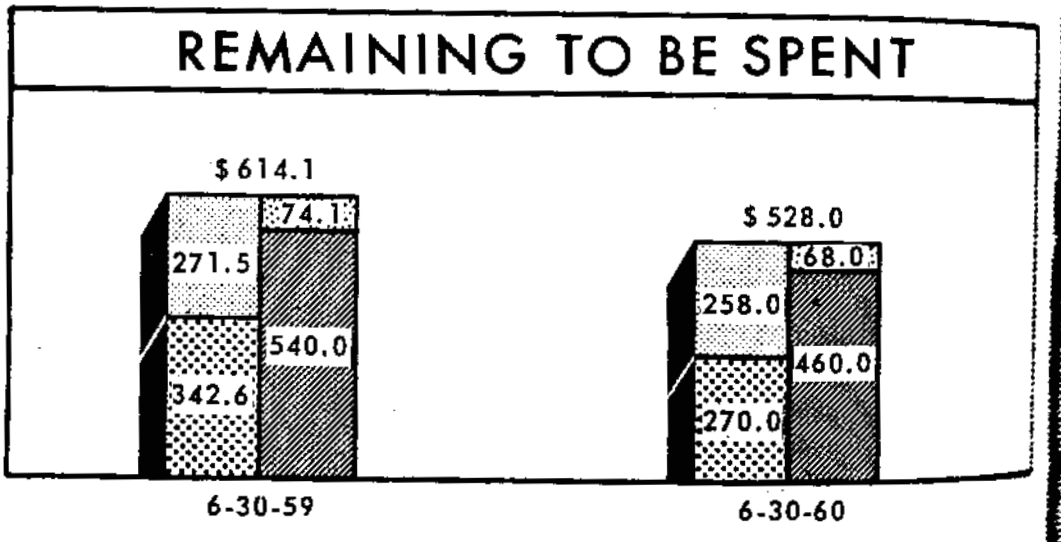
See pp. 5–6, and 353–365, Twenty-fourth Semiannual Report to Congress (January- June 1958).

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CIVILIAN REACTOR PROJECTS







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Recovery of unirradiated scrap from Commission operations by commercial firms increased from $116,000 for the year ended June 30, [illegible] to $275,000 for the year ended June 30, 1960, to $420,000 for the succeeding 5 months that ended November 30—an increase in those months alone of more than 50 percent over the entire previous year.

ANALYSIS OF REACTOR ACTIVITY

The Commission's report on its program for developing economically competitive power reactors, and the technological progress achieved under that program, are described in the second chapter of the report. In this summary, the Commission reviews some of the factors bearing on the development, growth, and state of the reactor component of the industry during 1960.

As of June 30, 1960, there were 66 civilian and military reactor projects under active design or construction for use in the United States, (exclusive of naval propulsion, aircraft and space reactors), compared with 59 a year earlier (see table 1).[4] Of the 59 under active design or construction on June 30, 1959, builders had completed 9 before June 30, 1960 at a cost of $55 million. Thus, the 66 reactors under active design or construction during fiscal 1960 included 15 new reactors and a reactor modification, started during that year; the estimated cost was $95 million.

The 9 reactors that were completed in the United States during fiscal 1960 included 7 for research, training, or testing. Two were military prototypes.

The Federal Government, chiefly the Atomic Energy Commission, continued to be the largest investor in these reactor projects, incurring costs of some $161 million during the 1960 fiscal year compared with $125 million by industry and others during the same period. The Federal backlog was $446 million compared with some $270 million remaining to be spent by industry and others (see table 2).

About one-half the Commission's costs for civilian power prototypes and experiments is for research and development. About 80 percent of electric utility costs are for plant and equipment. The distribution of costs for reactors under active design or construction during the fiscal year is shown in table 3.

In carrying forward many of the reactor projects the nuclear industry has reached a stage where it now can follow the construction pattern developed over the years in the conventional power field. Previously, industrial firms, educational institutions and nuclear consultants have played the principal role in the construction of civilian

[4] The two lists of reactors are given in Appendix 13.

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TABLE 1.—DOMESTIC REACTOR PROJECTS UNDER DESIGN OR CONSTRUCTION

	At June 30, 1959		Costs incurred July 1, 1959 thru June 30, 1960	At June 30, 196	
	No. of projects	Total estimated costs		No. of projects	Total estimated costs
		(millions)	*(millions)*		*(millions)*
ALL PROJECTS	59	$1,234.1	$289.0	66	
CIVILIAN REACTOR PROJECTS	46	$873.6	$224.2	54	
Power prototypes and experiments	18	$747.1	$188.6	23	
Civilian testing	8	74.6	20.7	7	
Civilian research	19	25.4	8.8	23	
Merchant ship propulsion	1	26.5	6.1	1	
MILITARY REACTOR PROJECTS [a]	12	$190.1	$48.4	11	
Military prototypes, experiments, and field plants	7	$163.6	$45.6	5	
Military testing	5	26.5	2.8	6	
MATERIALS PRODUCTION	1	$170.4	$16.4	1	

NOTE: See Appendix 13 for projects included in this tabulation and also in tables 2 and 3, following.

[a] Excluding naval propulsion reactors, and reactors and power units for aircraft and space applicat

TABLE 2.—COSTS AND ESTIMATES BY SOURCE OF FUNDS

	Costs incurred fiscal year 1960	Projects active as of June 30, 1960		
		Total estimated costs of projects	Cumulative costs incurred thru June 30, 1960	Estimated costs to be incurred after June 30, 196
	(millions)	*(millions)*	*(millions)*	*(millions*
ALL PROJECTS	$289.0	$1,328.3	$612.1	
SOURCE OF FUNDS:				
FEDERAL GOVERNMENT	[a] $148.0	$769.2	$323.0	
Atomic Energy Commission [b]	$148.0	$711.7	$281.0	
Department of Defense	10.0	41.9	28.4	
Other Federal agencies	3.3	15.6	13.6	
INDUSTRY AND OTHERS	$127.7	$559.1	$289.1	
Privately owned utilities	$110.7	$502.2	$251.8	
Publicly owned utilities	10.9	29.2	18.6	
Manufacturers & universities	6.1	27.7	18.7	

[a] The Commission incurred costs of $399.3 million during fiscal year 1960 in its reactor development program for reactor research and development. Of this total only $61.4 million related directly to project included here.

[b] AEC costs include depreciation and fuel consumed.

TABLE 3.—COST

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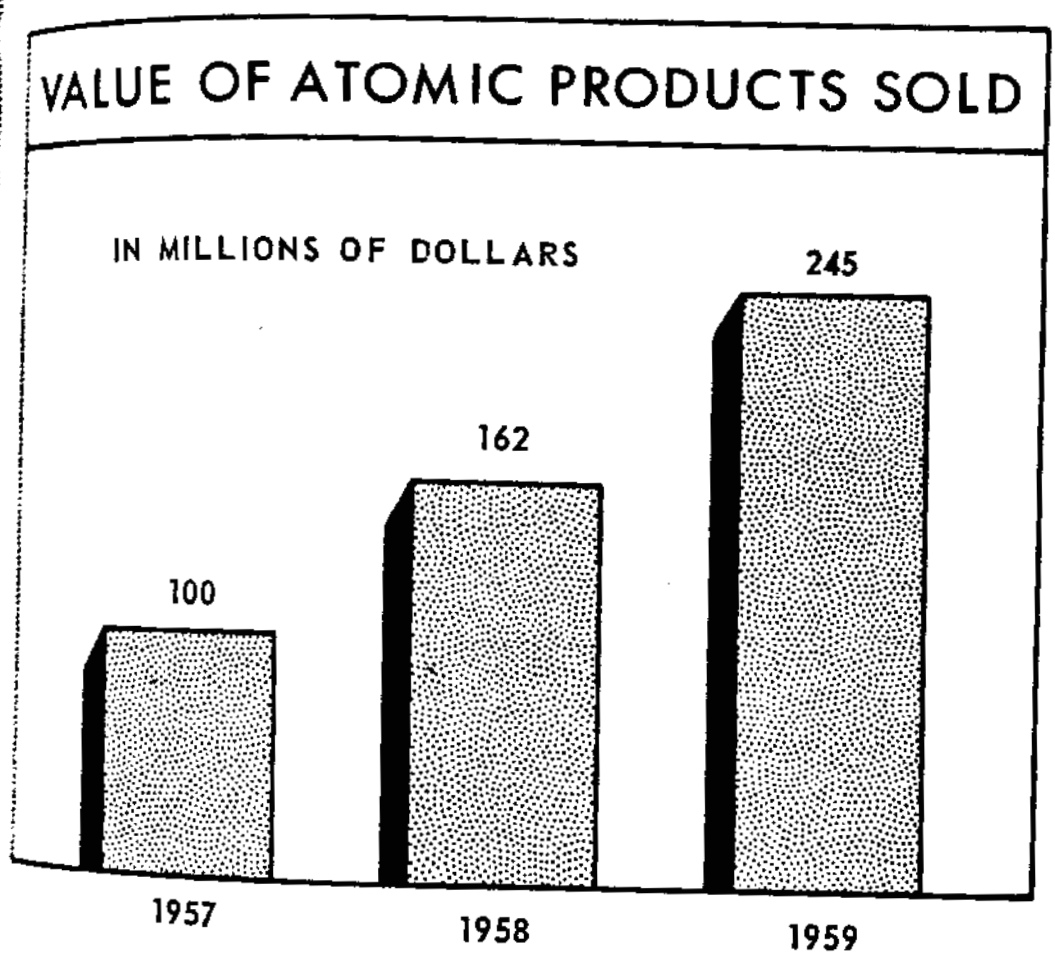
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TABLE 3.—COSTS AND ESTIMATES BY TYPES OF EXPENSE

	Costs incurred fiscal year 1960	Projects active as of June 30, 1960		
		Total estimated costs of projects	Cumulative costs incurred thru June 30, 1960	Estimated costs to be incurred after June 30, 1960
	(*millions*)	(*millions*)	(*millions*)	(*millions*)
	$289.0	$1,328.3	$612.1	$716.2
TYPES OF EXPENSE				
Plant and equipment	$208.3	$907.5	$398.3	$519.2
Research and development	65.0	314.9	181.6	133.5
Fuel fabrication	11.7	59.9	23.4	36.5
Land and land rights	0.4	4.6	3.3	1.3
Training	2.3	14.0	3.8	10.2
Fee charges waived	1.3	17.4	1.7	15.7

power reactors because of their experience gained in research and development work. In the pattern now developing, architect engineers are responsible for overall design, the broad parameters for major equipment, and the evaluation of equipment offered by competitive suppliers. Manufacturers design and furnish integrated reactor systems and guarantee performance of the systems. Construction con-



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TABLE 4.—MANUFACTURERS' SHIPMENTS OF KEY ATOMIC ENERGY PRODUCTS [a] 1959, 1958, 1957

(Value—Thousands of Dollars)

Product	1959	1958	1957
Nuclear reactors (includes only those assembled at place of manufacture)	$7,497	$1,156	
Reactor components and equipment:			
Primary vessels and tanks	19,989	17,099	
Control rod drive mechanisms and components	5,404	7,481	
Accessory instrumentation for reactor control	15,933	15,284	
Heat exchangers and condensers	27,233	13,799	
Pressurizers, components, and auxiliary equipment	3,620	1,758	
Pumps	19,455	9,516	
Valves	13,984	11,401	
Fuel handling equipment	1,747	(c)	
Complete reactor fuel elements and control rods	54,845	23,873	
Partially fabricated reactor fuel element materials and control rods not shipped directly for installation or use in a reactor	11,773	5,742	
Core structurals	5,255	3,908	
Specialized reactor components and equipment not included elsewhere	[b] 4,684	[b] 12,935	
Hot laboratory equipment	3,700	3,886	
Shielding	1,786	(c)	
Radiation survey, monitoring and control devices	12,547	*14,799	
Radiation counting equipment	16,381	10,387	
Radioactive isotopes shipped from non-AEC plants producing isotopes	394	171	
Radiation sources and other radioactive materials produced from purchased isotopes	3,748	3,071	
Control and measuring devices containing radioactive isotopes	8,897	*3,896	
Conversion of enriched uranium metal and compounds	5,986	1,503	
Commercial irradiation service		97	
Total	244,858	161,762	

*Revised.

[a] Data collected by Bureau of the Census.

[b] This product group covers residual items not specifically identified elsewhere and is not comparable from year to year.

[c] Included in "Specialized Reactor Components and Equipment Not Included Elsewhere."

tractors perform their normal role, integrating and coordinating their own activities, as well as those of subcontractors and suppliers, to assure that project schedules are met.

Shipments of key atomic energy products from private manufacturers increased in 1959 over 1958 by 50 percent. (See chart, Value of Atomic Products Sold.) Table 4 summarizes shipments by product groups for the 3 years for which the survey has been made as a joint undertaking by the Bureau of the Census and the Commission.

The Civilian Nuclear Power Program

In spite of some delays the development of atomic power for civilian purposes continued to show encouraging progress during 1960. The effort is carried out through the Commission's program, through ar-

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...the 805,000 electrical kilowatt nuclear power capacity of the United ...—a net addition of 290,000 kilowatts over the previous year—...possible the increasing and more rapid accumulation of operat... experience, cost information, and general advancement in reactor ...nology. The privately financed Dresden Nuclear Power Station ...the Commonwealth Edison Co., attained full power operation in ..., sending 180,000 electrical kilowatts over transmission lines into ...go and northern Illinois. This is considered adequate capacity ...serve a city of 200,000 population. In November, Dresden was shut ... because of control rod problems. The 110,000 electrical kilo... Yankee Atomic Electric Co. reactor, which is a cooperative proj... with the Commission located at Rowe, Mass., attained criticality in ...ust and full-power operation is expected in January 1961. ...22,000 electrical kilowatt boiling water reactor at Elk River, ..., is scheduled to achieve criticality in early 1961. The 60,000 ... Shippingport Atomic Power Station, which during 1958 and 1959 ...provided the bulk of nuclear generating capacity in this country, ...ued operation in April after its first refueling. In September, ... reactor passed its design lifetime objective of 8,000 equivalent ...power hours on the natural uranium blanket elements in the core. ...the basis of nuclear plants now authorized for construction in ... United States, it is anticipated that a nuclear generating capacity ...more than one million electrical kilowatts will be in operation by the ... of 1963. Most of this capacity will come into operation in the ...-62 period, during which time 15 electricity-producing nuclear ...ts are expected to go critical. These include a large fraction of ... demonstration facilities which now appear to be required to help ...ply the experience and technology essential for economic nuclear ...er in high cost areas of this country.

Some of the economies that improved technology and repetitive ...nufacture of fuel elements can accomplish, for example, is evidenced ...the naval submarine reactor program: Within recent years, the ... of naval reactor cores has decreased about 40 percent at the same ... that the useful life of these cores has increased about 70 percent. Evidence of progress toward economically lower nuclear power costs ... shown during the past year by several offers of leading reactor ...nufacturers to construct large-scale power reactors with price and ...formance guarantees which would result in power costs very nearly ...petitive with conventional costs in high fuel cost areas. A Cali... utility has sent a letter of intent to a reactor manufacturer to ...tiate contracts for design and construction of a 360,000 ekw reac-

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tor, larger than any yet undertaken in the United States. A second California utility is considering construction of a reactor of similar capacity. A seven-utility group in New York State called the Empire State Atomic Development Associates, Inc., announced on December 7 a research and development program leading to development of a large scale plant of 300,000 to 500,000 ekw. Contracts have been entered into with General Electric Co. to build a 5,000 ekw boiling water superheat reactor experiment at their Vallecitos plant in California and to conduct research and development work on this concept; and with General Atomic Division of General Dynamics Corp. to conduct longer range research and development work on a high temperature gas-cooled concept. The Associates anticipate that one of these research and development programs will result in design of a large-scale plant.

During 1960, reactor construction was started on four new power plants or prototypes, and two experimental reactors. These are:

The privately financed Saxton Nuclear Experimental Reactor at Saxton, Pa.

The privately financed Humboldt Bay Power Plant at Eureka, Calif.

The Consumers Power Co. Reactor, a cooperative project, under the Power Demonstration Reactor Program, at Big Rock Point, Mich.

The boiling Nuclear Superheat Reactor of the Puerto Rico Water Resources Authority, a cooperative project, under the Power Demonstration Reactor Program, at Punta Higuera, Puerto Rico.

The Carolinas-Virginia Tube Reactor, a cooperative project, under the Power Demonstration Reactor Program, at Parr, S.C.

The Experimental Organic Cooled Reactor of the Commission at the National Reactor Testing Station in Idaho.

Safety considerations and site selection problems altered a number of plans during the year. Construction of an experimental low temperature process heat reactor, a Commission project to provide heat to a saline water conversion plant of the Department of Interior, was not undertaken because the originally proposed site did not meet safety criteria, and no other safe site acceptable to Interior was found. Construction of the small pressurized water reactor, planned as a cooperative project with a public power organization, was also delayed because the initially proposed site of otherwise acceptable proposals failed to meet safety standards. After privately owned utilities did not respond to the Commission's invitation to make proposals for constructing and operating an organic cooled prototype reactor under the Power Demonstration Reactor Program, the Commission was

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considering the reactor's construction under a contract for operation by a publicly owned utility or, alternatively, by the Government on a Commission site. Late in 1960, the Commission selected a corporation proposal as a basis for negotiating a contract to construct a Commission-owned improved cycle boiling water reactor for proposed operation by the cities of Los Angeles and Pasadena, Calif.

The United States Court of Appeals for the District of Columbia set aside the Commission's granting of a construction permit for the Enrico Fermi Power Plant in Michigan, but construction of the plant is continuing under a stay pending final resolution of the case by the United States Supreme Court (for details, see section of this report on Licensing and Regulation).

If not revised by the Supreme Court, or clarified by new legislation, this decision could be a serious blow to the progress of power reactor development, especially with reactors which embody new features.

The Commission's program to develop technologies to use plutonium as power reactor fuel moved forward during the year with construction at Hanford of two major experimental facilities needed for this effort. The plutonium fabrication pilot plant, completed in August, is specially designed for working with plutonium. Fuel elements were fabricated in this plant for the first core of the Plutonium Recycle Test Reactor, which attained criticality in November and is expected to attain full power early in 1961. The facility will irradiate plutonium-bearing fuels and will be of major importance in developing an economic plutonium fuel cycle.

Early in 1960 the Commission completed a long-range study of the Civilian Power Program. The purpose of this study,[5] concerned

[5] Published volumes of the Commission's Civilian Power Reactor Program survey are:
Part I—Summary of Technical and Economic Status As of 1959, (TID–8516), price $1.00.
Part II—Economic Potential and Development Program As of 1959, (TID–8517), price $0.70.
Part III—Book 1, Status Report on Fast Reactors As of 1959, (TID–8518(1)), price $1.00.
Part III—Book 2, Status Report on Pressurized Water Reactors As of 1959 (TID–8518(2)), price $1.25.
Part III—Book 3, Status Report on Aqueous Homogeneous Reactors As of 1959 (TID–8518(3)), price $1.25.
Part III—Book 4, Status Report of Heavy Water Moderated Reactors as of 1959, (TID–8518(4)), price $2.25.
Part III—Book 5, Status Report on Boiling Water Reactor Technology as of 1959, (TID–8518(5)), price $0.60.
Part III—Book 6, Status Report on Sodium Graphite Reactors as of 1959, (TID–8518(6)), price $1.00.
Part III—Book 7, Status Report on Organic-Cooled Power Reactors as of 1959, (TID–8518(7)), price $2.25.
Part III—Book 8, Status Report on Gas-Cooled Reactor Concept, (TID–8518(8)), price $0.55.
Part IV—Plans For Development As of February 1960, (TID–8519), price $0.25.
All of the publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

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primarily with large central station nuclear power plants, was to ascertain the status of the technology for various reactor systems, to appraise their economic potential, and to outline future development plans. Much of the technology developed would be applicable also to small power stations.

This study was guided by the program objectives established in 1958 by the Commission:[6]

First: To reduce the cost of nuclear power to levels competitive with power from fossil fuels in high energy cost areas of this country within 10 years (1968).

Second: To assist friendly nations now having high energy costs to achieve competitive levels in about 5 years. This assistance is to be extended mainly through clearly defined programs of cooperation.

Third: To support 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.

Fourth: To maintain the U.S. position of leadership in the technology of nuclear power for civilian use.

Fifth: To develop breeder type reactors to make full use of the nuclear energy latent in both uranium and thorium, recognizing that uranium 235 alone may not be sufficiently plentiful to meet our needs over the long range.

When these objectives first were stated by the Commission, its available information on Western European conditions indicated that economically competitive nuclear power could be attained in Europe by 1963, as indicated in the Commission's second objective. In the last 2 years, however, the costs of conventional fuels have dropped as they became increasingly available, and this has lowered the costs of conventional power so that they approach those in certain sections of the United States. As a consequence, the time when nuclear power is expected to become economically competitive in Europe is much closer than formerly to the time when similar results may be expected in the United States.

For the United States, the short-range objective is to make it possible between now and 1968 for utility owners to choose to build large nuclear plants rather than conventional plants on the basis of economics alone in areas where fossil fuel costs are 35 cents per million BTUs or higher.

[6] See pp. 4–6, Annual Report to Congress for 1959.

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The longer-range objective is to achieve such technological economies as to enable ever-increasing numbers of utility owners to make economic choices in widening ranges of locations and plant sizes. A fixed target date for this objective has not been established, but it is expected that during the 1970's substantial progress will have been made toward this goal.

Studies and evaluation have indicated that at least two of the types of nuclear systems under development offer a high possibility of providing economically competitive nuclear power in high fuel cost areas of the United States by 1968, provided that the Commission's program of development and prototype construction is carried out.

The first of these systems, light water moderated and cooled reactors, includes pressurized water and boiling water reactor types. These reactors, fueled with slightly enriched uranium in the form of uranium oxide clad in stainless steel or zirconium, and producing saturated steam for generating turbines, have the greatest background of developed technology in the United States, and seem at this time to be closest to attaining economic nuclear power. Commission studies indicate that, with further development, water reactor technology can be expected to attain the short-range objective for high fuel cost areas. For the long range, such developments as nuclear superheat, engineering simplification, improved fuel performance, and lower fuel costs give promise of further reducing the cost of power from water-cooled reactors.

The second reactor system of short-range economic promise is the organic moderated and cooled reactor. Organic coolants offer the advantages of low operating pressures and fewer corrosion problems, and the technology already developed for water-cooled reactors is widely applicable to these reactors. These advantages are somewhat offset by the fact that the organic materials now used are slowly polymerized by radiation and must be replaced, and by the fact that the heat transfer properties of the system are not as good as those of water cooled reactors. These problems are not considered major obstacles. If present development efforts meet with the success anticipated, there is good reason to believe that this system also will be capable of meeting the short-range objective for high fuel cost areas.

In order to increase the probability that the longer term objective of generally competitive nuclear power will be achieved, and that the most economical systems will be developed, other reactor systems are being investigated. In general, lower construction, operating, and maintenance costs are sought in these systems through higher temperatures, greater neutron economy, and low-cost fuel cycles.

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It is doubtful whether any one reactor system will provide all these advantages, or whether any one reactor system will meet all the conditions required by the long-range objective for every location and plant size. The Commission therefore is investigating sodium-cooled thermal and fast reactors, gas-cooled reactors, fluid fuel reactors, and heavy water reactors. The United States also has entered into a cooperative program with Canada which is expected to make substantial contributions to the technology of heavy water reactors cooled with gas or sodium. Present knowledge indicates that high temperature systems cooled with gas or sodium, and particularly those systems which show a high uranium-plutonium conversion ratio, have great potential for meeting the long-range objectives. However, the state of knowledge of these systems is somewhat limited and there are many technical difficulties that must be solved at great expense in time and money before their potential can be realized.

The Commission also has under investigation several new reactor concepts—the so-called advanced reactor concepts—or modifications to concepts. If, after engineering studies, research and development, and evaluation, one or more of these seems promising, a reactor experiment will be built as required to provide the information needed to determine the extent to which the concept can help meet program objectives.

As large central station nuclear applications were the primary subject phase of the long-range study of the Civilian Power Program, studies were initiated in June 1960 to place special emphasis on small power reactors as well as process heat reactors and reactors using radiation to produce commercial chemicals.

The 1959 studies covered the economic and technical status of reactors of more than 75,000 electrical kilowatt capacity. During the past 6 months the Commission staff has been evaluating the economics and required research and development effort needed for nuclear plants below 75,000 ekw capacity in order to devise meaningful and productive development programs for concepts which have a potential in the small power field. In summary, the studies confirm previous views that nuclear power does not offer as great probability of competing with conventional plants in the range of 10,000 to 50,000 kilowatts as it does in the larger sizes. This is largely because many features like shielding, containment, safety precautions, and waste control are almost as expensive for a small plant as for a large plant. Detailed results of the studies will be published in 1961.

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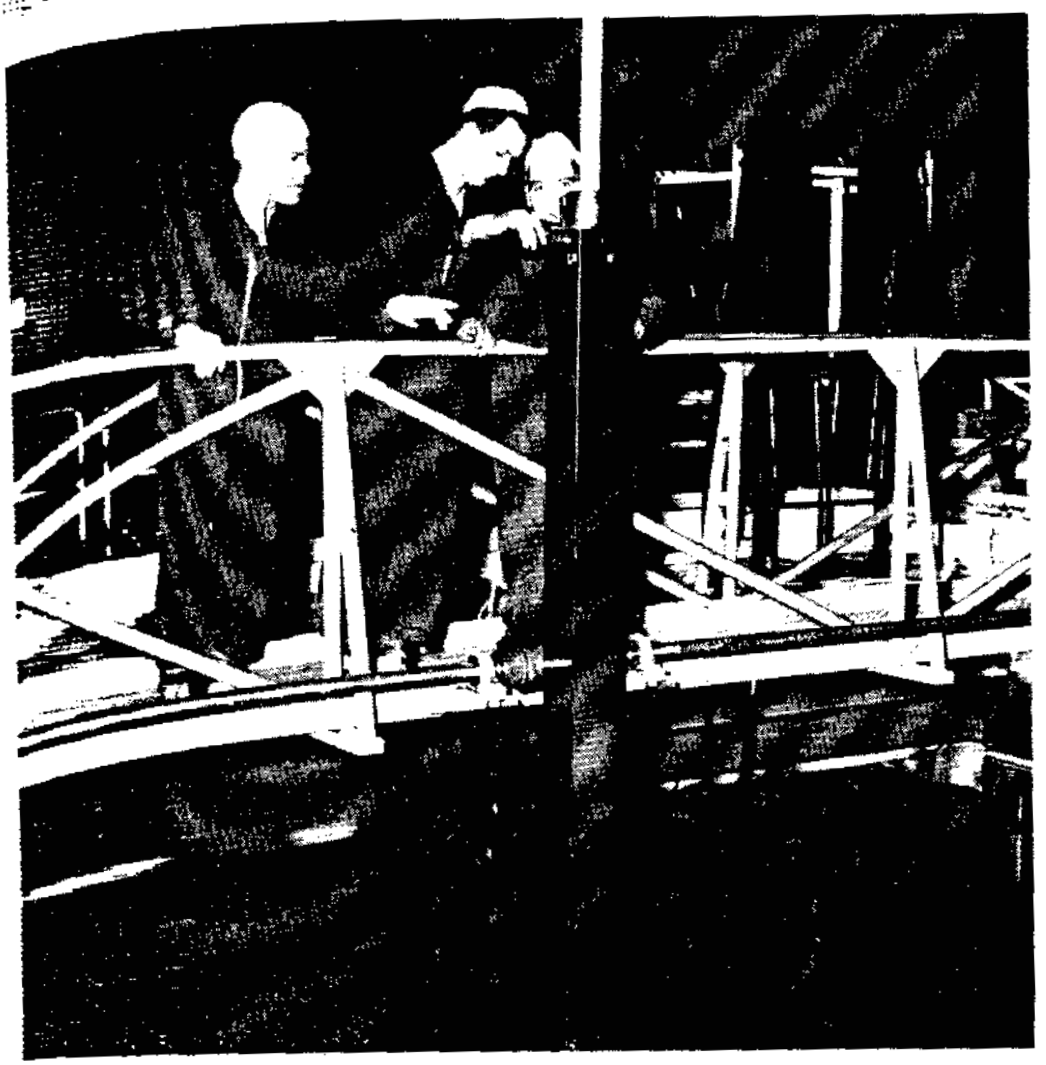
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PROGRESS IN POWER REACTOR TECHNOLOGY

In this section of the report, the Commission reviews progress during 1960 for each type of reactor under development.



Shippingport Refueling. After more than 2 years of operation, the Shippingport Atomic Power Station reactor was refueled with a new type of unit during 1960. Photo shows the first of 32 "seed and blanket core" units being lowered into the transfer canal for insertion into the reactor. Refueling is accomplished under water by remote control to reduce radiation hazards.

Pressurized Water Reactors

Shippingport (Pa.) Atomic Power Station

The Shippingport Station is the first major nuclear power electrical generating plant in the United States. The 60,000 kilowatt electrical (net) pressurized water reactor at Shippingport achieved criticality and began supplying electricity in December 1957 to the system of the

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Duquesne Light Co., operator of the reactor for the Commission. In the 3 years since startup, many tests have been conducted to evaluate design and performance of the nuclear reactor, its fuel elements, and the reactor plant as a whole. The information from these tests has provided much of the technology, operation and cost data today available on large water-cooled reactors for commercial generation of electrical power.

During the past year the principal contributions resulting from operation and testing of the Shippingport Station include: achieving burnups in the uranium oxide (UO_2) fuel elements higher than in any other reactor; further confirmation of the advantages of the "seed and blanket" core concept which minimizes the investment in uranium 235 and maximizes the power obtained from natural uranium; publication and distribution of test results and evaluations covering the nuclear and thermal performance of the plant and the first refueling of the reactor; successful operation of the Shippingport reactor as part of a large public utility system.

The first seed (32 enriched fuel assemblies) of the Shippingport (PWR) core was replaced after 5,808 equivalent full power hours operation which produced 388,500,000 kilowatt hours (gross) of electrical energy. This refueling was completed in March 1960 and the reactor, containing the new seed, went critical April 12. Full power operation was achieved May 7. Since May the plant has been operated most of the time at full power in order to develop information on the lifetime capabilities of the uranium dioxide blanket. Physics tests and student training also were conducted during this period. As of December 31, PWR Core 1 has generated a total of 655,000,000 kilowatt hours (gross) of electrical energy. The cumulative load factor for the second seed has been twice as great as the first seed. The average burnup in the natural uranium dioxide blanket is 3,200 megawatt days per ton, while the peak burnup is about 14,000 megawatt days per ton. This burnup represents the highest natural uranium dioxide fuel depletion achieved so far in any reactor.

Present plans are to replace the second seed of this first Shippingport core with a third seed about the middle of 1961, provided the blanket fuel elements still are performing satisfactorily. The blanket fuel elements were designed for a lifetime objective of 8,000 equivalent full power hours. This objective was actually achieved on September 9, 1960. When the second seeding is depleted, the blanket fuel elements will have operated for approximately 12,500 equivalent full power hours. Examination of some blanket fuel elements during the second seed refueling should give an indication of the conditions of this fuel and its ability to perform satisfactorily through a third seed life.

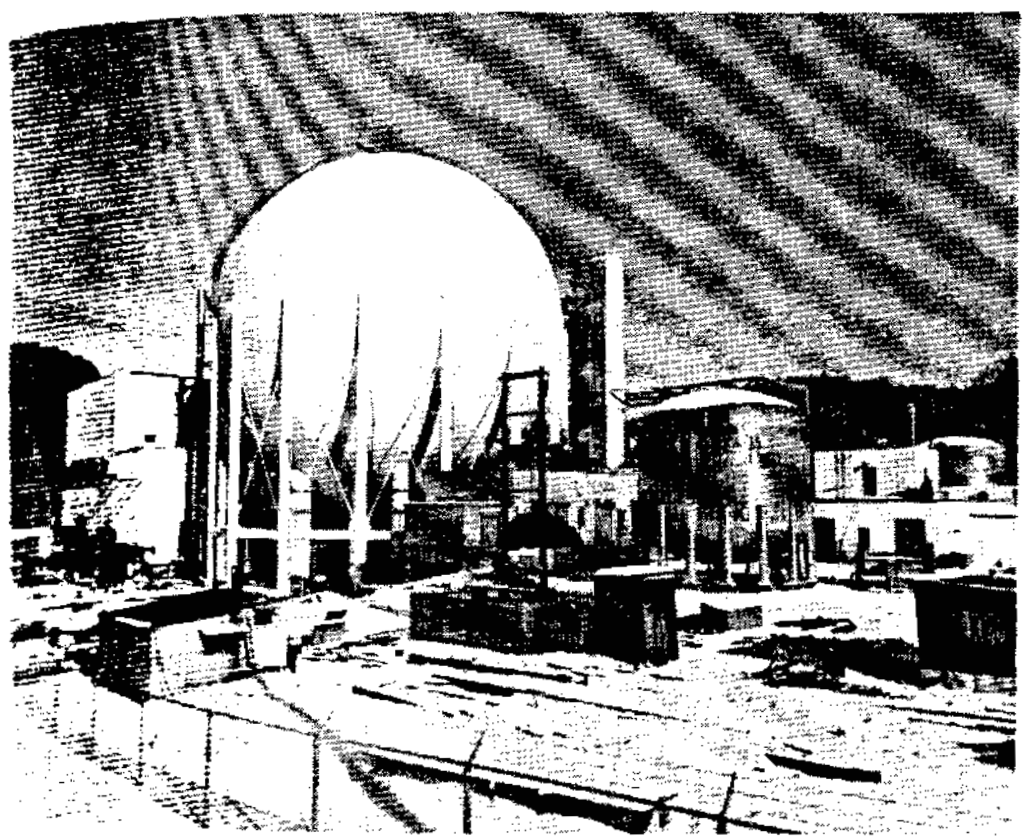
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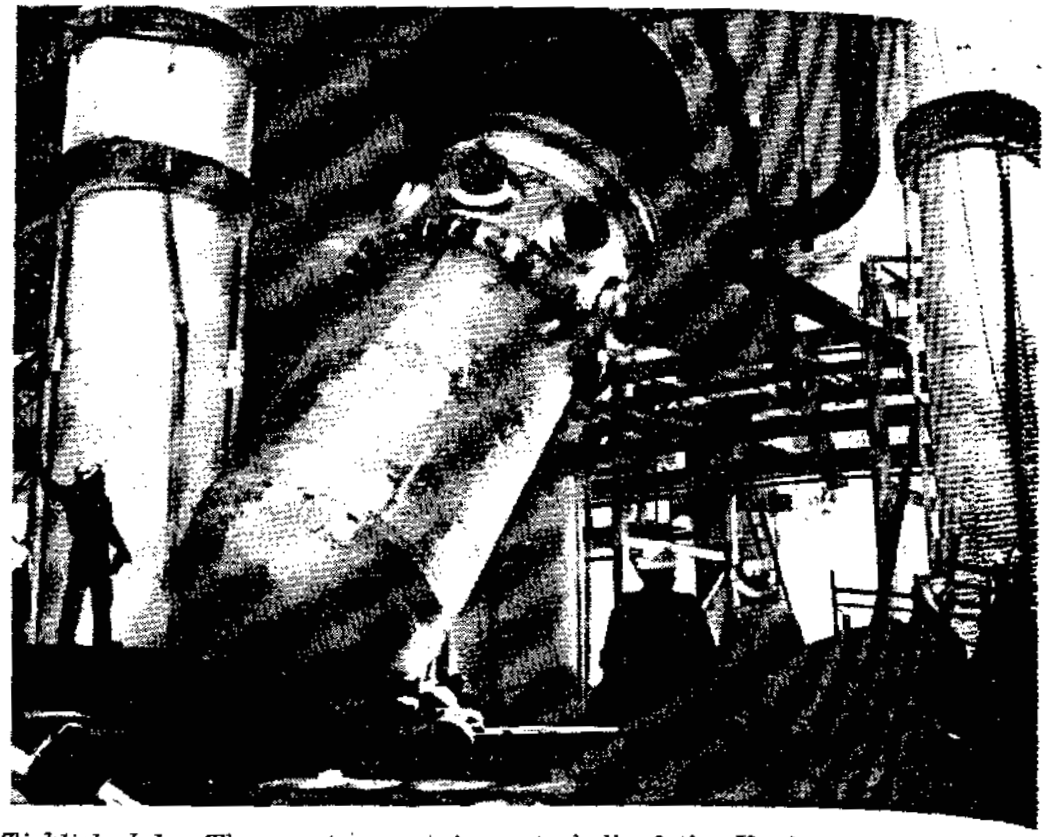
Yankee Plant Complete
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Design and planning for a second Shippingport core of advanced design is underway with completion of the core scheduled for early 1962. This new core, PWR Core 2, will have a power capability of 150,000 ekw and will have a design lifetime of 20,000 equivalent full-power hours. This results in a design energy output 5½ times that of PWR Core 1. The PWR Core 2 will utilize oxide full plates in both seed and blanket and will use fewer hafnium control rods than PWR Core 1. To dissipate the higher power which will be generated by PWR Core 2, it became necessary either to expand the present electrical generating facilities from 100,000 to 150,000 kilowatts or to provide a 50,000 kilowatt heat sink installation. Both these possibilities were investigated by the Commission and by the Duquesne Light Co.; it was concluded that a heat sink installation is economically more attractive. Use of the heat sink meets all requirements for proving out the higher power capabilities of PWR Core 2. Work on this installation is in progress and will be completed prior to installation of the second core.



Yankee Plant Completed. First joint Commission-industry nuclear power plant to be completed was the Yankee Atomic Electric Co. plant at Rowe, Mass., which is expected to begin full-power operation during January 1961. Contracts for the 110,000 ekw pressurized water facility were signed June 6, 1956—the first under the Commission's Power Reactor Demonstration Program. Photo shows the spherical containment vessel that houses the reactor.

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Ticklish Job. The reactor containment shell of the Yankee plant is a sphere located well above ground. Photo shows the reactor pressure vessel being eased into the sphere through an opening that allowed only inches of clearance. The photograph was taken February 7, 1960, and 6 months later on August 19, the reactor achieved initial criticality.

Yankee Atomic Electric Co. Reactor

Construction of the 110,000 ekw Yankee Reactor at Rowe, Mass., was completed on schedule in July and initial criticality was achieved August 19. Yankee then began low-power testing of this pressurized water reactor which was built under a Commission-Yankee contract as part of the Commission's Power Demonstration Reactor Program. The Yankee plant was the first project accepted under the program initiated in January 1955, and was the first completed.

Preliminary low power tests were followed by operation at increasing power levels up to 90,000 ekw by the end of the year. It is expected that design power level of the first core (110,000 ekw) will be achieved in January. The plant is rated at 136,000 ekw and further increases in power up to this level will be based on operating information accumulated at 110,000 ekw.

Important cost information in addition to operating and maintenance experience are expected from this full-size power reactor. Re

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Experimental Process Heat Reactor

Because of difficulty in selecting a site that was both safe from the standpoint of nuclear operations and also suitable for the requirements of the Department of the Interior, the joint Commission-Interior plans to use a nuclear plant as a source of heat for conversion of salt water into drinking water were not carried out during 1960.

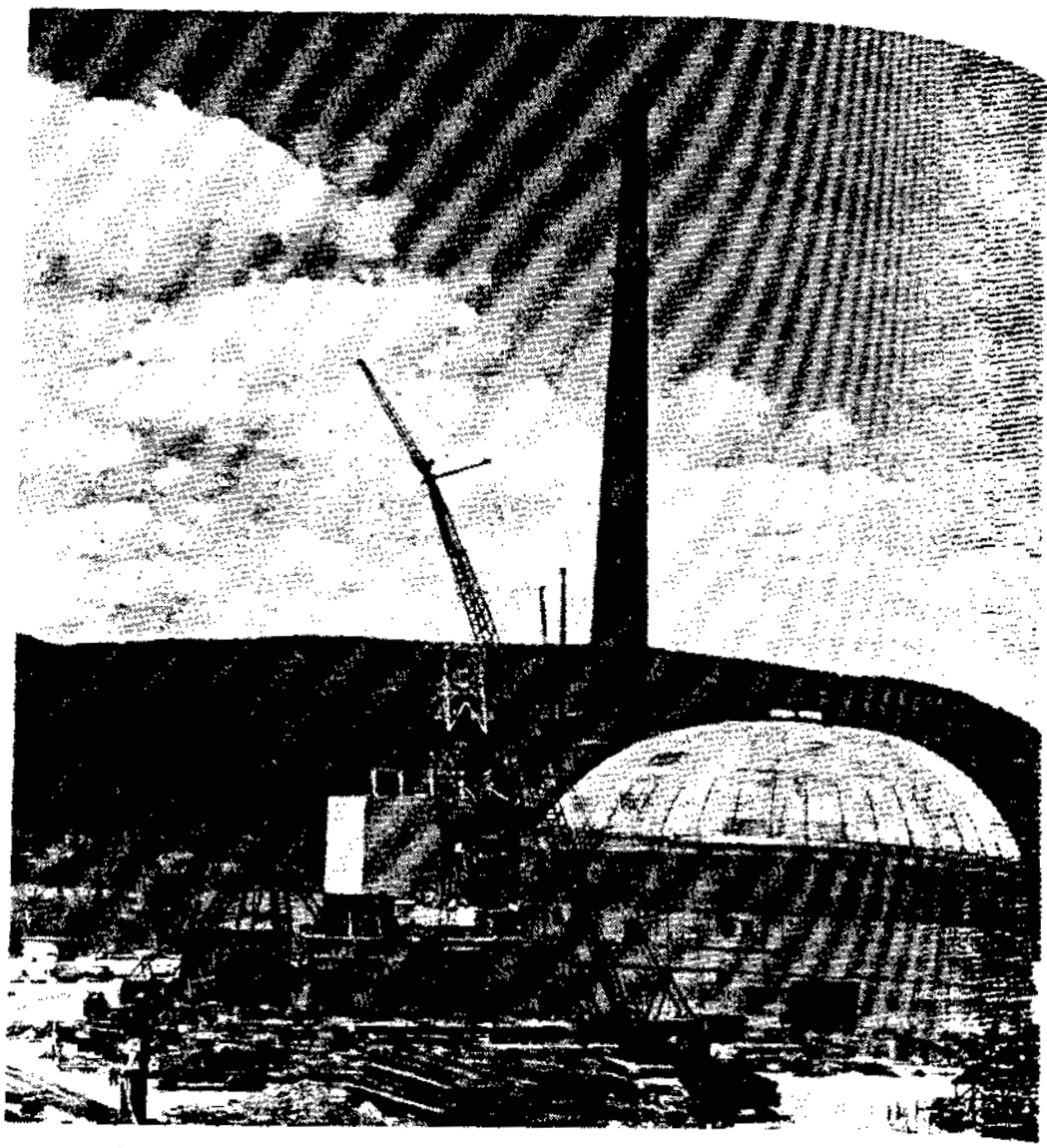
For this project, the Commission was to design, construct, and operate a 40,000 thermal kilowatt experimental low-temperature process heat reactor capable of producing saturated steam for the saline water conversion unit of the Department of the Interior. The proposed reactor site was at Point Loma, San Diego, Calif. However, the Commission's Advisory Committee on Reactor Safeguards (ACRS) recommended against this site. An alternate site at Point Mugu, 50 miles northwest of Los Angeles, which would probably have met safety criteria, was found by the Department of Interior not to fit its requirements. Further investigations are to be made with Department of Interior and with industry regarding this project.

Small Power Reactor

In August 1959, the Commission invited proposals from cooperative and publicly owned utilities for participation in a project under its Power Demonstration Reactor Program for a 16,500 ekw prototype pressurized water reactor, with a conventional superheater to increase the power to 22,000 ekw.

Five proposals were received and the Commission announced on April 26, that none was acceptable. Proposals submitted by the City of Jamestown, N.Y., and by the Dairyland Power Cooperative of La Crosse, Wis., are receiving further consideration. Alternate site suggestions were requested in each case for safety reasons. The alternate sites proposed by Jamestown and Dairyland were acceptable from the standpoint of safety but the proposed financial contributions for the sites had become less favorable and were not fully acceptable to the Commission. Negotiations were continued and at the end of the year the Commission was considering various courses of action regarding this project.

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Completion in 1961. The 255,000 ekw Consolidated Edison Co. nuclear power plant is scheduled for completion in late 1961. The privately financed facility will use a pressurized water, thorium-fueled reactor to produce 151,000 ekw and an oil-fired superheater to increase the output to 255,000 ekw. The reactor will be housed in the dome-shaped building; the tall stack is a part of the superheater unit. The plant is located on the Hudson River at Indian Point, N.Y.

Consolidated Edison Thorium Reactor

The 255,000 ekw privately financed plant of the Consolidated Edison Co. continued under construction at Indian Point, N.Y., during 1960. The nuclear reactor will have a capacity of 151,000 ekw and will have an oil-fired superheater to increase capacity by 104,000 ekw. Criticality is scheduled for September 1961 with design power operation by the end of 1961. The Indian Point plant will provide important operating data for large water-cooled reactor systems and technical data on the use of a fuel mixture of thorium and uranium 235.

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Saxton Nuclear Experimental Reactor

Construction began in February on the Saxton Nuclear Experimental Corp. 3,250 ekw privately financed developmental power reactor at the Saxton, Pa., site, about 20 miles south of Altoona. Westinghouse Electric Corp. is designing and building the reactor. By the end of the year, construction was about 35 percent complete. Power operation is scheduled for the first half of 1962. It is expected that this small experimental pressurized water reactor will be capable of being used for testing purposes under limited boiling water conditions.

360,000 Ekw California Plant

Southern California Edison Co. of Los Angeles announced in April that it had sent a letter of intent to negotiate contracts for design and construction of a 360,000 ekw plant to Westinghouse Electric Corp. and Bechtel Corp. The proposed closed-cycle pressurized water reactor, steam and electrical equipment, would be designed and built by Westinghouse. Bechtel would be the engineering constructor.

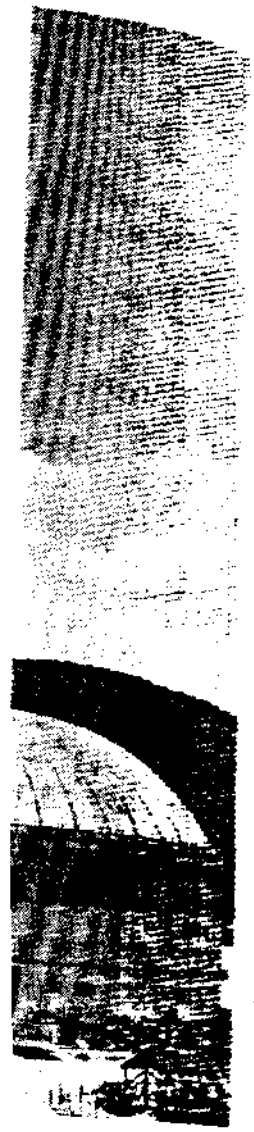
Completion of contract negotiations and start of construction will depend on several factors, such as granting of a permit by the Commission, approval by the California Public Utilities Commission, and selection of a specific acceptable site. Negotiations for a site on the Southern California coast now are under way.

The plant is estimated to cost about $78 million and would require about 4 years to construct.

Boiling Water Reactors

Experimental Boiling Water Reactors (EBWR)

The EBWR at Argonne National Laboratory was shut down in July 1959 for modifications to increase the thermal capacity of the plant, designed originally to operate at 20 megawatts, to 100 megawatts. After delayed delivery of equipment put back the schedule, limited plant operation was resumed temporarily in the spring of 1960 with the original core while outside construction continued. Completion of the 100-megawatt modification was delayed at the end of the year when leaks were found in two primary reboilers used for the additional heat removal. Full power operation should begin early in 1961.



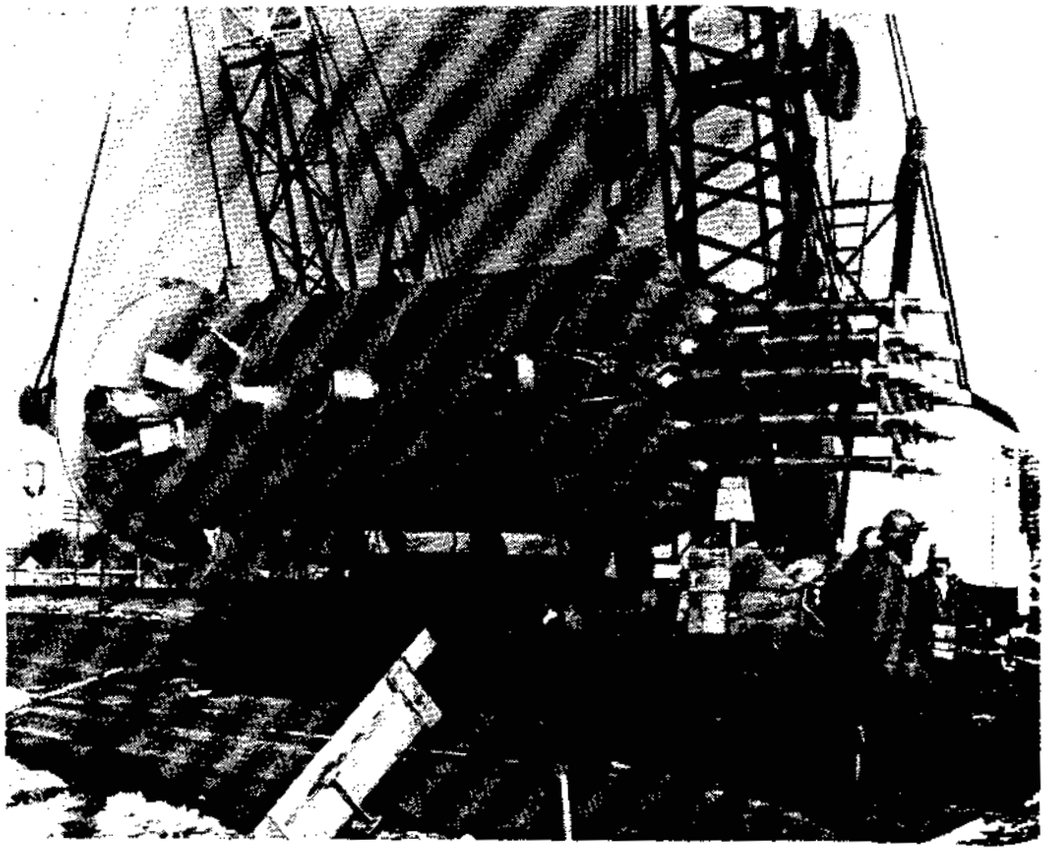
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Operation at the higher power level will permit tests to explore the stability limits of small, natural circulation, boiling reactors with cores of greater power densities than have been used previously.

The original power generating turbine capacity—5,000 ekw—will not be increased. The excess energy will be dissipated through heat exchangers.



Elk River Reactor. The Rural Cooperative Power Association's 22,000 ekw power plant at Elk River, Minn., will be the first commercial power station to go into operation utilizing a combination of nuclear and conventional heat sources, and also the first constructed jointly by the Commission and a publicly owned power group to be completed. The photo shows the boiling water reactor pressure vessel as it arrived at Elk River during February. The reactor control rods will enter the vessel from the bottom through the pipes shown at right of photo.

Elk River Reactor

Construction of the 22,000 ekw boiling water reactor of the Commission in cooperation with the Rural Cooperative Power Association was nearing completion at Elk River, Minn., in December and criticality is expected to be achieved during the Spring of 1961. Criticality was delayed because of cracks detected in four 16-inch reactor vessel nozzl
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[7] See p. 47, Nineteenth

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reactor vessel nozzles. Necessary repairs required approximately 6 weeks. There were also difficulties experienced in core fabrication which caused additional delays.

This reactor will provide performance and cost data on a small plant using an indirect, natural circulation, boiling water reactor coupled with a separate coal-fired superheater. Experience gained from it also will aid in evaluating certain variations in boiling water reactor design which may have application to larger plants; for example, use of mixed thorium oxide and uranium oxide fuels.

This reactor was built under the conditions of a second invitation issued by the Commission under its Power Demonstration Reactor Program[1] in September 1955 for proposals from publicly owned utilities. Under the terms of this "second round" invitation, the Commission constructs and owns the reactor, and the publicly owned utility supplies site and conventional turbogenerator equipment, operates the reactor, and purchases the steam.

Improved Cycle Boiling Water Reactor

The Commission extended an invitation in January for proposals to construct and operate a reactor with a minimum capacity of 50,000 ekw and an improved steam cycle. The two-part invitation, issued under "second round" conditions of the Power Demonstration Reactor Program, requested (*a*) proposals from publicly owned utilities to provide the site and the conventional portion of the plant, to operate the entire plant, and to purchase all steam produced; and (*b*) industrial proposals related to the design, development and construction of the reactor.

Of two proposals received from utilities before May 2 to operate the plant, the Commission selected the joint proposal of the cities of Los Angeles and Pasadena, Calif., which specified a site about 40 miles northeast of downtown Los Angeles.

Four proposals were received from manufacturers to supply the reactor. A General Electric Co. proposal first was selected in June as the basis for contract negotiations to supply the reactor for this project, but later an error was discovered in the information upon which the Commission based its decision. After thoroughly re-evaluating all factors involved in the consideration of making a selection from the four proposals received for furnishing the reactor plant and after checking and verifying all bid data, the Commission announced November 17 that it had selected the Allis-Chalmers Manufacturing Co.

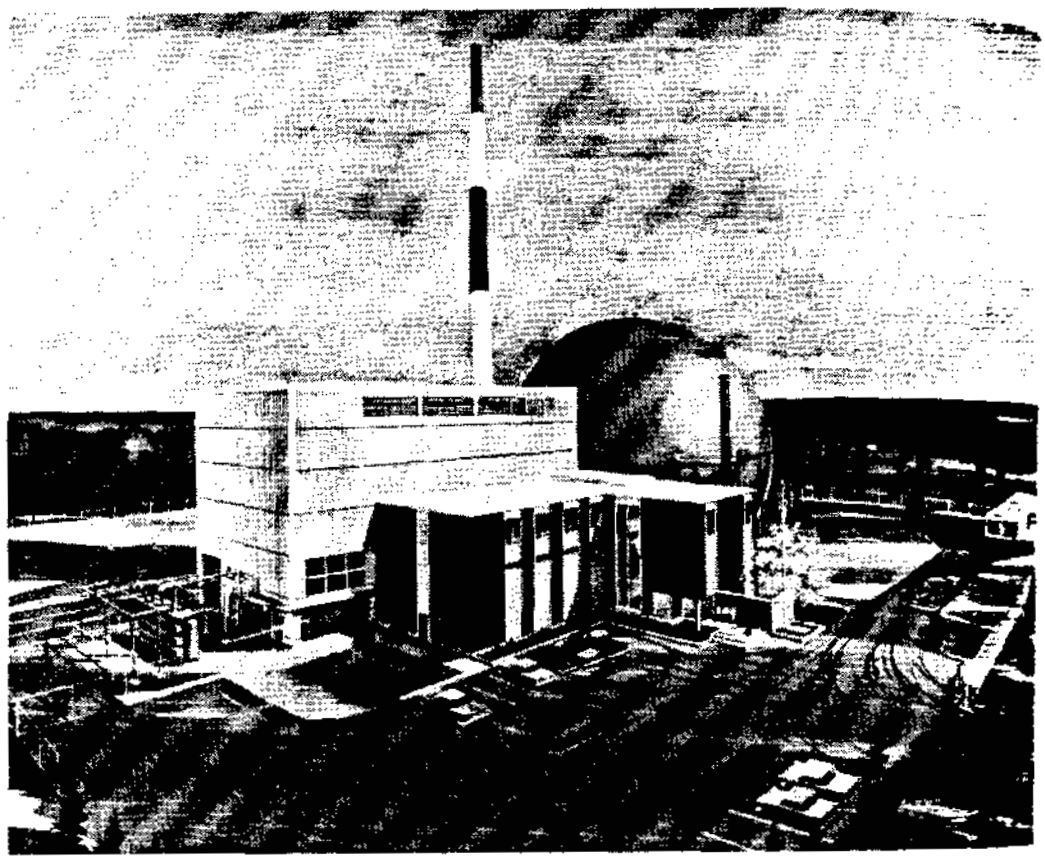
[1] See p. 47, Nineteenth Semiannual Report to Congress (July–December 1955).

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proposal as the basis for negotiation of a contract to furnish the reactor. Initiation of the project is contingent upon satisfactory negotiation of the contract and satisfactory negotiation of a cooperative arrangement with the cities of Los Angeles and Pasadena.

Under the proposed arrangements, the municipally owned utilities would provide a plant site in Haskell Canyon, Los Angeles County, and the turbogenerator facilities, would operate the facility for the Commission for not less than 5 years and purchase the steam produced by the reactor.

The Allis-Chalmers Manufacturing Co. would design, fabricate, construct and test operate the reactor, furnish the first core and spare fuel elements, and provide training for operating personnel. The plant, planned for completion in early 1964, is intended as a prototype for a 300,000 kilowatt reactor incorporating features aimed at reducing power costs.



Big Rock Point Plant. Artist's conception of the 50,000 ekw boiling water reactor power station being constructed at Big Rock Point in northern Michigan by the Consumers Power Co. Completion is scheduled for 1962. The reactor is expected to lead to development of fuel assemblies with greater power densities per liter of core volume. The Commission is furnishing research and development support for the project.

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Consumers Power Co. Reactor

The Commission reached an agreement in April with Consumers Power Co. of Michigan on its joint proposal to construct a 50,000 ekw high power density boiling water reactor, and with General Electric Co. to perform associated research, under the terms of the third invitation issued by the Commission for its Power Demonstration Reactor Program.[8] Construction began in June at the Consumers site at Big Rock Point, Mich.

Under the agreement, Consumers Power Co. is responsible for the design, construction, and operation of a reactor scheduled to achieve initial criticality in the latter part of 1962. For a period of 54 months after initial criticality, Consumers will make the plant available to carry out research and development aimed at achieving higher power per unit volume of fuel.

The Commission will support research and development by General Electric before and after construction up to a maximum cost of about $3.7 million subject to escalation not to exceed 10 percent. The Commission also will waive total fuel use charges of about $1.7 million for the first 5 years of operation. Plant capital costs, including site and site preparation, are estimated at more than $27 million.

It is anticipated that this reactor's first core will have a power density of about 45 kilowatts per liter of core volume. Tests in the reactor of improved fuel assemblies to be developed are expected to provide data to permit operation of complete reactor cores with a power density of about 60 kilowatts per liter.

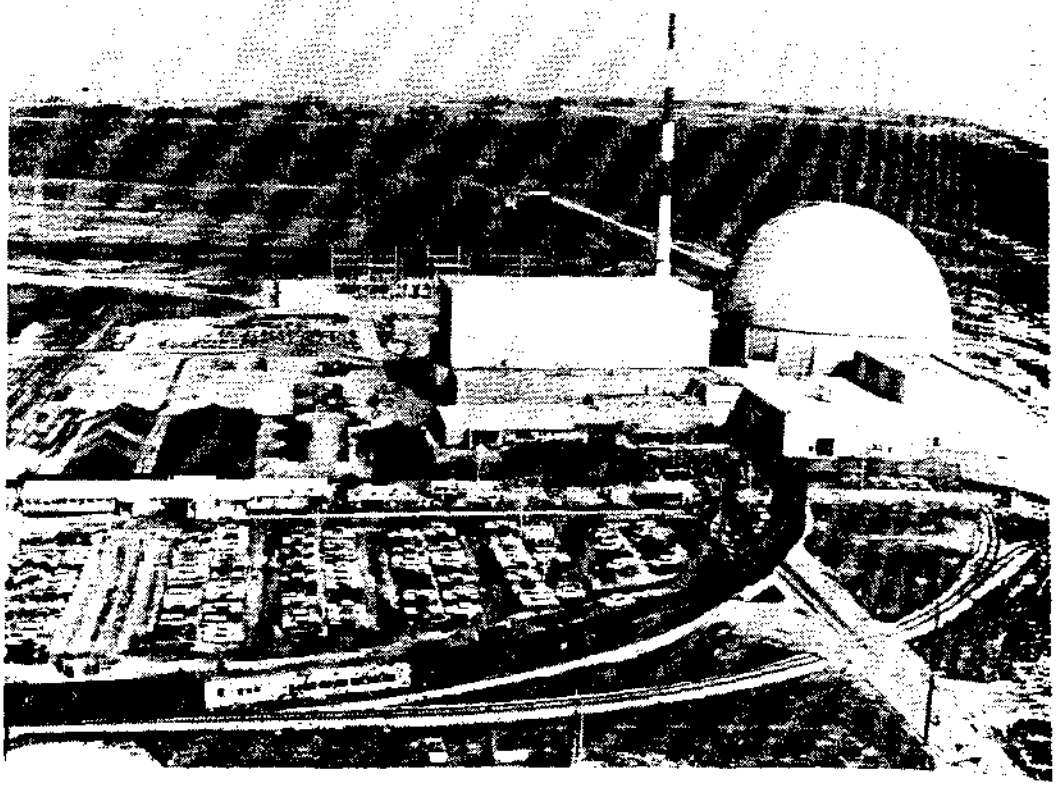
Vallecitos Boiling Water Reactor

The Vallecitos reactor, a privately owned 5,000 ekw reactor experiment of General Electric Co. (with Pacific Gas and Electric Co. supplying the generating equipment) was returned to operation in September 1960, after being shut down about 1 year for modifications. Modifications included installation of new circulating water pumps and piping and a new core structure to permit different fuel arrangements. Although the reactor had operated since July 1957, General Electric reported that radioactivity was not a serious problem during overhaul.

The Vallecitos reactor was initially constructed and operated to develop the fuel and reactor design for the Dresden Nuclear Power Station. It now is used for obtaining data related to advanced reactor technology such as high power density cores.

[8] See p. 55, Twenty-second Semiannual Report to Congress (January–June 1957).

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Dresden Dedicated. The nation's first full-scale, privately financed atomic power facility, the Dresden Nuclear Power Station, was dedicated on October 12, 1960. Owned by the Commonwealth Edison Co., and built by the General Electric Co., the plant uses a boiling water reactor to produce 180,000 ekw, enough electricity to serve a city of 200,000 persons. Photo shows the plant site on dedication day when 2,500 persons visited the facility about 50 miles southwest of Chicago.



Dedication Ceremony. iner, Chairman of the Chairman of Commo that started Dresden's Energy Commission C install the new contr dedication.

Dresden Nuclear Power Station

Commonwealth Edison Co. Dresden Station near Chicago was the first large privately financed nuclear power plant to go into operation in this country. The 180,000 ekw plant achieved initial criticality October 15, 1959, and went into full design power operation June 29, 1960. The plant generates 180,000 kilowatts of electricity, enough to service a city of 200,000 population.

The drive toward design power began after correction of control rod difficulties and completion of low-power experiments. The plant produced its first electricity on April 16, 1960. It then was operated at gradually increased power levels until full power was attained. After the demonstration production of full power, the reactor underwent a series of power tests with satisfactory results. The plant was then operated at low power levels and with frequent shutdowns for

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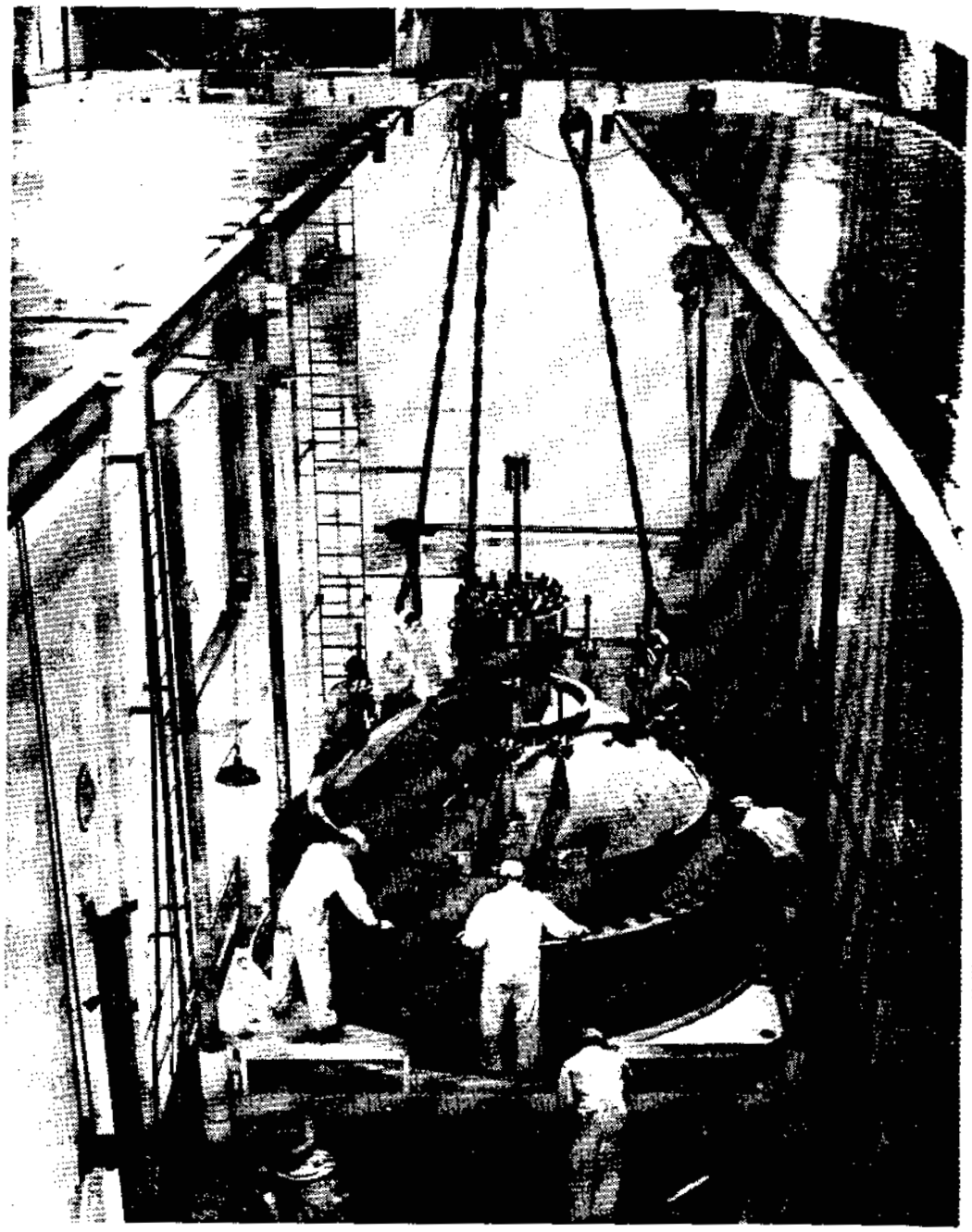
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Dedication Ceremony. As a highlight of the Dresden dedication, Ralph J. Cordiner, Chairman of the Board of General Electric (left), presented Willis Gale, Chairman of Commonwealth Edison (right) with the original control switch that started Dresden's first chain reaction on October 15, 1959. In photo, Atomic Energy Commission Chairman John A. McCone (center) watches Mr. Cordiner install the new control switch. Mr. McCone was the principal speaker at the dedication.

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Reactor Head. Photo shows the 50-ton head of the Dresden reactor pressure ves sel being emplaced. The reactor has a slightly enriched uranium core. Valued a about $15 million and weighing less than 65 tons, this initial loading of fuel is expected to last 3½ years and to produce as much electricity as would 2,000,00 tons of coal. The interior of the 300-ton reactor vessel is 41 feet high and 1 feet, 2 inches in diameter. The cylindrical walls are 5-inch carbon steel plus a ⅜-inch layer of stainless steel.

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Humboldt Bay Powe

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BORAX-5

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...purpose of training Commonwealth Edison operators. During ...ctober 1960, gross electrical generation exceeded 150 million kilowatt ...hours. On October 12 the plant was officially turned over to Common...ealth Edison Co. by the General Electric Co., its builder.

The Dresden plant was shut down on November 15 when one of ...e control rods became separated from its drive. Investigation ...owed that the drive tube, to which the control rod is attached, had ...vered. A second drive tube showed evidence of cracking. It was ...en decided to remove the entire core and examine all drive tubes. ...t is expected that the plant will be shut down for a minimum of ...ve months, during which construction cleanup work will be com...eted. The present control rod-problem is not related to the diffi...lty experienced with the control mechanism a year ago.

Humboldt Bay Power Plant

The planned April start of construction of the Pacific Gas and Electric Co. 48,500 ekw boiling water plant at Humboldt Bay, Calif. was postponed several months to allow time for tests of a pressure suppression containment system. The tests were completed, the reactor met the safety requirements of the Advisory Committee on Reactor Safeguards and site work began at Eureka, Calif. in November.

This reactor will exploit natural circulation of the coolant and will be the first to use pressure suppression containment. In this plant, vapor released by a reactor incident would be expelled through a pool of water which would reduce the vapor pressure by condensation.

Design power operation of this privately owned plant is scheduled for the latter part of 1962.

Nuclear Superheat Reactors

It is expected that the production of superheated steam in reactors will have some economic advantage in comparison with water-cooled reactors which now produce saturated steam. Three boiling water reactors are now under construction which have as their primary objective the development of nuclear superheat reactor technology.

BORAX–5

Construction of this reactor, the fifth in a series of boiling reactor experiments carried out by Argonne National Laboratory, is nearing

completion at the National Reactor Testing Station. It is designed primarily to demonstrate the safety aspects and feasibility of an integral boiling-superheating reactor—that is, a reactor core producing saturated steam which is subsequently superheated within the same core.

BORAX–5 will be operated initially in early 1961 with a limited number of test channels producing superheated steam, and by mid-year should attain design power of 40 megawatts (thermal) with the full boiling-superheating core.

Flexibility designed into the system will permit investigations of nuclear stability problems associated with various fuel and coolant arrangements.

Pathfinder Atomic Power Plant

Construction of the Pathfinder plant, a third-round cooperative project of the Commission and the Northern States Power Co., got under way at Sioux Falls, S. Dak., early in 1960 and by December 31 was approximately 42 percent complete. Reactor criticality is scheduled for June 1962. This 62,000 ekw reactor will provide test and operating data on an integral boiling-superheating core with a superheater centrally located within the reactor core.

Boiling Nuclear Superheat (BONUS) Reactor

Favorable results having been obtained from a preliminary design and feasibility study, the Commission signed a contract with the Puerto Rico Water Resources Authority in January for a 16,300 ekw boiling water reactor with nuclear superheat to be constructed as a second round cooperative project in northwest Puerto Rico. General Nuclear Engineering and Jackson and Moreland Inc., were selected to design the plant and Maxon Construction Co. was named construction contractor.

The proposed plant site at Punta Higuera was found satisfactory from a safety standpoint and construction was formally begun on August 23. Construction is scheduled to be completed in December 1962. This integral boiling superheat reactor will demonstrate for small reactors the practicality of nuclear superheat utilizing a superheater region located peripherally to the boiling core region.

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Organic Cooled Reactors

...anic Moderated Reactor Experiment (OMRE)

The OMRE has been in operation for 3 years. During that period ... reactor has operated on two core loadings accumulating over 1,800 ...awatt days. The primary objective of demonstrating the feasi... of an organic cooled and moderated reactor has been accom...shed. The reactor was shut down in March 1960 for evaluation of ... second core fuel elements and for modification of the primary ...ling system. The third core was loaded during September and ...ticality was achieved September 20, 1960. Low power tests are ...inuing.

Examination of the second core fuel elements verified the suspected ...rface fouling of certain fuel elements. Analysis of the material ...posited on the fuel surfaces indicated the fouling material contained ...large percentage of iron oxide and iron carbide as well as radiation ...composed organics. It is suspected that the fouling is the result ... iron particles present in the organic coolant as a contaminant. ...e mechanism of fouling is believed to result from electrostatic ...cipitation of the particles and polymerization of the organic ...which surrounds the particles) caused by intense radiation fields at ...e surface of the fuel plate. The special test elements in the second ...e loading, similar to those to be used in the City of Piqua power ...actor, showed only very small deposits.

The OMRE primary loop has been modified to provide tests of de... for removal of inorganic particulate matter. The third core will ...e operated under controlled conditions to remove the iron particulate ...m the coolant system. The reactor will be further modified late ... 1961 to provide more adequate fuel handling, fuel storage, and ...ocess equipment facilities. This modification is intended to extend ...e usefulness of the OMRE for at least the next 5 years. The OMRE ...ll continue to be used as a fuel-testing facility, for bulk organic ...adiation, for organic decomposition rates, and for heat transfer and ...ling tests. The OMRE schedule will include one year's opera... on low enriched metallic fuel similar to the Piqua reactor and ...year on uranium oxide fuel.

Experimental Organic Cooled Reactor (EOCR)

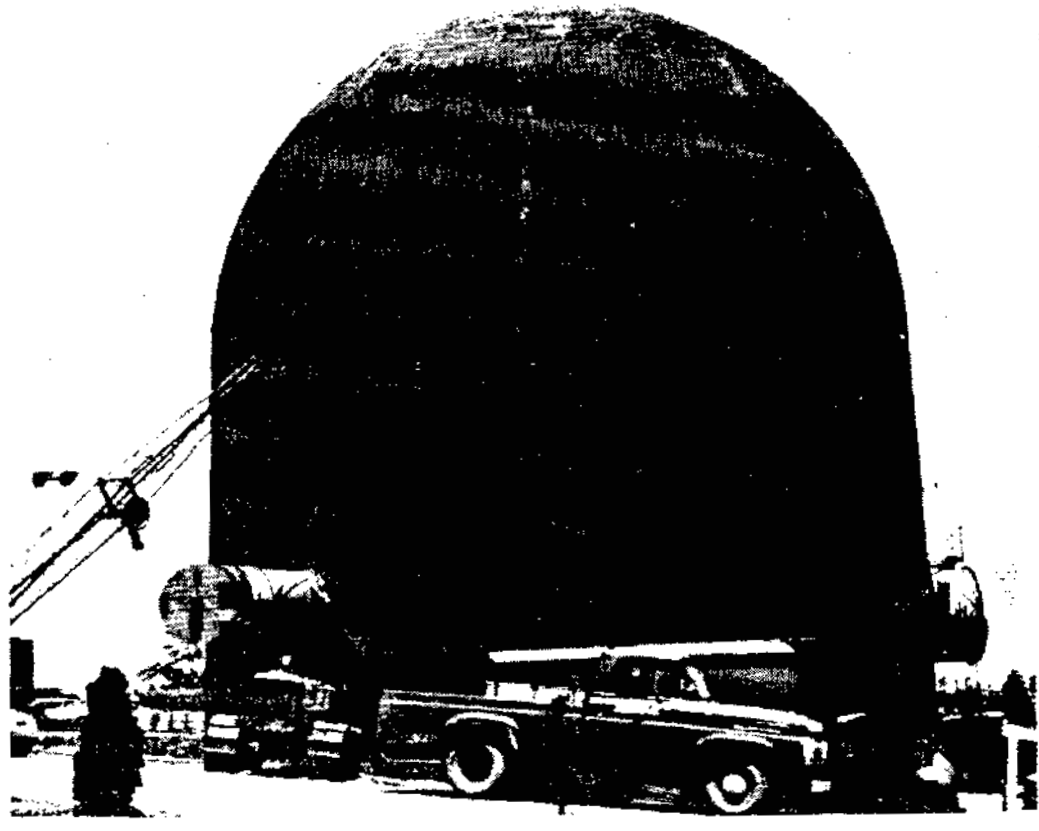
The EOCR is being designed to supplement operating data pro...ded by OMRE and to develop improvements for future organic re-

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actors. The experimental reactor, to be built at the National Reactor Testing Station, will have a 40 Mwt capacity but will produce no electricity. It will have five in-pile loops for testing new coolant and fuel elements. It will also provide a facility for investigating the upper limits in operating conditions for organic cooled reactors, and the possible use of other moderators such as graphite or heavy water in organic cooled systems.

Conceptual design was prepared by Phillips Petroleum Co. Fluor Corp. was selected for architect-engineering design, with Atomics International, a division of North American Aviation, Inc., as subcontractor on nuclear design. C. F. Braun and Co. was selected as construction contractor. Phillips Petroleum was chosen as operator.

Site construction began at the National Reactor Testing Station in April and the reactor is scheduled for completion by the end of 1961. Construction was estimated to be 20 percent complete by December 31, 1960.



Piqua Reactor. The 11,400 ekw organic cooled and moderated power reactor being built by the Commission for the City of Piqua, Ohio, is scheduled for completion by late 1961. Photo shows the 70-foot high containment vessel as the project appeared in mid-1960, a year after construction started. The reactor will be the first of its type integrated into a utility system.

Piqua Reactor

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Prototype Organic

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Piqua Reactor

The 11,400 ekw reactor project at Piqua, Ohio, is being built under a second round cooperative arrangement between the Commission and the city of Piqua. It will have primary importance as the first operating organic reactor integrated into an electric utility station. It also will demonstrate the degree of technical and economic feasibility of a small organic reactor of this size at the present stage of technology and provide valuable data on metallic fuel element lifetime and fuel costs.

Construction started in July 1959, and plant completion is scheduled for September 1961. At the end of 1960, the plant was about 30 percent complete.

Prototype Organic Cooled Reactor

In January the Commission invited proposals from utilities for the design, construction, and operation under third round terms of the Power Demonstration Reactor Program of a prototype organic cooled and moderated reactor of 50,000 ekw capacity. The invitation stated that if no proposals were received the Commission intended to proceed with construction of the reactor.

No proposals were received from utilities by the May 2 deadline.

Before proceeding, the Commission re-evaluated current technology of organic reactors in general and more specifically (*a*) the status of the research and development effort on aluminum powder metallurgy (APM); and (*b*) the fuel element fouling problem in the OMRE.

The results of aluminum powder metallurgy research and development indicated that the material has satisfactory mechanical properties and that uranium oxide fuel elements clad with this material can be fabricated. Studies of the fuel fouling problem have indicated that it can be solved through reactor modifications.

The Commission's decision to undertake a reactor of this kind was based on the need for a reactor of intermediate size to serve as prototype for a plant of 300,000 ekw capacity. A large reactor would be necessary to demonstrate achievement of economic nuclear power by 1968.

The prototype reactor will be used primarily to demonstrate (*a*) the low capital and maintenance costs associated with a plant utilizing a low-pressure coolant whose corrosive characteristics will allow use of low-cost materials of construction; (*b*) the low coolant replacement

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costs and acceptable heat transfer characteristics of the polyphen organics under forced convection and possibly nucleate boiling cond tions; and (*c*) the reduced fuel cycle costs associated with the use of high burnup fuel such as uranium oxide clad with the new aluminu materials.

In December, the Commission invited expressions of interest fro cooperatively and publicly owned utilities for participation in secon round Power Demonstration Reactor Program arrangements for con struction of this facility. Detailed proposals were not requested only sufficient information related to possible sites and an indicati of ability and willingness to cooperate with the Commission in th plant's operation be submitted to indicate a definite interest. Th Commission has undertaken the specific research and developme needed for the project and is proceeding with design of the reacto

Fast Sodium Cooled Reactors

Reactor systems which use liquid sodium as a coolant can opera over a wide range of neutron energies from fast to thermal, depending upon specific design characteristics of the core. In fast neutron sy tems, sodium-cooled reactors can be made capable of breeding, that i producing more fuel than they consume. Sodium-cooled reacto offer the additional feature of being capable of supplying steam t meet modern central station steam requirements. The main reacto projects in the fast breeder category are Experimental Breeder Re actors Nos. 1 and 2 at the National Reactor Testing Station, and th Enrico Fermi Atomic Power Plant, a cooperative Commission-in dustry project being constructed at Monroe, Mich., by the Powe Reactor Development Co.

Experimental Breeder Reactor No. 1 (EBR–1)

The EBR–1, completed in 1951, continued to operate throughou 1960 on its Mark III core. Stability experiments were performe with various core configurations.

The EBR–1 is scheduled to be shut down early in 1961 to begi modifications preliminary to installation of a plutonium alloy cor Fabrication of the plutonium fuel elements for the fourth core i underway at the Fuels Fabrication Facility at Argonne.

The reactor's Mark III core, installed in late 1957, was designe specifically to be as rigid and tight as possible in order to rule o mechanical movement as a source of the instability that was evide

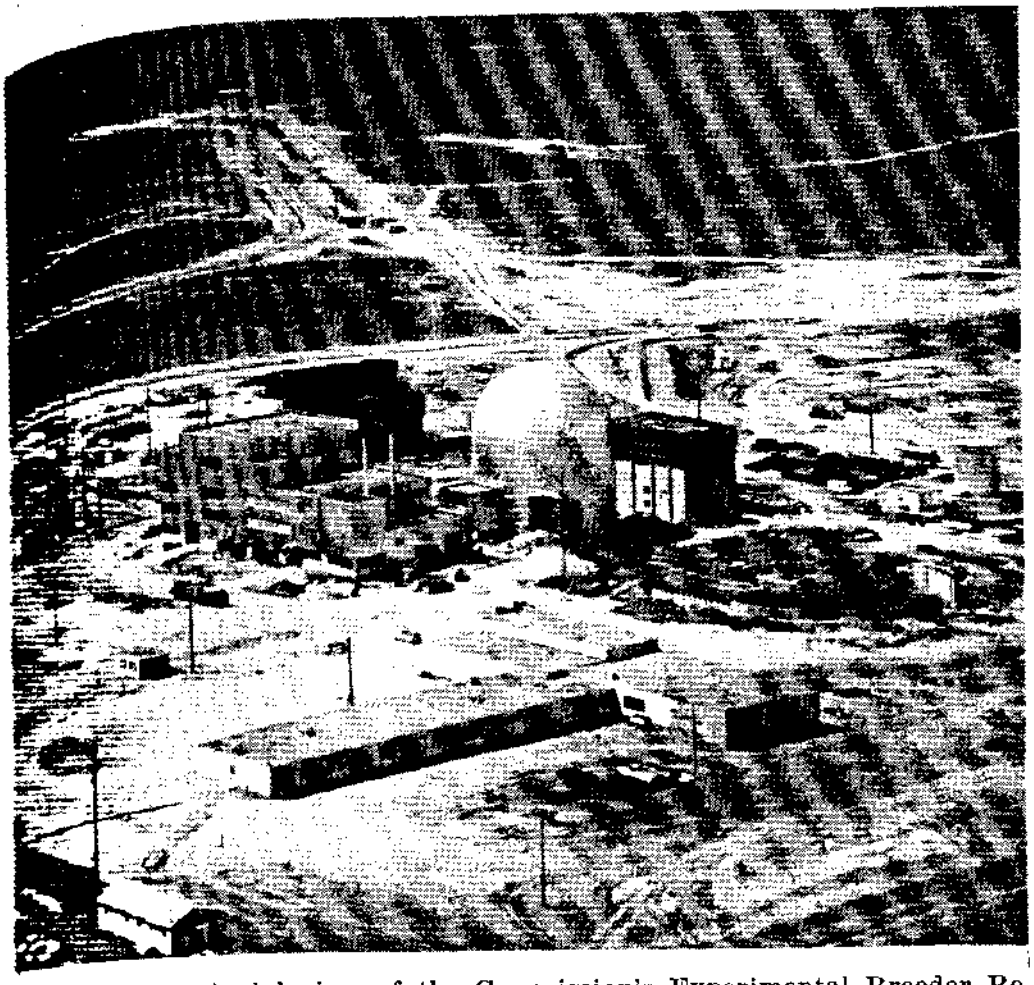


reeder Reactor. Aerial ctor No. 2 (EBR–2) whic er of 1961 at the National eactor containment dome rocessing building where ated into new fuel. The orld's first nuclear react

n the previous core (M onfiguration demonst prompt positive power eltdown of the Mark moved from some of th to be free to move un function measurements strated conclusively th power coefficient and neral aims at a negative reactivity.

* See pp. 45–47, Twentieth

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...eder Reactor. Aerial view of the Commission's Experimental Breeder Reactor No. 2 (EBR–2) which will produce 16,500 ekw when completed in the summer of 1961 at the National Reactor Testing Station in Idaho. To the right of the reactor containment dome can be seen the foundations of the integrated fuel reprocessing building where partially-spent EBR–2 fuel elements will be re-fabricated into new fuel. The 150 ekw EBR–1, forerunner of this reactor, was the world's first nuclear reactor to produce useful electricity in December 1951.

...the previous core (Mark II). Operation of Mark III in this tight configuration demonstrated that careful design had eliminated the prompt positive power coefficient of reactivity which caused a partial meltdown of the Mark II core.[9] In early 1960 spacer ribs were removed from some of the fuel and blanket rods in order to allow them to be free to move under thermal stresses. The results of transfer function measurements carried out on the partially free core demonstrated conclusively that freeing some of the rods altered the prompt power coefficient and made it less negative. Reactor design in general aims at a negative coefficient in which excess temperature reduces reactivity.

[9] See pp. 45–47, Twentieth Semiannual Report to Congress (January–June, 1956).

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Experimental Breeder Reactor No. 2 (EBR-2)

Construction of EBR-2, designed by Argonne National Laboratory, was nearly complete at the end of December. Design power operation of 16,500 ekw is scheduled for the summer of 1961. The first core will use fuel heavily enriched in uranium 235, and the second core may use plutonium.

A primary objective of this reactor's operation will be to demonstrate the feasibility of recycling fuel. The EBR-2 complex contains an integral fuel processing and fabrication facility. The partially burned out, highly radioactive fuel will be reprocessed by pyrometallurgical methods, and the partially decontaminated fuel will be refabricated into new fuel elements. The entire procedure will be carried out by remote control in the shielded fuel cycle facility.

Enrico Fermi Atomic Power Plant

Progress on this 94,000 ekw fast breeder reactor of the Power Reactor Development Co. (PRDC) is behind schedule because of construction delays and redesign of fuel elements. The completion date now will be mid-1961 instead of September 1960. Experiments performed with the original fuel subassemblies caused the fuel elements to warp with effects on the uniformity of the sodium coolant flow. The subassemblies were redesigned to prevent warping.

The court action involving issuance of the construction permit for this reactor is reported on in Part Two, Licensing, Regulation and Indemnification.

Transient Reactor Test (TREAT)

This safety experiment facility at the National Reactor Testing Station is used to subject fuel elements to high-intensity, short-duration surges of nuclear energy without damage to the facility itself. The high-intensity surges are useful in simulating meltdown conditions which a fuel element might be subjected to under abnormal operating conditions.

The first series of meltdown experiments in the TREAT facility were performed in the fall of 1959. Since that time a large number of fuel element samples of the type to be used in the EBR-2 and the Fermi fast reactor have been exposed to high level bursts of nuclear radiation. Based on results of meltdown experiments to date, it is concluded that incipient failure could occur as a result of power

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...sients leading to maximum temperatures of fuel cladding in the ...ge of 950° to 1,120° C. Below this range there will be no failures ... cladding.

...lad temperatures of such sodium-cooled plants as EBR–2 and the ...ermi and Hallam reactors are limited by design to about 500° C, ...ell below the temperature at which failure can occur because of a ...perature transient.

Thermal Sodium Cooled Reactors

...ium Reactor Experiment (SRE)

The SRE at Santa Susana, Calif., operated by Atomics International for the Commission, is a reactor experiment originally constructed to prove the sodium graphite concept, and is now used to ... fuel element development for sodium cooled reactors. Particular emphasis will be placed on uranium carbide fuels for use in the ...llam Nuclear Power Facility in Nebraska.

The SRE operated for more than 2 years on the first fuel loading, and provided heat for generation with a 6,000 kilowatt turbogenerator installed by Southern California Edison Co. of more than 15 million kilowatt hours of electricity. The reactor was shut down in July 1959 when plugged coolant channels caused overheating and resulted in failure of fuel cladding and fuel elements. The fuel failure definitely resulted from blockage of coolant flow due to leakage into the primary sodium system of the tetralin coolant from the primary pump seals. Use of tetralin as an auxiliary coolant has been discontinued and the plant has been modified to eliminate the possibility of accidents of this type.

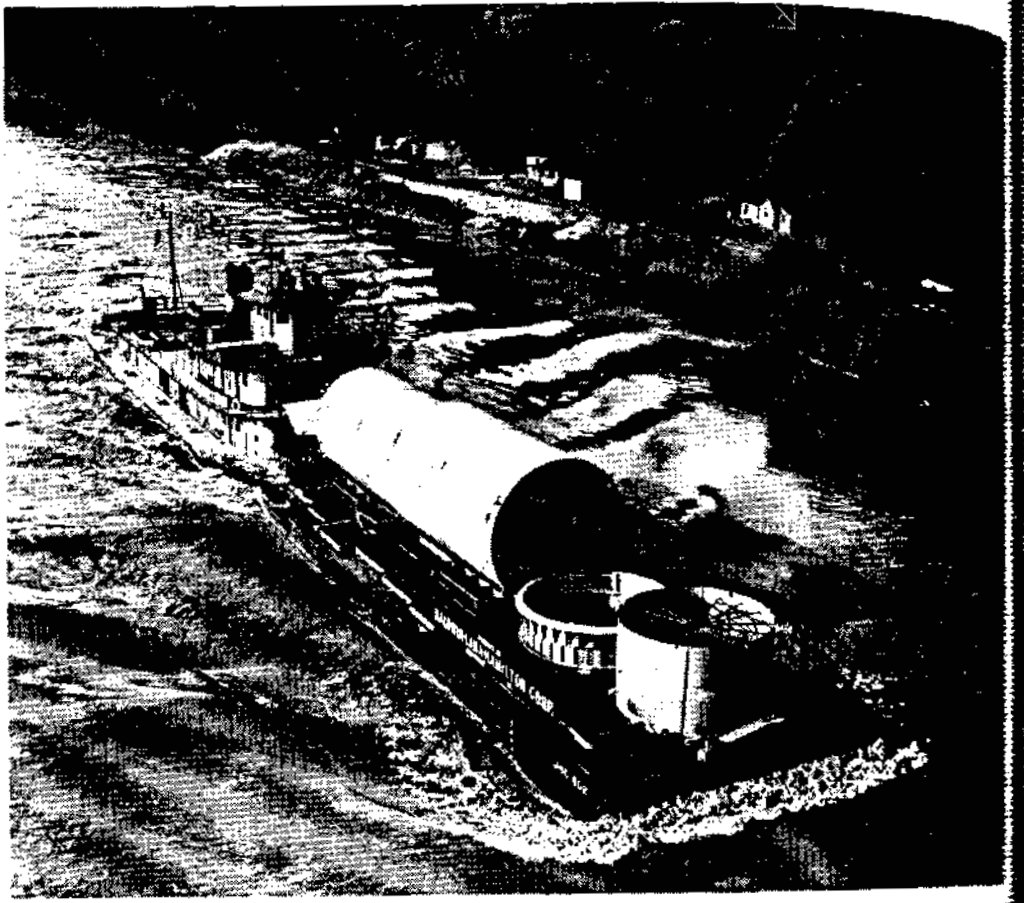
Criticality was attained on September 7, 1960, utilizing thorium-uranium alloy fuel. A detailed investigation of the nuclear characteristics of the new core loading was undertaken. At the close of 1960, the objective of reactor operation was attainment of a lengthy period of trouble-free operation to evaluate further the reliability of the reactor and its system. A secondary objective was irradiation of fuel elements of advanced types.

During removal of the fuel elements, the original SRE fuel handling machine was jammed by one of the damaged fuel elements. An improved machine, designed to handle moderator elements, pumps, and fuel elements was devised and utilized to complete rehabilitation of the reactor. Inspection of the cladding of individual graphite

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moderator units revealed that 16 units had developed leaks; t... defective moderator units were replaced. The cask and mode... cladding difficulties lengthened the rehabilitation period to more t... a year.

The shutdown delayed the advancement of sodium-cooled t... nology. However, useful information was acquired as a result of... incident. It gave evidence to confirm previous evaluations that, f... example, a reactor containment sphere is unnecessary for this type... reactor. The innermost portions of the core were successfully r... moved and replaced without overexposure of personnel to irradiat... and important lessons were learned about design of auxiliary com... systems, fuel and moderator handling casks, and reactor instrume... tion.



Eventful Trip. A barge carrying the 75,000 ekw Hallam (Nebr.) Nuclear P... Facility's 65-ton reactor vessel and its larger containment tank, is shown b... edged into a landing on the Missouri River near Plattsburg, Nebr. The ... hardware had been barged from Eddystone, Pa., down to and across P... across the Gulf of Mexico, and up the Mississippi and Missouri Rivers. ... 40 miles from Hallam, the 35-foot long, 22-foot diameter tank slipped off a ... and rolled 150 yards into a field. It sustained no serious damage.

...*lam Nuclear Power Faci...*

...uring 1960 a careful rev... ...sodium-cooled, graphite... ...ction at Hallam, Nebr.. ...as the fuel element failu... ...design changes were m... ...ill supply power to the dis... ...wer District of Nebrask... ...ed facility and buy the ... ...the facility is being desi... ...rp. is performing architec... ...Co. was awarded the ge... Construction of the Halla... ...1960 the facility was ap... ...scheduled for early in 1... ...nium-molybdenum alloy. ...uranium carbide fuel con... ...the second core loading. ...uction in fuel costs becaus... Construction progress wa... ...ctor vessel—successfully ...-Hamilton Corp. in Pl... ...Mexico, Mississippi and M... ...ped off a truck-trailer ... ...22 and rolled down an ... ...diameter, 35 feet tall, an... ...difficult, but it was deliv... ...mination revealed that t... ...was moved into place.

...*lam Components Develo...*

The Sodium Components ... ...1957, has the objective of ... ...designing and manufact... ...advanced sodium-cooled ... ...team conditions of 1,05... ...mponents under develop... ...rmediate heat exchanger ...ments. Investigations a... ...erials exposed to sodium...

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Hallam Nuclear Power Facility

During 1960 a careful review was made of the design of the 75,000 kw sodium-cooled, graphite-moderated prototype reactor under construction at Hallam, Nebr., to evaluate the possibility of an incident such as the fuel element failure at SRE. As a result of this evaluation, some design changes were made in the Hallam reactor. This reactor will supply power to the distribution system of the Consumers Public Power District of Nebraska, which will operate the Commission-owned facility and buy the steam it produces. The nuclear portion of the facility is being designed by Atomics International. Bechtel Corp. is performing architect-engineer services, and Peter Kiewit and Sons Co. was awarded the general construction contract.

Construction of the Hallam plant began in April 1959. At the end of 1960 the facility was approximately 55 percent built; completion is scheduled for early in 1962. The initial fuel loading will be a uranium-molybdenum alloy. The Commission's work on development of uranium carbide fuel continues to offer promise for their material in the second core loading. Its use should accomplish appreciable reduction in fuel costs because of its potential longer life in the reactor.

Construction progress was slowed somewhat because the Hallam reactor vessel—successfully shipped by barge from the Baldwin-Lima-Hamilton Corp. in Philadelphia via the Atlantic Ocean, Gulf of Mexico, Mississippi and Missouri Rivers to a landing in Nebraska—slipped off a truck-trailer about 40 miles from the Hallam site on June 22 and rolled down an incline into a field. The vessel is 22 feet in diameter, 35 feet tall, and weighs 65 tons. Reloading the vessel was difficult, but it was delivered to Hallam on July 11. A thorough examination revealed that the vessel sustained no serious damage and was moved into place.

Sodium Components Development Program

The Sodium Components Development Program, formally initiated in 1957, has the objective of developing within industry the capability for designing and manufacturing reliable and economical components for advanced sodium-cooled nuclear power plants capable of operating at steam conditions of 1,050° F. and 2,200 pounds per square inch. Components under development include superheat steam generators, intermediate heat exchangers, flow controllers, and sodium system instruments. Investigations are underway on the physical properties of materials exposed to sodium, and on the mass transfer characteristics



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of materials used in sodium systems. These investigations will pro-
vide better data for designing sodium components and systems f
high temperature service. Work is continuing on instruments t
measure impurities in sodium.

In 1960 a site at Santa Susana, Calif., near the SRE was selected f
a large nonnuclear facility required to test large prototype heat e
change equipment. Design and procurement for the facility wa
undertaken and operation is scheduled for 1962.

Gas Cooled Reactors

Experimental Gas Cooled Reactor (EGCR)

Plant construction of the 22,300 ekw EGCR at Oak Ridge was begu
in August 1959 and by the end of December 1960 was about 20 perce
complete.

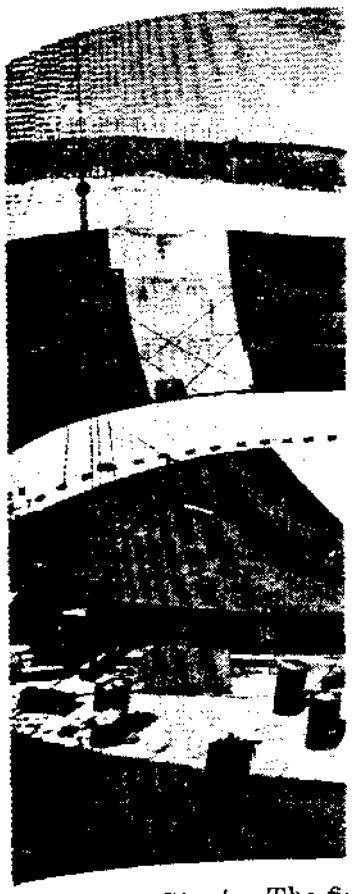
In late 1960 the Commission determined that the total cost of th
EGCR would be about $40 million instead of the $30 million origina
estimated. This increase resulted mainly from higher than anticipat
costs for engineering and purchase of major components such as th
pressure vessel and charge and service machinery.

When finished in October 1962, this reactor will be the first civili
gas-cooled nuclear power plant in this country. Work on military a
marine gas-cooled concepts is reported in other sections. Power pr
duced by the EGCR will be fed into the electrical system supplying th
Commission's Oak Ridge facilities.

Experimental facilities within the reactor will be of two types
those involving experimental loops and those involving fuel channe
Separate heat exchangers and pumping equipment will be provided s
that each loop can operate as a completely independent unit. Desig
changes were made late in 1960 when it was decided that installatio
of some test loops would be deferred until after some operating ex
perience with the reactor. In the reactor core, fuel channels are rea
ily accessible for inserting experimental fuel assemblies. The varie
and flexible experimental capabilities of the EGCR will be useful n
only in the initial development of fuel assemblies, but also in pilot o
eration of fuel elements for large-scale plants.

High Temperature Gas Cooled Reactor (HTGR)

Research and development work continued during the year on th
High Temperature Gas Cooled Reactor proposed by Philadelp

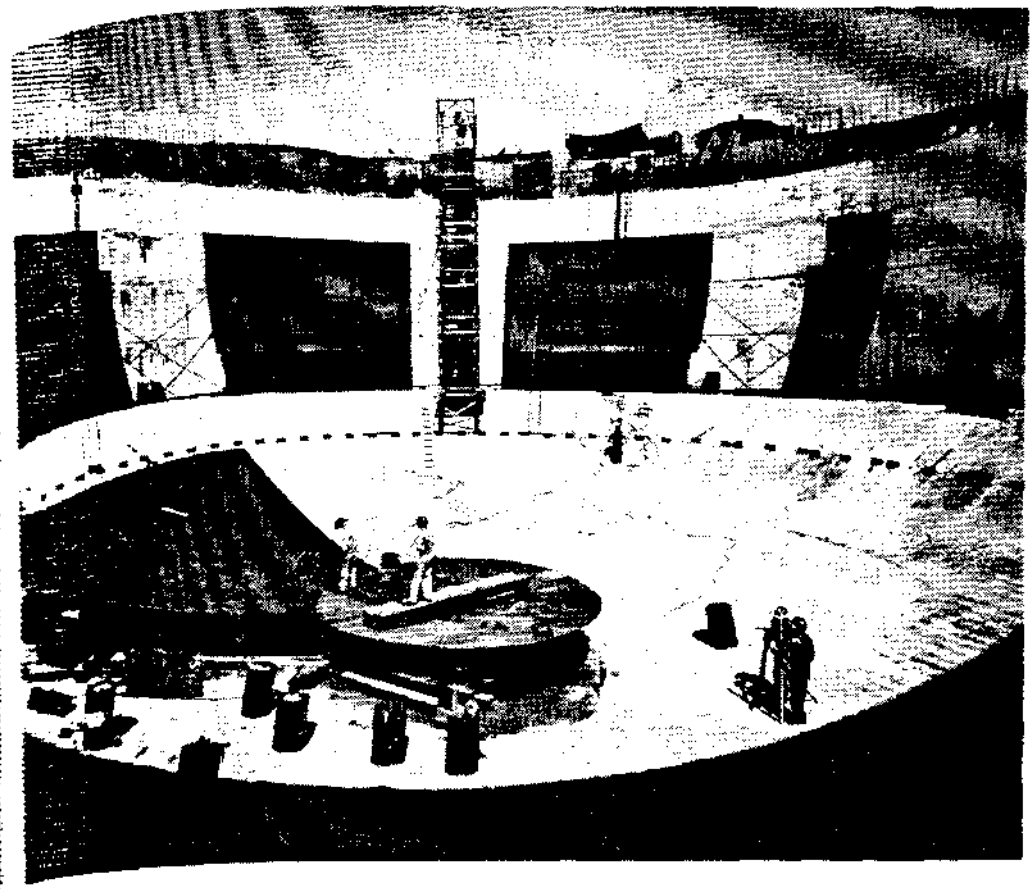


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...ction Start. The first section of the 150-foot high containment shell that ... the 22,300 ekw Experimental Gas Cooled Reactor (EGCR) is shown ... attached to the foundation base plate. The EGCR, under construction at ... Ridge, Tenn., will be the nation's first gas-cooled reactor to produce com... electricity. The facility is scheduled for completion in October 1962. ... be operated by the Tennessee Valley Authority under contract to ... Commission.

...tric Co. and General Dynamics Corp. under the Power Demon... Reactor Program. The proposed site for the reactor is at ... Bottom, Pa., about 20 miles south of Lancaster, and construc... is scheduled to start in April 1961 with completion by September ... The ultimate goal in developing the HTGR is to combine in one ... the high temperature potentialities of gas cooling with high ... density and a fuel capable of high burnup.

...esign has reached a point that will permit placing orders for ... components by the beginning of 1961. Based on favorable re... of research and development work and commercial availability ... permeability graphite, General Atomic Division of General ... recommended, and the Commission approved, revising the ... for the first core loading from the use of metal-clad fuel elements ... immediate use of graphite-matrix elements which had originally

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been planned for subsequent cores. This decision will make possible the design of a first core compatible with the overall plant design capacity of 40,000 ekw whereas a capability of only 28,500 ekw would be possible with metal-clad fuel.

The General Atomic recommendation was based on research and development work dealing with the feasibility of graphite-clad fuel elements for the first core loading. Full scale fuel elements of the HTGR design were fabricated from normal commercial graphite and subjected to mechanical tests which demonstrated the fabrication technique and mechanical integrity of the elements. Irradiation tests indicated that impermeable graphite of the type to be used for the fuel element cans and sleeves can be expected to stand up under the environmental conditions of the reactor core for the anticipated core lifetime. General Atomic began operation of an HTGR critical experiment facility in July.

The HTGR preliminary hazards report was reviewed by the Advisory Committee on Reactor Safeguards (ACRS) during December in connection with Philadelphia Electric's application for a construction permit. The ACRS reported that, based on the status of reactor development, it could not go beyond its statement of March that the proposed site is satisfactory for a reactor of this general design and power level. This ACRS action probably will result in some delay in issuance of a construction permit and could result in delaying the project schedule.

Florida West Coast Reactor

Research and development work continued on the gas-cooled, heavy-water-moderated 50,500 ekw reactor proposed by the East Central and Florida West Coast Nuclear Groups in the Power Demonstration Reactor Program. In August, the Commission announced plans to develop beryllium-clad fuel instead of stainless steel-clad fuel for the first core loading. Future plans for the reactor depend on the success of the research and development program which will require about 2 years.

A major advantage of gas-cooled, heavy-water reactors is the fact that, in large sizes, they can use natural, unenriched uranium as fuel. Natural uranium fuel, however, requires use of a cladding material that absorbs few neutrons such as beryllium.

The plant, if constructed, would be located at Pierce, Polk County, Fla., about 35 miles east of Tampa. The 50,000 ekw reactor, fueled with slightly enriched uranium, is designed as a prototype for a similar 300,000 ekw plant fueled with natural uranium.

Exchange Agreement

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Exchange Agreement on Gas-Cooled Reactors

An exchange of information agreement was completed in late 1959 between this country and the United Kingdom regarding the EGCR at Oak Ridge and Britain's Advanced Gas-Cooled Reactor. The exchange of technical information on these two projects was supplemented in early 1960 by an agreement to exchange information on the HTGR and the DRAGON project, which is a high temperature, gas-cooled reactor to be built in England (see section of this report on International Activities).

Heavy Water Reactors

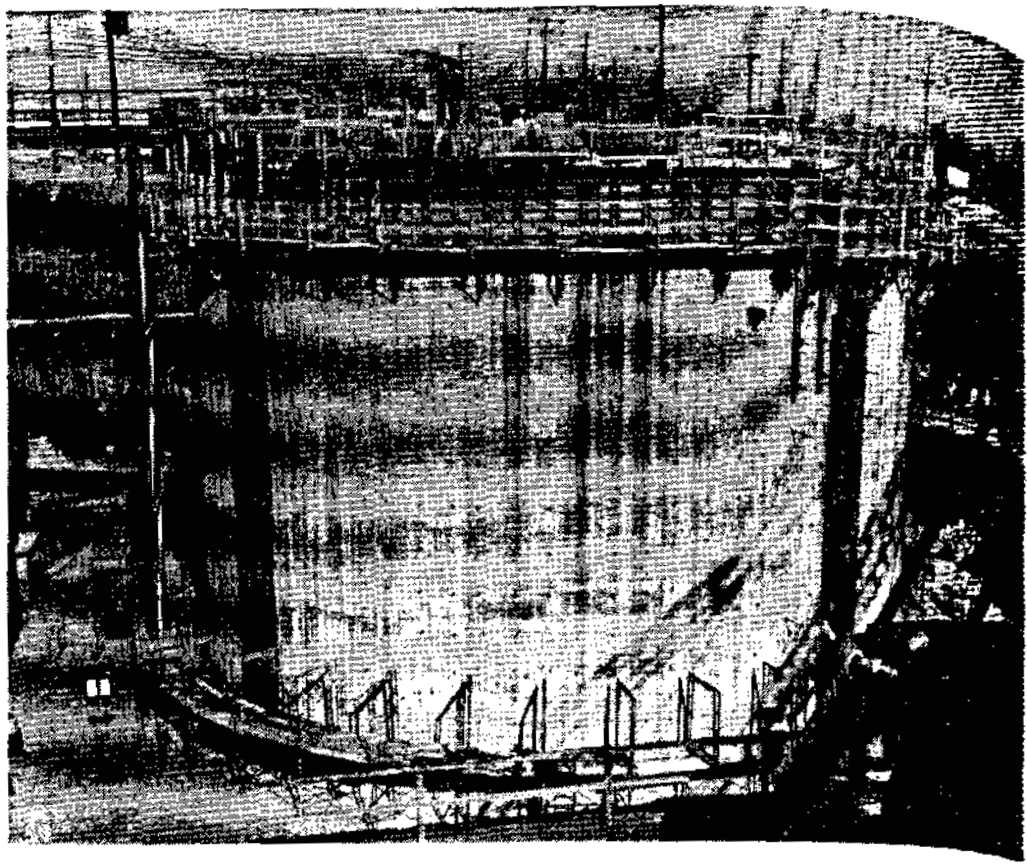
Carolinas Virginia Tube Reactor (CVTR)

Site clearance, excavation, and other preparations for construction of the 17,000 ekw (of which 1,500 ekw is conventional superheat) heavy water moderated and cooled, pressure tube reactor began at Parr, S.C., in June. Construction of this cooperative project by the Carolinas Virginia Nuclear Power Associates, Inc. was to start in April but delays in fuel fabrication set back completion of a prerequisite critical experiment by Westinghouse Electric Corp. By the end of December, construction was 10 percent complete. This CVTR represents the first time that private companies have invested in a reactor that will use heavy water for cooling and moderating.

The new reactor also will eliminate the large pressure vessel which has been the main component in previous pressurized water reactors. In place of the heavy steel vessel which houses the entire core and its structural support under a high pressure, the Carolinas Virginia reactor will accomplish the same function with 42 pressure tubes installed in a low pressure tank. This type of reactor is expected to be more flexible because fuel elements can be more easily inspected and replaced.

A critical facility for the reactor, the LRX at Waltz Mill, Pa., will be used in determining physics parameters, essential to completion of prerequisite research and development. The facility went critical in July. Irradiation experiments in the Westinghouse test reactor of the CVTR fuel bundle to determine effects of radiation are pending.

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Reactor Foundation. Initial operation of the Heavy Water Components Test Reactor (HWCTR), now under construction at the Commission's Savannah River, S.C., plant, has been re-scheduled for late 1961. This early 1960 photo shows the concrete foundation of the containment shell. The reactor has been designed to permit simultaneous test irradiation of up to 12 full-sized natural uranium fuel elements at temperatures, pressures, and power densities similar to those encountered in operating power reactors.

Heavy Water Components Test Reactor (HWCTR)

Construction of the HWCTR, started at Savannah River, S.C., in April 1959, was approximately 45 percent complete at the end of 1960. Construction progress on this project was slowed by the labor-management disputes in the steel industry in late 1959. The reactor vessel is expected to be delivered in May 1961, about 10 months behind the previous schedule. The delay was caused by the inability to obtain steel for the reactor vessel and welding difficulties encountered in the fabrication of this unit. Initial operation is now set for the fall of 1961.

This 61 Mw (thermal) test reactor will yield operating information on a heavy water-moderated system under conditions similar to those for power production. It will irradiate fuel elements and test other heavy water reactor components.

Cooperative Program

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...perative Program with Canada

The Commission and Atomic Energy of Canada, Ltd., signed a ...morandum of understanding in mid-year providing for an ex...nded program of cooperation in development of heavy water-...derated power reactors.

The program includes: exchange of information on heavy water ...tor projects under construction or design; close cooperation in ...search and development work including mutual use of pertinent ...search and development facilities and provision for transfer of ...tain materials; and exchange of personnel. In the United States, ...e Commission is undertaking research and development work at a ...ximum cost of $5 million during the next 5 years. This work will ...e specifically directed toward heavy water reactors to be constructed ...Canada. The program covered by the memorandum of under...nding will continue at least 5 years beyond the date of initial ...eration of Canada's 200,000 ekw CANDU heavy water power ...ctor.

A joint technical board was established to review progress of the ...perative program and to establish future requirements to meet its ...ectives.

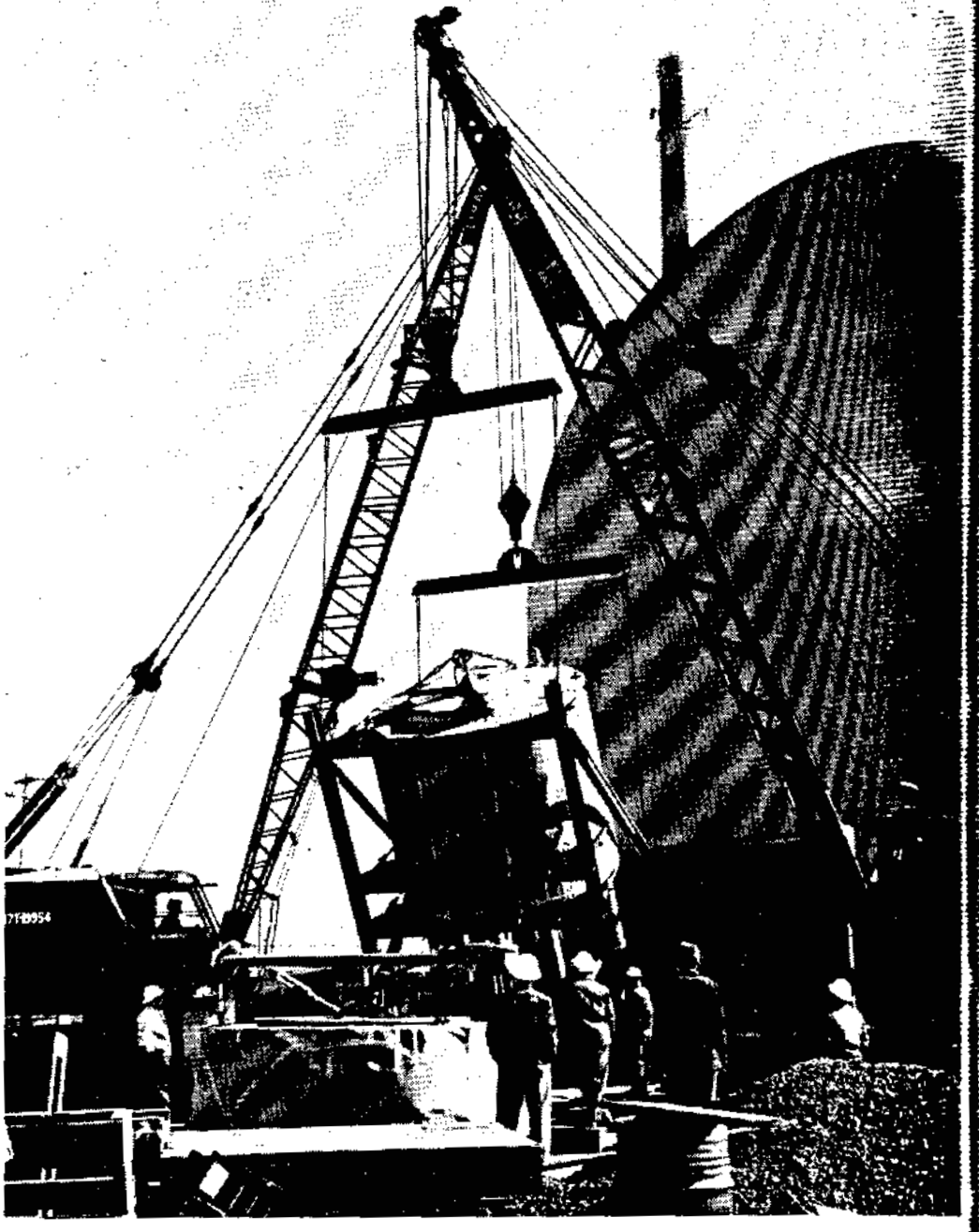
Plutonium Recycle Program

...tonium Recycle Test Reactor (PRTR)

The PRTR at Hanford, Wash., attained initial criticality on No...mber 21. Design power of 70,000 Mw (thermal) is expected early ...1961. Construction of the full PRTR plant and associated facil...es is scheduled for completion by June 1961. Critical tests are ...derway and reactor operation meets expectation.

This experimental test reactor will be used to investigate and demon...te the economic feasibility of recycling plutonium, and to develop ...e technology for using plutonium as an alternative, or a supplement, ...r uranium 235 in power reactor fuels. The primary focus of the ...ogram is on thermal reactor fuels, which commonly contain low ...ncentrations of fissionable materials as contrasted to fast-neutron ...breeder reactor fuels which generally involve higher concentrations ...fissionable materials. About one-third of the first core loading of ...e fuel elements contains plutonium in the form of an aluminum alloy ...th 1.8 percent plutonium; the remainder of the elements are natural ...anium oxide rods clad with zircaloy. Mixed plutonium-uranium ...ds are to be used later.

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Plutonium Test Reactor. The "heart" of the Plutonium Recycle Test Reac (PRTR) is shown as it was swung off its delivery truck and rigged for moveme into the containment vessel (background) at the Commission's Hanford, Wash plant. Made of aluminum, the reactor calandria will contain the heavy wa coolant and moderator of the reactor which has been designed for flexibility i irradiation of plutonium-bearing fuel and investigation of the operating chara teristics of plutonium re-cycle systems.

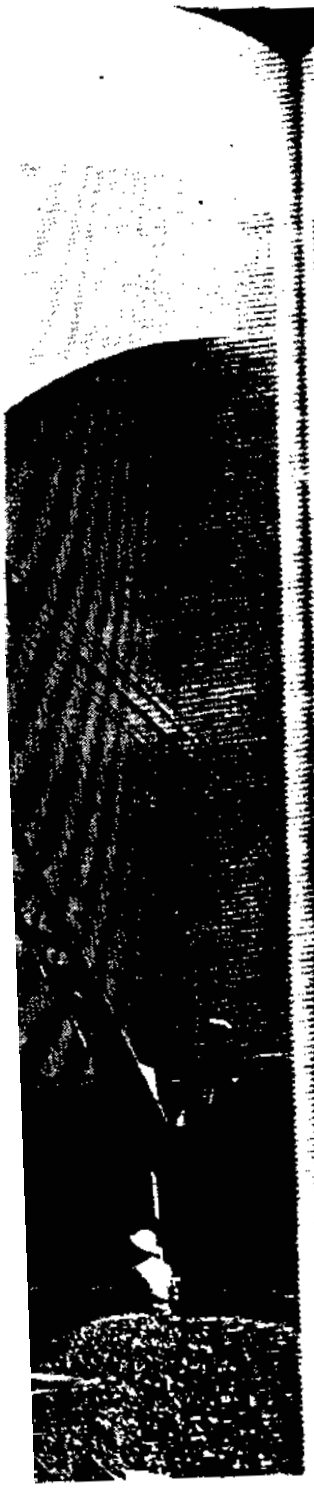


Plutonium Processing. with extreme caution. glove-box production l ford, Wash. The use of a negative pressure than outside) prevent tion of plutonium-bear

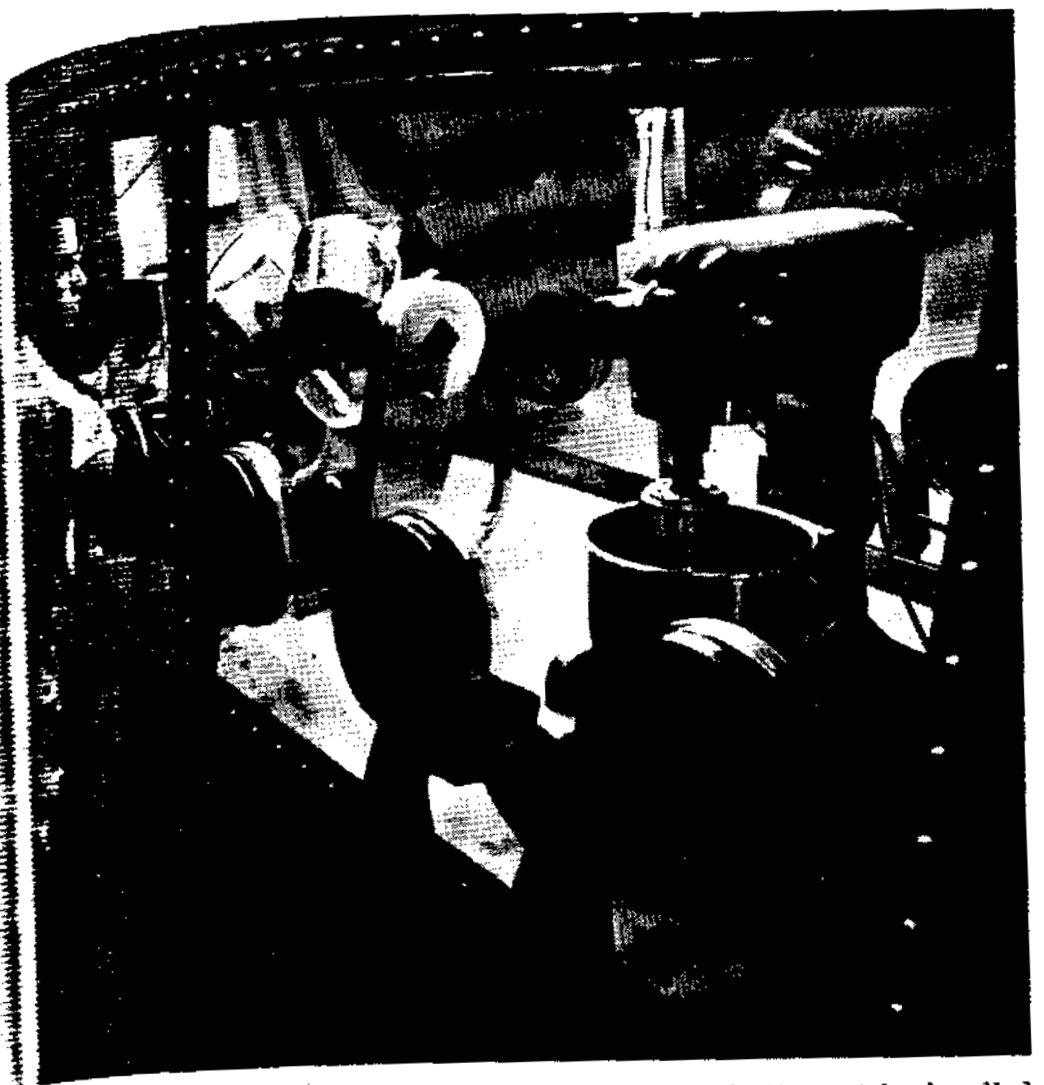
Since PRTR is coolant and moder it will be an import and technology.

Essentially full-s *plant* at Hanford almost all major equ plutonium-containi PRTR, supports t for fabrication of ation and test.

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Recycle Test Re
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Processing. Because plutonium is highly toxic it must be handled
extreme caution. Photo shows the mixing of plutonium oxide powders in a
production line at the new Plutonium Fabrication Pilot Plant at Han-
Wash. The use of gloves sealed into the plexiglass sides and maintenance
negative pressure within the chamber (air pressure is lower inside the box
outside) prevents the escape of plutonium-contaminated air during fabrica-
of plutonium-bearing fuel elements for the Plutonium Recycle Test Reactor.

PRTR is a pressure-tube reactor, using heavy water as a
and moderator, and operating at power-reactor temperatures,
be an important source of additional power reactor information
nology.

tially full-scale operation of the *plutonium fabrication pilot*
Hanford started in August following the installation of al-
major equipment items. This facility, which fabricated the
um-containing fuel elements for the first core loading of the
upports the development of advanced, semi-remote processes
ation of plutonium-bearing fuels preparatory to their evalu-
test.

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Fluid Fuel Reactors

The Commission's research and development program on reac... that would utiliz... fluid fuels includes the aqueous homogeneous co... cept which first came under study during 1954, and the newer mol... salt and molten plutonium approaches.

Aqueous Homogeneous Reactors

Detailed evaluation studies were conducted during the year o... aqueous homogeneous reactors which tended to confirm their poten... as thermal breeders. Preliminary results of the study indicate su... reactors would breed each year 16 percent more fuel than consum... at a fuel cycle cost of 1.2 mills per kilowatt hour.

The aqueous homogeneous reactor concept incorporates solub... fuel, continuous fission product removal and freedom from mechani... control and safety rods. The program objective is to solve the pr... lems of the corrosiveness of the fuel solution, the instability of t... fuel at very high temperatures, and the maintenance of a hig... radioactive loop. When these problems are solved, the simple f... cycle together with the potential of breeding can be balanced aga... the disadvantage of limited thermal efficiency.

The General Advisory Committee of the Commission [10] revie... the development program and made an evaluation of the potentia... the aqueous homogeneous concept. It recommended early in the y... that laboratory work should continue on this system, and that t... work should include studies of other aqueous uranium solutions a... alternative core tank materials in an attempt to find a combinatio... which corrosion will be less severe and the permissible operating te... perature higher than in previous experimental reactors. The Co... mittee also recommended that the second homogeneous reactor exper... ment be operated with reverse flow of the aqueous fuel in the ho... that this would shed light on the difficulties of operating the aque... uranyl sulfate system in the Homogeneous Reactor Experiment N... (HRE–2).

Further work on the aqueous system would be necessary to de... mine whether the advantages inherent in the simplicity and low c... of the fuel cycle, and in the breeding capability, might outweigh l... steam efficiencies resulting from temperature limitations and the te... nical complexities of the system.

[10] See Appendix 2.

After 105 days of
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Molten Salt Reacto

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After 105 days of continuous operation, the HRE–2 was shut down January 22 to investigate a marked increase in fuel concentration in the blanket region of the reactor. Inspection of the reactor core revealed that corrosion had eaten a second hole between the core region and the blanket region. The new hole, measuring about ½ inch by ⅛ inches, was about the same size as the one found in the core tank in the autumn of 1958. Examination of a sample cut from the edge of the hole indicated melting due to a heat source other than metal-water reaction with the temperature excursion lasting not more than seconds. Other shallower pits appeared in the lower half of the core wall, but the upper half appeared to be in generally good condition.

Major modifications were made in the HRE–2 during the period from February through October, including patching the holes, reversing the diffuser screens, and brush-cleaning the core interior. All these operations were carried out in the 32-inch-diameter core through a 2-inch opening in the top of the core fuel pipe. This required development of greatly improved remote maintenance techniques and the perfection of remote methods for detailed inspection of the core interior.

In addition, several components were replaced and the direction of flow was reversed. Mockup tests have shown that, with reversed flow, local stagnation in the reactor is reduced and uranium-bearing solids are swept out of the core rather than allowed to settle on the lower half of the core wall where they can cause local overheating.

Operation of the reactor was resumed in November. The immediate objective is to determine whether the revisions made in the reactor system will allow it to be operated stably under the original design conditions. The reactor is being operated at gradually increasing power levels and system performance is monitored at each step in an attempt to determine precisely the nature of any instabilities and the conditions under which they occur.

The HRE–2 is scheduled to be operated at full power in January 1961 to establish its performance characteristics with reversed flow. The remainder of fiscal year 1961 will be used to close out the aqueous homogeneous program, including operation of the HRE–2, in favor of continued development of the molten salt concept.

Molten Salt Reactor

Favorable evaluation of the molten salt concept by the Commission's General Advisory Committee and other study groups resulted

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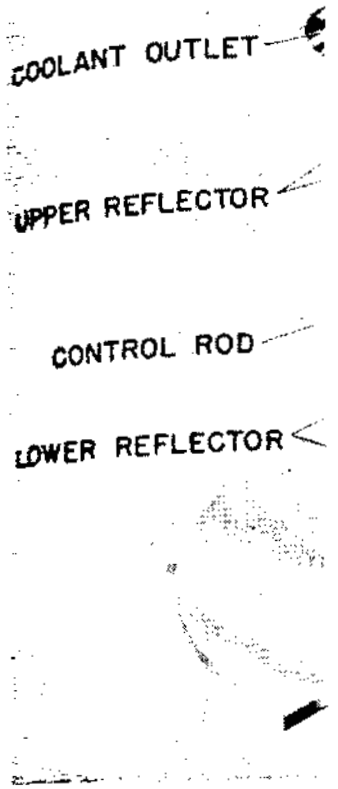
in a decision to continue the research and development program. T... evaluations cited a number of practical advantages of this reacto... type.

The Committee stated that the slightly lower breeding ratio as com... pared with the aqueous homogeneous reactor, is not a serious disa... vantage at present U-233 prices, and recommended that the researc... program be pursued vigorously, including construction and opera... tion of a reactor experiment. Evaluation studies indicated that th... molten salt reactor has potentially low fuel cycle costs and has ... somewhat better breeding potential than was anticipated. Preli... inary results indicated a maximum annual fuel yield of 8 percent a... a probable fuel cycle cost of 1.0 mill per kilowatt hour.

Conceptual design of a 10 Mw (thermal) molten salt reactor expe... ment (MSRE) was completed by Oak Ridge National Laboratory ... September and the Commission decided in October to authorize co... struction. The proposed reactor has a cylindrical, single regio... graphite-moderated core about 4½ feet in diameter and height. T... graphite core is made up of graphite columns pierced by vertic... channels for fuel flow. The fuel, a molten mixture of beryllium... lithium, zirconium, uranium and thorium fluorides, would discharg... its heat to a molten salt of the same type, but containing no uraniu... in the primary heat exchanger. In the experiment, heat from th... secondary loop is discharged to the atmosphere through a secondar... air blast heat exchanger.

The major objectives of the MSRE are to demonstrate the de... pendability, serviceability, and safety of the molten salt concept fo... civilian power purposes, and to provide confirmation of earlier expe... mental work and information on components needed for a larger r... actor. The molten salt reactor concept offers the potential econom... advantages of improved steam conditions and high efficiency throug... operation at very high temperatures and power density. As the fu... is in solution, no fabrication of fuel elements is necessary and co... tinuous removal of fission poisons is possible as in the aqueous hom... geneous reactors, thereby providing greater continuous neutro... economy.

Construction of the MSRE will begin early in 1961 at Oak Ridg... in an existing building previously used for the Aircraft Reac... Experiment, a reactor of the molten salt type which was dismantl... after operation in November 1954 as part of the Commission's Air... craft Nuclear Propulsion Program. Much of the research and de... velopment work earlier carried out in connection with aircraft reac... systems is applicable to MSRE work. Tentative completion date ...



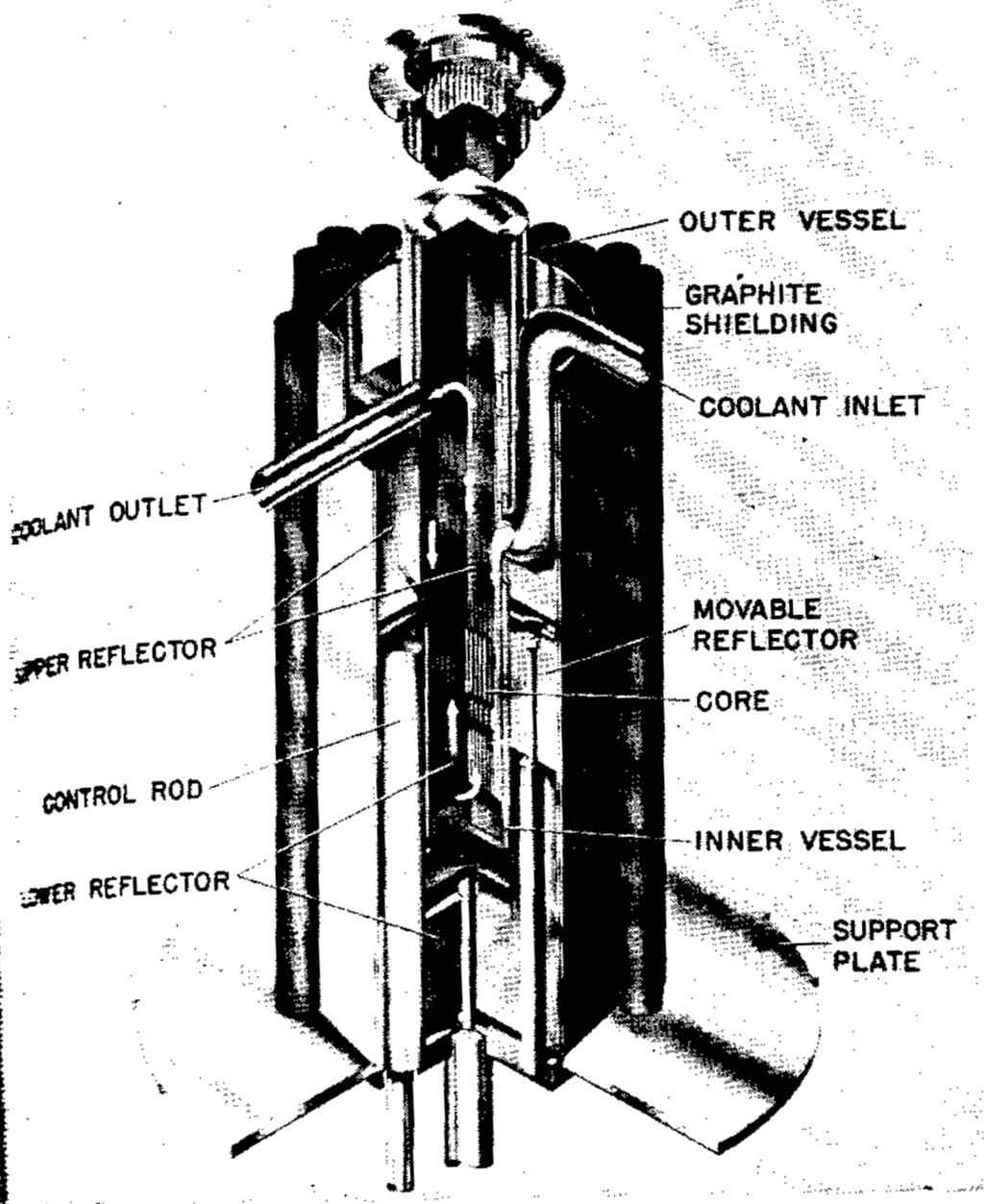
Plutonium Experiment. ... the Los Alamos Molten ... used in the long-range pr... which uranium 238 or th... of the main components o...

the reactor is May 19... research and develop...

Los Alamos Molten S...

This small reactor ... as a short-term expe...

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Experiment. Although built as a short-term experimental device, Alamos Molten Plutonium Reactor Experiment (LAMPRE) is being in the long-range project of developing fuel suitable for breeder reactors in uranium 238 or thorium can be converted into fuel. Above is a diagram main components of the LAMPRE.

reactor is May 1963; the estimated cost, exclusive of supporting search and development, is about $4.2 million.

Alamos Molten Plutonium Reactor Experiment (LAMPRE)

This small reactor experiment of 1,000 thermal kilowatts was built a short-term experiment primarily to explore use of a fuel of

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melted plutonium alloy containing 10 percent iron. A tantalu tungsten alloy is being tested as a container material for molten pl tonium. A dry critical experiment was conducted with LAMPR in November 1959. Sodium was circulated at operating temperatur late in 1960, and hot criticality tests are expected to start early in 19

When the reactor has demonstrated stable operating performan and suitable characteristics, it will be used to test other fast fu materials under development at Los Alamos, including ternar plutonium alloys.

Results of LAMPRE tests will permit design of a core for test i a higher power facility.

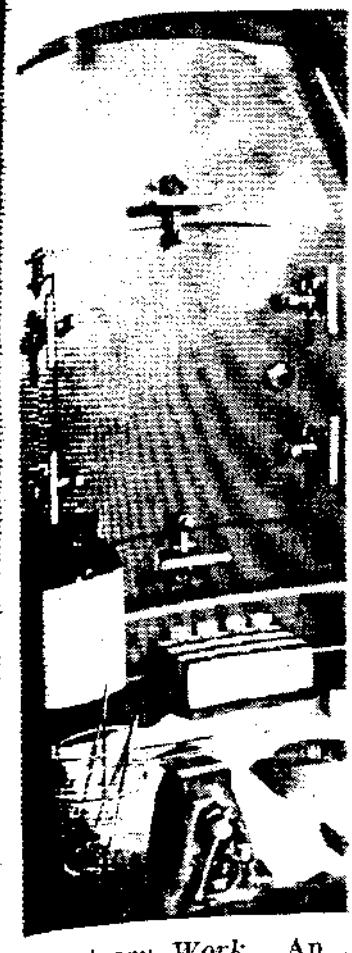
New Reactor Projects

Research and development was continued during 1960 on a numb of new reactor concepts, each of which offers one or more improv ments over existing reactor designs. None is sufficiently developed t current stages of their respective technologies to permit plant desig construction and operation. Each concept is subjected to continu evaluation and development is continued to the point where a decisi can be reached on whether to build an experiment or to termina the work. In 1960, development work on one of the advanced co cepts, the Molten Salt reactor, had reached a point where a decisi was made to construct a reactor experiment.

Three Evaluated Concepts

Three of these advanced concepts so far have survived prelimina evaluation: the liquid fluidized bed, advanced epithermal thoriu and pebble-bed, gas-cooled reactors.

Fluidized bed reactor. The Martin Co., under Commission contra to investigate and develop the fluidized bed reactor concept, co structed a critical experiment for such a reactor at the Martin Nucle Division site near Baltimore. Experiments will begin early in 19 The idea of this reactor type is to maintain a bed of fissionable an fertile material in a fluidized state under turbulent flow condition Water or organic liquids are considered as possible fluidizers an coolants. High power density, ease of charging and discharging fu and uniform fuel burnup are potential advantages of this system. also may offer the possibility of reactor control without control rods



Preliminary Work. An
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Epithermal Thorium Rea
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Advanced epithermal
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...inary Work. An Atomics International scientist prepares a wafer of ...active uranium dioxide for an experiment in connection with the Advanced ...ermal Thorium Reactor which has been proposed as a privately financed ... by Southwest Atomic Energy Associates. Preliminary studies are being ...ed on the nuclear characteristics of uranium-thorium core configurations ... might be used in the reactor. The work is being done in a critical experi... facility at Santa Susana, Calif.

...anced epithermal thorium reactor. This reactor, which would ... uranium 233-thorium fuel cycle, operates with neutron energies ... the thermal range—the high epithermal neutron energy ...—and be cooled with sodium, is sponsored by the Southwest ...ic Energy Associates, a group of privately owned electric com... in the southwest area of the United States. In order to obtain ...tor physics information on this reactor concept, Atomics Interna... completed construction of a critical facility at Santa Susana, ... late in 1960 and operation was begun using part of 25 kilograms ...anium 233 provided by the Commission. It is expected that this ... of reactor would have high operating temperatures, which pro... good steam conditions and high thermal efficiency; low reactor ..., minimizing the difficulty of vessel manufacture; compactness

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and high power density, with resultant low investment per unit of power in the reactor structure.

Pebble Bed Gas Cooled Reactor. Work on the pebble bed concept was being performed during the year by Oak Ridge National Laboratory and by Sanderson and Porter, Inc., under Commission contract. A feasibility study and conceptual design of a reactor experiment was being completed at the year's end to help determine whether or not an experimental reactor should be undertaken. In this concept, a stationary bed of spherical balls or pebbles of graphite containing uranium fuel is cooled by helium gas. Because of the nature of the structure, coolant, and fuel, the reactor can produce steam at temperatures high enough for use with modern generating equipment. The fuel also is amenable to simple handling techniques in loading and unloading.

A new type of fuel material has been developed and tested under this program. It consists of small particles of uranium oxide or uranium carbide coated with a high temperature ceramic as described in the later section on Fuels Development.

Other Concepts

Other reactor concepts in earlier stages of development include the *mercury cooled fast reactor;* the *variable moderator reactor;* the *supercritical water reactor* studied for application to aircraft and maritime propulsion and now being considered for a central station plant; and the *moderator control or spectral shift reactor* in which heavy water is added and subtracted from the light water coolant.

Section 111 of the Authorization Bill for fiscal year 1961 authorized the Commission to carry out a design and engineering study of *steam cooled power reactors* for a report to the Joint Committee on Atomic Energy by April 1, 1961. Ten different variations of the steam cooled concept are being considered.

Work on an advanced fluid concept using *boiling sulphur* as coolant was terminated in mid-year by the contractor, Aerojet General Nucleonics. The study of boiling sulphur, interesting because of its potential in a direct-cycle reactor for obtaining a high thermal efficiency, was limited to corrosion and heat transfer measurements. The corrosion studies indicated that gross out-of-pile corrosion rates for the metal alloys most promising for reactor use were of the order of 10 to 20 mills per year, which was considered excessive.

Unsolicited New Re

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Unsolicited New Reactor Concepts Proposals

The Commission announced on March 23 a revision of its procedures for evaluation of unsolicited proposals received from industrial companies for studies of new reactor concepts. Previously, unsolicited proposals were reviewed twice each year in March and September, although proposals could be submitted at any time. Under revised procedures, proposals may be submitted at any time and will be reviewed by Commission staff as received. The New Reactor Concepts Board, previous evaluator of unsolicited proposals, was abolished.

Twelve proposals asking Commission support were submitted by companies between September 1, 1959 and March 1, 1960. The Commission accepted the proposal on a mercury-cooled fast reactor, and rejected all other requests for Commission support.

Reactor Safety

The Commission's intensive experimental and theoretical program to increase reactor safety and to reduce safety costs includes five facilities designed for reactor tests as well as research and development in containment of reactor systems, and in chemical aspects of reactor safety.

Work with Facilities

Three facilities at the National Reactor Testing Station are exclusively devoted to safety tests. They are known as Special Power Excursion Reactor Tests (SPERT) 1, 2, and 3. A fourth facility SPERT–4 will be completed by May 1961. A fifth facility is the Kinetic Experiment on Water Boilers (KEWB) at Santa Susana, Calif., which is an aqueous homogeneous type.

SPERT–1, an open vessel reactor, has been used for kinetic testing of various cores since 1955. During early 1960, tests were run on an extremely fast integral control system. Results showed that the control system is capable of limiting nuclear excursions having periods as short as 3 milliseconds.

Following these tests, a program of capsule experiments was started to investigate, on a limited scale, the details of void behavior and other effects that contribute to reactor self-shutdown during a power excursion. The SPERT–1 program has been extended to include a study of the behavior of cores, such as oxide cores that are assuming

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importance, but for which overall kinetic and safety aspects have not been previously studied. During the last quarter of 1960, a low enrichment oxide core was installed in the reactor for a series of reactor behavior studies. This low enrichment core, fabricated from N.S. *Savannah* type of fuel, is representative of cores being used in power reactors where high fuel burnup is important for economic or military reasons.

SPERT–2, a medium pressure reactor (375 psig, 400° F.) is designed to study the comparative kinetic behavior of cores using various moderators and reflectors. Initial criticality with light water moderator was achieved in March 1960 followed by static measurements in light water. Criticality with heavy water was achieved in August and was followed by static measurements in heavy water. The transient program with these cores was started before the end of the year.

SPERT–3 can operate at temperatures up to 668° F, pressures up to 2,500 pounds per square inch (gauge), and with flow up to 20,000 gallons per minute, and is able to simulate either boiling water or pressurized water conditions. This reactor completed measurements of static physics parameters in the spring of 1960, and a test program was initiated at ambient temperature to investigate the effects of pressure and flow on transient behavior. Preliminary results indicate that the SPERT–3 reactor can safely withstand a 10 millisecond transient while operating with a system pressure of 2,500 psi, an initial coolant temperature of 70° F, and a coolant flow of 20,000 gallons per minute.

SPERT–4, now under construction, is designed to investigate the kinetics of pool reactors which are commonly used for university research and training, as well as to further investigate the instabilities observed in the SPERT–1 experiments. Completion of this pool type reactor is scheduled for mid-year of 1961.

The Kinetic Experiment on Water Boilers (*KEWB*) was designed to obtain data on the dynamics of simple homogeneous reactors. After experiments were completed with a spherical core in 1959, a cylindrical core was installed, and achieved criticality in March 1960. On May 10, this reactor underwent the shortest period nondestructive transient power burst ever recorded in a thermal reactor. An instantaneous power of 2,300,000 kilowatts was reached on a 0.90 millisecond period. The total energy released was about 8,600 kilowatt seconds. Investigations are underway to determine the usefulness of the KEWB reactor for studies of fuel processing accidents.

Research and Developm

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...arch and Development

...Brookhaven National Laboratory started a study to determine the ...ical and physical identity of biologically hazardous fission prod... that might be released should a reactor accident occur. This ...wledge can be used to design filter systems, washout systems and ...tainment systems more accurately and cheaply.

...Oak Ridge National Laboratory completed the design and fabrica... of the first in-pile loop to measure fission product release under ...listically simulated reactor accident conditions.

...At Argonne National Laboratory, metal-water reaction rates of ...conium and uranium were measured at atmospheric pressure at ...peratures up to 3600° C. A series of in-pile measurements were ...made in the TREAT reactor in order to correlate the laboratory ...dings. Work is continuing at higher pressures and on other im... reactor materials such as aluminum and stainless steel.

...Studies of ignition of pyrophoric metals discovered that halogen... hydrocarbons drastically inhibit the ignition of zirconium and ...nium. This may provide a means of assisting safe handling of ...highly pyrophoric metals.

...A survey and analysis was completed of criticality hazards in proc... uranium hexafluoride into uranium oxide or uranium metal—...first of a series of studies to cover each step in the fuel cycle.

...In studies of reactor containment, the leak rates of components for ...ldings to contain low overpressures that might result from a reac... incident were measured to determine the usefulness of this type of ...lding for low enthalpy (heat content) coolant systems. Methods ...ducing the initial leak rates of some components by a factor of ...have been determined. In another study, an equation has been ...eloped and experimentally verified to describe the velocity of sound ...oiling water with various void fractions. This equation makes ...sible more accurate calculations of the transmittal of shock during ...olent reactor excursion.

...During October contractual negotiations were started for design of ...new test facility to model and examine loss of coolant accidents oc... as a result of the rupture of primary coolant circuits in water ...tors. Construction will begin early in 1961. This facility will aid ...the test and evaluation of new containment concepts eventually ...ding to the reduced cost of containment.

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MARITIME REACTORS

The Maritime Reactors Program has as its goals the demonstra
of the safety and reliability of nuclear merchant ships, and the
duction of capital and operating costs to encourage the construc
of privately owned nuclear vessels. To achieve these objectives, t
Commission and the Maritime Administration are engaged in a j
research and development program. On the nuclear phase of t
program, the Commission has determined that emphasis should
placed on the development for maritime use of pressurized wa
reactors as in the N.S. *Savannah*, and of gas-cooled reactors.

N.S. Savannah

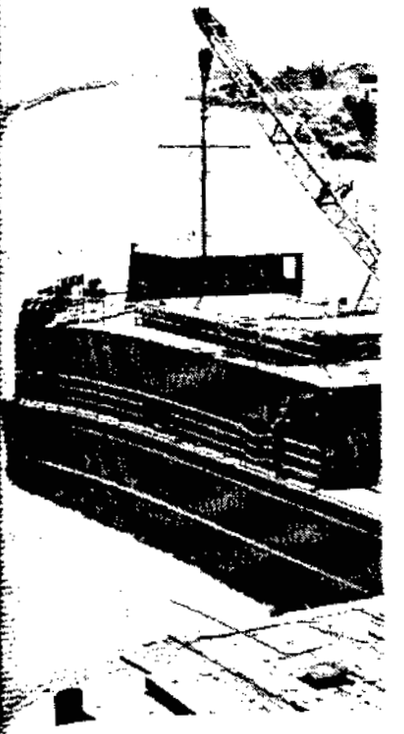
Construction of the N.S. *Savannah*, the first nuclear powered m
chant ship, was essentially completed at the Camden, N.J., yard of
New York Shipbuilding Corp. at the end of December. Ini
criticality of the ship's pressurized water propulsion plant is sch
uled for early 1961. Startup was delayed by ship construction pr
lems, and by extension of precritical testing and analysis.

During the past year The Babcock & Wilcox Co. and Ebasco Se
ices, Inc., carried forward design reviews to identify any poten
difficulties that might impede future operation of the nuclear pl
and to provide a basis for developing improved components. T
reviews did not find any need for major changes, but some mi
modifications were undertaken to improve reliability. Additio
changes may be made at the first refueling. Future effort will
pointed toward improving components for the nuclear plant. T
Commission will hold a public hearing early in 1961 on nuclear saf
aspects of the *Savannah*.

Yorktown, Va., has been selected as the base from which the *Sav
nah* will undertake her sea trials. It is expected that the ship will
taken from the shipyard to the Yorktown base in the early spr
of 1961.

After sea trials are completed, the *Savannah* is to be operated
an experimental vessel for two to three years. Toward the end
this period, the vessel will enter limited commercial service and vi
major world ports. Operation under commercial conditions will
tribute to resolution of legal and regulatory problems.

Negotiations were conducted during the year both with U.S.
authorities and with foreign governments regarding the *Sava*



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by the Todd Shipyards Corp.
expended fuel elements, to pr
to disposal, and to decont
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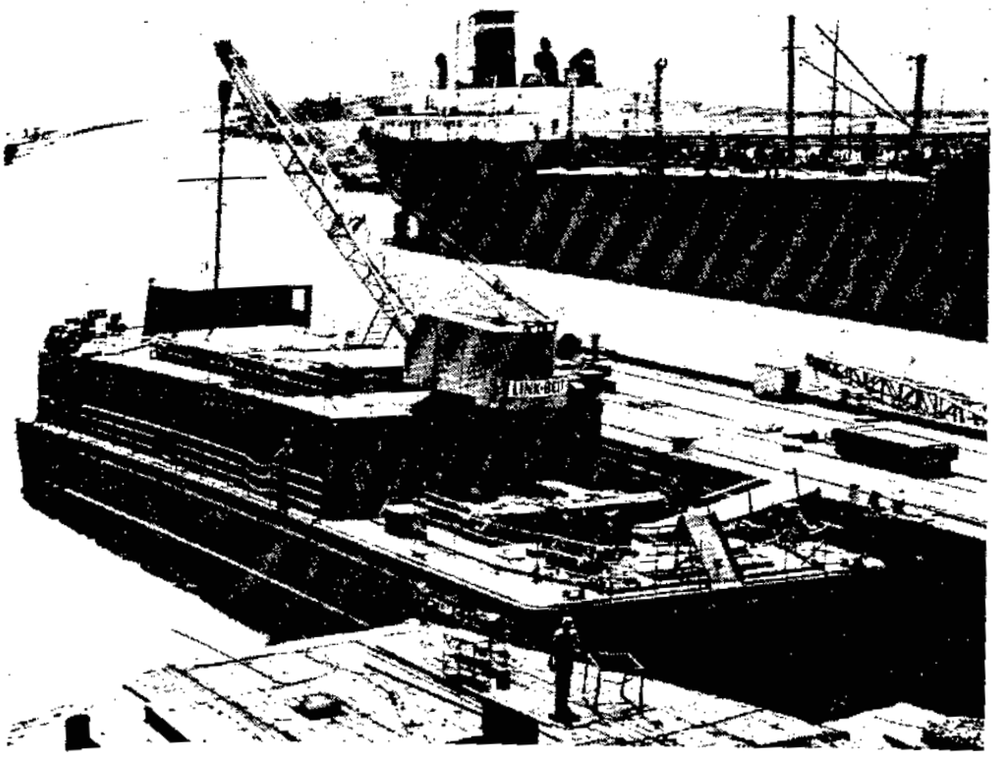
rance into major domestic
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In June the Maritime Admi
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The engineering and deck c
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ent and procedures of the

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...ning Barge. A specially-designed barge will be used to service the N.S. *...annah.* The 129 x 36 x 14-foot barge has a displacement of 650 tons and was ...by the Todd Shipyards Corp. in Houston, Texas. The barge is equipped to ...expended fuel elements, to process liquid and solid radioactive wastes prepa... to disposal, and to decontaminate the *Savannah's* reactor components. ...crane is an integral part of the Commission-Maritime Administration vessel.

...ance into major domestic and foreign ports. Safeguards studies ...environmental surveys were made on Atlantic Coast waters, and ...th and safety studies were undertaken to minimize effects in the ...ely event that a nuclear incident would occur.

...porting Activities

...June the Maritime Administration initiated arrangements to pro... maintenance and repair services to the *Savannah.* A 129-foot ...propelled nuclear servicing vessel constructed by Todd Shipyard ... was launched in April and is ready for the startup tests and ...s of the merchant vessel.

...engineering and deck officers for the *Savannah*, trained at dif... Commission sites in reactor operation, management and regu... aspects, reported in early summer to Camden to learn physical ... and procedures of the *Savannah.*

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Nuclear Tanker Studies

Commission evaluation was completed, and a summary report submitted in April to the Joint Committee on Atomic Energy of the Congress, on design studies to determine the type of reactor which has the greatest potential for early use in a tanker under existing conditions. Studies on direct cycle boiling water, advanced pressurized water, and indirect cycle boiling water concepts were performed by General Electric Co., Combustion Engineering, Inc., and Westinghouse Electric Corp., respectively.

Although tanker use was emphasized, the studies undertook to identify a prototype nuclear propulsion plant suitable for relatively broad application in merchant ships. The studies accordingly provide additional evaluative data for continuing investigations and analyses of various reactor-ship combinations.

Maritime Gas Cooled Reactor (MGCR)

The gas cooled reactor shows considerable promise as a propulsion system for merchant vessels. The Commission also determined that this basic reactor concept possesses promise for use in stationary power plants.

Development of the MGCR, which has been carried out since February, 1958, for the Commission by the General Atomic Division of General Dynamics Corp. has been directed primarily toward solving basic problems of metal-clad fuel elements, materials, controls, and reactor physics associated with early construction and test operation of a 30,000 shaft horse-power gas-cooled beryllium oxide (BeO)-moderated plant. As this basic concept shows promise for merchant ship propulsion as well as for stationary power plants, and since no facility existed to test a gas-cooled BeO-moderated core at suitably high temperatures and pressures, the Commission has approved development of a flexible gas-cooled, BeO-moderated reactor experiment, to be known as BORE. Development of the MGCR prototype will be deferred for the present. BORE, which will have a thermal capacity of about 10 megawatts, will be constructed at the National Reactor Testing Station. The current estimated cost of this project, including research and development, is about $8 million. The plant is scheduled for completion in June 1962.

Construction of an MGCR beryllium-oxide critical experiment was completed in July at the San Diego site of General Atomic, and experiments were begun in August. Irradiation tests of reactor mate-

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...were conducted during the year in a high temperature gas loop ... Hanford, and in the Materials Testing Reactor, the Engineering ... Reactor, and the reactor of the Battelle Memorial Institute.

SPACE PROPULSION REACTORS

The objective of the nuclear rocket propulsion effort, designated Project ROVER, is to develop reactors and related nuclear technology for the propulsion of space vehicles.

The major ROVER effort during the year consisted of the development of a series of nonflyable experimental reactors—designated Kiwi after the flightless Australian bird. A basic complex of test facilities was constructed at the Commission's Nevada Test Site which would be suitable for assembly, test, disassembly, and limited post-mortem examination of these reactors. This work is conducted under the technical direction of the Los Alamos Scientific Laboratory, operated for the Commission by the University of California.

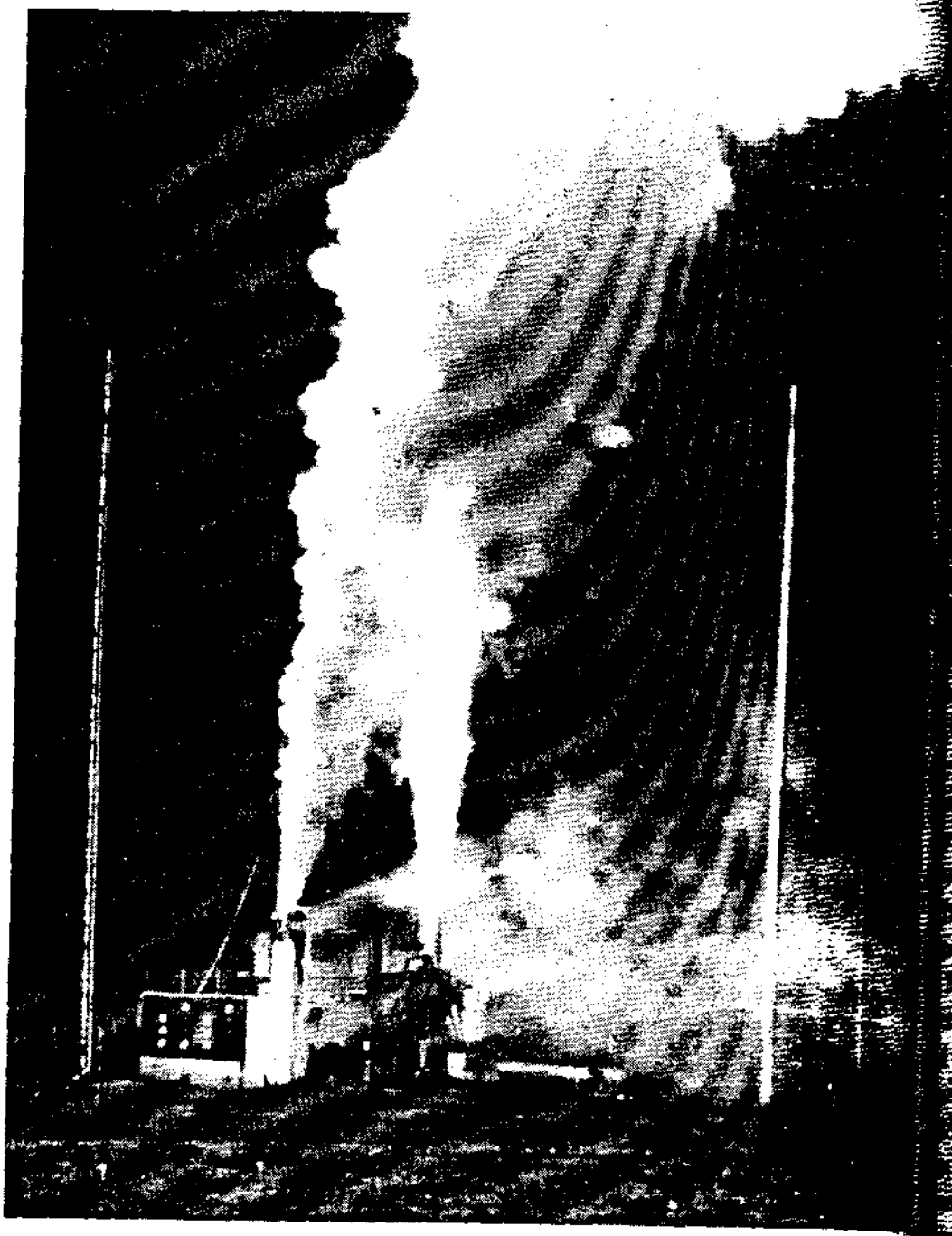
The first of the planned series of reactor experiments in Project ROVER was completed in July 1959. The primary objective of the Kiwi-A test was to operate the reactor at high power at a predetermined temperature level and a duration representative of an operational cycle. The attainment of high power was successful on the first attempt, and the Kiwi-A test objectives were satisfactorily met. The reactor was disassembled using remote manipulator equipment. An elaborate and well planned post-mortem examination and diagnostic analysis of internal components was conducted and yielded valuable information for later reactor designs.

The experiments continued during 1960 with the successful test of Kiwi-A Prime in July and Kiwi-A3 in October. Both reactors were similar to Kiwi-A, using high pressure hydrogen gas as propellant, but contained modifications and design improvements for increased performance. The Kiwi-A3 test was the most successful in the initial experiment series. All performance goals were achieved or exceeded. On-site radiation levels were extremely low. There was no measurable off-site radiation, although traces were detected at a few points on the site perimeter.

Improved procedures resulted in completion of Kiwi-A3 reactor reassembly in less than 6 days, a considerable reduction from the time required for the Kiwi-A Prime reactor.

These tests concluded the Kiwi-A series and work is now underway on construction of new and enlarged test facilities preparatory to conduct of an advanced series of reactor experiments in 1961. The

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Nuclear Space Propulsion. As a part of the Commission-NASA develop program of a nuclear rocket, a third experimental reactor engine was su fully tested during October 1960. The KIWI–A3 reactor (called Kiwi after flightless bird) is shown in action in above photo. The white exhaust co from the nozzle of the reactor (right of photo) is burning hydrogen gas whic been heated to a high temperature by fissioning uranium inside the reactor. plume on the left is a chemical smoke released to enable sampling aircra follow the hydrogen cloud.

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new Kiwi-B reactor series will involve the use of liquid, rather than gaseous, hydrogen as the coolant-propellant. This is a requirement for a flyable system. A vigorous research program to develop fuel element materials for higher power density, lighter weight reactors is being pursued concurrently.

Joint AEC-NASA Office

On August 31, a joint AEC–NASA Nuclear Propulsion Office was formally established to develop nuclear space propulsion systems. This Office now integrates the respective agency efforts previously carried out by the Commission in its Aircraft Reactors program and in NASA's Office of Launch Vehicles. Concurrently, a Memorandum of Understanding was signed by the Commission Chairman and NASA Administrator outlining the broad division of agency responsibilities.

In accordance with the statutory responsibilities of both agencies, the Commission will have primary responsibility for development of all reactors and their components, including those for flight missions specified by NASA. NASA will have primary responsibility for research and development of nonnuclear components and integration of the nuclear components in engines and vehicles of rocket systems.

Pursuant to a joint agreement between the Commission and the National Aeronautics and Space Administration (NASA) made early in 1960, the Commission, within the broad framework of NASA guidance, would retain prime program management responsibility and would fund for operations and facilities through the ground feasibility demonstration phase. In support of the Commission, NASA would provide liquid hydrogen and other fluids at the test sites and would fund for the development of nonnuclear engine components. NASA would assume prime program management responsibility and would fund for flight engine and flight test system development and operation including the construction of necessary facilities. The AEC would support the flight system development by providing the reactors.

On November 1 it was announced that a request for proposals would be sent to a number of qualified manufacturers for research and development of a nuclear rocket engine. Consideration had been given to contracting for a six-month preliminary design study, but after careful evaluation of program requirements, it was decided that the interest of Project ROVER would best be served by an early selec-



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SUPPORTING ENGINEERING AND DEVELOPMENT

In addition to specific work on individual power reactor projects, the Commission develops broadly based technology applicable generally to nuclear reactor systems and operation. The objectives of this nuclear technology program of reactor development are to provide data on reactor fuels, cycles and processes, reactor materials, reactor physics, reactor components and associated equipment, to carry out engineering development of a general and fundamental nature, to investigate the feasibility and potential of new methods for improving reactors, and to provide tools, such as test and research reactors and remote handling devices, for use in reactor research and development. The increasing emphasis which the Commission places on this work, and the broadening of the effort, is reflected in increased expenditures, some $40 million in the fiscal year ended June 30, 1960, which was 50 percent more than the 1959 outlay.

Developments in this area may help to lower the cost of power generation through improvements in reactors and through reductions in the cost of fuel cycles. Interim results obtained during the year from contract work showed encouraging progress in development of new fuel combinations, cladding techniques, and fabrication methods. Related work conducted during 1960 included development of techniques for irradiated fuel which will lower costs for current reactor fuels or permit reprocessing future fuels not susceptible to existing practices. Environmental investigations continued in development of practical systems for safe handling and disposal of a wide variety of radioactive wastes.

Reactor Physics

Reactor core studies using critical and subcritical assemblies and involving different fuels and moderators were conducted at a number of installations during 1960. The technical data and information obtained from these studies are used for design purposes by reactor engineers in determining critical size of reactors, the degree of fuel enrichment needed, and the lifetime of core reactivity.

A cooperative program of critical experiments was completed by The Babcock & Wilcox Co. and Argonne National Laboratory on

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reactor lattices (fuel arrangements in core) fueled with oxide mixtures of thorium and uranium 235 in light water-moderated and heavy water-moderated systems. The fuel used was from the Argonne thorium-uranium development program and the Babcock & Wilcox-Consolidated Edison Co. critical experiment program. The program generated highly useful reactor physics information while avoiding expensive fabrication of oxide fuel. This physics information is needed for the design of power reactors using the above fuels and moderators.

A program of reactor lattice physics studies, including exponential experiments on low enrichment uranium rods in heavy water, was started at Massachusetts Institute of Technology. Varying uranium enrichment will be tested. Arrangements are being made through the International Atomic Energy Agency to lend low enrichment fuels from Norway for use in reactor lattice physics studies planned to start in 1961.

A critical experiment facility approved for construction at Brookhaven National Laboratory will provide a tank in which measurements can be made at high temperature and high pressure.

Advanced Reactivity Measurement Facility

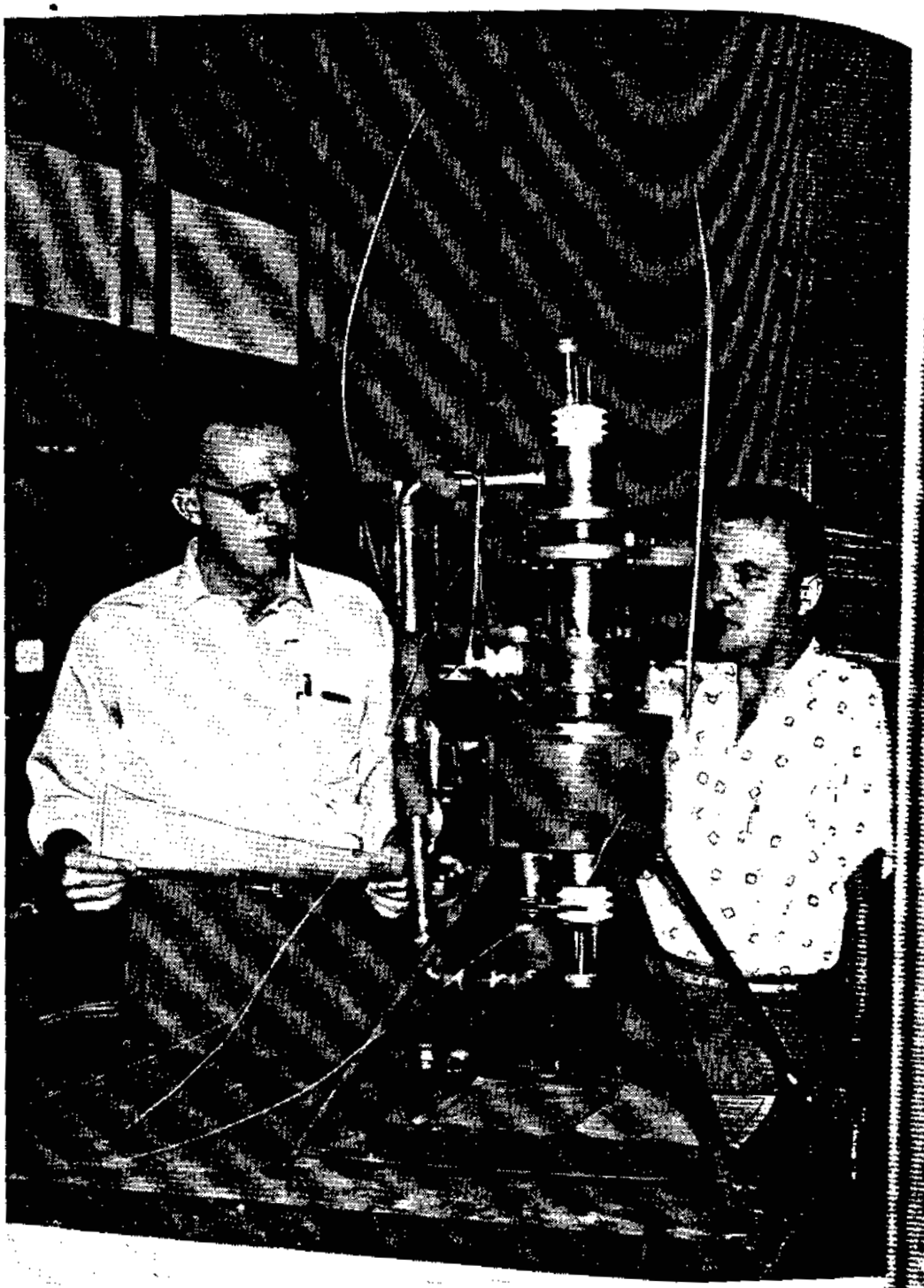
Construction of an Advanced Reactivity Measurement Facility was completed at the National Reactor Testing Station in August, the second facility of this type at that site. The other is the Reactivity Measurement Facility which has been in continuous use since 1955. Studies at these facilities are part of the Commission's program to achieve more efficient reactor fuel utilization, prolong core lives, and provide basic data of general value for designing and evaluating advanced reactors and concepts.

The new facility will permit very precise reactivity measurements with a sensitivity 10 times that of the older facility which up to now has been the most sensitive in the world. Studies of reactivity changes as a function of fuel burnup, and of resonance integral measurements can be expanded by the use of both facilities.

Neutron Thermalization

A program of studies on neutron thermalization—direct measurements by time-of-flight techniques of neutron spectra resulting from use of various moderators and reactor lattices—is being carried out

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Plasma Thermocouple. As part of the Commission's program of develop[ment] means of direct conversion of nuclear heat into electricity, a plasma ther[mo]couple (shown above) has been developed at Los Alamos Scientific Lab[oratory]. The device transforms heat, generated by fissioning of zirconium carbide-ura[nium] carbide mixtures, directly into electricity without use of any moving parts.

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for the Commission by General Atomic Division of General Dynamics Corp. utilizing a pulsed linear accelerator as a neutron source. Measurements have been completed in water, polyethylene, and zirconium hydride with various degrees of rare earth or boron poisoning.

Thermal Inelastic Scattering of Neutrons

In order to study the interaction with moderators of monoenergetic neutrons near thermal energies, Phillips Petroleum Co. has developed a double rotor neutron velocity selector and has made direct scattering measurements on beryllium, water, and several organic gases such as propane, ethane, methane, and normal butane. Data are taken as a function of both scattering angles and the incident and emergent energy of the neutrons. These measurements are useful in developing neutron scattering theory and serve to evaluate the importance of the vibrational and rotational energy levels of molecules in reactor materials.

Direct Conversion

Programs on direct conversion of heat from nuclear fission to electrical energy—the thermoelectric reaction—continued at Los Alamos Scientific Laboratory and Westinghouse Atomic Power Division. The work at Los Alamos consists of research and development on the thermionic vapor diode, a plasma thermocouple in which electrons are emitted from a high temperature cathode are collected on an anode at lower temperature. The high temperature required is developed by causing fission in zirconium carbide-uranium carbide cathode material.

A thermoelectric nuclear fuel element in which thermoelectric materials as an integral part of the fuel element would convert the fission heat directly to electricity is the goal of the Westinghouse program. Current results indicate that thermoelectric materials may be found that are suitable in the intense radiation fields of a nuclear reactor.

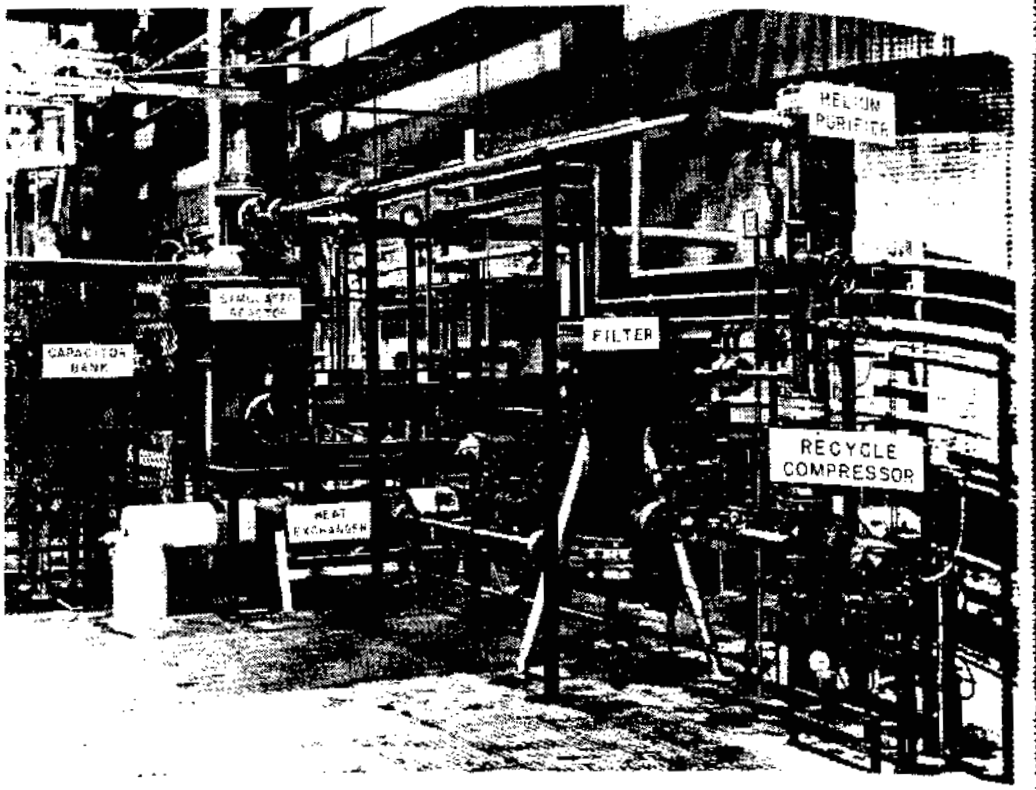


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High Temperature Work

Achievement of high temperature operation of power reactors is important to achieving lower cost power since there is a direct relationship between high temperature and heat-conversion efficiency in power plants.



High-Temperature Facility. Use of high-temperature nuclear heat for industrial processes—including the gasification of coal—is the goal of work being done with a Commission-Bureau of Mines high-temperature test facility at Morgantown, W. Va. The helium gas recycle system is powered by electrical induction heaters which simulate a high-temperature nuclear reactor. During September and October the test facility was operated continuously for more than 1,000 hours at a gas temperature of 2,500° F. and under 250 pounds per square inch. Photo shows the experimental facility with its major components labeled.

High Temperature Reactor Facilities

A pioneer effort to develop advanced technology for reactor systems operating at temperatures far in excess of limitations imposed by current technology has been the helium-cooled Induction Simulated Reactor facility operated for several years at Morgantown, W. Va., as a joint Commission-Bureau of Mines project. The ISR contains all the components of a reactor system except fissionable fuel. On October 22, it completed a test of 1,000 hours of continuous operation

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rated conditions of 2,500° F gas temperature and 250 pounds per square inch pressure. This is believed to be the first time that the feasibility of operating a reactor system for sustained periods at such severe conditions has been demonstrated.

The high temperature gas-cooled Turret reactor experiment planned for construction at Los Alamos Scientific Laboratory, was to carry forward development of technology applicable to very high temperatures, including possible industrial process heat. It has been determined that unclad fuel performance and problems of radioactive circulating coolant gas can be investigated in existing reactors. Therefore, the Commission does not propose to proceed with construction of this reactor experiment at this time. Basic studies of high temperature, high burnup, power reactor systems employing unclad fuel will continue.

Temperature Instrumentation

Successful operation of reactors at high temperatures will depend to a great measure on devising means for accurate and reliable measurement of the many physical operating variables of the system. Development work on techniques and instruments has produced several new instruments during the past year.

One instrument is a new type of neutron sensor, employing microwave absorption techniques and utilizing a waveguide filled with helium 3. This instrument can be used to measure neutron flux in an environment up to 3,000° F without requiring the use of special high temperature electric cables.

Another instrument has been developed for rapid quantitative determination of oxidizing impurities in inert high temperature gas coolants such as helium.

A liquid level sensor also has been developed for use in liquid-cooled systems operating at temperatures up to 950–1,000° F. This instrument employs no moving parts and operates on the principle of ultrasonics. It can be sealed permanently into a system and will provide remote indication and control.

High Temperature Reactor Components

Mechanical equipment that will operate satisfactorily with helium in high temperature reactor systems also is being developed.

The past year has seen successful design and long-term operation of a helium compressor operating at a gas inlet temperature of 1,000° F—

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a substantially more severe operating condition than any compre... has met previously in reactor service.

Encouraging results were achieved in development of an ele... static precipitator for removing particulate matter, specifically f... element erosion products, from high temperature gas coolants. Te... to date have indicated efficiencies of 95 to 99 percent in removal ... particles less than 9 to 10 microns in size from gas streams at te... peratures up to 1,200° F.

High Temperature Heat Transfer

In order to predict performance of gas-cooled reactors more a... curately, thermodynamic properties and heat transfer data are ... quired for higher temperatures and pressures of specific gases th... heretofore have been available. Tables of thermal properties f... helium and molecular nitrogen have been extended to temperatures ... 4,000° F and pressures to 2,500 psia. Heat transfer and pressu... drop data have been obtained for helium at temperatures to 2,500° ... The results of these studies confirm the classical relationships of forc... convection. This work is being continued for helium to temperatur... approaching 4,000° F.

Nuclear Fuels and Materials Development

Development of new and improved fuels and materials is essenti... to achievement of economic nuclear power. In addition to work o... specific individual power and military reactors, the Commission co... ducts comprehensive fuels and materials development under its nucle... technology program. In this effort, specific projects develop, desi... fabricate, and test prototype fuels and fuel elements aimed at advan... ing and improving nuclear reactor efficiency, output, and life.

The program supplies data on physical and mechanical properti... of metals, alloys, and materials, required by reactor designers, and im... proves current technology by utilizing advanced concepts to provi... novel combinations and configurations of materials for efficient r... actor use. Work in this program is carried out at the Commission's ... laboratories and in private industrial and research institutions under ... contract to the Commission. Many of these contracts now are at the ... midway point and encouraging progress has been shown.

Fuels Development

A recent successful effort in the fuels area is the development ... of coated fuel particles as mentioned earlier in the discussion of the ...

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...ble-bed gas-cooled reactor concept. Programs at Nuclear Materials ... Equipment Corp. and at Battelle Memorial Institute have shown ... feasibility of coating techniques and have indicated that fission ... duct leakage can be materially reduced. In this process, small ...es of fissionable material—comparable in size to common table ... are individually coated with a dense refractory material by a gas ...mposition technique using fluidized-bed procedures. The coating ... both protect the fuel from damage by chemical reaction with the ...ant at the high temperatures of the nuclear reactor and also pre- ... escape of the fission gas produced by the fuel. Alumina coating ... uranium oxide has worked well in early tests conducted at Battelle ... work related to the pebble-bed reactor concept. In using this ma- ...al as a fuel, the individually coated fuel particles are evenly dis- ...ed in a matrix material such as graphite, and the dispersion can be ...veniently and economically shaped into reactor fuel elements by ...ple mass production techniques. Such a fuel appears particularly ...ctive for the high temperature operation required for gas-cooled ...tor systems by eliminating the need for temperature-limited metal- ... cladding.

...has been demonstrated by the Oak Ridge National Laboratory ...NL) that reductions in cost may be achieved in fuel elements ... aluminum plate. These elements use uranium enriched to 20 per- ... in uranium 235, the type used by many foreign countries. ...factory and economical elements result from the use of disper- ...s of U_3O_8 rather than a more conventional high-uranium alloy. ...h this fuel element, it is estimated that a reduction of about ... may be achieved in each core loading for a pool reactor.

A timely conclusion of the Argonne National Laboratory's study ...uranía-calcia-zirconia as a ceramic fuel for water reactors led to ...immediate application in the Experimental Boiling Water Reactor. ...tudies of synthesis and fabrication of uranium monocarbide have ...ogressed to the point where this material is ready for in-reactor ...luation in a variety of configurations. This material can be cast ...pressed and sintered to achieve a high density. Development of ...able claddings is continuing to allow its use in high temperature ...tor applications.

...dding and Container Materials

...search with beryllium has confirmed the existence at tempera- ... above 1,260° C of a body-centered cubic phase of metallic struc- ... This structure may prove more ductile than the normal ...gonal close-packed beryllium structure. An alloy containing up

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to 8 percent nickel showed this structure at a temperature of approximately 1,060° C.

A recent study at Oak Ridge National Laboratory indicated that potassium is one of the more attractive molten metals for reactor turbine-generator power sources for space vehicles. In order to investigate the compatabilities of various container materials with boiling potassium, a testing program has been initiated.

Ames Laboratory has found that ultra-high purity yttrium exhibits high resistance to high temperature oxidation, and that the oxidation resistance appears to increase as the purity increases.

The program on properties and characteristics of pressure vessel materials has shown an unexpected result. It was found that the vast amount of data on materials which are currently available is of direct value for structures used for nonnuclear applications where load and temperature histories are quite different from those encountered by nuclear pressure equipment. The type of materials data needed are those to be acquired under test conditions simulating the pressure equipment's actual service environment. The program is being expanded to obtain these data.

Control Materials

A comprehensive research and development program on control rod materials is underway at the Vallecitos Atomic Laboratory of General Electric.

Experimentation is leading to improved understanding of the neutron current flow into control rods. Samples of all known important reactor control materials are being irradiated in a high flux test reactor. These measurements are providing useful information on the alterations in control value of these materials to be expected over the long-term in power reactor service.

The need for these measurements arises from the incompleteness of basic neutron cross-section data. For example, it has been found that dysprosium apparently will have a useful lifetime in a reactor that is approximately twice the value given by the best estimates based on cross-section data .

Moderator Materials

Studies at Brookhaven National Laboratory on graphite absorption of xenon 135, a fission product gas with a high cross-section for neutron capture, have shown that 99 percent of the gas formed

reactor graphite at el
of graphite pores, and
cedures for annealing
oxidation of graphite h
It has been determin
temperature range in
about 600° C, which
the type of fuel elemen
A program has bee
that is dimensionally s
tion, and to develop
graphite in quantities.

Fabrication Technology

Gas pressure bonding
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percent of uranium dio
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Fuel elements clad in
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Nondestructive Testing

Outstanding programs
and Hanford on non-des

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...tor graphite at elevated temperatures is held in the void volume ... graphite pores, and only 1 percent is adsorbed on surfaces. Pro... ...ures for annealing irradiated graphite have been developed and ...idation of graphite has been evaluated.

It has been determined that even under unfavorable conditions, the ...perature range in which graphite reactions become troublesome is ...bout 600° C, which is well above the operating temperatures for ...type of fuel elements used in air-cooled reactors.

A program has been initiated at Hanford to develop a graphite ...hat is dimensionally stable under high-temperature neutron irradia... ... and to develop manufacturing processes for producing this ...phite in quantities.

...brication Technology

Gas pressure bonding techniques were developed by Battelle Memo... ... Institute for producing fuel elements containing 60 to 90 volume ...cent of uranium dioxide dispersed in matrices of stainless steel, ...lybdenum, niobium, or chromium. Dispersions of this type make ...sible high loadings with uranium dioxide and thermal conductivi... ...3 to 10 times more favorable than bulk uranium dioxide.

Fuel elements clad in aluminum, stainless steel, and zircaloy have ... fabricated at Hanford by vibrational compaction of uranium ...ide. Tubular fuel elements and fuel rods of various diameters ...ve been fabricated using stainless steel cladding as thin as 0.005 ...h in some instances. Remarkably good performance has been ...monstrated with fuel elements up to eight feet long in irradiation ... involving core temperatures to 5,000° F and exposures up to ...,000 megawatt days per ton. This development shows considerable ...nomic promise and further studies are in progress.

...ladding, McBean and Co. is perfecting a unique method of fabri... ...ing flat plates of nuclear grade urania by rolling urania powder ... strips. Work to date indicates that the rolling process provides ...ethod of rapid production of high quality, uniform, dense urania ... of precision dimensions, available in a wide variety of complex ...figurations valuable for use in fuel elements. These urania parts ... be made with length-to-thickness ratios that cannot easily be ...ieved by any other process.

...Destructive Testing

...utstanding programs are in progress at Oak Ridge, Argonne, ... Hanford on non-destructive test techniques for evaluation of

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reactor fuels and materials. Excellent methods have been dev
for determining presence of defects, thickness of cladding, loca
of core positions in fuel plates, and for identifying metal compos
As one example, Oak Ridge National Laboratory performed seve
series of measurements on the wall thickness of the zircaloy 2
vessel of Homogeneous Reactor Experiment Nos. 2 during shutdo
These tests were performed remotely and did not require disasse
of the core vessel.

Chemical Processing Development

Significant progress has been made in developing methods f
chemical reprocessing of spent fuels from nuclear reactors. T
work may be more specifically defined as the conversion of irradia
fuel elements into products suitable for refabrication into fuel, pro
ucts returnable to the Commission for credit, and waste prod
which can be stored safely. Chemical reprocessing is justified wh
ever material can be recovered for a credit greater than the cost
reprocessing. The three general approaches being followed are (
aqueous processes with single or multiple dissolution facilities; (
uranium hexafluoride volatility processes; and (*c*) integrated pro
esses in which a reactor and processing plant are built and oper
as a single unit.

Aqueous Processing

Aqueous processes are the most advanced in development beca
of experience gained in uranium and plutonium production pr
grams. For this reason, they are being applied to reprocessing civil
reactor fuels. The basic concept involved in aqueous processes is t
reduction of solid fuel elements to an aqueous solution, followed b
solvent separation of contained fissionable materials from each oth
and from dissolved fission products and structural materials.

Long experience with solvent extraction techniques for alumin
clad uranium and uranium-aluminum fuels has been gained at Ha
ford, Savannah River, Oak Ridge, and the Idaho Chemical Proces
Plant. With the extreme diversity of fuel compositions (e.g., z
conium, niobium, chromium, nickel, molybdenum, graphite, carb
etc.) being developed or considered for power reactors, the aque
nitrate systems previously used do not alone suffice. This result
in the need for multiple dissolution facilities wherein fuels could
combined into groups having similar dissolution chemistries, the d

silver solutions being
subsequent standard sol
During 1960, several a
zirconium and stainless
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with irradiated fuels.
as the cermets and those
are under continuing in
An alternate to a cen
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plant for a typical civi
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analysis, indicated that

Volatility Processing

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tillation or adsorption-
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At Argonne National
apply to civilian power
military reactor fuels.
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Pyrometallurgical Proc

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specific reactor. This a

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solutions being converted to a pure nitrate system for the subsequent standard solvent extraction.

During 1960, several aqueous processes particularly suitable for the zirconium and stainless steel clad oxide fuels were explored successfully in the laboratory and are ready for pilot plant demonstration with irradiated fuels. Processes for the more advanced fuels such as cermets and those containing carbides, graphite, and beryllium are under continuing investigation.

An alternate to a centrally located, large-scale reprocessing plant capable of handling a variety of fuels is a small-scale plant located at the reactor site to process the fuel load from a single reactor complex. Phillips Petroleum Co. completed a study at the Idaho Chemical Processing Plant of the technical and economic feasibility of such a plant for a typical civilian power reactor site. The study, which included a conceptual plant design, hazards evaluation, and cost analysis, indicated that this approach has considerable promise.

Volatility Processing

In volatility processing, uranium fuels are fluorinated to produce uranium hexafluoride and the fluorides of the fission products and cladding metals. Uranium hexafluoride, being much more volatile than the other fluorides, can be readily separated by fractional distillation or adsorption-desorption processes. Potential cost advantages of volatility over aqueous techniques result from the reduced number of process steps, and an approximate 30-fold reduction in the volume of high level wastes.

At Argonne National Laboratory, studies are being conducted to apply to civilian power fuels the fluoride volatility process used for military reactor fuels. Before a practical reprocessing method can be devised, considerable knowledge must be acquired about the conditions of formation of volatile plutonium hexafluoride, its reactions with construction materials, and the general problems of handling and storing this species which is highly reactive chemically.

Pyrometallurgical Processes

In the pyrometallurgical or low decontamination processes, also called closed cycle processes, all operations in the fuel cycle from decontamination through re-enrichment and refabrication are performed by remote control in a facility closely integrated with a nuclear reactor. This approach recognizes that the customary high

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decontamination of irradiated fuels, followed by manual refabrication of fuel elements, may not be as applicable to civilian power fuels as in the military program from which it was derived. The closed fuel cycle concept presents technical difficulties. Unless reasonable economics can be shown, its greatest application will be to reactors with large fuel inventories such as fast reactors, or to those that operate on plutonium recycle or thorium-uranium 233 fuel systems.

The first successful demonstration of pyro-processing of irradiated metallic fuels was completed in 1960 by Atomics International. In this demonstration, a stainless steel-clad uranium dioxide fuel sample irradiated to 7,000 megawatt days per metric ton of uranium was declad through oxidation, reprocessed in three oxidation-reduction cycles, and prepared for the first of five additional successive test irradiations.

A pyrometallurgical facility is integrated with the Experimental Breeder Reactor No. 2.

Environmental and Sanitary Engineering

The Commission long has recognized radioactive waste management as an important factor in the over-all health and safety program of the nuclear industry. Accordingly, the Commission has pursued a vigorous program which is aimed at developing methods of minimizing the release of radioactive contaminants to the environment.

Environmental Studies on Wastes

Cooperative studies are being carried out at national laboratories and other Federal and private institutions on specific ground, air, and water environments which may receive limited radioactive discharges of low-activity and intermediate-activity radioactive wastes from nuclear power operations. The waste disposal problem at each nuclear energy operation must be evaluated on an individual basis to fit variations in sites and inherent differences in nuclear facilities.

A comprehensive field investigation of the Clinch River below Oak Ridge National Laboratory was initiated during 1960. The purpose of the study is to obtain fundamental information on the physical, chemical, and biological dynamics of a flowing, freshwater ecosystem which is receiving large volumes of low-level radioactive wastes. The U.S. Public Health Service, the U.S. Geological Survey, the Tennessee Valley Authority, and the Tennessee Stream Pollution Control Board are actively participating in the program. Routine monitoring ...

...tinues to indicate that ... well below permissible ... of specific radionuclid... standing of the mechan...

A project is being c... of Technology and S... ralves studies on the ... duced into a municipal ... developed and a limited ... activity concentrations ... Beta emitters such as str... in approximately 10 s... States, as well as in the ... fate and behavior of th... also to assist in evaluati... release criteria applied t...

Sea Disposal

The Cleveland Pneum... environment of two sea ... work entails collection an... al samples, measuremen... ocean bottom, and testing ... phases of these compreh... activity attributable to ...

The Chesapeake Bay I... developing a complete un... from West Point, N.Y., ... dies investigation of a ... predict the fate of any ... system. The work involv... and salinity information ... data for use in a co... peake Bay Institute has ... the laboratory elemental ... predict the fate of activi...

The Commission has i... mers currently used in s... ing at sea some 150 act... lected at random from ... series of laboratory tests ... stitute to measure the ef...

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...ases to indicate that releases of radioactivity to the Clinch River are ...ll below permissible limits. This study will determine the fate ...f specific radionuclides released and will develop a better under...anding of the mechanisms of stream dispersion.

A project is being carried out jointly by the California Institute ... Technology and Scripps Institute of Oceanography which in...olves studies on the origin, effects and fate of radioactivity intro...uced into a municipal sewerage system. Last year, techniques were ...veloped and a limited number of analyses made of cesium and cobalt ...tivity concentrations in the Los Angeles sewage treatment plant. ...a emitters such as strontium 90 and other isotopes are being studied ... approximately 10 sewage treatment plants around the United ...ates, as well as in the Los Angeles plant, not only to determine the ...e and behavior of the materials in sewage treatment plants, but ...o assist in evaluating the effectiveness of the Commission's waste ...ease criteria applied to licensed operations.

...Disposal

The Cleveland Pneumatic Industries is completing a study of the ...ironment of two sea disposal sites off the California coast. This ...k entails collection and analysis of biological, geological and chemi... samples, measurement of water currents, photography of the deep ...n bottom, and testing a deep water buoy marking system. Initial ...s of these comprehensive studies have indicated that no radio...ity attributable to waste disposal operations can be detected.

The Chesapeake Bay Institute of the Johns Hopkins University is ...loping a complete understanding of the New York Harbor system ... West Point, N.Y., to the mouth of the harbor. This study in... investigation of a mathematical model which can be used to ...n the fate of any radioactivity introduced at any point in the ...m. The work involves an analysis of tide, current, temperature, ... salinity information collected by the Coast Guard and collation of ... data for use in a computer. As part of this study, the Chesa... Bay Institute has developed a chemostat which reproduces in ...laboratory elemental biological systems and makes it possible ...dict the fate of activity.

... Commission has initiated an evaluation of all types of con... currently used in sea disposal operations. One phase involves ... at sea some 150 actual disposal containers with waste materials ...d at random from waste packagers. The other phase involves ... of laboratory tests being conducted at the Southwest Research ...te to measure the effects of pressure and impact forces on var-

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ious variables of containers such as concrete thickness, contained com-
pressible space, amount and spacing of reinforcement steel and
pressure relief vents.

Field investigations related to the feasibility of disposal in inshore
locations off the North Atlantic coast were completed early this year.
The study was carried out through the cooperation and participation
of the U.S. Coast & Geodetic Survey, U.S. Public Health Service,
University of Connecticut, and U.S. Fish and Wildlife Service. In-
cluded was a survey of a site in Massachusetts Bay formerly used for
disposal of limited quantities of packaged wastes. This survey did not
reveal any radioactivity attributable to disposal operations. Although
the investigations indicated that the locations studied could safely
receive up to 250 curies per year of strontium 90 or its equivalent,
Commission policy continues to require that solid packaged wastes be
disposed in water at least 6,000 feet deep.

A later section of Part One reports on Commission policy on interim
land burial of wastes.

High Level Wastes

At present the primary means of handling highly radioactive
liquid fuel reprocessing wastes at the few locations where they are
produced is to provide special underground storage tank facilities
and appropriate monitoring. Approximately 15 years' experience
has shown that these systems provide a safe and practical means
of interim containment. However, because of the nature of the
particular category of wastes, including their long effective life
(measured in hundreds of years), and volume (estimated at a total
accumulation of approximately 65 million gallons in 1959), and the
comparatively shorter life of the physical structures containing the
wastes, it is possible to envision a potential hazard in this method
of handling over the long-term.

Recognizing this potential problem, the Commission is directing
current research and development along the lines of transforming
these wastes to solid form for long-term storage or disposal, or plac-
ing the wastes in a geological environment which would serve as a
safe, perpetual tank farm.

Laboratory tests over the past several years have indicated the
technical feasibility of storing high level radioactive liquid wastes
in such geological formations as salt. Field tests to verify the labo-
ratory results and to establish engineering feasibility are required.
Such tests are presently being conducted in a mined-out portion of
the Carey Salt Mine near Hutchinson, Kans. In this program, both



Waste Disposal Experi
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At the National
fluidized bed plant
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Disposal Experiment. To determine the feasibility of storing high-level active wastes in abandoned salt mines, the Commission is conducting a of experiments in a salt formation near Hutchinson, Kans. Heated non-active materials are used as simulative wastes. The experiments are be-conducted to determine whether there would be movement of the wastes the formation and what chemical or other changes the rock salt might Photo shows one of the underground test cavities (foreground).

and neutralized 2-year-old nonradioactive simulated Purex is stored in two 7.5 x 7.5 x 10 foot deep cavities and the var-parameters are monitored.

temperatures in the system have reached equilibrium and have the pattern predicted by laboratory research and subsequent retical calculations. Parameters still to be verified include migra-of the cavities themselves, and salt deformation. On the assump-that the results of the field test will continue to be favorable, radio tests and experiments are being contemplated at another site.

ation of radioisotopes in a solid form not only would decrease the volume of high level wastes generated but also would make them ively immobile. Immobility facilitates management of the waste, decreases the hazard. It is presently contemplated that wastes in solid form would be stored in an impervious environment a salt mine under continuous monitoring.

the National Reactor Testing Station (NRTS), a hot pilot bed plant to demonstrate and evaluate the feasibility of ation to dry solids of aqueous aluminum nitrate waste is nearing

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completion and is scheduled for cold runs in the first half of 19[illegible]. This program will require the resolution of some severe problems concerning heat removal, encapsulation, and treatment of off-gases from fluidized bed operations. Though by no means insurmountable, these problems can be resolved only by engineering scale experiments utilizing actual wastes.

Preliminary studies have been initiated also to evaluate the feasibility of utilizing the fluidized bed technique to process wastes from zirconium and stainless steel fuels. It is expected that similar handling problems will be encountered that are similar to those of the aluminum nitrate process.

In the radiant heat spray calcination method used at Hanford, simulated Purex waste is mixed and atomized with steam and introduced into the top of a tower. The walls of the tower are heated to a high temperature. The atomized liquid, in the form of small droplets, passes through zones of radiant heat where the suspension achieves increased degrees of dryness. The configuration of the spray must be such that the atomized waste is completely dry before it hits the walls of the tower in order to preclude deposition of calcined solids on the walls and to eliminate operational interference.

The solid wastes could be in the form of a fine powder or be utilized with a fluxing agent, in the form of a larger coagulated solid. The solids and gases are separated at the bottom of the column in filters with the gases scrubbed with caustic and exhausted to the building vacuum system. Though only assessed on a laboratory scale, the preliminary results indicate the system's adaptability to changes in waste composition. Further studies are required on corrosion, feed rates, effect of additives, and ruthenium and cesium behavior.

Studies have been underway at Oak Ridge on transforming liquid radioactive wastes through use of a pot calciner to thermally stable solid materials more suitable for ultimate disposal. The contents are heated to dryness, and the stainless steel cylinder serves as the final storage container. Laboratory experiments have been conducted with waste containers 8 inches in diameter and 78 inches long. Current research and development is being conducted on the off-gas and aerosol problems of this method of calcination.

Intermediate Level Wastes

At present, some intermediate level wastes are being dispersed into the ground at Hanford, Oak Ridge, and Savannah River. However, this operation is carefully controlled and monitored by the extensive use of monitoring wells in the area. Concentrations of radioisotopes

which appear in surf
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Low Level Wastes

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which appear in surface waters are, on the average, several orders of magnitude below acceptable levels. Research and development continues to evolve methods of handling these wastes which may make it unnecessary to dispose of them into the ground.

Current research which has had encouraging results is a method called "hydrofracking" being investigated at Oak Ridge National Laboratory. In this process, the intermediate level waste is mixed with cement to form a grout. The mixture then is injected into a specially prepared well under high pressure. The chosen geologic strata is fractured at the predetermined elevation by the high hydrostatic pressure maintained on the grout. The grout continues the fracturing of the stratum until the entire volume of waste has been "consumed." Pressure is maintained on the system until the grout solidifies, fixing the waste in an impervious geologic stratum. To date, approximately 250,000 gallons of simulated waste containing radioactive tracers have been experimentally disposed of by this means. The geologic formation is currently being probed in an effort to evaluate this method in order to predict the results of future tests.

Low Level Wastes

Low level wastes are released to the environment either directly or after primary treatment. Research conducted at Oak Ridge National Laboratory which utilizes a lime-soda treatment for precipitating the dissolved radionuclides. Inclusion of clays in this process makes it possible to obtain up to 95 percent removal of cesium and strontium. In an effort to accomplish still greater decontamination, research and development efforts are exploring the use of specific natural and synthetic resins. Results obtained to date are encouraging. Similar programs are conducted at Hanford to evaluate ion exchange capabilities for specific waste. In addition, various Commission installations and contractors are engaged in basic ion exchange research in an effort to gain better understanding of this phenomenon and to predict operational characteristics.

Gaseous Effluent Studies

Studies directed toward new and improved systems for control of radioactive gaseous discharges and particulates in gaseous wastes are concentrating on such problems as improved high capacity filters for iodine removal and equipment for filtration of particulates at high temperatures (above 1,000° F).

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Meteorological research by the U.S. Weather Bureau at several Commission sites is centered around obtaining a better understanding of the ability of the lower atmosphere to disperse pollutants—an ability affected by topography, temperature conditions, and the flow of air as determined by barometric conditions.

In the air cleaning program, fundamental development work is continuing on aerosols and filtration devices which will operate with lower resistance to air flow, and with high efficiency at lower capital costs. A simple electrostatic fluidized bed for cleaning supply air is being developed based on work at the University of Illinois and Harvard University.

The Harvard Air Cleaning Laboratory evaluation of an incinerator developed for burning solid combustible radioactive waste materials has been completed with analyses of its combustion characteristics and air cleaning system. The device will burn about 20 pounds of mixed waste an hour. The next step is to develop and construct a commercial prototype for field testing. During the past year, effort has been concentrated on developing the air cleaning system.

RESEARCH AND TEST REACTORS

Test Irradiation Services

New and untried reactor fuel materials as well as reactor structural materials, moderators and coolants, must be tested under conditions of radiation and temperature which simulate those experienced in operating reactors. Such characteristics as corrosion resistance, mechanical strength, and good thermal conductivity while exposed to radiation must be determined. The ability of a proposed fuel material to resist undesirable irradiation-induced changes, as tested in a reactor, will almost invariably form the final basis for its acceptance or rejection.

Most fuel and material irradiation tests in the United States have been conducted in the Materials Testing Reactor (MTR), which went critical in 1952, and the Engineering Test Reactor (ETR), which began operation in late 1957. These two test reactors, both at the National Reactor Testing Station in Idaho, have performed irradiation services for military as well as civilian reactor projects. Both are high neutron flux reactors, although the larger and more advanced ETR has a greater variety of fluxes than the MTR. (Neutron flux is the intensity of neutrons in a given region of a reactor to which components and materials may be subjected. This region provides environmental conditions similar to conditions in reactors for which

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[1] See p. 82, Annual Repo

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components and materials are intended.) The ETR provides test volumes within the reactor fuel core, a feature not included in the MTR.

Both MTR and ETR, which have fluxes up to about 5×10^{14} neutrons per square centimeter per second, operate on established schedules calling for regular shutdowns to insert or remove experiments and related equipment, and to replenish or rearrange fuel loadings. The principal objective is to provide the most intense neutron flux for the highest percentage of operating time. With some materials, three months exposure in the high flux MTR or ETR is equal to two or more years in an actual power reactor, which generally operates in the low or medium flux ranges.

In October 1958,[11] the Commission invited industry to submit proposals for performance of test irradiation services in addition to those carried out in the MTR and ETR. From the 11 proposals received, the Commission selected in July 1959 the proposal of The Babcock & Wilcox Co., as a basis for contract negotiations. A portion of the company's proposed reactor space was to provide the Commission with test irradiation services in the low and mid-flux ranges. Anticipated industrial requirements, as estimated earlier by industry for test reactor space, failed to materialize, and the negotiations were mutually terminated by the Commission and Babcock & Wilcox on July 8, 1960.

The Commission's needs for test irradiation space, materially unchanged since the start of negotiations, will be met in existing and planned Commission reactors and in two privately owned test reactors now in operation. They are the Westinghouse Test Reactor at Waltz Mill, Pa., and the General Electric Test Reactor at Pleasanton, Calif. Expected industry demand for space in private reactors has not materialized and this situation makes additional space available to the Commission.

In response to the 1958 public invitation, industry made no proposals for building a test reactor capable of producing neutron fluxes of greater intensity than those in the MTR and ETR. The Commission's needs for high-flux irradiation space will be met by a Government-built advanced test reactor authorized by the Congress. The conceptual design study for this test reactor was done by Phillips Petroleum Co. The new reactor will be known as the Advanced Test Reactor (ATR)—a 250 Mw (thermal) reactor with a ribbon of fuel elements in a four-leaf clover configuration. An experimental loop facility, running vertically parallel to the fuel region, is provided in each of nine flux concentration zones, providing an even greater

[11] P. 82, Annual Report to Congress for 1959.

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variety of fluxes up to 10^{15}. The new reactor will be located adja-
cent to the MTR–ETR complex at the National Reactor Testing
Station.

Phillips Petroleum is responsible for conceptual design; Ebas-
Services Inc. was awarded the contract for architect-engineering
services; Babcock & Wilcox wil be subcontractor to provide assistance
in designing the nuclear portion. Construction is scheduled to start
by March 1961 and to be completed in 3 years.

Other high flux reactors. Research and development work continues
on an Argonne High Flux Reactor planned for Argonne National
Laboratory and on a High Flux Isotope Reactor (HFIR) to be built
at Oak Ridge National Laboratory. A site for the HFIR in the
Melton Valley at Oak Ridge was approved in August from the standpoint of safety by the Advisory Committee on Reactor Safeguards.
Construction of this 100 MW reactor is expected to start late in 196

Programs In Support Of Industry

The Commission during 1960 reaffirmed its policy of using commercial
facilities for needed services and supplies wherever practical, and of
curtailing its services or supplies to industry whenever commercial
sources become reasonably available. The Commission improved and
increased its information services to industry, declassified further
broad areas of information, and simplified its access permit program.
A manpower survey conducted for the Commission counted 185,000
persons employed in atomic energy activities and estimated some fu-
ture needs. These developments, recent activities in the commercial
field and added Commission assistance to industry, are summarized
in this portion of the report.

All Commission activities, except those directly related to weapons,
have the potential of contributing to industrial progress. This is
especially true of the broad research programs in the life and physical
sciences—this year the subject of a special report to the Congress[12]—
which help expand the basic knowledge on which the industry and
its safe operation are founded.

[12] "Atomic Energy Research in the Life and Physical Sciences"—1960, Superintendent of Documents, Government Printing Office, Washington 25, D.C., $1.25.

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POLICY

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The program developments in the effort to achieve economic production of nuclear power have been described in the preceding chapter. In Part Two of this report, separate sections deal with civil uses of nuclear explosives and radioisotope and radiation applications.

Highlights of 1960 included the following actions and developments:

- The Commission again reduced prices on two key radioisotopes, by 26 percent on carbon 14 and from 30 to 70 percent on cobalt 60. The Commission also proposed to alter its regulations to permit use of radium in self-luminous instrument dials under general license. A major price reduction for the stable isotope helium 3 also was announced.
- A program was established to test and demonstrate the technical and practical feasibility of extending the shelf life of certain refrigerated foods by irradiating the foods.
- The Commission plans to use space in two privately owned testing reactors to complete its requirements for low and intermediate neutron flux irradiation.
- Three experiments with nonnuclear high explosives were carried out to increase knowledge of crater formation in planning for possible future civil uses of nuclear explosives.
- Small business' share of Commission subcontracts increased from 37 percent in the fiscal year ended June 30, 1959, to 42.1 percent in the following fiscal year.
- Preliminary steps were completed looking toward take-over by various States of responsibility for licensing and inspecting certain categories of atomic energy activities.
- A total of 584 personnel of the Commission and its contractors was available to respond to local calls in assigned areas whenever help was requested in accidents believed to involve radiation.
- The Commission inaugurated a program to develop techniques for nondestructive analysis of fuel materials for reactors to assist in compliance with the requirements for maintaining safeguards against diversion of fissionable materials from peaceful uses.
- Seminars were held to inform public carriers on the transportation characteristics of atomic energy materials and products.

POLICY ON COMMERCIAL SERVICES

In carrying out its statutory responsibility to encourage widespread use of atomic energy in such a manner as to strengthen free competition in private enterprise, the Commission has maintained a firm policy to procure goods and services from private industry wherever prac-

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tical.[13] The Commission redeclared this policy in February 19[illegible] when it responded to inquiries from the Chamber of Commerce of the United States, the National Association of Manufacturers, and the Manufacturing Chemists' Association concerning the Commission's application in its operations of Bureau of the Budget Bulletin [illegible] on "Commercial-Industrial Activities of the Government Providing Products or Services for Governmental Use." [14]

The Commission has consistently maintained two broad policies, one, that it will supply with its own facilities materials and services needed by industry only to the extent that they are not available commercially at reasonable costs, and two, that in meeting its own needs, it will procure goods and services from private industry wherever practical.

The first policy has been in effect since the Atomic Energy Act of 1954 made possible the participation of private industry in the development of nuclear power. As private industrial capacity has come into being, the Commission has withdrawn from providing a number of supplies and services, as announced publicly from time to time and described in the Semiannual and Annual Reports to the Congress.

In 1958 the Commission issued a listing of materials and services which it would no longer provide, since they were then available from private industry.[15] As early as 1956 the Commission announced that it would permit the use of Commission-owned test reactors for non-Government purposes only if privately owned facilities were not available for the irradiation services required. With industrial irradiation facilities [16] becoming available in 1960, the Commission, in July 1960, reaffirmed its policy of not performing irradiation services for commercial firms if privately owned facilities are reasonably available. The announcement also extended this policy to foreign requirements.

The Commission policy of utilizing to the fullest practical extent the services of private business enterprise in carrying out its various programs has been fundamental since passage of the Atomic Energy Act of 1946. At its inception the Commission turned to private industry to construct and operate its major facilities. Government ownership of these facilities was essential, since no reasonable way could

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[13] See pp. 153–55, Twenty-third Semiannual Report to Congress (July–December 19[illegible]); pp. 61–63, Twenty-fourth Semiannual Report to Congress (January–June 1958).

[14] See Appendix 18 for text.

[15] See p. 14, Twenty-fifth Semiannual Report to Congress, (July–December 1958).

[16] The General Electric Test Reactor at Vallecitos, Calif. and the Westinghouse Test Reactor at Waltz Mill, Pa. The Commission also is obtaining irradiation services from these reactors.

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found to provide adequate incentives for private investment in

Passage of the Atomic Energy Act of 1954 opened new opportunities for industrial participation in the nuclear field. Specific responsibility for identifying industrial activities, including those performed by the Commission, which lend themselves to performance by private industry, was centralizd within the Commission the following year. Since then, coincident with the development of private capability, the Commission has taken a number of steps directed toward enlarging the area of commercial participation in Government financed programs.

Although the continued use of existing Government facilities is clearly necessary in the public interest for the production of fissionable materials, the assembly of weapons, and the conduct of most advanced research and development, the facilities and skills of private industry are and will be employed when they are adequate to carry out specific activities in the military and peaceful applications of atomic energy at the rate required to attain national objectives. However, care will be exercised in discontinuing a specific government activity to assure that related activities which are closely integrated do not unduly suffer in development, cost or efficiency by reason of the enforcement.

In the nuclear industry, the tempo of technological developments in many instances does not permit establishing precise specifications to assure a volume of repeat orders necessary to attract investment of private capital in the specialized facilities, equipment, and personnel required. Consequently, there still remain areas of the Commission's work where it is premature to expect that such work can be procured from private industry on a competitive basis. Nonetheless, as the atomic energy industry grows, there will be areas of activity appropriate for transfer from Government to private operation.

The Commission has directed its field offices and operating contractors to follow this policy. In implementing the policy, decisions to procure materials or services from commercial sources rather than from Government-owned plants will be made whenever it is reasonable under the policy to do so.

COMMERCIAL ACTIVITIES

Industrial Laboratories' Contracts

Reactor development work conducted for the Commission by private industrial organizations largely in their own facilities has con-

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tinued to increase. In the fiscal year ended June 30, 1960 it repre-
sented 26 percent of the $361.7 million spent by the Commission fo
such work and an increase, from $75.9 million to $94.1 million, or 2
percent, over the amount so spent in the previous fiscal year. The
distribution of these funds for the past three fiscal years is shown in
the following table:

DISTRIBUTION OF AEC REACTOR DEVELOPMENT FUNDS

Type of organization	Fiscal year (millions of dollars)		
	1958	*1959*	*1960*
Industrial	$49.1	$75.9	[illegible]
AEC laboratories	237.3	246.0	[illegible]
Universities	0.8	1.3	[illegible]
Other nonprofit	1.8	1.3	[illegible]
Other Government	1.2	1.7	[illegible]
Total*	$290.2	$326.2	[illegible]

* These totals do not include depreciation on AEC-owned facilities or special nuclear materials consumed. Such costs are included in costs reported for reactor development work in the Annual Financial Report, Appendix 21.

Commercial Processing of Fuel

Orders placed by the Commission and its principal contractors with commercial sources for the conversion of uranium hexaflouride to materials suitable for fuel elements, and for the fabrication of fuel elements, rose from $41.4 million in the year ended June 30, 1959 to $52.4 million in the year ended June 30, 1960, an increase of 26 percent.

These amounts represent, in large part, orders for cores of naval reactors. The Department of the Navy transfers funds to the Commission for procurement of all shipboard reactor cores. Excluding the orders for naval purposes, the awards totaled $2.8 million for fiscal year 1959 and $3.8 million for fiscal year 1960, an increase of 36 percent.

An indication of the extent to which procurement from commercial sources has increased also is given in the following table which shows enriched uranium furnished in the form of uranium hexaflouride compared with that furnished in a form requiring processing in Commission facilities:

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ENRICHED URANIUM FURNISHED TO ALL SOURCES

Excluding the Weapons Production Chain

	Fiscal Years (kilograms of uranium)				
	1956	*1957*	*1958*	*1959*	*1960*
[illegible] as UF 6	0	6,000	24,000	110,300	86,200
[illegible] in forms other than UF 6	2,400	4,000	21,000	6,300	3,400
[illegible]	2,400	10,000	45,000	116,600	89,600

Thus, although all enriched uranium furnished in 1956 required processing beyond the uranium hexafluoride stage in Commission facilities, in 1960, 96 percent was processed beyond this stage in commercial plants—86,200 kilograms out of a total of 89,600.

Chemical Processing of Fuel

During 1960 a chemical company in cooperation with five utilities completed an independent study leading to the conclusion that the available technology necessary to process the irradiated fuel under consideration is adequate for design and operation of a privately owned plant. At least two other companies are studying the desirability of entering this field.

Although services of this kind now are offered to reactor owners by the Commission, suitable privately owned facilities are a key requirement for a self-sufficient nuclear power industry.

Toward the end of the year the Industrial Reprocessing Group (Harrison Chemical Co. and five utilities) were in Phase II of their study, to determine the economic feasibility of their plan.

Plutonium Fabrication

The first license covering fabrication of plutonium was issued in December 1960 to Nuclear Materials and Equipment Corp., Apollo, Pa. The license also covers the manufacture of plutonium-beryllium neutron sources, all of which heretofore have come from Commission-owned plants.

At the end of 1960 the Commission, through its New York Operations Office, was surveying industry capability and interest in the recovery of plutonium from nonirradiated scrap with a view toward developing industrial participation in this aspect of the Commission's work.

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Two other private organizations, Battelle Memorial Institute, and Nuclear Development Corp. of America, also have fabricated plutonium under Commission contracts which did not require a license.

Changes in Reactor Status

As a result of the reorientation of the Aircraft Nuclear Propulsion manned aircraft program, the Georgia Nuclear Laboratory facility, an unshielded reactor operated for the Air Force by Lockheed at Dawsonville, Ga., no longer was required in support of the program. The facility remains operational but on a limited standby basis. Under these arrangements, Lockheed has applied for a Commission license to operate the facility for both Government and commercial purposes.

Two other facilities, the Air Force Nuclear Engineering Test Facility at Wright-Patterson Air Force Base, and the Curtiss-Wright reactor at Quehanna, Pa., were built in anticipation of required support of various proposed nuclear powered systems. Since developments have not progressed as rapidly as forecast, the need for these facilities has been deferred. The Air Force-Nuclear Engineering Test Reactor will be placed in a standby status after initial startup and checkout for proper operation. The Quehanna reactor has been donated by Curtiss-Wright to Pennsylvania State University, about 25 miles away. Curtiss-Wright activities in the reactor and isotopes fields, formerly located at Quehanna, have been transferred to the Princeton, N.J., Division.

COMMISSION ACTIVITIES

Standard Lease Agreement

On March 1, 1960, the Commission put into effect a new standard lease agreement covering all special nuclear material distributed to licensees. Except with respect to material in neutron standards distributed by the National Bureau of Standards. At the same time the Commission modified procedures followed in the leasing of material. These actions were intended to improve and clarify those functions of a business nature which the Commission must carry out in distributing and accounting for special nuclear material.

The new lease does not alter or affect the rights or obligations of any Commission licensee under its license or construction permit. A standard provision of the new form is an expiration date of June 30, 1963. The uniform expiration date was established to provide a rea-

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...ably early re-evaluation of the Commission's terms and conditions ...distributing special nuclear material in the light of changing ...chnology and circumstances in a new industry. At the uniform ...piration date the Commission intends either to renew existing ...reements or to offer lessees an appropriately amended agreement.

By the end of 1960, about 95 percent of material with licensees ...alued at $86 million was brought under the new agreement, and the ...mainder was expected to be brought under it shortly.

The new agreement is expected to facilitate lessees' dealings with ...e Government not only by standardizing lease arrangements but ...so by clarifying responsibilities and establishing procedures in ...re detail than had been available previously. Administrative ...nctions relating to the lease of special nuclear materials have been ...ntralized in the Oak Ridge Operations Office.

In a related action in April 1960, the Commission published in the *...deral Register* base charges, special charges, specifications, and ...kaging information for uranium hexafluoride. Although the base ...arges heretofore had appeared in public releases, the specifications, ...ecial charges and packaging information, referred to in the stand-...d lease agreement, had not been published previously.

...gulation and Indemnification

The Commission adopted two revisions to Part 50 of its regula-...—"Licensing of Production and Utilization Facilities"—which ...rified and simplified procedures to be followed in obtaining licenses ...r nuclear reactors.

The first revision made clear the extent of construction work per-...ssible prior to issuance of a construction permit. It allowed prep-...ation of the site for construction of the facility, including con-...uction of roadways and utility lines, procurement and manufacture ...components of the facility, construction of nonnuclear facilities ...d temporary buildings, and construction of buildings to be used for ...ivities other than operation of a reactor even though they may ...ouse a medical or research reactor.

The second revision provided for issuance of a provisional operating ...se under circumstances where a final operating license cannot ...issued because construction has not been completed, or limited oper-...g experience at limited power levels is necessary to test certain ...atures, components or characteristics of the facility.

A third revision to Part 50 proposed by the Commission would make ...ear that it is Commission policy to issue provisional construction

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permits, even though there may exist at the time of issuance unresolved safety questions relating to important design features, provided that a research and development program will be conducted which is reasonably designed to resolve the safety questions. The intent of this proposed revision is to prevent unreasonable delays, which could total 1 to 3 years in construction of most developmental reactor projects, pending resolution of all substantial safety questions. However, no action has been taken toward issuing this third revision of Part 50 pending a final court decision in the case of the construction permit issued to the Power Reactor Development Co. which now is in litigation.

The Commission continued work on two studies directed toward establishing safety criteria for reactors which would provide advance guidance for organizations in designing reactors or in choosing sites for them. Both studies were nearing completion at the year's end. The central problem is to determine whether development of reactor technology has reached a point that would permit delineating specific safety requirements either for design or for sites. Specific criteria could have both advantages and disadvantages. Knowing in advance the specific safety criteria which the Commission would apply would enable reactor-building organizations to plan with more assurance and with a firmer estimate of costs. At the same time, fixed criteria during a period of rapidly evolving technology could place obstacles in the way of innovations in reactors that might accomplish needed economies in construction and operation. Establishment of criteria would in no way relax the Commission's requirements that its health and safety standards be met.

During the year the Commission also notified applicants for facility licenses of specific procedural steps to be taken in licensing actions and their relation to project schedules. The Commission established, after consultation with the applicants, tentative schedules for regulatory actions designed to prevent necessary procedures from causing delays in reactor construction and startup schedules.

A complete revision of Part 140, Financial Protection Requirements and Indemnity Agreements, was issued effective May 7, 1960. In issuing the revision the Commission made it clear that those sections of the regulation relating to financial protection required of those licensed to construct and operate reactors would be re-evaluated in consultation with licensees and the insurance syndicates concerned. A conference for this purpose was held October 11, 1960, and at the end of the year the Commission was considering recommendations on the regulation

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Land Burial of Wastes

In January 1960, the Commission announced a policy for land disposal of radioactive wastes. It provides for permanent land-burial of low-level packaged radioactive wastes only on Government-owned land, under long-term Government control, to assure adequate protection of public health and safety throughout the period of any potential hazard. Interim sites initially selected, pending possible later designation of permanent land-burial sites to serve various areas of the country, are on Federal reservations at the National Reactor Testing Station in Idaho and the Oak Ridge National Laboratory grounds in Tennessee. The new policy is not expected to affect commercial sea disposal activities being carried out under Commission licenses, except as convenience or economic factors may influence sea disposal firms to use land burial facilities.

When growth of the atomic energy industry establishes the need for new sites, the Commission expects that State governments may wish to establish and control sites for the benefit and convenience of their citizens.

The low-level wastes to which the policy applies include broken glassware, rags, paper, laboratory paraphernalia, and the like. Such solid wastes, packaged to meet the Interstate Commerce Commission regulations will be acceptable for burial at the two designated sites. Licensees will pay transportation costs. Charges for burial will be at a rate of 70 cents per cubic foot with a minimum charge of $21 for 30 cubic feet or less of packaged wastes. Details regarding this service are available from the Manager of Operations at either the Oak Ridge or Idaho Operations Office.

High-level wastes from the chemical processing of irradiated fuels will continue to be stored in specially designed underground storage tanks at Commission sites where these elements are processed.

A related amendment to Part 20 of the Commission's regulations permits Commission licensees to continue past practices in burial of their own very low-level wastes, but prohibits issuance of licenses to receive wastes from others for disposal on land not owned by the Federal or State governments (see later section on "Waste Disposal Licensing").

INFORMATION FOR INDUSTRY

Through further declassification of technical information, publication of increased numbers of reports, abstracts, books, translations and technical films, and revision of access permit categories, the Com-

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mission continued during 1960 to enlarge and improve the availability of technological material to the atomic energy industry. These activities are detailed in Part Two of this report; only highlights are summarized in this section.

The new Classification Policy Guide, issued in January, opened up entire areas of information previously classified—for example, all chemical engineering activity relating to atomic energy. The 37 categories of classified information previously requiring access permits for interested industry were reduced to 2. Some 5,000 additional documents were declassified.

Four new technical books were published, and six others were in press. Engineering drawings of atomic energy equipment were made available through a commercial source. Some 300 foreign language, chiefly Russian, documents were translated and placed on sale. Ten new professional-level films were prepared. More than 4,000 copies of classified reports, and 150,000 unclassified reports were sold, and more than 5,000 new unclassified reports were placed on sale.

Gas Centrifuge Information

The Commission initiated late in 1960 a revision of its regulation on access permits (10 CFR 25) to allow private industry to work in the classified area of gas centrifuge separation of heavy isotopes. This action was taken after industry informed the Commission that it believed there was substantial commercial potential in using gas centrifuges to provide enriched fuels (enriched in uranium 235) for reactors.

Under the proposed amended regulation permitting industrial access, industry could use its own funds for development work in this field, and, under appropriate safeguards, retain the benefits of its achievements. The amendment is a necessary first step toward establishing a basis for a commercial service to provide enrichment of fuels—a service now provided only by Commission plants.

The gas centrifuge was one of the methods investigated during the war-time program for producing weapons-grade uranium 235 concentrations. When development work at that time indicated this method was not ready for use in producing the required quantities and grades of uranium 235, work on this process was discontinued temporarily, and the present gaseous diffusion process was emphasized. Work on the gas centrifuge method was resumed in 1953 in the United States and has been expanded gradually as the technology advanced.

Scientists in other western countries also have been engaged in developmental work on gas centrifuge separation for many years. A

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major goal is to find a cheaper way to produce uranium 235 for the relatively low enrichments required for most types of nuclear power reactors and to expand the sources of fuel supply. The gas centrifuge method also could find use in separating plutonium isotopes, uranium 233-uranium 235 mixtures, and other stable isotopes now made available only in small quantities by electromagnetic separation.

Scientific effort aimed at lowering the cost of nuclear fuels also could develop the capacity for producing highly enriched uranium 235 for use in nuclear weapons. It is impossible, however, to fix a precise time schedule when this might be possible by the gas centrifuge method because of the early stage of development and uncertainties in the pace of technology.

The technology of gas centrifuge separation is not now developed to a point where this process can produce uranium 235 at a cost competitive with the product from the gaseous diffusion plants. However, projections of possible gains in the gas centrifuge process indicate the possibility that the process may become attractive from the economic standpoint in the future. This would come only after very substantial further advances in centrifuge technology. For the United States, the gaseous diffusion method remains the most economical process for large-scale production of uranium 235 at this time.

The Commission's research and development program on the gas centrifuge system is described in Part Two under Production of Special Nuclear Materials. A statement by Chairman John A. McCone on the gas centrifuge, and a Commission report on the current status of gas centrifuge technology, made public in December 1960, are included as appendix 20.)

Two possible advantages of the gas centrifuge method are its low requirement for electrical power and its requirement for fewer units in series in order to produce the necessary enrichment. The United States has kept abreast of advances in the gas centrifuge field outside its own program. Because of its potential significance to production of weapons materials, the United States program is classified.

Access to advanced industrial and technical resources would be required in order to develop and build within the span of a few years, a gas centrifuge plant able to produce enough enriched uranium for an initial atomic weapon. To achieve such a production capability, it would be necessary to install large numbers of centrifuges in a complex arrangement.

Scientists in West Germany and the Netherlands have worked to develop the potential of the gas centrifuge process for its interesting scientific and commercial possibilities. They have been particularly

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interested in the potential of the centrifuge for the production of low enriched uranium for civilian research and power reactors.

In July 1960, representatives of the Department of State and of the Atomic Energy Commission discussed centrifuge technology with the West German and Netherlands governments in connection with general discussions on the peaceful uses of atomic energy.

The United States asked that Germany and the Netherlands give consideration to the control of gas centrifuge technology. The governments of these two countries shared our concern over the implication of the centrifuge process for weapons development.

The United States also has discussed the gas centrifuge question with the United Kingdom. Both the United Kingdom and Canada follow classification criteria similar to those of the United States on the gas centrifuge process.

The West German Government announced late in 1960 that it had taken steps to control the dissemination of information on the gas centrifuge process. The United States understands that the Netherlands Government is actively studying the question of applying controls to its work.

Many of the civil reactors planned or in operation throughout the world will produce materials which can be used in nuclear weapons. The United States has supported broad international action to insure that nuclear material used in civil programs is not diverted to military use.

The General Conference of the International Atomic Energy Agency, which met in Vienna in September, endorsed proposed safeguards to apply to reactors and special nuclear materials that will be subjected to IAEA controls. The principles of these safeguards can be extended to apply to the gas centrifuge.

Reactor Physics Data Centers

As a means of providing a centralized source of information on neutron cross section data needed by reactor engineers, designers, and physicists, the Commission has established a Cross Section Evaluation Center at the Brookhaven National Laboratory. Information generated at the center will be available to the nuclear industry.

The basic working unit at the center will be the recently-formed Neutron Cross Section Evaluation Group, which will evaluate cross section measurements and make theoretical extrapolations of the data. The services of the group will also be available in determining the completeness of measurements in various areas and knowledge of planned experiments to improve and broaden measurements knowledge. The informa
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edge. The information processed by the group will be obtained from Commission laboratories and other facilities engaged in neutron cross section measurement studies.

The Commission's Advisory Committee on Reactor Physics will serve as a consultant body and assist in establishing priority assignments for critical evaluations and theoretical assessments. Contractual arrangements have been made with the Nuclear Development Corp. of America for consultant services.

Other reactor physics data centers include the Neutron Cross Section Compilation Center, also located at Brookhaven, which compiles and publishes all seemingly reliable results of neutron cross section measurements; and the Reactor Physics Constants Center at Argonne National Laboratory, which compiles, evaluates, and publishes determinations of quantities other than cross section, quantities exemplified by the number and energy of neutrons emitted in fission, values of resonance integrals, neutron age in reactor materials, and the types of fission products resulting from fission.

Patents

In keeping with the Commission's practice of securing United States and foreign patents on worthy inventions originating under Commission sponsored work, 230 additional United States patents issued during calendar 1960. The Commission today has a portfolio of some 2,499 United States patents available for royalty-free licensing. As of December 1, 1960, 801 licenses within this group had been granted.

The Commission's portfolio of foreign patents on December 31, 1960, numbered some 505, an increase of about 215 during the year. The Commission, under a policy adopted in December, will license Commission-owned foreign patents for royalties to nationals of those countries charging royalties of the U.S. Government or its citizens. No royalty charges are made in those countries extending free royalty licensing to United States citizens. Where a foreign government has no policy, Commission decision on charges will be made on a case basis. Licenses or foreign patents granted by the Commission may be exclusive or nonexclusive for a period of 3 to 5 years.

The Commission adopted a new policy in December of authorizing contractors to file for foreign patents and retain substantive rights under specified terms and conditions. The policy applies to inventions

derived from work performed in privately owned or operated facilities, and is retroactive to include existing contracts.

In order to secure the foreign patent rights, the contractor is to file the United States application which would serve as a basis for the foreign application. The Commission acquires the rights in the United States application but the contractor would retain all rights in the foreign applications subject to receipt by the U.S. Government of a nonexclusive, irrevocable license to the U.S. Government for U.S. governmental purposes, with the right of the U.S. Government to grant licenses to foreign governments for purposes of use by such foreign governments pursuant to a treaty or agreement with the U.S. Government or any agency thereof. The contractor is required to grant, upon request, nonexclusive, royalty-free licenses to United States citizens and agrees to grant to foreign users and purchasers of a product of a United States licensee, a license at a reasonable nondiscriminatory royalty. If after 5 years of the issuance of a particular foreign patent the contractor or its assignee cannot demonstrate, upon the Commission's request, that practical application has been made of the subject matter covered by such foreign patent, the contractor or its assignee shall, at the request of the Commission, grant licenses on any such foreign patents at reasonable royalties.

MANPOWER FOR ATOMIC ENERGY

The Commission began during 1960 an annual collection and analysis of statistics on total employment[17] in atomic energy activities throughout the United States. As of January 1960, total employment including private, Federal contract, and direct Federal employment exclusive of members of the Armed Forces was estimated at approximately 185,000 of which only 10,000 represent direct Federal employment.

Detailed figures for 1960 cover about two-thirds of total employment; the survey for 1961 will be expanded to include the remaining third which, this year, is estimated on the basis of data collected for other purposes.

The two-thirds of the work force surveyed this year by the Bureau of Labor Statistics, Department of Labor, at the request of the Com-

[17] This employment comprises research and production activities exclusively and directly devoted to the development of goods and services for the atomic energy field, including uranium mining, milling, enrichment of uranium, reactor manufacturing, operation of reactors, etc., and various types of nuclear research as well as training in nuclear subjects. Excluded are the actual applications of reactors, (transmission and consumption of electricity are excluded) nuclear ship operation, industrial, medical, and pharmaceutical applications, etc.

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mission,[18] is employed by 158 establishments operated by 130 prime contractors of the Commission. These establishments have reported total employment in their atomic energy activities, including both those working full-time on Commission contracts and also those who devote part or full-time to private research or industrial atomic energy operations. Among the 130 prime contractors, 29 operate 38 Government-owned facilities which employ about 70 percent of the total work force of the prime contractors.

The 158 establishments operated under prime contracts with the Commission employ a total of 125,921 (see Table 1). In addition, the Government's direct employment is estimated at 10,000 (excluding the Armed Forces, but including the Commission), and industrial and educational organizations that do not hold prime contracts with the Commission employ an estimated 48,900 (see Table 2).

Among the establishments under Commission prime contracts, scientists and engineers made up 20 percent of all employees as of January 1960. Skilled workers made up 19 percent of the total, and technicians and other technical personnel 15 percent (see Table 3). The high percentage of skilled workers results from the complexity of products, precise tolerances required, and the custom manufacture of many products required.

Distribution of Manpower

Of ten major segments of the atomic energy field,[19] laboratories and research facilities employed 33 percent of the 126,000 workers included in the survey, and defense production facilities—the production of uranium 235, plutonium and weapons—employed 28 percent, production of feed materials an additional 9 percent of the total. Reactor design and manufacturing accounted for another 9 percent. The remaining 21 percent was distributed among 6 other major segments, and one small miscellaneous category.

The largest number of employees in single occupation was 4,400 mechanical engineers. Other occupations with substantial employment were maintenance mechanic, 3,100; chemist, 3,100; and electrical

[18] Employment in the Atomic Energy Field, Results of a 1960 Survey, Bureau of Labor Statistics, Department of Labor, January 1960, Superintendent of Documents, Government Printing Office, Washington 25, D.C.

[19] The 10 major segments are: (1) Commission laboratory and research facilities, (2) atomic energy defense production facilities, (3) reactor and reactor component design and manufacturing, (4) production of feed materials, (5) design, engineering, and construction of nuclear facilities, (6) private research laboratories and centers engaged in atomic energy work, (7) production of special materials for use in reactors, (8) uranium milling, (9) fuel element fabrication, and (10) power reactor operation and maintenance, plus a small miscellaneous category.

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or electronic engineer, 3,000. It is of interest to note that a numb
of persons are employed in occupations peculiar to atomic energy
for example 372 Health Physicists, 720 Health Physics Technician
and 881 Reactor Operators.

1961 Requirements

As of January 1960, when the survey was made, need for an increa
of 4,000 employees by January 1961 was forecast by Commission prim
contractors (see Table 1). Commission-owned laboratories expecting
to need 1,800 additional employees, defense production facilities 1,40
Requirements included 1,000 engineers and 850 scientists.

The 1961 round-up of atomic energy employment will include
survey of industrial employment by the Bureau of Labor Statistics
a survey of Federal employment by the Civil Service Commission, and
a survey of employment in universities and colleges by the Office of
Education, Department of Health, Education, and Welfare.

The Commission participates in the Government-wide effort de
signed to increase the pool of professionally and technically compe-
tent workers available in the United States, and in other countries
of the free world. These various programs are described, as appro-
priate, in sections of this report on International Activities, Radio-
isotope and Radiation Development, Education and Training, and
Health and Safety.

TABLE 1.—EMPLOYMENT IN THE ATOMIC ENERGY FIELD, 158 AE
PRIME CONTRACTORS

Type of Activity	January 1959		January 1960		January 196 (anticipated	
	Number	Percent	Number	Percent	Number	Perce
Atomic Energy Commission laboratories	40,531	32.81	42,172	33.49	43,951	3
Atomic energy defense production facilities	35,627	28.84	35,590	28.26	36,945	2
Reactor design and manufacturing	12,049	9.75	11,760	9.34	12,149	
Production of feed materials	12,003	9.72	11,717	9.31	11,631	
Construction of nuclear facilities	6,319	5.12	6,575	5.22	6,320	
Private research laboratories	4,832	3.91	5,295	4.21	5,725	
Production of special materials	3,222	2.61	3,584	2.85	3,555	
Uranium milling	3,261	2.64	3,432	2.73	3,500	
Fuel element fabrication	2,924	2.37	2,903	2.31	3,021	
Power reactor operation	235	.19	366	.29	531	
Miscellaneous	2,527	2.05	2,527	2.01	2,373	
Total, all activities	123,530	100.00	125,921	100.00	130,007	10

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

TABLE 2. EMPLOYM

Uranium mining-----
Research at universiti
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Other university resea
Research and develop
tories not under co
Nuclear instrument m
service and manufac
Government (exclusiv
Construction of nucle

Total----------

TABLE 3.—EMPLOYM
PRIME CONTI

Occupa

Scientists----------
Engineers----------
Technicians----------
Other technical personnel---
Managerial, administrative,
Clerical and other office pers
Skilled trades----------
Other production, maintenar
Service workers----------
Nuclear reactor operators----

Total, all employees---

SOURCE: U.S. Departmen

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TABLE 2. EMPLOYMENT IN ATOMIC ENERGY FIELD, EXCLUSIVE OF AEC PRIME CONTRACTORS

Field	*Number Employed*
Uranium mining	4,100
Research at universities with AEC contracts other than those covered in the survey and including supporting personnel	15,000
Other university research and teaching, including supporting personnel	11,400
Research and development in private (other than universities) laboratories not under contract with AEC	1,300
Nuclear instrument manufacturing, radioactive waste disposal and other service and manufacturing establishments not under contract to AEC	2,200
Government (exclusive of military)	10,000
Construction of nuclear facilities	15,000
Total	59,000

TABLE 3.—EMPLOYMENT IN THE ATOMIC ENERGY FIELD, 158 AEC PRIME CONTRACTORS, BY MAJOR OCCUPATIONAL GROUP

Occupational Group	January 1960		January 1961 (anticipated)	
	Number	Percent	Number	Percent
Scientists	9,488	7.53	10,333	7.95
Engineers	15,112	12.00	16,154	12.43
Technicians	14,612	11.60	15,393	11.84
Other technical personnel	3,744	2.97	4,017	3.09
Managerial, administrative, and other professional personnel	12,417	9.86	12,599	9.69
Clerical and other office personnel	18,537	14.72	18,413	14.16
Skilled trades	23,881	18.97	24,383	18.76
Other production, maintenance, and construction workers	17,495	13.89	17,933	13.79
Service workers	9,754	7.75	9,824	7.56
Nuclear reactor operators	881	.70	958	.74
Total, all employees	125,921	100.00	130,007	100.00

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

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Part Two

Major Activities in Atomic Energy Programs

January–December 1960

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Raw Materials

Receipts of domestic uranium oxide, plus imports, totaled 33,500 tons of uranium oxide (U_3O_8) during 1960, of which 17,730 tons were from domestic suppliers, 11,310 tons from Canada, and 4,460 tons from overseas.

Progress was made during the year in stretching out uranium deliveries to bring supply more nearly in line with projected current requirements. Under agreements negotiated with Canada, approximately 9,300 tons of U_3O_8 in Canadian concentrates scheduled for earlier delivery have been deferred until after April 1, 1962. Similarly, 3,050 tons scheduled for earlier delivery from domestic producers have been deferred and will be delivered in the 1962–1966 period. Negotiations with other domestic producers are continuing. The Commission program for bonus payments upon initial ore deliveries from new domestic mines expired on March 31, 1960.

Shipments totaling about 400 tons were received through September from the Congo, completing deliveries under this long standing contract. Uranium concentrate deliveries under long term Combined Development Agency contracts with Australia, Portugal, and South Africa were continued at a normal rate during the year.

The Commission has virtually completed negotiations of all proposals submitted in accordance with the program announced April 2, 1958, of limited expansion of milling facilities to provide a market for ores developed prior to November 1, 1957, in those areas where milling capacity was inadequate. The Commission also worked toward completion of arrangements with mine operators and milling companies pursuant to its modified purchase program for the 1962–66 period announced November 24, 1958.[1] Property holders seeking to qualify under this program have submitted statements claiming ore reserves developed prior to November 24, 1958. Agreements on these reserves have been reached with the owners of most large deposits, but a number of small properties remain to be examined.

DOMESTIC ACTIVITIES

Production

The United States maintained its position as the world's leading producer of uranium. Uranium ore production in the United States

[1] See pp. 5–6 and 353–365, Twenty-fourth Semiannual Report to Congress (January–June 1958), p. 8, Twenty-fifth Semiannual Report to Congress (June–December 1958), and pp. 56–57, Annual Report to Congress (January–December 1959).

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totaled 8.0 million dry tons during 1960, as compared to 6.9 million tons in the previous 12 months. Production of uranium oxide (U_3O_8) in concentrates for the year totaled 17,730 tons.

Ore Reserves

Preliminary estimates of domestic uranium ore reserves totaled 82.0 million tons containing 0.28 percent U_3O_8 as of December 31, 1960, a decrease of only about 4.0 million tons from the previous year-end estimate despite the fact that 8.0 million tons were mined during the year. In addition, approximately 1.3 million tons of ore were in Government and private stockpiles at the end of 1960.

Only a portion of the estimated ore reserves in a number of large deposits will be mined to meet deliveries to the Commission under existing contracts extending through 1966. Notwithstanding the reduced level of exploration that followed the placing of limitations on purchases, and the absence of important new discoveries during the past two years, substantial domestic ore reserves will still be available in 1967. The estimate is that the equivalent of between 45 and 50 million tons of average grade ore (0.25 percent U_3O_8) from present reserves will remain. Additional reserves routinely developed during the course of mining may add several million tons.

These reserves, although not large in terms of the long-range requirements of a major atomic power program, would provide a firm base for the domestic mining industry and they could be augmented by renewed exploration as demand increases.

1962–1966 Purchase Program

Under a November 24, 1958, announcement, the Commission limited its purchase of domestic uranium concentrates during the period April 1, 1962–December 31, 1966, to appropriate quantities of concentrates derived from ore reserves developed prior to November 24, 1958. Producers wishing to qualify under the 1962–66 procurement program were given until October 1, 1959, to file statements and supporting data showing ore reserves developed as of November 24, 1958. The Commission received statements covering claimed reserves on approximately 2,650 properties involving many thousands of mining claims. The November 1958 ore reserves contained in most of the larger deposits have been calculated, and agreements reached as to production allocations with the operators. A number of small properties remain to be examined.

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In accordance with the 1962–66 uranium purchase program, a number of contracts with ore processing mills have been modified and extended to provide an appropriate market in the post-1962 period for uranium concentrates produced from reserves developed prior to November 24, 1958. In addition, a contract was executed with the Petrotomics Co. which provides that the company may, at its option, build its own mill to produce concentrates in the 1962–66 period from ores located in the Shirley Basin, Carbon County, Wyo., qualifying under the November 24, 1958, announcement, or arrange for treatment of its ores at some existing plant. Of 25 mills now operating, 13 have contracts extending through 1966, and two have contracts which terminate in 1965 by reason of a limited eligible ore supply. Extensions of other milling contracts will be considered in the light of eligible ore reserves tributary to the mills. The major features of each of the contracts are in Appendix 19.

Milling Operations

With the exception of final action on a contract for the purchase of uranium from the lignite area of North Dakota-South Dakota, the



Largest Mill. Twenty-five domestic mills are currently processing uranium ore for the Commission at the rate of 22,100 tons of ore per day, and three more mills now under construction or planned will increase production by approximately 1,000 tons. Shown in this aerial photo is the largest of the mills in operation, the Nuclear Fuels Corp. uranium mill at Grants, N. Mex., which processes 1,200 tons of ore a day. The ore is primarily from the Ambrosia Lake district which is the nation's largest known body of uranium ore reserves.

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Commission has completed its contracting of limited expansion milling facilities in accordance with the program announced April 1958,[2] in areas where milling capacity was inadequate for ores developed prior to November 1, 1957. In the lignite area, completion of a contract with International Resources Corp., involving the purchase of U_3O_8 produced from uraniferous lignite, is pending. Reassessment of ore supply by milling companies resulted in a reduction in the total amount of additional mill capacity as estimated in April 1958.

Increases in capacity resulting from contracts involving new facilities and expansion of existing mills are as follows:

	Tons per day	
	Contemplated in April 2, 1958 announcement	Provided to date
Southeast Texas	600	[a] 200
North Dakota-South Dakota (lignites)	600	[b]
Wyoming (Gas Hills-Crooks Gap)	1,700	1,200
Colorado Front Range	200	200
Nevada (Austin)	200	...
	3,300	1,400

[a] Mill under construction.

[b] Pending contract would provide for plant having initial capacity of 200 T/day with proposed increase to 600 T/day after April 1, 1962.

Southeast Texas. The April 2, 1958, announcement provided for a 600-ton-per-day mill in Southeast Texas, based upon ore deposits located in Duval and Karnes Counties. Several companies investigated the feasibility of such an operation, but their studies led to the conclusion that a greater portion of the Duval deposits could not be mined economically and that a milling operation would depend largely on the ores in Karnes County. Susquehanna-Western, Inc., in July 1960, signed a contract with the Commission to supply uranium concentrates from a 200-ton-a-day processing plant to be built 10 miles southwest of Falls City, Tex.; it will draw its major ore supply from Karnes County.

North Dakota-South Dakota. Negotiations with International Resources Corporation, which may result in the construction of a plant in this area to process uraniferous lignites, have been concluded. Execution of the contract is waiting completion of financial and management arrangements.

The Company originally planned a 600-ton-per-day mill but the pending contract calls for construction of a plant to process 200 tons

[2] See Appendix 11, p. 352, Twenty-fourth Semiannual Report to Congress (January–June 1958).

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Bonus Payments

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Vanadium Sales

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[1] See p. 9, and pp. 127–

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lignite a day with a provision for increasing the capacity to 600 per day after March 31, 1962.

Wyoming. The additional capacity of 1,560 tons of ore per day provided for Wyoming was attained through construction of two new mills, one by Globe Mining Co., and one by Federal-Radorock-Gas Mills Partners; and by additions to the capacity of two existing mills, one operated by Western Nuclear, Inc., and one by Utah Construction and Mining Co. (formerly Lucky Mc Uranium Corp.). The original program for this area provided also for expansion of Susquehanna-Western's mill at Riverton, Wyo., but this expansion was dropped because the production rate of eligible ores did not require expansion in plant capacity.

Colorado Front Range. The 200-ton-per-day mill indicated for this area was provided for by expansion to 200-tons-per-day capacity of the 50-tons-per-day Cotter Corp. pilot plant at Canon City, Colo.

Austin, Nevada. Ore from the principal property near Austin is being marketed at existing mills in other areas, and no proposals are under consideration for a Nevada mill.

A list of operating mills, and those under construction as of December 31, 1960, is given in Table 1.

Bonus Payments

The Commission's program of bonus payments for initial production from new domestic sources of uranium ores expired on March 31, 1962. Between March 1, 1951, when the program began,[3] and termination, total bonuses of approximately $17.7 million were paid for initial production of about 5.4 million pounds of U_3O_8. The bonus program, which was established when domestic reserves and production appeared small, encouraged uranium prospecting and exploration and assisted miners during early development of new ore bodies.

Vanadium Sales

In April, the Commission's Grand Junction Operations Office issued a public invitation for bids on approximately 1.5 million pounds of vanadium pentoxide. The Vanadium Corp. of America was the successful bidder and purchased the entire quantity at $1 a pound.

[3] p. 9, and pp. 127–134, Tenth Semiannual Report to Congress (January–June 1951).

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TABLE 1.—URANIUM PROCESSING PLANTS

Company	Location of mill	Present contract terminates	Tons of ore per day	Estimated cost of [illegible]
Anaconda Co.[a]	Grants, N. Mex.	12/31/66	3,000	
Climax Uranium Co.	Grand Junction, Colo.	12/31/66	330	
Cotter Corp.	Canon City, Colo.	2/28/65	200	
Dawn Mining Co.	Ford, Wash.	12/31/66	400	
Federal-Radorock-Gas Hills Partners	Fremont Co., Wyo.	12/31/66	520	
Globe Mining Co.	Natrona Co., Wyo.	12/31/66	490	
Gunnison Mining Co.	Gunnison, Colo.	12/31/62	200	
Homestake-New Mexico Partners	Grants, N. Mex.	3/31/62	750	
Homestake-Sapin Partners[a]	do	12/31/66	1,500	
Kermac Nuclear Fuels, Corp.	do	12/31/66	3,300	
Kerr-McGee Oil Industries	Shiprock, N. Mex.	6/30/65	300	
Lakeview Mining Co.	Lakeview, Oreg.	11/30/63	210	
Mines Development, Inc.	Edgemont, S. Dak.	3/31/62	400	
Phillips Petroleum Co.[a]	Grants, N. Mex.	12/31/66	1,725	
Rare Metals Corp. of America	Tuba City, Ariz.	3/31/62	300	
Susquehanna-Western, Inc.[b]	Falls City, Tex.	12/31/66	200	
Susquehanna-Western, Inc.[c]	Riverton, Wyo.	12/31/66	500	
Texas-Zinc Minerals Corp.	Mexican Hat, Utah	12/31/66	1,000	
Trace Elements Co.	Maybell, Colo.	3/31/62	300	
Union Carbide Nuclear Co.	Rifle, Colo.[d]	3/31/62	1,000	
Union Carbide Nuclear Co.	Uravan, Colo.	3/31/62	1,000	
Uranium Reduction Co.	Moab, Utah	12/31/66	1,500	
Utah Construction & Mining Co.[e]	Fremont Co., Wyo.	12/31/66	980	
Vanadium Corp. of America	Durango, Colo.	3/31/62	750	
Vitro Chemical Co.	Salt Lake City, Utah	3/31/62	600	
Western Nuclear, Inc.	Jeffrey City, Wyo.	12/31/66	845	
		TOTALS	22,300	
PROPOSED MILLS				
International Resources Corp.[f]	Bowman, N. Dak.			
Petrotomics Co.[g]	Carbon County, Wyo.	12/31/66		

[a] Amended contracts which include provisions for delivery stretch-out to 1962–66 period:

	Tons U_3O_8
Anaconda Co.	2,000
Homestake-Sapin Partners	700
Kermac Nuclear Fuels Corp.	1,850
Phillips Petroleum Co.	500
Total	5,050

[b] Under construction.

[c] Formerly Fremont Minerals, Inc.

[d] Union Carbide Nuclear Co. also buys and upgrades ore at Slick Rock, Colo. and Greenriver, U[illegible] feed for the Rifle, Colo. mill.

[e] Formerly Lucky Mc Uranium Co.

[f] Pending contract would provide for plant having initial capacity of 200 tons/day with propos[illegible] crease to 600 tons/day after April 1, 1962.

[g] Commission contract provides that Petrotomics Co. may, at its option, construct a mill for proc[illegible] of U_3O_8 covered by the contract in the 1962–66 period or make arrangements with existing mills fo[illegible] recovery.

NOTE: The above listed mills are privately owned and operated and are licensed to buy uraniu[illegible] from producers. The USAEC buys the concentrate product under the terms of a contract with each operator.

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G PLANTS

Present contract terminates	Tons of ore per day	Estim... cost of ...
12/31/66	3,000	$19,...
12/31/66	330	3,...
2/28/65	200	1,...
12/31/66	400	3,...
12/31/66	520	3,...
12/31/66	490	3,...
12/31/62	200	3,...
3/31/62	750	2,...
12/31/66	1,500	5,...
12/31/66	3,300	9,...
6/30/65	300	16,...
11/30/63	210	3,...
3/31/62	400	2,...
12/31/66	1,725	1,...
3/31/62	300	9,...
12/31/66	200	3,...
12/31/66	500	2,...
12/31/66	1,000	3,...
3/31/62	300	7,...
3/31/62	1,000	2,...
3/31/62	1,000	8,...
12/31/66	1,500	5,...
12/31/66	980	11,...
3/31/62	750	6,...
3/31/62	600	5,...
12/31/66	845	4,...
TOTALS	22,300	143,...

12/31/66		

tch-out to 1962–66 period:

	Tons U_3O_8
	2,000
	700
	1,850
	500
	5,050

lick Rock, Colo. and Greenriver, Ut...

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The concentrate stored at Grand Junction, Colo., had been bought from uranium processing mills under earlier contracts that provided the Commission would purchase vanadium extracted from uranium-vanadium ores when vanadium production was in excess of current commercial requirements. Such contracts helped maintain uranium production from ores of the Colorado Plateau containing values of both uranium and vanadium—originally the only domestic source of uranium. Commitments of this kind have been reduced by revision of mill contracts, and will terminate March 31, 1962. An additional 3 million pounds of vanadium is being offered for sale with bids to be opened in January 1961.

...dioactive Hazards in Mills and Mines

The Commission transferred administration of the contract for operation of the Process Development Laboratory at Winchester, Mass., from the Division of Raw Materials to the Division of Biology and Medicine, effective July 1, 1960. Originally operated to develop and improve ore processes, this laboratory has been working since 1957 on techniques and procedures for determining and reducing radiation hazards connected with milling operations—work that will benefit from being more closely associated with other biomedical studies.

The Division of Raw Materials continues to act in a liaison capacity with the milling industry with respect to radiation hazards and will continue to sponsor meetings for technical discussions in this area. Such a meeting was held in October at Grand Junction, Colo., attended by representatives from the milling industry, the Public Health Service, State organizations, and personnel from various Commission divisions.

Compliance actions relating to licensed uranium milling operations are reported in the section on Licensing, Regulation and Indemnification.

Enforcement of mine safety, including control of radiation hazards, is a principal responsibility of the States. Most uranium-producing States have established permissible concentration levels in mines for radon and its decay products. However, mine management also must assume major responsibility for maintaining safe working conditions established by the States as mine workings are continually being extended and adequate ventilation must be provided for new working areas.

The Commission controls several uranium mining properties that are operated privately under lease agreements, and has arranged with

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the Bureau of Mines for periodic health and safety inspections, incl... ing radiation surveys. As a result of these surveys and Commiss... inspections, ventilation and dust control have been improved. Th... gains are believed to demonstrate that, in most cases, the concentra... of radon gas—a radioactive decay product of radium always associa... with uranium—can be controlled in mines, without unduly prohibi... costs.

In December, a conference of the governors of the States concer... with uranium mining was held in Denver, Colo. This confere... sponsored by the Secretary, Department of Health, Education, a... Welfare, and attended by representatives of interested governm... agencies, was called for the purpose of discussing possible radiat... hazards in uranium mines.

FOREIGN ACTIVITIES

Deliveries of foreign uranium concentrates to the United Sta... during 1960 totaled 15,770 tons of contained U_3O_8 with 11,310 to... coming from Canada and the rest coming from Australia, Belgi... Congo, Portugal, and South Africa under contracts of the Combi... Development Agency.

Canada

In November 1959, the Canadian Government and the Commiss... announced an agreement for stretching out deliveries of uranium u... der existing contracts.[4] The announcement also stated that the Co... mission would not exercise its options to purchase additional Canadi... uranium concentrates in the post-1962 period.

The stretch-out arrangements will result in a major deferral ... United States deliveries amounting to approximately 9,300 tons ... U_3O_8 which will be delivered in the period March 31, 1962–Decemb... 31, 1966, when the Commission's total purchase commitments are low...

Overseas Procurement

Deliveries under Combined Development Agency contracts wi... Australia, Portugal, and South Africa were normal. Shipm... under the Agency contract for Congo uranium were completed.

[4] See pp. 61–62, Annual Report to Congress (January–December 1959).

Belgian Congo

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Belgian Congo (The Republic of Congo)

Union Miniere du Haut-Katanga began refining some ores to metal-grade uranium oxide in 1958 and deliveries of this product, in lieu of concentrate, began in December of that year.

Deliveries from the Congo in September completed the contract with CDA's most important historic supplier. Since the first delivery in the latter part of 1942, over 30,000 tons of U_3O_8 were produced from the Belgian Congo, most of which came to the United States. Throughout World War II, the Shinkolobwe mine, located in Katanga Province, Congo, in Africa, was the principal source of uranium and supplied most of the material for the early weapons program. It continued to be the most important source for a number of years after the war when supplies of uranium were critically short.

South Africa

In February, exploratory discussions were held in South Africa between representatives of the Combined Development Agency and the South African Atomic Energy Board regarding a possible stretch-out in production and in deliveries to the Agency. Discussions were continued in Johannesburg in November.

Assistance to Foreign Countries

Limited technical assistance in uranium exploration in Brazil, Chile, and Peru was terminated at the end of the year.

Production of Special Nuclear Materials

During calendar year 1960, production of special nuclear materials required for weapons manufacture, research and development, and for peaceful applications of atomic energy, was in accordance with schedules. The total cost of the special nuclear materials program in 1960 was $553 million as compared with $541 million in 1959, an increase of 2.2 percent.

Raw materials receipts at the two feed processing plants located at Fernald, Ohio and Weldon Spring, Mo., were in line with current requirements. The eight graphite reactors at Hanford, Wash., and the five heavy water reactors at Savannah River, S.C., were operated to produce the requirements for both plutonium and tritium

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during 1960. The gaseous diffusion plants located at Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio, were operated to produce the 1960 requirements for uranium 235. Process development effort was directed toward technical plant support to assure continuity and safety of operations, development and improvement of processes and equipment, and attainment of the required production levels.

Disposition of Facilities

Following an operations analysis study, the feed materials processing plant at Destrehan St. in St. Louis, Mo., was closed in June 1958. In August 1960, bids were received for building demolition and site restoration, and a demolition contract was awarded to Arch Wrecking and Salvaging Co. on October 25. Demolition is expected to be completed in May 1961. The buildings and equipment are owned by the Commission, the land by the Mallinckrodt Chemical Works.

Mallinckrodt will take over the land and some of the buildings and facilities which the company has agreed to purchase, such as the incoming power station and equipment, the steam power plant and equipment, storage tanks, fencing, railroad siding and tracks, as well as some of the metal plant buildings. Before the demolition contract was let, $1,461,000 worth of usable equipment at acquisition value was transferred within the Commission or to other Government agencies, and an additional $402,000 worth of equipment, at acquisition value, was sold to Commission licensees in the uranium industry. Restricting the sale of this equipment to licensees made it unnecessary to decontaminate the equipment prior to sale.

New Production Reactor

Design and construction of the New Production Reactor (NPR) at Hanford, Wash., proceeded satisfactorily during 1960. As of November 30, design was estimated to be 80 percent complete, construction was 7.5 percent complete, and about 60 percent of the major equipment had been ordered.

Completion of construction is scheduled for October 1, 1962, the original target date. Costs of the reactor are expected to remain within the $145 million authorized by Public Law 85–590. These costs do not include supporting facilities, estimated at an additional $7.2 million.

The NPR fuel elements will be slightly enriched uranium metal clad by co-extrusion with zircalloy-2. The co-extrusion and fuel element finishing operations will be performed by the General Electric

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[1] "Reactor Power Plan
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at Hanford. Proposals from private industry were received during the summer in response to an invitation for proposals to manufacture, in private facilities, the uranium metal billets for the coextrusion process. The prices quoted by private concerns exceeded by a substantial margin the costs of producing these billets in Government facilities. Consequently the Commission decided to produce the fuel billets in Government facilities.

A study on the economic feasibility of converting the NPR for the recovery of electric power was made by the Federal Power Commission (FPC); its report was published during February 1960.[5] Arrangements have been made for additional studies, including an updating by FPC of its earlier report, to be available in 1961.

Gas Centrifuge Studies

The Commission has recently increased its effort on development of the gas centrifuge process of isotope separation to an expected total of approximately $2 to $3 million per year. The development program will continue to be classified. (See Appendix 20 for AEC statement on gas centrifuges.)

The expanded program includes three major areas:

Continuation of basic research which has been underway at the University of Virginia, Charlottesville, Va.

Experimental operation of small groups of machines incorporating presently available technology. This work is being performed for the Commission by Union Carbide Nuclear Corp. at Oak Ridge, Tenn.

Development of advanced gas centrifuge models. Interested private companies with the best capabilities for contributing to the program will be invited to submit proposals to perform development work on the advanced machine under contract for the Commission.

Military Application

Production of nuclear weapons by the Commission continued during 1960 as authorized by the President. The production effort included

[5] "Reactor Power Plant Economic Feasibility Study" TRD–5762. Price $2.50, available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

meeting new weapon system capabilities, modernization of older and less efficient designs in stockpile, and a retirement program for obsolescent weapons.

The Commission's program of weapons research and development has consisted during 1960 essentially of laboratory study and analysis of data obtained on the 1958 Hardtack and earlier nuclear test series, with a large portion of the effort being devoted to translating these results into operational weapons to meet specific Department of Defense requirements. These efforts have been fruitful and defense needs for numerous weapons of various weights and yields have been met.

Further intensive research and refinements by the United States nuclear weapons organizations, even without tests, can continue to produce some design improvements. However, without nuclear testing, major advances in nuclear weapons design do not appear possible.

Test Facilities

The Eniwetok Proving Ground and its facilities were maintained on a stand-by basis until June 30, 1960, when the facilities were made available to the Department of Defense for its Pacific Missile Range. The Proving Ground will remain available for Commission activities if needed. Weapons test facilities at the Nevada Test Site have been maintained on a stand-by readiness state.

Weapons Facilities

Work was initiated on the construction of a $2 million plant for treatment of chemically and radiochemically contaminated liquid wastes generated by the metallurgical, chemical, biological and cryogenic laboratories at Los Alamos Scientific Laboratory, Los Alamos, N. Mex. Construction also began on a $3 million special metal fabrication plant at Oak Ridge, Tenn. to meet weapons production requirements.

Transfer of ballistic drop test operations from the Salton Sea Test Base, Calif. to Tonopah Test Range, Nev. began during 1960 and is expected to be completed during 1961 at which time the Salton Sea Base will be placed on a standby basis. The Tonopah Test Range[1]

[1] See p. 66.

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northwest of the Navada Test Site and is used for determining the ballistic characteristics of inert (non-nuclear) weapons shapes dropped from aircraft and for firing high altitude research rockets.

Computer facilities are being expanded. Additional computing systems are required to solve complex weapons research problems. In addition, there are problems which require computer solutions in other fields of research being carried on by those laboratories participating in research on such programs as controlled thermonuclear reaction and nuclear propulsion.

Mutual Defense Agreements

Exchanges of information under Agreements for Cooperation with other nations for mutual defense purposes, reported in the Annual Report to Congress for 1959,[6] continued during 1960. The United States-United Kingdom Agreement for Cooperation, which is considerably broader than other agreements, involves the exchange of classified information on nuclear weapons and the exchange of visits between scientists of the two countries.

The United States has mutual defense agreements in effect with Australia, Canada, France, the Federal Republic of Germany, Greece, The Netherlands, Turkey, the United Kingdom, and the North Atlantic Treaty Organization (NATO).

Weapons Test Negotiations and Related Research

The United States voluntary suspension of nuclear weapons tests continued in 1960. This suspension dates back to October 31, 1958, when negotiations between the United States, the United Kingdom and the Union of Soviet Socialist Republics began at Geneva on a treaty for the discontinuance of nuclear weapons testing.

To put in perspective the United States position on its voluntary suspension of nuclear weapons tests it is necessary to review the history of the test cessation negotiations beginning with the 1958 Conference of Experts at Geneva. This group, comprising representatives of the United States, United Kingdom, France, Canada, Soviet Union, Poland, Czechoslovakia and Rumania, met from July 1 to August 21 and concluded that it was technically feasible, within

[6] p. 86.

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certain limits, to set up a world-wide control system for the detec
of violations of a possible agreement on the cessation of nucl
weapons tests. Following this, President Eisenhower announced
August 22, 1958, that the United States, taking account of the
neva conclusions, was prepared to proceed promptly to negotiate
agreement with other nations which have tested nuclear weap
for the suspension of nuclear weapons tests and the actual establi
ment of an international control system on the basis of the exper
report. He also announced that, provided the Soviet Union
likewise, the United States would suspend nuclear weapons te
for a period of one year from the beginning of the negotiati

Representatives of the United States, United Kingdom and Sov
Union began negotiations on a test ban treaty on October 31, 1958.
the negotiations proceeded it became apparent that it would be diffic
to reach agreement with the Russians on the establishment of an eff
tive control system to police any test ban treaty. A special Uni
States scientific panel concluded that, on the basis of data which h
become available since the 1958 Conference of Experts as a result of t
underground nuclear explosions of HARDTACK II—the last series
United States weapons tests held at Nevada Test Site in the fall
1958—underground explosions are more difficult to identify than h
been previously believed. This information was presented to t
United Kingdom and the Soviet Union in Geneva in early Janua
1959. On January 22, the Soviet Union responded by questioning t
need to consider any new information which differed from the agre
conclusions of the Conference of Experts.

In April and May of 1959, President Eisenhower's proposal to b
all nuclear tests in the atmosphere as an initial step in arriving a
safeguarded treaty was rejected by Soviet Premier Khrushchev w
insisted that the treaty encompass the testing of nuclear weapons in a
environments. However, Mr. Khrushchev did agree in a letter to Pre
ident Eisenhower dated April 23, 1959, that it should be possible to
tablish such controls as would guarantee strict observance of the trea
He also agreed to have the Soviet Union join in an experts meeting
controls for high altitude nuclear detonations. Later the Soviet Un
agreed to have their experts re-examine underground detection wi
the United States and United Kingdom. However, this latter confe
ence which convened in November 1959 concluded with major d
agreement between the experts of the Western allies and the exper
the Soviet Union.

In December 1959, President Eisenhower noted that the negot
tions had been in progress for 14 months and that no satisfacto
agreement was in sight. He called attention to the fact that prospe

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an agreement had been injured by the unwillingness of the politically guided Soviet experts to give serious scientific consideration to the effectiveness of seismic techniques for the detection of underground nuclear explosions. Therefore, he said the voluntary moratorium would end on December 31, 1959, and the United States would consider itself free to resume nuclear weapons testing but would not do so without announcing its intention in advance of any resumption.

In February of 1960, the United States proposed a phased treaty which would immediately end all nuclear weapons tests in environments in which controls could be established. These would include tests in the oceans, those above ground as high as effective controls could be agreed upon, and underground tests above a seismic magnitude of 4.75 (equivalent to a 19 kiloton yield in Nevada tuff). The proposal also called for a research program among the three countries to improve the capability of detecting underground seismic events below a magnitude of 4.75. The United States proposal was rejected immediately by the Soviet Union, but on March 19, 1960, a Russian counter-proposal was made which accepted the threshold figures, provided that the negotiating parties agree not to test below the 4.75 seismic threshold while a joint research program to improve underground detection capabilities was being conducted. The Russians estimated that this research program would take 4 to 5 years. On March 29, 1960, President Eisenhower and British Prime Minister Macmillan offered to agree to institute a unilateral moratorium of agreed duration, and effective on treaty signature, on tests below the 4.75 seismic threshold, provided that a treaty was signed and that a coordinated program for improving the capability of detection and identification of underground nuclear tests was agreed to and instituted without delay.

The Russians indicated general agreement on May 3, and on May 11 a conference of scientists from the United States, United Kingdom, and the Soviet Union met in Geneva to exchange views on the conduct of a coordinated seismic research program. These experts reached what appeared to be a wide area of agreement. On May 27, however, the U.S.S.R. delegate to the test cessation negotiations overruled the views of the U.S.S.R. experts and stated instead that: the Soviet Union continues to recognize the recommendation of the 1958 Experts Report as being adequate; furthermore, the Russians would not conduct a seismic research program in Russia; and they would not carry out high explosive experiments which their scientific experts had indicated they would perform. In addition, the U.S.S.R. delegate subsequently stated that all aspects of any United States seismic research program, including the interpretation of all data generated, would have to be open to Russian participation, and the devices used

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would be subject to Soviet internal inspection. Otherwise, the Rus-
sians said, they would consider that the United States had resume
nuclear weapons testing and they would do likewise.

The importance of the research program can be illustrated by the
following discussion of the problems involved in monitoring a possible
agreement on nuclear weapons test cessation. Nuclear weapons tests
can be conducted in four environments:

In the *atmosphere*, with the resultant production of fallout. How-
ever, an adequate number of air sampling detection stations and air-
craft sampling flights could detect nuclear detonations of any
appreciable size. Such a series of stations and flights was recom-
mended by the 1958 Geneva Conference of Experts.

Deep underwater. It is expected that detonations of moderate size
carried out deep in the oceans would probably not produce atmospheric
fallout in amounts adequate for detection at appreciable distances.
Hydroacoustic stations could monitor such underwater signals and
radioactivity would be dispersed rapidly in the vast quantities of
water which would be evidence that such a test had taken place.
However, pinpointing the violator in this case would be difficult.

Detonations *above the sensible atmosphere* produce little, if any,
fallout. Adequate detection methods for such tests do not now exist
and, in fact, cannot be proven to be effective without further extensive
research and experimentation in this medium.

Underground tests produce no fallout if they are completely con-
tained beneath the earth's surface. This lack of fallout eliminates
the one established way in which nuclear detonations might be proved.
There is no known way of proving that an underground nuclear
explosion has occurred other than by on-site inspection which, in
order to achieve the difficult objective of proving a violation, involves
extensive drilling operations to obtain a sample of radioactive debris.
Current instrumentation if installed in a world-wide control system
could provide information on the location of significant seismic events
and in some cases identify the event as an earthquake. It cannot
identify all seismic events as being natural in origin, nor can it dis-
tinguish between nuclear and conventional explosives. Further com-
plicating the picture is the possibility of nuclear detonations being
hidden by the decoupling technique, the use of a large underground
cavity as the site for a nuclear test in order to reduce, up to perhaps
a factor as great as 300, the resulting distant seismic signal.

The Russian negotiators at Geneva have offered to permit only
three "on site" inspections per year in their country for all unidentified
seismic events. The United States position is that, in view of the fact

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that more than 100 locatable seismic events of greater than 4.75 magnitude occur each year in the Soviet Union, 20 percent of these should be eligible for inspection (20 inspections per year). The proposed treaty would cover only events above seismic magnitude 4.75 and there are thousands of seismic events lower than the 4.75 threshold annually in that country.

On the proposed research program to improve capabilities of detecting and identifying underground nuclear events, the Russians have taken the position that no such program is needed and that adequate capability already exists. However, they have demanded the right to participate in the United States program and to inspect both the internal and external construction of any devices which the United States proposes to use in its seismic research program. They have rejected two United States offers to guarantee that no weapons development information would be obtained from any nuclear tests in the seismic research program. One of the two United States proposals rejected by the Soviet Union would permit Russian inspection of United States devices, provided they also contributed devices and allowed United States inspection. Yet, they have threatened to resume nuclear weapons testing if the United States should use any nuclear devices in its seismic research program without their agreement on the safeguards to be employed for assuring no weapons development.

In the United States view, an adequate capability for detecting and identifying underground and outer space nuclear detonations must be developed, if possible. To do this it is necessary to:

a) Develop improved instrumentation and techniques to detect and identify the nature of seismic events. The improvement necessary can be obtained only by developing and assembling necessary instrumentation and testing its capability through a seismic improvement program which includes both nuclear and chemical detonations.

b) Develop instrumentation and techniques for the detection of nuclear explosions in space.

c) Establish an adequate world-wide detection network based on the recommendations of the Geneva Conference of Experts improved on the basis of data gathered since 1958 and on data which must be obtained from further scientific efforts and experimental research programs.

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d) Obtain agreement on a sufficient number of on-site inspections to be reasonably sure that no clandestine underground testing of nuclear weapons is taking place above an agreed threshold. The agreement must have a reasonable relation to the number of natural seismic events which occur in each country, and the capability of the system.

To improve the capability of detecting and identifying seismic events and detecting detonations in space, the United States has embarked on the VELA program which is aimed at attempting to improve the capability of detecting and identifying nuclear detonations for the purpose of developing an adequate system capable of monitoring a nuclear test ban treaty. During 1960, the Commission participated with other Federal agencies in this program.

Project VELA is under the direction of the Advanced Research Projects Agency, Department of Defense. It grew out of recommendations by the Berkner Panel on Seismic Improvement—a panel of scientists competent to advise in this field which was appointed by the President's Advisor on Science and Technology and chaired by Dr. Lloyd V. Berkner, president of Associated Universities. Its recommendations were made known to the Geneva negotiators on June 12, 1959.

On May 7, 1960, President Eisenhower approved a major expansion of the research and development directed toward seeking an improved capability to detect and identify underground nuclear explosions. He announced that $10 million was funded for the fiscal year that ended June 30, 1960, and that an estimated $66 million was contemplated for fiscal 1961. Participating in the program are the Commission, the Department of Defense, the Department of Commerce, the Department of Interior, universities and private organizations.

The VELA program has three parts:

VELA-UNIFORM—to increase the level of basic research in seismology; procurement of instrumentation for a world-wide seismic research program; development of improved seismic instruments; construction and operation of prototype seismic detection stations; and an experimental program of underground nuclear and high explosive detonations to provide signals for the experimental research.

The Commission in a program related to project VELA conducted successfully a series of non-nuclear high explosive experiments between December of 1959 and March of 1960 in the Carey Salt Mine near Winnfield, La. The purpose of these experiments was to measure seismic effects resulting from these explosions and to verify the

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theory of decoupling, that is, the use of a large underground cavity as a site for an explosion to reduce the seismic signals generated. These experiments proved that decoupling is possible and that the seismic signals are reduced markedly if a detonation occurs in a sufficiently large hole. Unexpectedly, these experiments also proved that lesser, but significant, factors of decoupling also occur in holes which are smaller than the size predicted as adequate by the theory.

Laboratory study and investigation have been carried out by the AEC on various phases of the seismic research program. In addition, bids have been asked for exploratory drilling in a Mississippi salt dome to determine if it is suitable for use as a possible site for nuclear detonations as part of the seismic research program. The Commission also is preparing sites at its Nevada Test Site for detonations in this program. VELA program plans call for 11–12 high explosive and about 11–13 nuclear detonations. Final schedules have not yet been established.

VELA-SIERRA—to develop ground-based instruments for possible detection of nuclear explosions in near space.

In this program, the Commission's Los Alamos Scientific Laboratory has developed and is testing an experimental air fluorescence detection station and is having developed an experimental direct optical detection station to examine reactions to natural phenomena in the upper atmosphere and near space.

VELA-HOTEL—to develop satellite-based instruments and systems to detect nuclear explosions in space.

In this program, Los Alamos and Sandia Laboratory, which is operated for the Commission by Sandia Corp., a subsidiary of Western Electric Co., Inc., have carried out research and development on nuclear detection instrumentation for possible inclusion in satellites, and Lawrence Radiation Laboratory is engaged in some space background measurements under this program.

The Seismic Improvement Program is being carried out solely for the purpose of increasing our basic knowledge of seismology and the development of instrumentation and techniques necessary for improving the monitoring capabilities of a control system. The Seismic Improvement Program is not part of PLOWSHARE, the program to develop nuclear explosives for peaceful purposes.

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As 1960 drew to a close, the three negotiating countries in Geneva—after negotiating for more than 2 years—still had not reached agreement on the major issues.

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Military Reactor Development

ARMY REACTORS PROGRAM

Major emphasis during 1960 in the Commission-Army program was on development of four types of reactors that are compact and light weight, and capable of being set up rapidly and at minimum cost to provide power and heat at remote military installations. The four types are the pressurized water, boiling water, gas-cooled and compact reactor systems.

Pressurized Water Reactors

Stationary Medium Power Plant No. 1 (SM–1)

On July 1, 1960, responsibility for the SM–1 pressurized water reactor was assumed by the Army's Corps of Engineers, following more than 3 years of successful operation by a Commission contractor. The 1,855 kwe (kilowatts electric) plant, the first prototype reactor developed within the Army program, continued in operation for training military operators, for research and development test projects, and for production of electricity at Fort Belvoir, Va., where the plant is situated.

The first core had produced 16,470 thermal kilowatt years of power by April 28, when the first replacement of fuel was necessitated. This was 1,430 kilowatt years more than expected on the basis of design analyses. More than 28 million kilowatt hours of electricity was produced with the first loading. In September, two fuel elements were replaced with special test elements and the other elements were rearranged to further extend the core burnup and to test the two added elements.

At the year's end, 92 military operators had completed one-year training courses conducted in conjunction with plant operation. The operators include personnel from the three military services who will operate military field plants such as the SM–1A in Alaska and the PM–2A in Greenland, as well as the SM–1 itself. Additional military crews will be trained to operate the PM–1 at Sundance, Wyo., and the PM–3A at McMurdo Sound in the Antarctic.

Stationary Medium Power Plant No. 1A (SM–1A)

The SM–1A, located at Fort Greely, Alaska, is essentially a direct extrapolation of the SM–1 design to a higher power output to provi

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1,640 ekw of electric power and 38 million BTU's per hour of steam for space heating (the SM–1 does not provide any space-heating steam). Construction, which began in June 1958, was delayed several months by steel shortages, local strikes and in-transit damage to plant equipment, but is expected to be essentially complete in March 1961. Acceptance of the completed plant by the Army is anticipated for June 1, 1961.

Stationary Medium Power Plant No. 2 (SM–2)

The SM–2 pressurized water project was initiated originally as a Commission effort to develop a 6,000 ekw core for use in a plant being designed for the Army by Alco Products, Inc.

This plant was originally required to provide reliable high quality power for use at Nike-Zeus missile sites. As a result of a later Department of Defense decision not to use nuclear power for these sites there now is no direct requirement for the SM–2 plant. Accordingly, the SM–2 core and pressure vessel program will be continued only to complete certain design and development test work now in progress which will provide a substantially complete design.

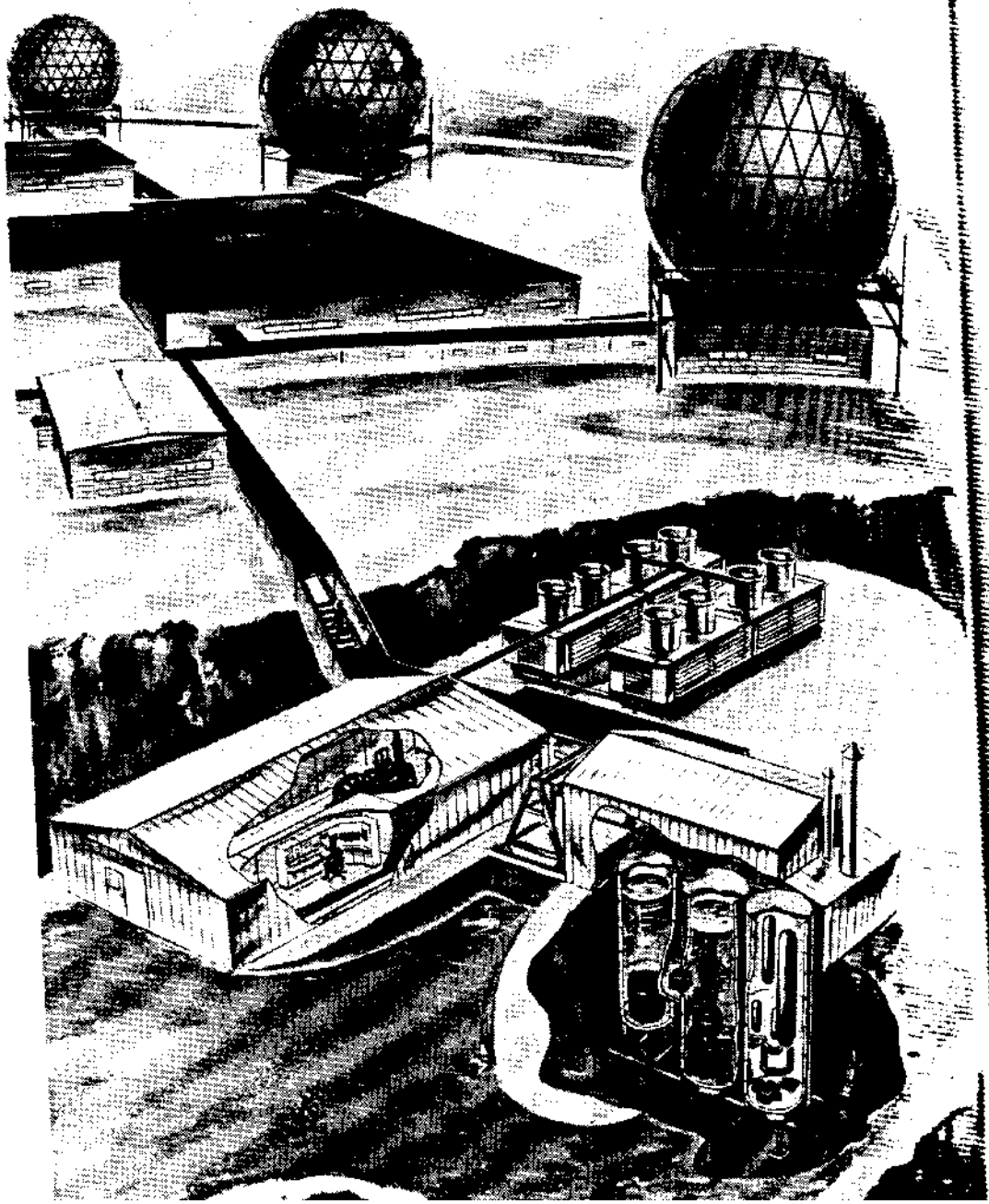
Portable Medium Power Plant No. 1 (PM–1)

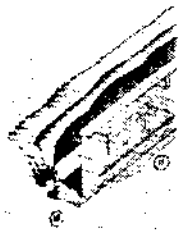
This pressurized water prototype is a factory-assembled, modular, air-transportable nuclear power plant developed under Commission contract with the Martin Co. and funded in part by the Air Force. Initial operation at Sundance Air Force Station, Wyo., is scheduled for September 1961.

This plant is capable of being transported in 16 cargo aircraft and can be erected within 60 days. These two features are of particular importance at remote installations where construction time and support facilities are severely limited. For example, in polar environments the construction season is so short that any on-site construction requiring more than 3 or 4 months must necessarily extend over two or more years. The PM–1 is the first plant incorporating stainless steel, uranium oxide, tubular fuel elements.

Portable Medium Power Plant No. 2A (PM–2A)

The PM–2A, located at Camp Century in Northern Greenland, about 150 miles east of Thule, is a further development based upon the SM–1 design. This plant was fabricated in 27 packages which were assembled and subjected to nonnuclear tests at Dunkirk, N.Y.





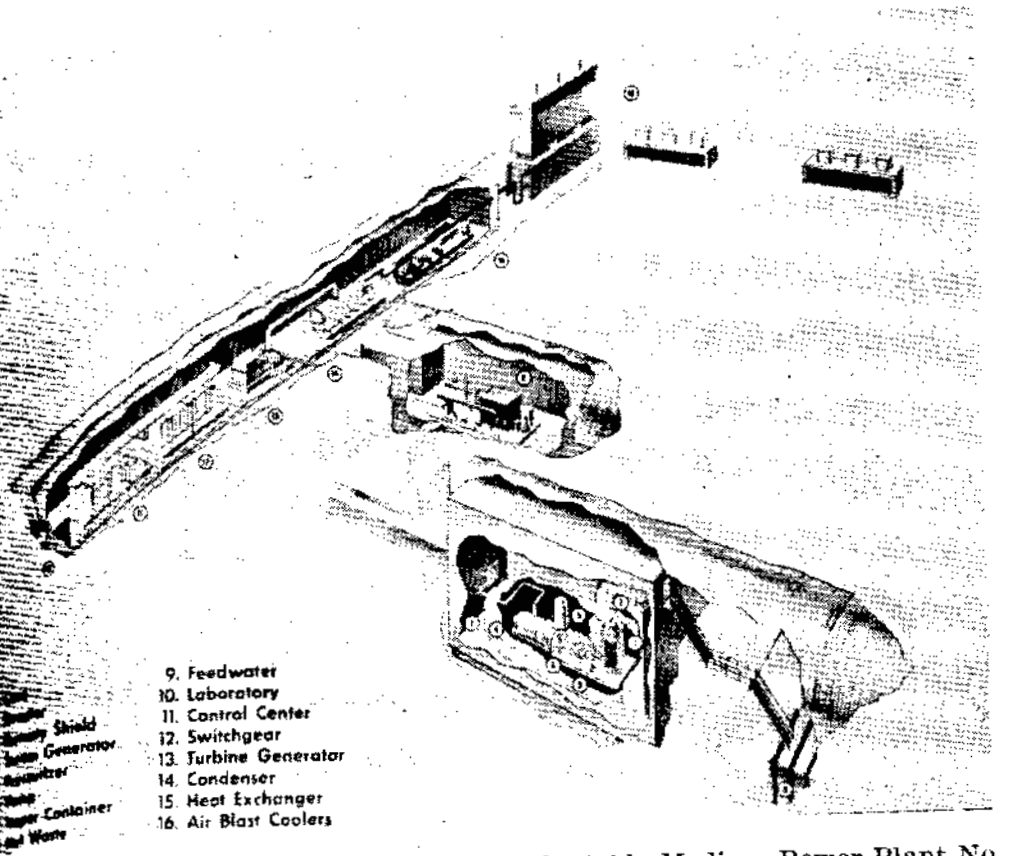
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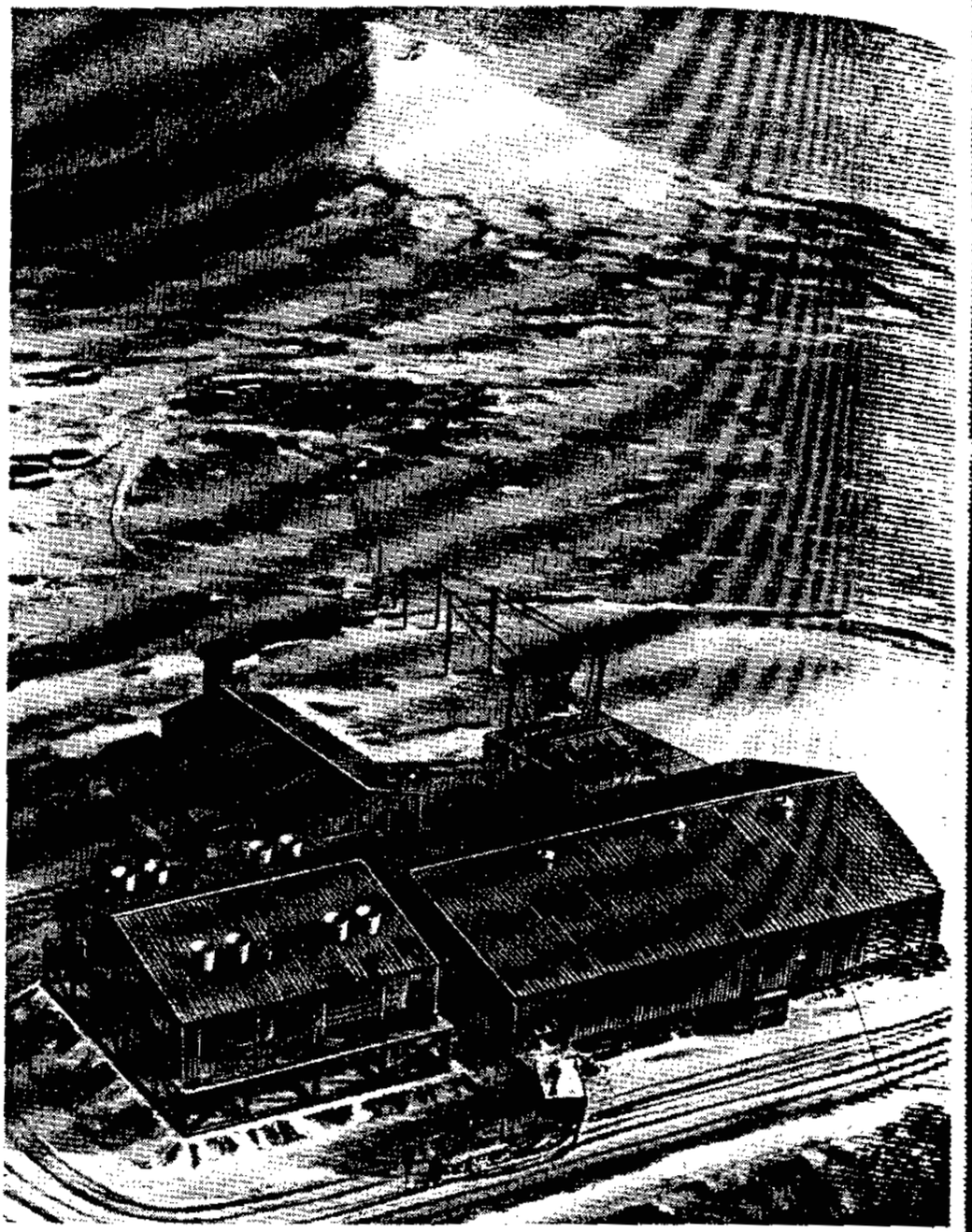
...ctic Reactor. Artist's cutaway view of the Portable Medium Power Plant No. ...(PM-2A) now in operation at a remote Army post in northern Greenland. ...1,500 ekw pressurized water reactor plant was shipped to Greenland in 27 ...ages during June and installed in snow tunnels. It became operational ...November and is the first reactor to provide power and heat for a remote ...ary post. The only above-snow portions of the plant are the cooling towers ...right of photo).

...plant then was disassembled and shipped by air and sea to Camp ...ury. On-site construction and testing in tunnels in the Green- ...Ice Cap, where the average temperature is 5° F., required 3½ ...ths. Full power operation was attained in November, the first ...tor to start supplying power and heat for a remote military post. ...plant produces 1,500 ekw and 1 million BTU's per hour in the ...of steam for space heat.

...table Medium Power Plant No. 3A (PM-3A)

...August a contract was awarded to the Martin Co. for design, ...struction and test operation of a prepackaged 1,500 ekw pressurized ...plant to be shipped, in November 1961, to McMurdo Sound ...Antarctic Continent. Martin's proposal was selected from ...three submitted.

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Antarctic Power Plant. The Portable Medium Power Plant No. 3A (PM-3A) is expected to look like the above artist's conception when installed on a ridge overlooking the Naval Air Facility at McMurdo Sound in the Antarctic. The plant, using a pressurized water reactor, will produce 1,500 kilowatts of electricity for the principal base of all United States scientific efforts on the southernmost continent. The plant is scheduled to be shipped, in sections, to the Antarctic during November 1961.

The contract was for a fixed price with guaranteed performance and contained provision for payment of liquidated damages in event of failure to deliver on schedule, or to perform according to specifications.

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On March 31, the Commission reported to Congress on a study of the economics of nuclear power at various remote military installations. Ten sites were investigated in different areas throughout the world, and it was established that at several remote locations military requirements for power could be met economically with nuclear power. McMurdo Sound in the Antarctic was one of the most promising sites found.

In May a further report was presented to the Congress on the Byrd and South Pole stations in the Antarctic. Power required at these two stations was less than the range of 5,000 to 40,000 ekw established as criteria for the original study. At both these two locations, nuclear power shows a marked economic advantage over conventional power in view of the fact that delivered diesel fuel costs several dollars a gallon. Construction of nuclear plants was authorized at Byrd and South Pole sites in Antarctica but funds were not appropriated during 1960.

Nuclear Test Plant (NTP)

This core test facility was scheduled for completion in late spring 1962, with a SM–2 core, the first to be tested. As a result of a change in plans cancelling immediate requirement for the SM–2 core, and because of the absence of definite plans to use small pressurized water plants in appreciable numbers in the near future, it was decided not to construct the NTP.

Pressurized Water Reactor Model and Code

The Martin Co. continued the program to develop a nuclear physical model and fuel calculation code for pressurized water-cooled and moderated reactors. The ultimate objective is to provide methods to permit design of cores with longer life, improved power distribution, reduced coolant flow and pressure requirements, and to refine methods of reactor control. Through an associated experimental tests program, the physical models and calculation codes developed will be verified and compared experimentally with critical experiments, and actual reactor operating data.

Boiling Water Reactor

Stationary Low Power Plant No. 1 (SL–1)

This small stationary boiling water plant continued to operate during 1960 at the National Reactor Testing Station, where it was used

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primarily as an operating prototype for the design and develop... of the PL–1 and PL–2, 200 ekw and 1,000 ekw prepackaged ver... respectively. Also, the reactor was used to train military oper... and to provide operating data relating to military use of this k... of plant.

Development and fabrication of a stainless steel core to replace ... installed aluminum core was underway. Installation of the cor... the SL–1 is scheduled for mid-1961. As of the end of 1960, the pl... had operated for 9,300 equivalent full power hours and had genera... about 1.9 million kilowatt hours of electrical power.*

Gas-Cooled Reactor Systems

Gas-Cooled Reactor Experiment (GCRE)

This reactor achieved initial criticality at the National Rea... Testing Station on February 23. Full power operation at 2 M... (thermal) started in July. The initial developmental core contai... plate fuel elements was replaced in September by a core contai... new pin elements. The GCRE achieved full power with the se... core in November.

The reactor was operated to develop engineering data for incor... ration in the Mobile Low Power Reactor No. 1 (ML–1), a proto... gas-cooled mobile plant. The ML–1 (reactor and power conver... equipment combined) is to be transportable by standard military s... trailer or aircraft. It will have a net capacity of 300 to 500 kw ... pending on ambient temperature conditions.

Construction of the prototype ML–1 reactor will be complete... Aerojet-General Corp. in January 1961 and reactor criticality ... scheduled for April 1961 at the National Reactor Testing Sta... Idaho.



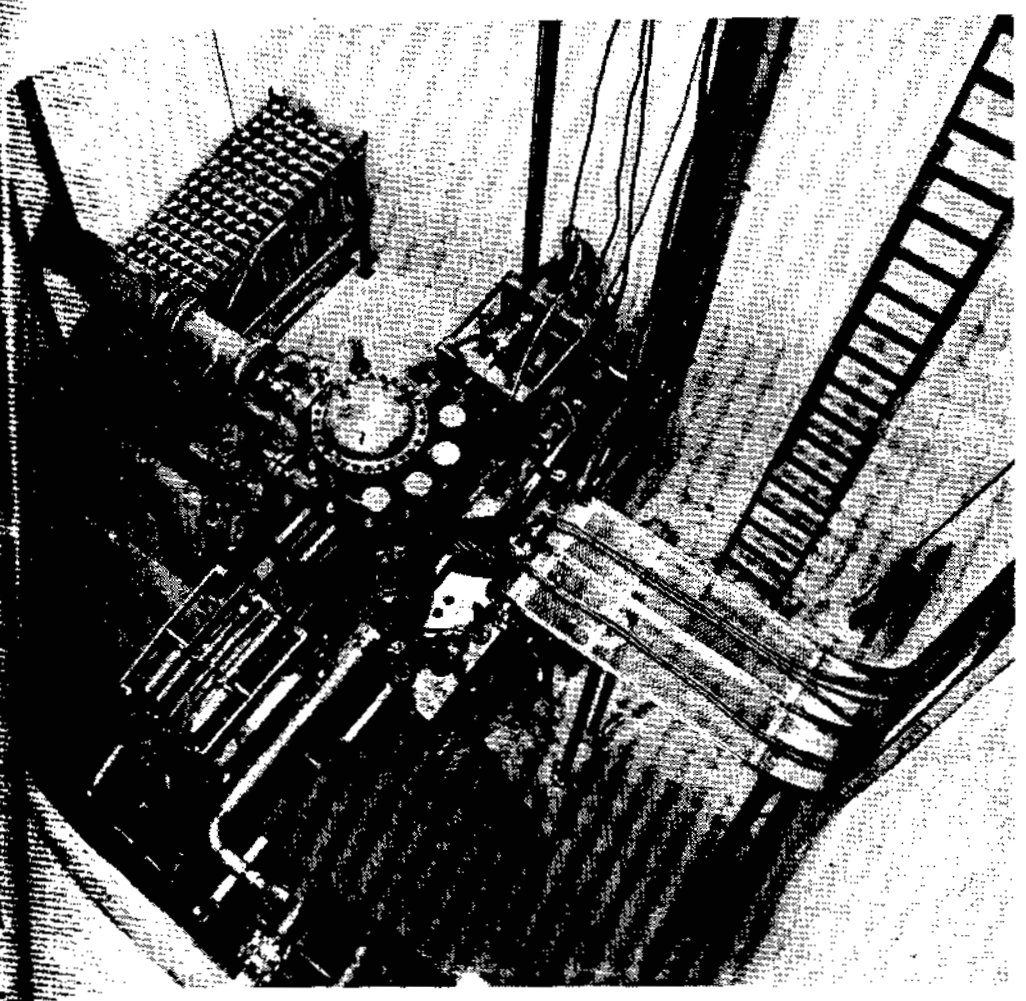
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On June 27, a co... ...p. of America ... ...light weight, c... ...2000 to 3,000 ek... ...plications. The ... ...ors Corp. Pre... ...e to the end of J...

* On January 3, 1961 an accident at the SL–1 reactor caused the death of tw... and one Navy man who were getting ready to start the closed-down reactor. Determ... the cause of the accident and measures to be taken to prevent its recurrence was ... a large task force of experts as this report went to press.

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...cooled Experiment. Successful full-power operation of the Gas-Cooled ... Experiment (GCRE) during July marked an important milestone in ...opment of the first direct- and closed-cycle gas-cooled reactor in the United ... In such a system the gas, heated within the reactor core, is used to drive ...ine and then is recycled to the reactor. Photo shows view looking down ...RE pit at National Reactor Testing Station in Idaho.

Compact Reactor

...y Compact Reactor (MCR) Program

...June 27, a contract was signed with the Nuclear Development ... of America for preliminary design and development of a mo... ...ght weight, compact nuclear power plant having a power rating ... to 3,000 ekw. Such a plant could serve a variety of military ...tions. The principal subcontractor for the project is General ... Corp. Preliminary design and development effort will con... ...the end of June 1961.

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Supporting Activities

Army Reactor Experimental Area (AREA)

A section of the National Reactor Testing Station is designated the Army Reactor Experimental Area (AREA). Reactors in the Army Program and necessary support facilities are located within AREA.

Construction of support facilities, including hot cells, a shop and maintenance building, and necessary utilities was completed by Tel Construction Co., Idaho Falls, Idaho, on February 29. Phillips Petroleum Co. was selected in May as operating contractor. Hot cell operation started in August.

NAVAL REACTORS PROGRAM

Nine nuclear-powered naval vessels were launched during 1960, including 8 submarines and an aircraft carrier, as the United States continued the expansion of its nuclear fleet. Fourteen nuclear submarines were in operation, 21 others were under construction and more authorized; a guided missile cruiser, a guided missile destroyer (frigate), and an aircraft carrier were under construction.

The nuclear submarines continued to hang up "firsts"—a mid-winter cruise of 6,000 miles submerged under polar ice; a submerged circumnavigation of the earth.

The first nuclear submarine equipped with Polaris missiles bearing nuclear war-heads has started its first mission after a series of successful tests with unarmed missiles.

Nuclear Fleet

Submarine Fleet Reactor (S3W/S4W)

In January and February, the USS *Sargo* carried out the first mid-winter cruise under the polar ice cap. Sailing from Pearl Harbor she gained access to the Arctic Basin by way of the Bering and Chukchi Seas, thus proving it possible for a nuclear-powered submarine to travel this shallow route at any time of year. The *Sargo* surfaced at the North Pole February 9 and returned to the open Pacific via the Bering Sea. She steamed 6,000 miles under ice in 31 days and surfaced 20 times, frequently through the ice.

In August, the USS *Seadragon* completed an east-to-west crossing from the Atlantic to the Arctic Ocean by way of Baffin Bay and Parry Channel. After reaching the North Pole, the *Seadragon* entered the

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High Speed Submar

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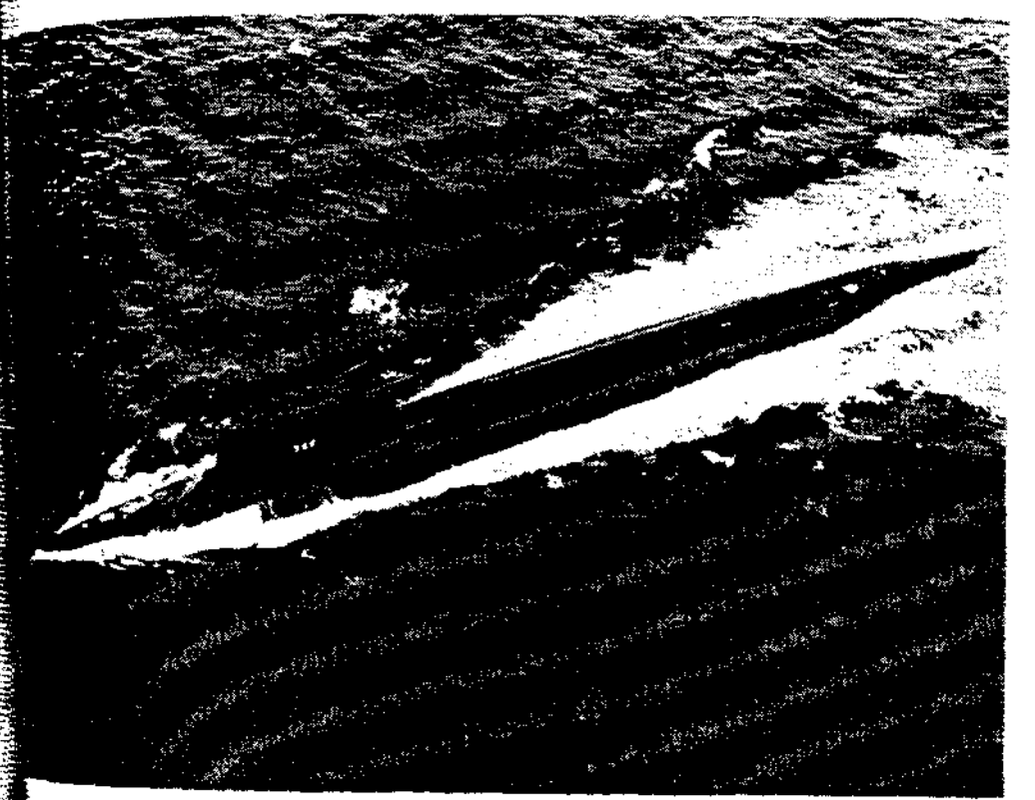
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Pacific by way of the Chukchi and Bering Seas and continued on to Pearl Harbor in Hawaii. She steamed a total of 11,231 miles of which 10,415 were submerged. *Seadragon* proved the feasibility of an all-weather Northwest passage for submarines.

High Speed Submarine Reactor (S5W)

The High Speed Submarine Reactor is the plant used by most of the nuclear submarine fleet. A total of 37 submarines which will use this plant have been authorized by Congress, including 23 attack submarines and 14 Polaris ballistic missile-launching submarines. Two high speed attack submarines, the *Sculpin* and the *Shark*, were launched in March, a third, the *Thresher*, in July, and a fourth, the *Tunny*, in October. The *Scorpion*, commissioned in July, is the second of these attack type submarines to become operational. The *Skipjack* was commissioned in April 1959.

Three Polaris-launching submarines are operating. The *George Washington* was commissioned in December, 1959, the *Patrick Henry* on April 9, and the *Robert E. Lee* on September 16, 1960.



Triton. Ever since the USS *Nautilus* put to sea, the U.S. Navy's nuclear-powered submarines have been performing history-making voyages. The latest exploit during 1960 was the 36,014-nautical mile submerged voyage around the world of the USS *Triton* (shown above). The *Triton* is the first submarine with two reactors for propulsion power.

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Nuclear-Powered Carrier. When the nation's first nuclear-powered aircraft c
rier, the *Enterprise*, is commissioned she will be able to make 20 trips aro
the world at speeds up to 30 knots without stopping to refuel. The 85,0
ship will use eight reactors for power, and has a flight deck that is 1,10
long and 252 feet wide. Photo shows the *Enterprise* being moved by tugs to
outfitting dock after her September 24, 1960, launching at Newport News.

Triton's Cruise

The nuclear-powered radar picket submarine *Triton*, powered
two reactors of the S3G type, completed a submerged circumna
tion of the world on May 10. Navigating over much the same
taken by Ferdinand Magellan, the *Triton* steamed 36,014 nau
miles submerged in 83 days and 10 hours.

Tullibee Now

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Tullibee Now Operating

The hunter-killer nuclear submarine, *Tullibee*, which uses an S1C type reactor plant, was commissioned November 9.

Enterprise and Long Beach

The aircraft carrier *Enterprise*, powered by eight A1W Type reactor plants, was launched September 24 at Newport News, Va. Construction of the guided missile cruiser *Long Beach*, powered by two D1W-type reactors, was interrupted by a strike at Bethlehem Shipbuilding Co. which lasted from January 23 to June 22.

Destroyer (Frigate) Construction

Construction of the guided missile destroyer *Bainbridge* at Bethlehem Shipbuilding Division, Quincy, Mass., was similarly delayed. The *Bainbridge* is to be powered by two D1G-type reactor plants.

Status of Nuclear Naval Program

The status of the naval nuclear propulsion program is summarized in Table I.

Prototype Plants

Six land-based prototype plants for specific naval shipboard applications, and associated test facilities, have been authorized for the development and test of various reactor plant systems, components, and new reactor cores under the naval reactors program of the Commission. Four of the prototypes are in operation, one is under construction, and one is in the design stage.

S1W Reactor Facility

The S1W Reactor Facility, located at the National Reactor Testing Station, was designed and operated originally as the land-based prototype of the reactor plant installed in the submarine *Nautilus*. The plant now is operated as a flexible test facility in support of advanced development work on improved submarine reactor plant systems, components, and cores. In 1960, the third refueling of the S1W plant was underway. Several special subassemblies are being inserted in the core for testing in support of advanced core development work.

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TABLE 1.—NUCLEAR POWERED NAVAL SHIPS

Submarines and surface ships [1]	Type	Status	Shipbuilder [2]
SSN571 Nautilus	Attack	Operating	Electric Boat.
SSN575 Seawolf	do	do	Do.
SSN578 Skate	Small attack	do	Do.
SSN579 Swordfish	do	do	Portsmouth.
SSN583 Sargo	do	do	Mare Island.
SSN584 Seadragon	do	do	Portsmouth.
SSN585 Skipjack	Fast attack	do	Electric Boat.
SSR(N)586 Triton	Radar picket	do	Do.
SSG(N)587 Halibut	Regulus missile	do	Mare Island.
SSN588 Scamp	Fast attack	Launched Oct. 8, 1960	Do.
SSN589 Scorpion	do	Operating	Electric Boat.
SSN590 Sculpin	do	Launched Mar. 31, 1960	Ingalls.
SSN591 Shark	do	Launched Mar. 16, 1960	Newport News.
SSN592 Snook	do	Launched Oct. 31, 1960	Ingalls.
SSN593 Thresher	do	Launched July 9, 1960	Portsmouth.
SSN594 Permit	do	Under construction	Mare Island.
SSN595 Plunger	do	do	Do.
SSN596 Barb	do	do	Ingalls.
SSN597 Tullibee	Hunter-killer	Operating	Electric Boat.
SSB(N)598 George Washington.	Polaris missile	do	Do.
SSB(N)599 Patrick Henry	do	do	Do.
SSB(N)600 Theodore Roosevelt.	do	Launched Oct. 3, 1959	Mare Island.
SSB(N)601 Robert E. Lee	do	Operating	Newport News.
SSB(N)602 Abraham Lincoln	do	Launched May 14, 1960	Portsmouth.
SSN603 Pollack	Fast attack	Under construction	New York Ship.
SSN604 Haddo	do	Authorized	Do.
SSN605 Jack	do	Under construction	Portsmouth.
SSN606 Tinosa	do	do	Do.
SSN607 Dace	do	do	Ingalls.
SSB(N)608 Ethan Allen	Polaris missile	Launched Nov. 22, 1960	Electric Boat.
SSB(N)609 Sam Houston	do	Under construction	Newport News.
SSB(N)610 Thomas Edison	do	do	Electric Boat.
SSB(N)611 John Marshall	do	do	Newport News.
SSN612 Guardfish	Fast attack	Authorized	New York Ship.
SSN613 Flasher	do	Under construction	Electric Boat.
SSN614 Greenling	do	do	Do.
SSN615 Gato	do	do	Do.
SSB(N)616 Lafayette	Polaris missile	Authorized	Do.
SSB(N)617 Alexander Hamilton	do	do	Do.
SSB(N)618 Thomas Jefferson	do	do	Newport News.
SSB(N)619	do	do	Mare Island.
SSB(N)620	do	do	Portsmouth.
SSN621	Fast attack	do	Ingalls.
SSN622	do	do	Unassigned.
SSN623	do	do	Do.
SSN624	do	do	Do.
CG(N)9 Long Beach	Guided missile cruiser	Launched July 14, 1959	Bethlehem.
CVA(N)25 Enterprise	Aircraft carrier	Launched Sept. 24, 1960	Newport News.
DLG(N)25 Bainbridge	Guided missile destroyer (frigate).	Under construction	Bethlehem.

[1] Westinghouse is listed as the reactor designer for all vessels except for the *Triton* and *Bainbridge* which are General Electric, and for the *Tullibee* which is Combustion Engineering.

[2] Electric Boat—Electric Boat Division of General Dynamics Corp., Groton, Conn.
Portsmouth—Portsmouth Naval Shipyard, Portsmouth, N.H.
Mare Island—Mare Island Naval Shipyard, Vallejo, Calif.
Newport News—Newport News Shipbuilding and Dry Dock Co., Newport News, Va.
Bethlehem—Bethlehem Steel Co., Shipbuilding Division, Quincy, Mass.
Ingalls—Ingalls Shipbuilding Corporation, Pascagoula, Miss.
New York Ship—New York Shipbuilding Corpration, Camden, N. J.

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Destroyer (Frigate)

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	Electric Boat.
Mar. 31, 1960	Ingalls.
Mar. 16, 1960	Newport News.
Oct. 31, 1960	Ingalls.
July 9, 1960	Portsmouth.
struction	Mare Island.
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Oct. 3, 1959	Mare Island.
	Newport News.
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struction	New York Ship.
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July 14, 1959	Bethlehem.
Sept. 24, 1960	Newport News.
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...marine Advanced Reactor (S3G)

The S3G land-based prototype located at West Milton, N.Y., consists of a portion of a submarine hull containing one reactor, with its ...ciated steam generating equipment, and engine room machinery ...operating one shaft of a propulsion plant. A two reactor nuclear ...pulsion plant of this type using two shafts is installed in the USS ...rm. After extensive operations to confirm the design features ...rporated into the shipboard plants, a comprehensive test program ... been initiated with the S3G prototype plant in support of ad...ed reactor plant development work.

...ll Submarine Reactor (S1C)

The Small Submarine Reactor land-based prototype plant, designed ... application to a small attack submarine, is located at Windsor, ... Performance evaluation testing of the plant was conducted ...960. Test operation of this highly instrumented plant continued ... provide design and operating information for the small attack ...marine *Tullibee*.

...ge Ship Reactor (A1W)

The A1W prototype plant at the National Reactor Testing Station ...vides the facilities for the development and testing of a two-re... power plant and associated equipment suitable for propulsion of ... naval surface ships. Plant operations have continued in 1960 ... provide for analysis and evaluation of dual reactor plant per...ance and for periodic physics tests. Results of test operations ...being factored into the design and construction of the aircraft ...r *Enterprise* and the guided missile cruiser *Long Beach*.

...troyer (Frigate) Reactor Prototype (D1G)

The Destroyer Reactor Prototype (D1G), located at West Milton, ... consists of a section of a destroyer hull containing a complete ...r plant with one reactor and an engine room with machinery ... shaft, together with related systems and equipment. Two ...s of this type are being installed in the destroyer leader *Bain...*. Work on this plant was resumed on June 22, 1960, after an ...ption of 5 months because of the strike against Bethlehem ...ilding Co. The plant is presently scheduled for completion ...

Natural Circulation Reactor (S5G)

Design and development work for the Natural Circulation Rea
(S5G), authorized by Congress in 1959, continued at Knolls Ato
Power Laboratory, Schenectady, N.Y. The land prototype plan
to be constructed at the National Reactor Testing Station, with c
pletion scheduled for 1963. The natural circulation concept prom
advantages in pressurized water reactors for submarine applica
because of its inherent safety, plant simplification, increased r
bility, and noise reduction.

AIRCRAFT REACTORS PROGRAM

The Commission-Air Force aircraft reactors program contin
during 1960 to work on both direct cycle and indirect cycle meth
of aircraft propulsion, placing emphasis upon the development of h
temperature materials, components, and reactor systems capable
meeting power plant performance criteria that were established by
Department of Defense.

Nuclear rocket propulsion, known as Project *Rover*, and form
part of the aircraft reactor program, is described in Part One of
report.

Work on ramjet propulsion (*Pluto*) and auxiliary power for s
vehicles and other applications was continued.

Nuclear Propulsion For Manned Aircraft

Based upon guidance received from the Department of Defens
the fall of 1959, both direct cycle and indirect cycle approaches to
velopment of a nuclear power plant for a manned aircraft were co
tinued on a substantial scale. In the direct-cycle approach hea
transferred within the reactor core to air which has passed thro
the turbo engine compressor. In the indirect-cycle approach, h
from the reactor core is transferred to a liquid-metal coolant wh
releases the heat to the air in a radiator within the engine. The D
partment of Defense established an initial objective of developi
nuclear propulsion system capable of powering an aircraft with re
tively conventional aerodynamics in the 500,000-pound weight cla
a speed of from Mach 0.8 to 0.9 at an altitude of approximately 35
feet, and with a potential power plant life of 1,000 hours.

Oak Ridge National Laboratory is providing general support in
search, applied development, and testing in both direct and ind
cycle programs. In November, following preliminary low-p

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...ritical tests, the new Tower Shielding Reactor there became available ... use in obtaining shielding data and in testing an indirect cycle ...ield. High-power operation is scheduled for mid-1961.

Since March 1959, General Dynamics Corp., Convair Division, Fort Worth, Tex., has continued to provide airframe design support to contractors for both propulsion systems. A preliminary design of an airplane which is compatible with both systems has been accomplished. Analysis of the design indicates that such an airplane could meet and possibly exceed the Department of Defense performance criteria with current design versions of either type of propulsion reactor. The performance of the two propulsion cycles as applied in this airplane analysis is based on projected fuel element and reactor capabilities to be established under the current reactor testing programs.

...irect Cycle

The direct cycle approach is being developed by General Electric ... under Commission contract, at Evendale, Ohio, and at the National Reactor Testing Station in Idaho.

...Heat Transfer Reactor Experiment No. 3 (HTRE–3), a development project to obtain the experience and engineering data needed to ...erate a flyable nuclear propulsion system, completed its testing program in December. Designed to operate with two modified J–47 turbo... engines, HTRE–3 operated for 146 hours at a 32-megawatt power ... in February. This experiment was a more sophisticated and ...r power test than HTRE–1 in January 1956. HTRE–2 (HTRE–... modified to test inserts in a central hole in the reactor core) was used ... the year to test several high temperature fuel elements.

...Research and development and planning continued on the ... and reactor designs and tests to be pursued.

...ndirect Cycle

...Development of the indirect cycle approach is being carried out ... Commission contract by the Pratt and Whitney Aircraft Division, United Aircraft Corp., at the Connecticut Aircraft Nuclear ... Laboratory (CANEL), Middletown, Conn. Research and ...pment continued on the reactor and liquid metal loop components required for a 10-thermal megawatt high temperature experimental reactor as an initial program objective.

...In August, operations were initiated in a hot laboratory facility ...NEL that contains seven hot cells for working with materials ...components exposed in in-pile test programs.

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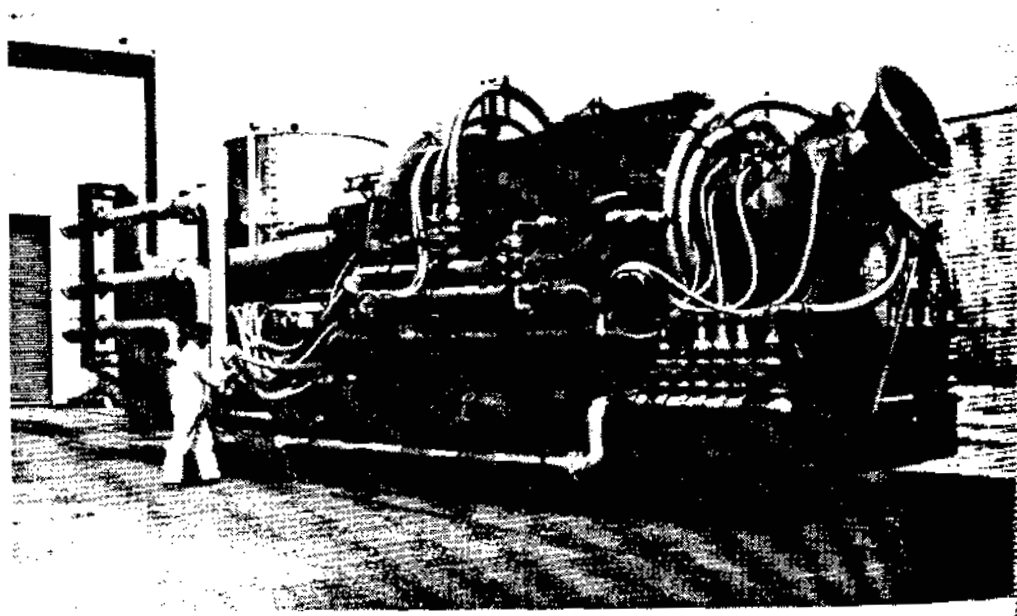
In February, the Blaw-Knox Co. was retained as architect-engineer for the design of indirect cycle facilities which will be required at the National Reactor Testing Station. Construction of a reactor test facility is planned to start in early 1961.

Nuclear Power For Unmanned Vehicles

Application of nuclear energy to unmanned vehicles is carried on in the program of nuclear ramjet propulsion, designated Project *Pluto*, and the program to develop Systems of Nuclear Auxiliary Power designated Project *SNAP*.

Nuclear Ramjet Propulsion

Project *Pluto* is a joint Commission-Air Force program aimed at demonstrating the feasibility of a nuclear ramjet propulsion system. Reactor work is under the direction of the E. O. Lawrence Radiation Laboratory, University of California, at Livermore, with some support on materials research supplied by the Atomics International division of North American Aviation. The Air Force has the Marquardt Corp. under contract to provide engineering studies of ramjet engine performance.



Propulsion Reactor. Shown above is the Tory–IIA, one of a series of engineering test reactors being used in the Commission-Air Force program of development of a nuclear reactor for the propulsion system of high-speed, ramjet missiles. The reactor is expected to provide engineering, thermodynamic, and nuclear experience necessary for development of a ramjet reactor. In photo, the Tory–IIA is mounted on a test which facilitates its movements to and from the experimental area at the Nevada Test Site.

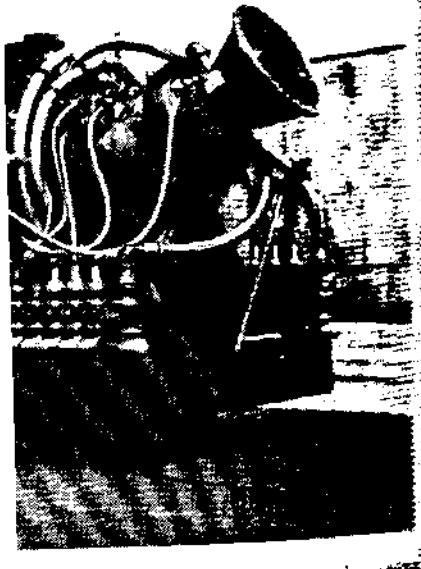
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The program consists of conducting a series of reactor tests at the
ada Test Site (NTS) beginning with Tory IIA an engineering
reactor which is expected to provide the engineering, thermo-
amic and nuclear experience necessary for development of a
jet reactor. Tests of Tory IIC, a more advanced reactor which
more closely approximate a flight reactor is scheduled for NTS in
future. A milestone in this program was attained when Tory
A achieved criticality on December 9.

ems for Nuclear Auxiliary Power (SNAP)

The aim of the SNAP program is to develop small, lightweight
ear powered electric generators for satellites, space vehicles, and
cial applications. Two approaches to provide nuclear heat are
er development; one using the heat from the radioactive decay
a radioisotope to generate electricity in thermocouples (as in
AP-1A and SNAP–3), the other using heat from very compact
ors to drive turbines (as in SNAP–2 and other even-numbered
AP projects). Other work sponsored by the Commission, using
first approach, is described in the section of this report on Radio-
e and Radiation Development.

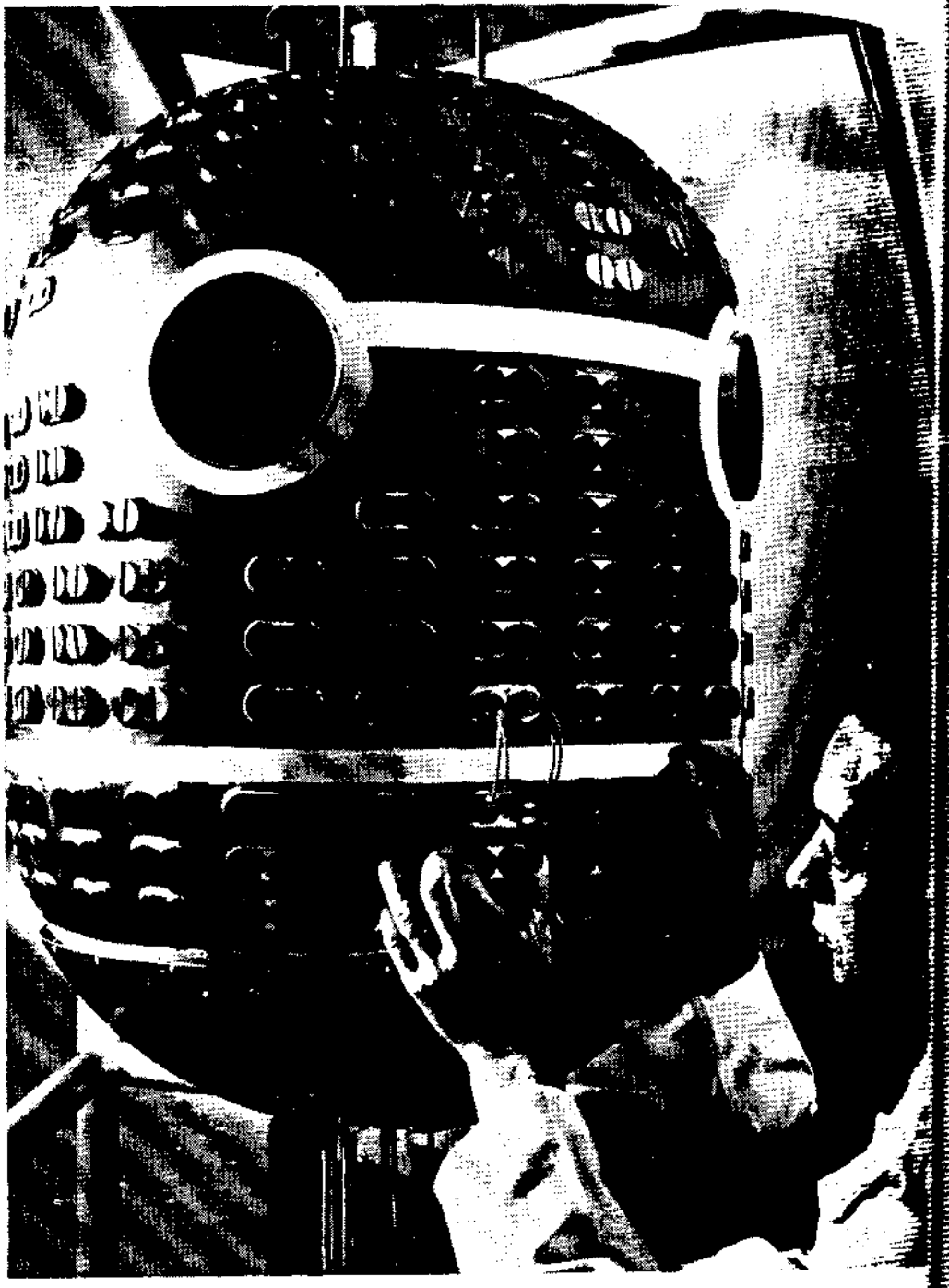
moelectric projects. In October 1959, the Department of De-
curtailed its requirement for SNAP–1A. This two-module
m, in which each module produces 125 electrical watts, was to
for an Air Force satellite.

s work was already well under way, hardware development is
completed by building three prototype units and the first and
nd are to be tested with an electrical heat source. The third unit,
d with cerium 144, is scheduled to undergo test in June 1961, as
onstration of high power radioisotope units.

NAP–3, a 3.5-watt, polonium-fueled thermoelectric generator used
proof-of-principle device, has satisfactorily completed shock,
ion, and acceleration tests and is undergoing a life-test to com-
this program by June 1961. The Commission's Mound Labora-
at Miamisburg, Ohio, produced two refueling capsules for this
, the first containing 2,200 curies and the second 2,400 curies
nium 210.

U.S. Coast Guard has requested the Commission to pro-
prototype 5-watt and 30-watt units powered with stron-
) for use in coastal light buoys. This will be an 18-month
m with the units designated as SNAP–7A and B. Initial
-of-principle work in this field was carried out under the Com-
's Isotopes Development Program, reported elsewhere.

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Electricity Generator. Above is the SNAP–1A, "big brother" of the grapefruit-sized, 2.5-watt SNAP–3 which was unveiled during 1959 by President Eisenhower. In this larger electricity generator, heat from tightly sealed pellets of cerium 144 is converted into 125 watts of electricity by the hundreds of thermocouples leading to the outer surface of the device. The generator was developed by The Martin Co. for the Commission's Systems for Nuclear Auxiliary Power (SNAP) program.

Similar 5 and 30-watt strontium 90 units will be developed to meet a Navy requirement for automatic weather station power supplies. These units are designated SNAP–7C and D. Deliveries of flight prototypes are scheduled for August 1961 and March 1962.

Reactor projects. ...velopment since 1... ...electric system for ... type, the SNAP I... (50 kwt, 1200° F) ... The reactor was o... ...accumulated a tot... ...tional analysis. I... ...efficients, and c... ...ermined.

SNAP–2 turboe... ...3 ekw at 40,000 re... ...ance runs. The fi... ...cluding turbine, be... ...64 hours of conti... ...maller version of ...erated for 2,500 ...esign lifetime of ...to be mated to a S... ...facility in early 1... ...delivery by 1964.

SNAP–8 will be ...to meet National A... ...uirements. The ... ...ersion unit and 60 ...the same react... ...system contractor t... ...Commission has re... ...ontrols, and shiel... ...first reactor powe... ...ured system lifet... ...ne by late 1965. ...will coordinate dev... ...stem.

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reactor projects. The goal of SNAP–2, which has been under development since 1956, is to develop a 3 ekw reactor-powered turboelectric system for space application. A lightweight SNAP–2 prototype, the SNAP Experimental Reactor (SER), achieved full power (55 kwt, 1200° F) in November 1959, and ran until November 18, 1960. The reactor was operated at 50 thermal kilowatts for 4,200 hours and accumulated a total of 6,052 hours before shut down for post-operational analysis. Hydrogen leakage rates, xenon buildup, temperature coefficients, and other operating performance data are being determined.

SNAP–2 turboelectric conversion equipment, designed to produce 3 ekw at 40,000 revolutions per minute (rpm), has undergone endurance runs. The first test of the SNAP–2 combined rotating unit including turbine, bearings, alternator, and pumps, was terminated after 1,000 hours of continuous operation at 35,000 rpm and 2 kilowatts. A smaller version of this mercury vapor turbogenerator package has operated for 2,500 hours at 40,000 rpm, which is equivalent to the design lifetime of this unit. The conversion equipment is scheduled to be mated to a SNAP–2 reactor in the SNAP Environmental Test Facility in early 1961. The end objective in the SNAP–2 program is delivery by 1964 of a system capable of being used in flight.

SNAP–8 will be a reactor turboelectric conversion system designed to meet National Aeronautics and Space Administration (NASA) requirements. The system will produce 30 ekw with one power conversion unit and 60 kilowatts with two power conversion units coupled to the same reactor. NASA has selected Aerojet-General as the system contractor to develop conversion equipment for SNAP–8. The Commission has responsibility for development of the reactor, reactor controls, and shielding. Design and analysis is under way with the first reactor power test scheduled for early 1962. Objectives are proved system lifetime of 90 days by late 1963 and 1-year proved lifetime by late 1965. A Commission-NASA Coordination Committee will coordinate development of the SNAP–8 reactor and conversion system.

The development effort on SNAP–10, a 300-watt thermoelectric system, has been redirected and the project has been redesignated SNAP–10A. Program effort now is aimed toward the production of a conduction-cooled system utilizing the SNAP–2 reactor and the thermoelectric conversion materials developed for SNAP–10. In the SNAP–10A device, reactor heat is transferred to the converter by a mixture of liquid sodium and potassium, which is circulated through a loop by a small electromagnetic pump. This system, weighing about 700 pounds, will be capable of producing 500 watts.

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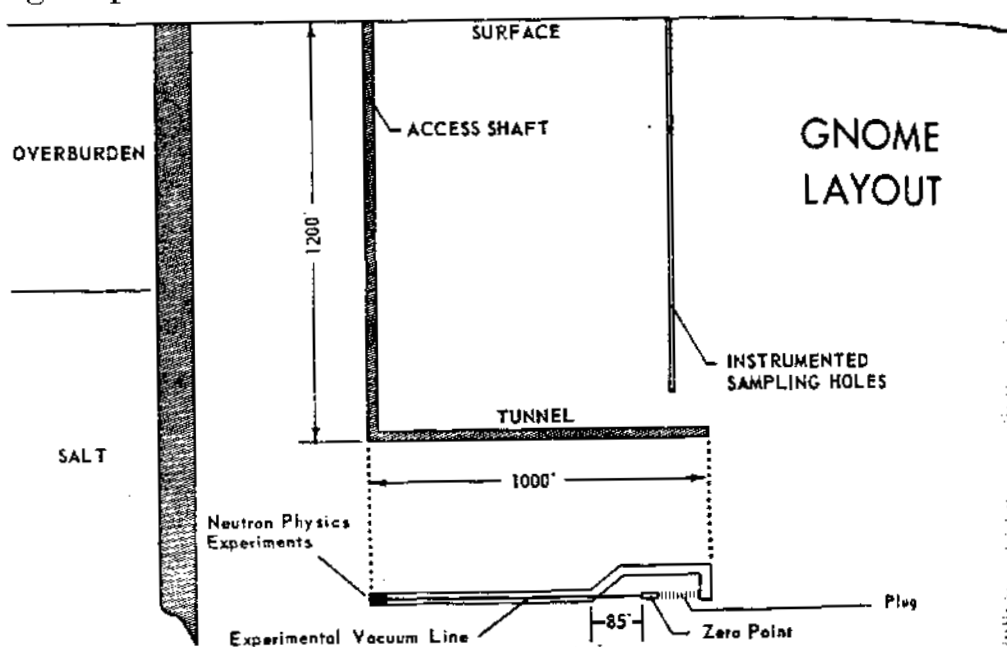
Aerospace Nuclear Safety Board

An Aerospace Nuclear Safety Board, established within the Commission in late 1959, is analyzing nuclear safety problems relating to nuclear-propelled aircraft and missiles and systems of auxiliary power. Operation of these devices requires that safeguards be developed in advance to meet such problems and contingencies as (a) release of fission products under routine or accidental conditions, (b) shielding of aircrews and supporting ground personnel from direct radiation, (*c*) contamination of ground facilities, (*d*) launch and powered orbital failures, and (*e*) random return to the earth of intact or partially intact devices.

The Board was briefed on aerospace programs, visited installations and met with representatives from Federal agencies and private groups in order to develop criteria for safe use of nuclear-powered aerospace devices. The Board is preparing a report to the Commission incorporating recommendations on aerospace policy and procedures and standards of safe practice.

Civil Uses of Nuclear Explosives

During 1960, the Commission's Plowshare program of research and development to investigate possible civil uses of nuclear explosives included theoretical studies and laboratory and field experiments with high explosives.



Possible Experiment. If the United States should decide to detonate a nuclear device to demonstrate civilian use of nuclear explosives, one of the first Plowshare program experiments would be conducted in southeastern New Mexico. The project, called Gnome, would be to study the production and recovery of tritium and isotopes produced in a contained nuclear explosion. Above is a schematic diagram of how a 1,200-foot shaft would be sunk into a thick subsurface salt bed for detonation of a 10-kiloton explosive.

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Engineering

A series of high explosive cratering experiments was conducted during the year. These experiments were designed to increase knowledge of crater formation and to establish scaling laws in different rock and soil media, in order that more accurate data may be available for the design of nuclear cratering experiments.

Three projects at Nevada Test Site constituted the major portion of this program for 1960.

Toboggan was an experiment with linear high explosive charges in alluvium.

Buckboard was a series of 1,000-pound and 40,000-pound high explosive shots in basalt.

Scooter was a 500-ton high explosive shot in alluvium.

In Project Chariot, a study to determine the feasibility of a possible excavation experiment for civil engineering projects, environmental background studies were continued by Commission contractors. Approximately 75 people were in the field during the working year. Nuclear explosive techniques for possible construction of earthfill dams, canals, and other large earth-moving projects also are being examined.

The Gnome Experiment

Planning for a nuclear experiment in the Salado Salt Basin near Carlsbad, N. Mex., as reported in the Annual Report to Congress for 1959, continued during 1960. In this experiment, designated Gnome, plans call for a 10-kiloton explosive to be detonated at a depth of 1,200 feet in a thick subsurface salt bed in southeastern New Mexico. Gnome may be carried out only if authorized by the President of the United States.

Detailed measurements are planned in Gnome to study the production and recovery of heat and isotopes produced in a contained nuclear explosion. Observations will be made to increase understanding of underground nuclear explosion phenomenology in a salt medium.

In addition, the plan has been enlarged to include taking certain basic physical measurements to enlarge basic knowledge of atomic behavior. This added program of physics and radiochemistry research will be conducted jointly by Lawrence Radiation Laboratory, Los Alamos Scientific Laboratory, and Brookhaven National Labora-

p. 82.

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tory. The work consists of four neutron experiments that are either impossible or extremely difficult to perform with presently available laboratory techniques.

Three of the basic experiments utilize moderated (1–1,000 ev) neutrons which have traveled down a 1,000-foot vacuum pipe to provide time-of-flight separation of neutron energy spectra. The neutrons will be used to study fission and capture reactions as well as resonance parameters for various heavy nuclei.

The fourth basic experiment, utilizing fast neutrons, will study the direct interaction process in inelastic scattering in carbon. These experiments also will help establish techniques for the utilization of nuclear explosions as a research tool.

Technical and scientific construction, and preparations up to, but excluding, the emplacement of a nuclear device, were authorized March 16, 1960. On June 9, the prime contract for Gnome construction was awarded.

Laboratory investigations of (*a*) the chemical and thermal effects and (*b*) the mass and heat transfers associated with power, isotope and chemical production have been started. Corrosion rates of materials of construction are being studied. Phase equilibria studies at high temperature and pressure also are planned for other media of interest in the Plowshare program.

Exploitation Of Natural Resources

Drilling and mining operations at the Rainier site (Nevada Test Site) have demonstrated the possibility, by using commonly accepted mining methods, of mining back into the area of underground nuclear explosions in volcanic tuff. Experimental mine installations at Rainier has demonstrated that it may be possible to apply nuclear explosives in preparation for economic mining by a modified block caving technique.

Another potential application of nuclear energy to mining operations would be the use of nuclear explosives to shatter a buried orebody so that the ore could be leached *in situ*, thereby recovering metal from a deposit that would not repay mining by conventional means.

A study is continuing on the feasibility of using nuclear explosives in the recovery of petroleum products from tar sands and oil shale. A small-scale high explosive experiment, called Pinot, to measure migration of gaseous products along bedding planes in oil shale was conducted in August 1960 at Rifle, Colo.

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General Research

Improved design of Plowshare nuclear explosive devices and greater accuracy in the prediction of their effects are the objectives of a Lawrence Radiation Laboratory research program in the field of strong shocks in solids. This program includes development of laboratory experiments to simulate the shocks from underground nuclear detonations, the design of instruments to measure shock parameters, and a thorough investigation of strong-shock phenomenology in rock materials similar to those in which future Plowshare experiments might be conducted.

Underground Explosions Research

Work on the phenomenology of contained underground explosions is continuing. Plowboy was a post-Cowboy excavation study of effects of a high explosive shot in salt. The actual detonation was conducted under the Cowboy project, a part of the Seismic Improvement Program.

Special Devices Research

The Commission has recognized that many peaceful applications of nuclear explosives will require nuclear explosives designed specifically for these uses and is conducting theoretical and laboratory studies of several possible design concepts. Generally, these devices would be designed to minimize the production of radioactive debris and to minimize the cost and utilization of special nuclear materials.

Safety

The Commission places major emphasis on safety in its studies of the Plowshare proposal. No nuclear detonation for the Plowshare program has yet been authorized and the Commission will not recommend authorization of any detonation until all safety requirements have been met. Studies which assist decisions on safety include such effects as radiation release; weather prediction; blast and shock propagation; seismic damage; possible ground water contamination; and possible effects on any biological systems. All these factors are being continuously evaluated in connection with all proposed Plowshare experiments.

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The Plowshare Advisory Committee met in October and, among other things, considered the emphasis placed on public safety in Plowshare work. It reviewed the program in total from the safety point of view and took into account precautions and experiences of the weapons test organization, analysis of weapons effects tests and special field experiments with high explosives designed to furnish solutions to safety problems.

Physical Research

Some 18 percent of the Commission's $167 million expenditures for physical research programs in the year that ended June 30, 1960, went for the design and construction of research facilities. Chief among these facilities are large particle accelerators which are essential for research in high energy physics which helps scientists increase their understanding of nuclear phenomena.

During the year, Brookhaven National Laboratory completed construction of the new $31 million Alternating Gradient Synchrotron (AGS), and produced a beam with an energy of more than 30 billion electron volts (Bev)—the highest so far achieved by any machine in the world. Design and components of the AGS are described in this report. The initial research program will be devoted to a thorough search for hitherto undiscovered nuclear particles which the great energy of this machine makes it possible to produce.

During this year, the Commission returned the 3 Bev Cosmotron at Brookhaven to operation after modifications and improvements; planned major improvements on the 6 Bev Bevatron at the University of California E. O. Lawrence Radiation Laboratory; went ahead with construction of the 10 to 15 Bev Zero Gradient Synchroton (ZGS) at Argonne National Laboratory, the 3 Bev Princeton-Pennsylvania Proton Accelerator and the 6 Bev Cambridge Electron Accelerator; began design and engineering work on the Stanford University linear accelerator project.

Among other projects are plans for construction of two high-flux research reactors costing between $10 and $15 million each, one at Brookhaven, the other at Oak Ridge National Laboratory, which will produce 3 to 5 million billion neutrons per square centimeter per second.

The research activities and results, usually described in this section of the Annual Report to Congress, have been made the subject

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...pecial report to the Congress in 1960.[8] In this regular Annual Re...rt to Congress, the Commission describes construction and improve...ent of various research facilities.

PARTICLE ACCELERATORS

Brookhaven's Alternating Gradient Synchrotron

The outstanding accomplishment in high energy physics in the ...ited States during 1960 was completion of construction and success...l operation of the United States newest and most powerful particle ...celerator—the Alternating Gradient Synchroton (AGS) at Brook...aven National Laboratory. On July 29, this machine for the first ...me produced a beam of protons at an energy of more than 30 bil...ion electron volts (Bev), the highest yet attained anywhere. The ...ighest energy so far attained with the AGS is between 32 and 33 Bev. ...e accelerator of similar design was completed late in 1959 at the ...uropean Organization for Nuclear Research (CERN) Laboratory at ...eneva, Switzerland. Its beam has an energy of some 28 Bev. Other ...ew accelerators being planned or built in the United States are in ...e 10–15 Bev range. The Soviet Union is constructing a proton syn...rotron in the 60–70 Bev energy range.

With successful operation of the AGS, scientists and technicians ...re concentrating efforts on perfecting its performance—increasing ...e intensity of the beam and determining its characteristics. These ...udies will help provide information used to determine arrangement ...f auxiliary equipment for guiding beams from the machine into the ...esearch devices.

...search Program

...Early research with the AGS will be devoted to indentification of ...ear particles generated when protons from the machine collide ...th the nuclei of target atoms, and to a thorough search for hitherto ...scovered particles. The high energy beam makes it possible to ...oduce new particles of masses intermediate between electrons and ...otons (mesons); others of mass greater than protons (hyperons); ...d antiparticles corresponding to most of them. It is believed that

[8] ...tomic Energy Research in Life and Physical Sciences—1960," A Special Report to ...ss by the United States Atomic Energy Commission, January 1961, Superintendent ...cuments, U.S. Government Printing Office, Washington 25, D.C., $1.25.

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understanding these particles may give scientists the key to the [illegible] structure of the atomic nucleus.

One purpose of a high energy accelerator is to produce large quantities of various types of *mesons* found by physicists to be intimately involved with the powerful forces that hold nucleons together within the nucleus.[9] The AGS will make possible studying meson interaction with protons and other atomic nuclei at much higher energy than previously available in the laboratory. The new accelerator also will be an important and prolific source of *hyperons*—important members of the family of elementary nuclear particles, the discovery of which was instrumental in developing the useful theory of "strange nuclear particles."

Another important research program for the new accelerator will deal with *antimatter;* such as antiprotons and antineutrons. The higher energy of the AGS will produce these particles in greater abundance so that their detailed properties can be studied with the hope of opening a new chapter in the field of particle physics.

Research Methods

Mesons and other high energy nuclear phenomena will be observed by means of the newly developed device known as the "bubble chamber." Until recently, interactions were observed primarily by means of "cloud chambers," where charged particles produced condensation of supersaturated vapor and left a visible trail of liquid droplets. But in cloud chambers the density is low and interesting collisions between particles occur with relative infrequency. Moreover, a comparatively long time must elapse after a single picture has been taken of a nuclear event to clear the chamber and make it ready for the next event.

The bubble chamber overcomes these limitations by using a liquid medium instead of gas; for example, hydrogen cooled to a temperature of −414° F under a pressure of about 70 pounds per square inch. When this pressure is released, the liquid is momentarily superheated, i.e., ready to "boil". If a stimulus, such as a charged particle, is introduced into the medium, boiling begins along the track of the particle. The particle thus makes a visible track of bubbles in the liquid hydrogen, and these can be photographed by special cameras located behind a glass wall of the chamber. The cameras are [illegible]

[9] See pp. 78–79, Atomic Energy Research in Life and Physical Sciences, 1960: [illegible] 1961. Superintendent of Documents, Washington 25, D.C., $1.25.

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...nized with a high-voltage light-source, the entering beam of ...barding particles, and the mechanism controlling the pressure ... the chamber. In this way, photographs are taken for each pulse ... particles from the accelerator. Increasing the pressure in the ...amber makes the bubbles disappear, erases the track and makes the ...bble chamber ready to receive and register another pulse of particles. ... large bubble chambers now are used at Brookhaven in connection ...th the 3 Bev Cosmotron accelerator; in the future most of these ...ill be used at the AGS. In addition, an 80-inch hydrogen bubble ...amber, expected to be the largest in the world, now is under con...ction at Brookhaven. A 72-inch hydrogen bubble chamber, the ...rgest chamber built to date, is in use at the Bevatron.

...ounters provide another important group of tools for research at ... AGS. These include both scintillation and Cerenkov counters ...hich indicate the passage of ionizing elementary particles by means ...light flashes. Very large and complex arrays of counters are used to ...entify nuclear particles and to help in determining their paths and ...elocities.

...sign and Construction

The AGS was authorized and funds allocated for its construction in ...54, following completion of preliminary design studies which had ...en started in 1952. Three Brookhaven scientists, E. D. Courant, ... S. Livingston, and H. S. Snyder, had evolved the idea [10] that par...les could be accelerated to greater energies than were then being ...hieved through use of "strong", or "alternating-gradient", focusing ... the accelerated beam.

...otal cost of the AGS and its buildings is approximately $31 ...illion.

The staff working on the AGS consists of over 170 people. The ...oject has been under the direction of L. J. Haworth, Director of the ...boratory, and of G. K. Green, Chairman of the Accelerator De...lopment Department, and J. P. Blewett, Associate Chairman, all ... whom played important roles in the design and construction of the ...er Cosmotron.

Various elements of the AGS are pictured and described in the ...companying series of photographs.

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[10] It since has been found that a similar idea of strong focusing had been proposed earlier ... K. Christofilos of Greece.

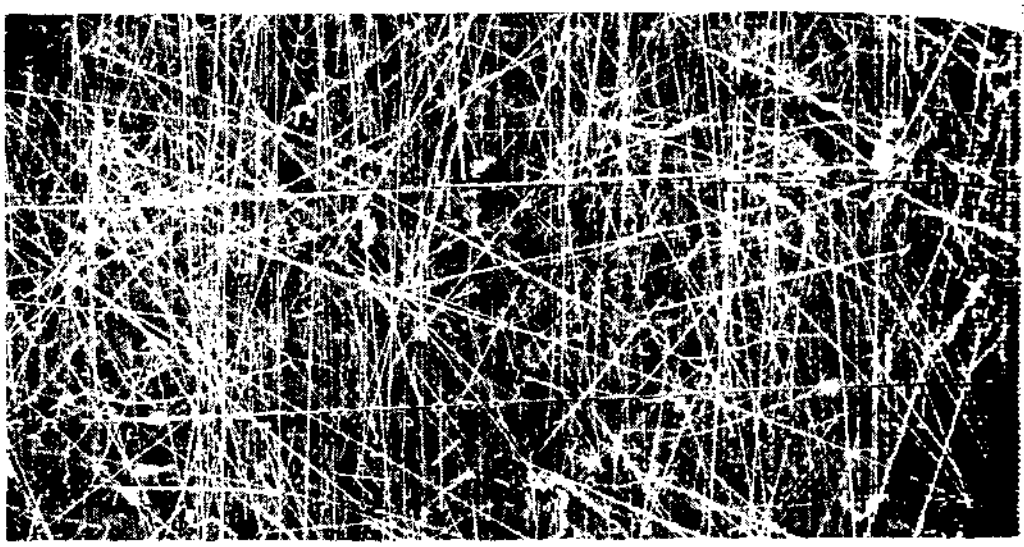
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Atomic Particle Accelerators

Just as the telescope enables the astronomer to probe the heavens a... the microscope aids the biologists' quest for the secrets of nature a... the life processes, the high energy particle accelerator, or "ato... smasher", makes infinitesimal bits of matter perform in a manne... that can be observed, thus providing man with increased knowledge... of the characteristics of the atom.

The key to accelerating particles is the fact that like electric... charges repel each other, while unlike charges attract each other. B... using alternating electrical fields within vacuum chambers, scien... is able to speed up the flight of electrons and protons to such a velocity... that their collision with other atomic nuclei smashes the target atom... sending its component particles streaking or whirling off into spa... Detection, through photographic and other means, and analysis of t... paths of these component particles provides man with knowledge o... the structure and binding forces of the atom.

The photos on the following pages show some of the major equip... ment used in the Commission's high energy physical research progra...



Ionized particle tracks in this early "cloud" chamber photograph offered many information on the structure and binding forces of the atom. Taken in 19... it is one of the first cloud chamber photos obtained with the Cosmotron accelera... tor at the Commission's Brookhaven National Laboratory. It shows high energy particles resulting from a single pulse of 1.2 billion electron volt (Bev) proto... striking a ⅛-inch brass target inside the Cosmotron. The cloud chamber was located 125 feet from the target. Particles reaching it traversed the one-... stainless steel outer wall of the Cosmotron's vacuum chamber, two heavy doors... and the ¼-inch stainless steel wall of the cloud chamber. Subsequent develop... ment of the "bubble" chamber and the means for accelerating particles to great... speed enabled science to make more "readable" photographs of nuclear events...

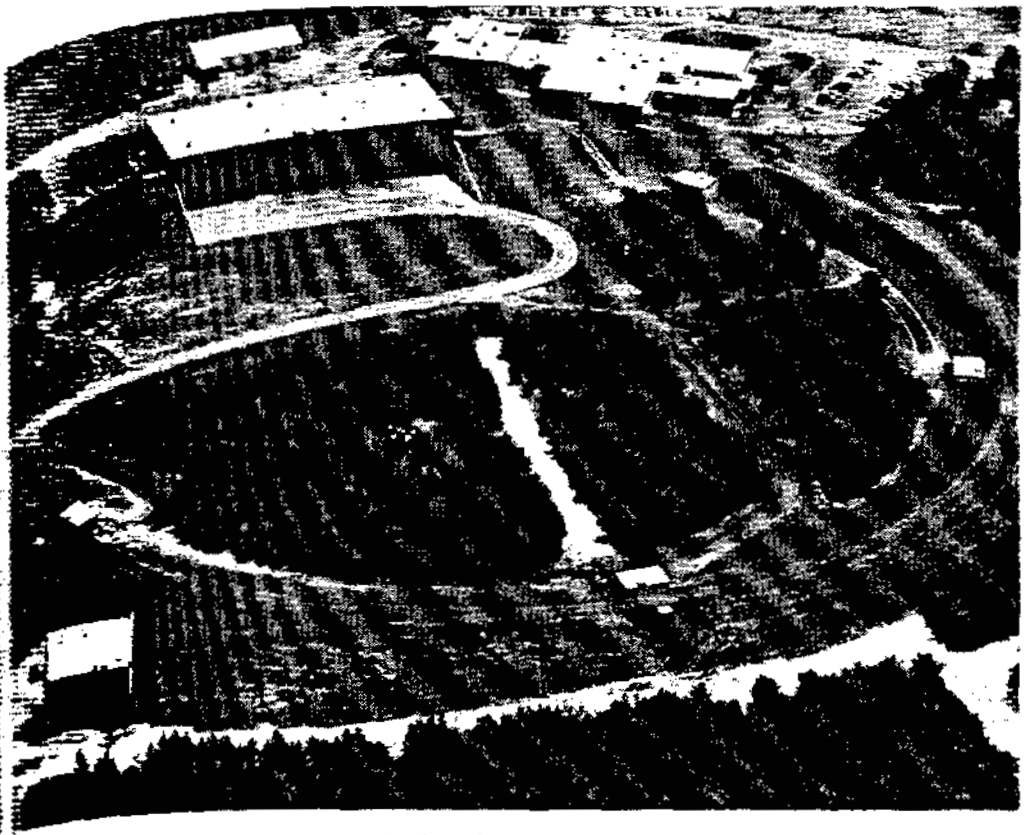
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Fewest member of t... ators is the Alternati... Laboratory. In July ... atoms stripped of ... electron volts (Bev) ... ator. In the above ... meter, half-mile circu... is located within an ... ft feet of earth. T... small building (bott... 120,000 miles around ... mated within the r... particles' pathway is ... passes through the ... each weighing 16 to... orbit within the vacu... by radiofrequency a... ...t boost in speed s... ...a velocity within ... approximately 186,0... relativity, the mass ... ...at this velocity. He... ...ction against the C...

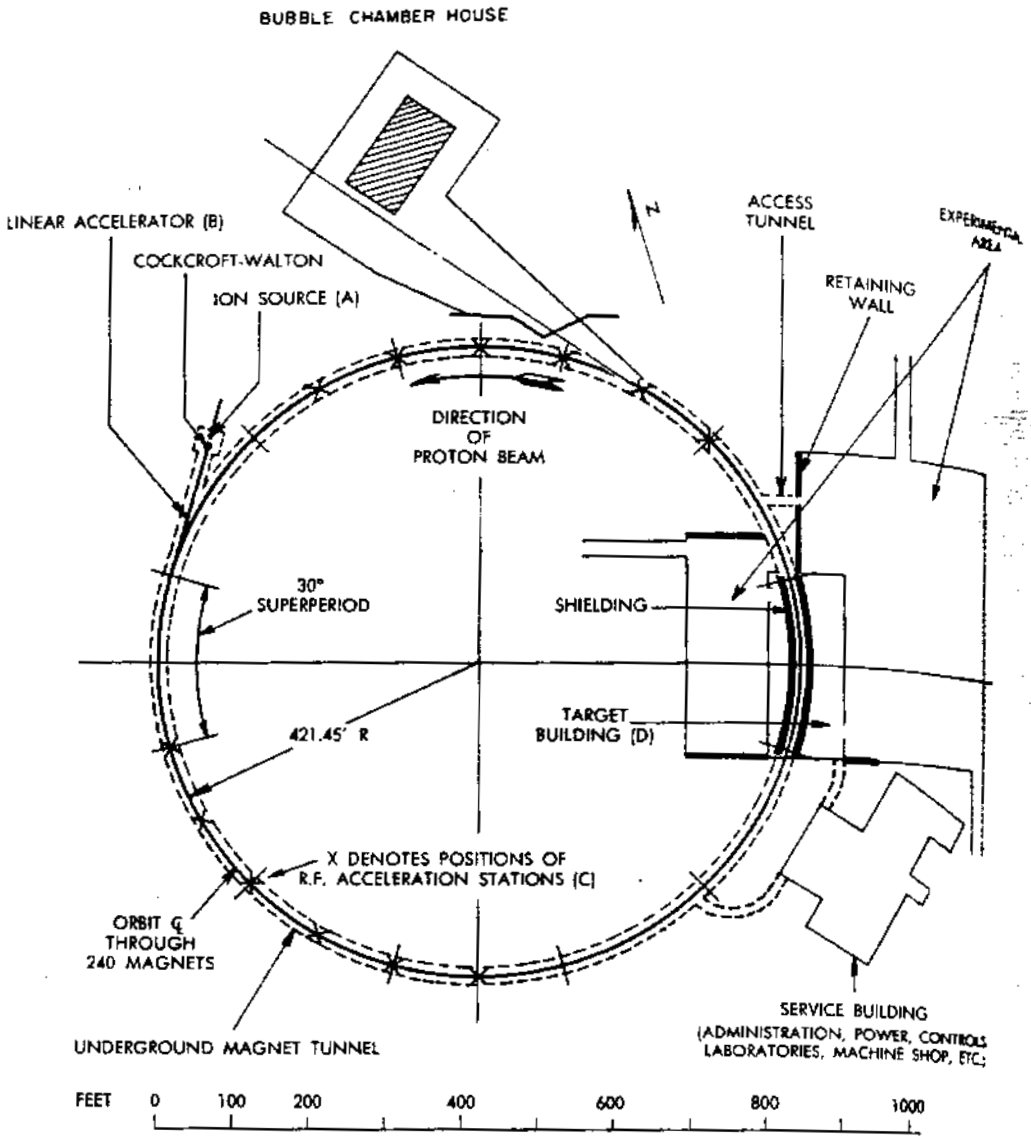
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New Alternating Gradient Synchrotron



newest member of the Commission's "family" of high energy particle accelerators is the Alternating Gradient Synchrotron (AGS) at the Brookhaven National Laboratory. In July, 1960, the AGS accelerated a beam of protons (hydrogen atoms stripped of their electrons) to an energy of more than 30 billion electron volts (Bev), the highest energy yet obtained with a particle accelerator. In the above photo, the outline of the tunnel housing the 843-foot diameter, half-mile circumference magnetic ring can be discerned. The accelerator is located within an 18-foot square, concrete-lined tunnel that is covered by 50 feet of earth. The particles are injected into the accelerator from the small building (bottom, left) and make a one-second journey of more than 300,000 miles around the magnetic track before crashing into an atomic target located within the research building astride the tunnel (top of photo). The particles' pathway is an oval-shaped vacuum pipe, about 7 x 3 inches, that passes through the jaws of C-shaped magnets. There are 240 magnet units, each weighing 16 tons. The magnets hold the particles in a relatively stable orbit within the vacuum chamber while they pick up speed as they pass through the radiofrequency accelerating units. Each unit gives the particles an 8,000-volt boost in speed so that toward the end of their journey they are traveling at a velocity within a fraction of 1/10 of one percent of the speed of light, or approximately 186,000 miles per second. According to Einstein's theory of relativity, the mass of the protons has been increased by more than 30 times with this velocity. Heavy shielding (earth and concrete) is required for protection against the Cosmic-type radiation given off by high energy particles.

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A particle's path as it is accelerated and put to research use at the AGS can be traced on the above diagram of the Alternating Gradient Synchrotron's principal features. Protons are produced in the ion source (point A) by passing hydrogen through an electric arc which strips the electrons off the hydrogen atoms. The resulting protons then are given an initial acceleration in the Cockcroft-Walton generator to 750,000 electron volts (750 Kev) before being injected into the Linear Accelerator (point B) where their energy is boosted to 50 million electron volts (50 Mev). At this energy they are injected into the AGS magnetic ring where they make some 370,000 circuits around the half-mile track in a second before being forced into a 30–32 Bev collision with an atomic target in the research building (point D). The shower of atomic sub-particles resulting from the collisions are detected by photographic equipment in the bubble chamber house (top) or in special detection devices located in the experimental area (right).



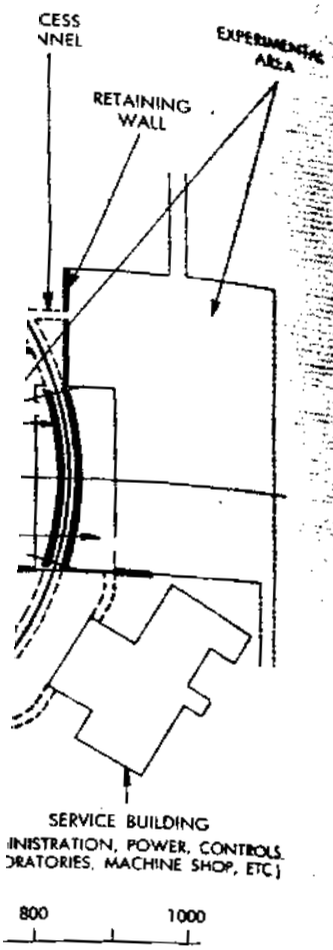
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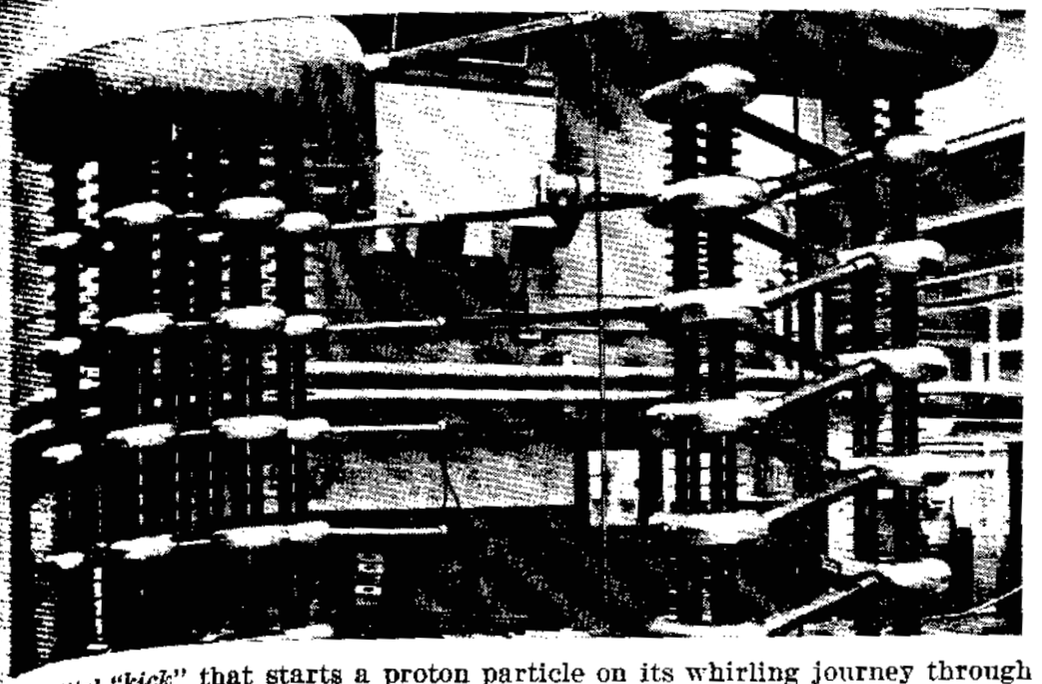


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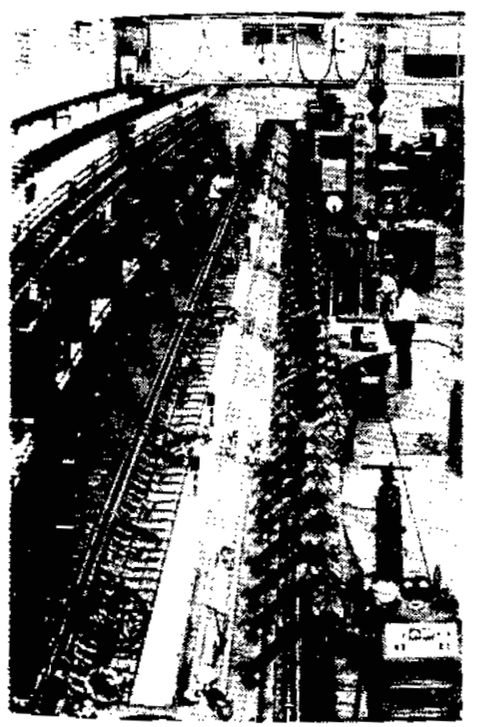


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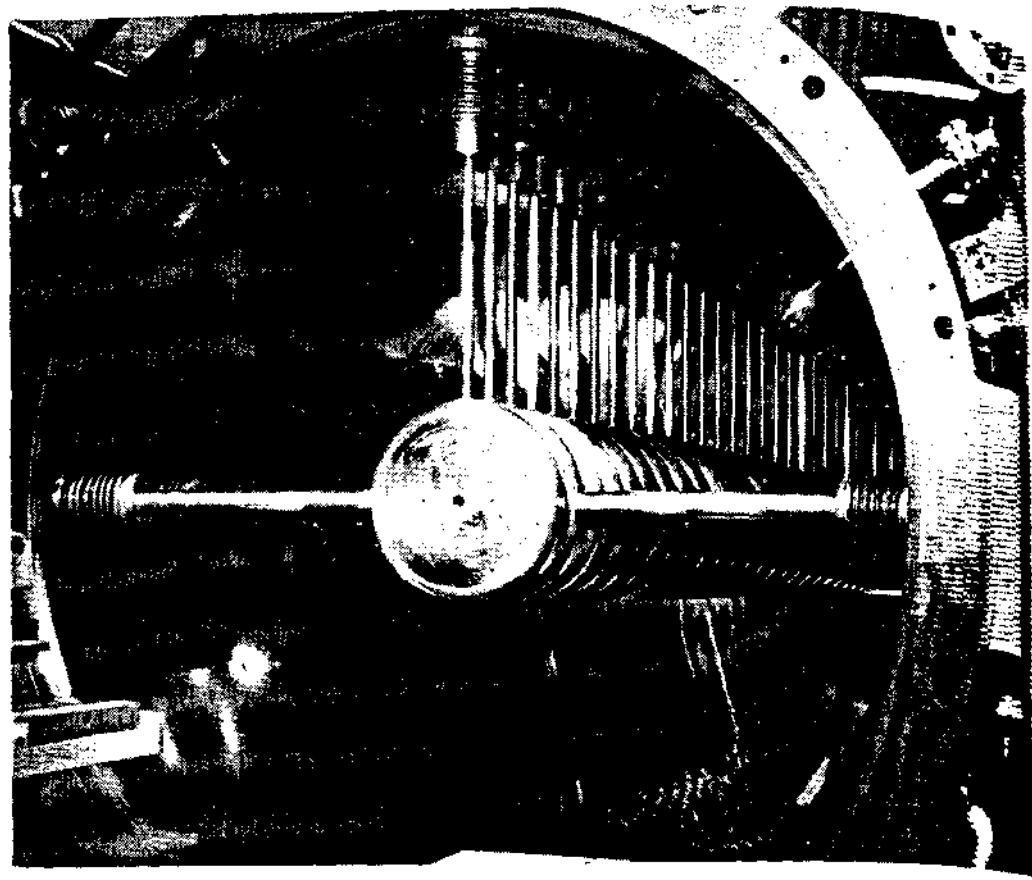
The initial "kick" that starts a proton particle on its whirling journey through the AGS is applied by a Cockcroft-Walton generator, the type of accelerator used years ago to obtain the first artificial nuclear transformation. The particle is ejected from the generator, shown here during its installation at the AGS with an energy of 750,000 to 800,000 electron volts (750–800 Kev) and passes through a second accelerator, the Linac, before entering the AGS.

The *proton's second stage* of acceleration occurs in the 110-foot length of the Linear Accelerator (Linac) where the particles are given an incremental velocity as they pass through each gap between 124 accelerating electrodes activated by a high frequency electrical source. Leaving the vacuum tank of the Linac, the proton has an energy of 50 Mev. Photo shows the length of the Linac, looking toward its terminal with the AGS (hidden by concrete brick wall). To the right rear of the Linac are four "towers" which house the high power radiofrequency system. The system pulses the acceleration electrodes, or "drift tubes", at a rate of 200 million cycles per second. With each pulse cycle, the attracting and repelling force of alternate drift tubes is reversed. Resonant frequency tuners located within the vacuum tank, working on a radar-like principle, energize the electrodes only when the proton is crossing a gap between the tubes. Thus, the repelling force of the tube behind aids the attracting force of the tube ahead to give the proton an accelerating "kick".



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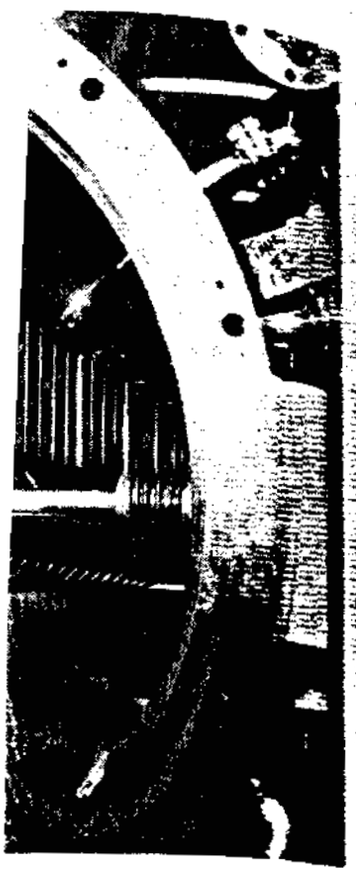
Although the tank of the Linear Accelerator has a 37.4-inch inside diamet the pathway for the proton beam is only one-half of an inch across at the lo energy end, where the particles enter from the Cockcroft-Walton generato The particle beam passes through the small hole in the center of the 124 a celerating electrodes, or "drift tubes", which can be seen with their vertic and horizontal support stems in place within the tank. Alternating gradie focusing magnets within the drift tubes exert forces to keep the protons fro wandering very far from the central axis. The particles receive an accelerati "kick" as they pass across the gap between each of the tubes, and in the upp right hand section of the tank can be seen the ball tuners which serve t provide the proper resonant frequency of the tank. The copper-lined outer tan is 110 feet long and this length is maintained constant by circulating wate with a temperature constant to 0.1 degree. A high vacuum is maintained wit minimum organic contamination by the use of 20 titanium evaporation pump The 50 Mev Linac is itself a major accelerator and is one of the three larges existing proton linear accelerators in the world; the others are the 50 Me machine at CERN, Geneva, Switzerland, and the 70 Mev research linea accelerator at the University of Minnesota.



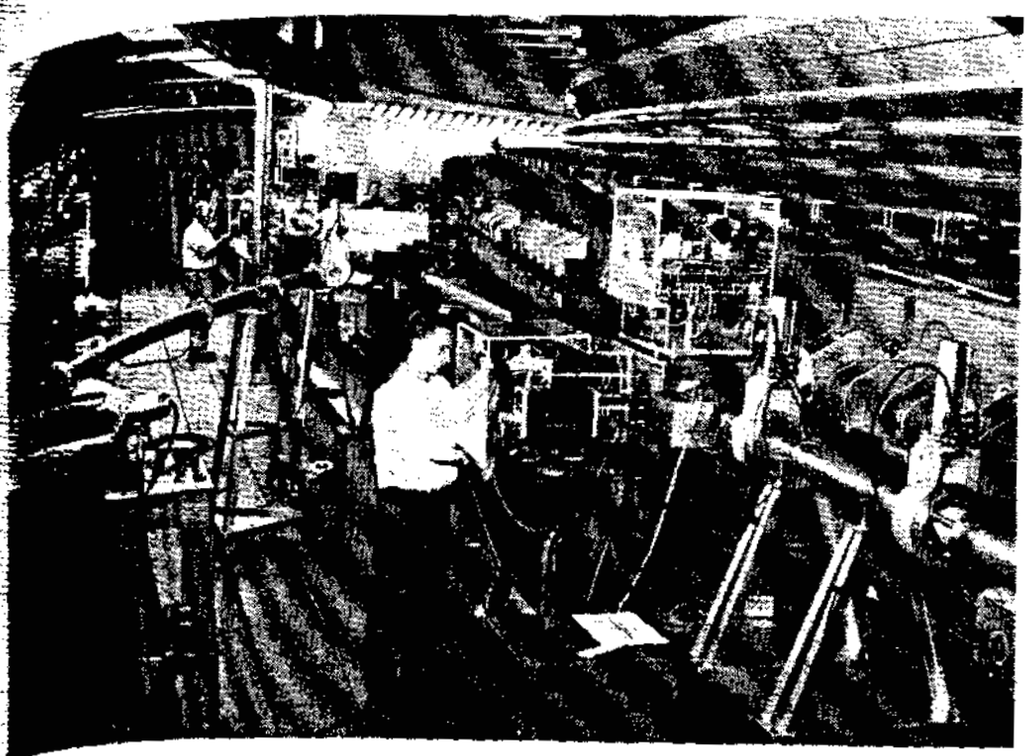
The proton beam le of photo) through passes through a se the AGS magnet ri pipe for an analyz determine the energ with lucite covers which are used to a distribution in orde inside the viewing the beam for visual impinging upon the camera in front of t

Huge magnets, each weighing 16 tons, k tons on a relativel Each magnet secti about 3,200 lamina steel plates. The v tween the C-shape nets, which alternat and vertical forces keep them from the vacuum tube.

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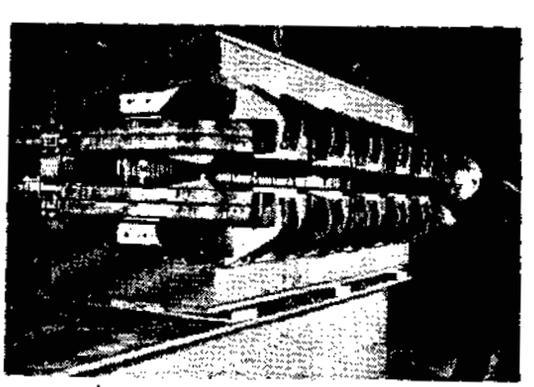


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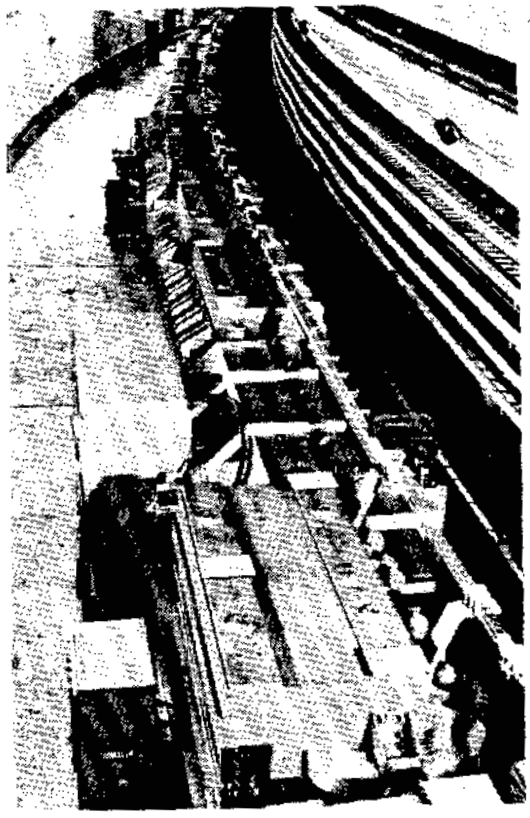


The proton beam leaves the Linear Accelerator (behind shielding wall, left rear of photo) through the four-inch pipe (leading to lower right of photo) and passes through a series of focusing lenses and steering magnets into the orbit of the AGS magnet ring. The pipe extending across the aisle (to left) is the exit pipe for an analyzer magnet which bends the proton beam through 25° to determine the energy spread of the protons. In the foreground is a viewing box with lucite covers over the drive mechanisms. Inside it are adjustable slits which are used to align the proton beam and to examine its spatial and angular distribution in order that the correct focussing adjustments can be determined. Inside the viewing box there is also a quartz plate which can be rotated into the beam for visual observation of the beam position and dimension; the protons impinging upon the quartz produce light, which is observed by means of the TV camera in front of the man in foreground.

Bending magnets, each 90 inches long and weighing 16 tons, keep accelerated protons on a relatively stable orbit path. Each magnet section is made up of some 3,200 laminations of 0.035-inch steel plates. The vacuum tube fits between the C-shaped jaws of the magnets which alternately exert horizontal and vertical forces on the particles to keep them from "wandering" within the vacuum tube.



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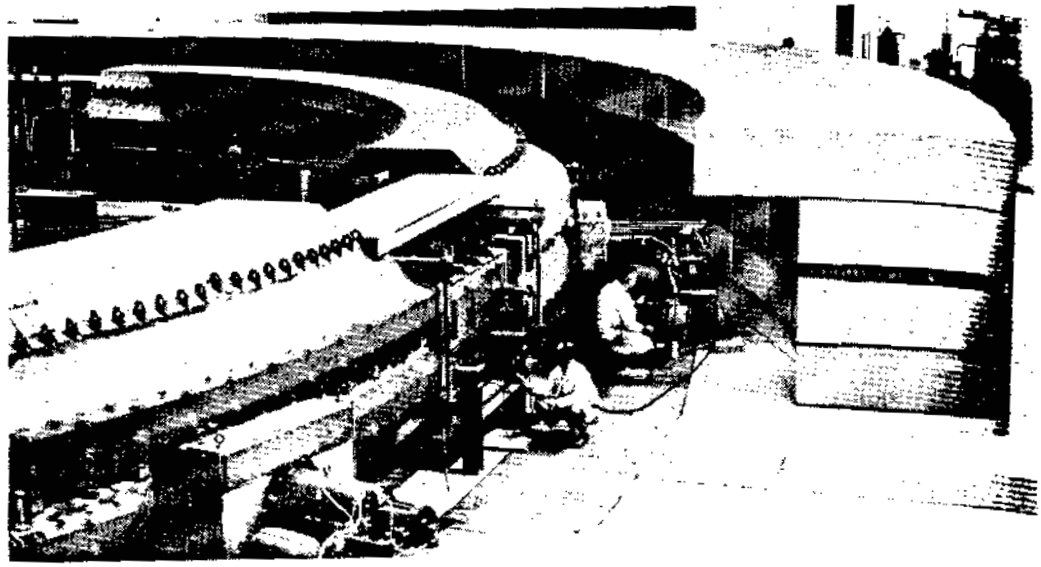


The easy curved pathway the [illegible] beam follows within the AGS can be seen in this photo. In foreground is one of the magnet sections used to bend the speeding protons in a circular path. Just above is one of the 12 radio-frequency accelerating stations (containers with handles) used to boost the particle's energy. In center rear of photo is one of the 48 titanium evaporation pumps used to maintain a vacuum in the beam passageway, and the cylindrical object at top of photo is the survey monument used in aligning the ring of magnets. Alternate groups of magnet sections are faced in opposite directions to help the portons maintain a steady orbit path.



Energized particle [illegible] are normally [illegible] sudden reduction [illegible] that pulsed partic[illegible] leave trails of tin[illegible] cameras. The cha[illegible] genta, and other "cloud" chambers [illegible] inch bubble chamb[illegible] ber is located at [illegible] campus; and an [illegible] synchrotron facili[illegible]

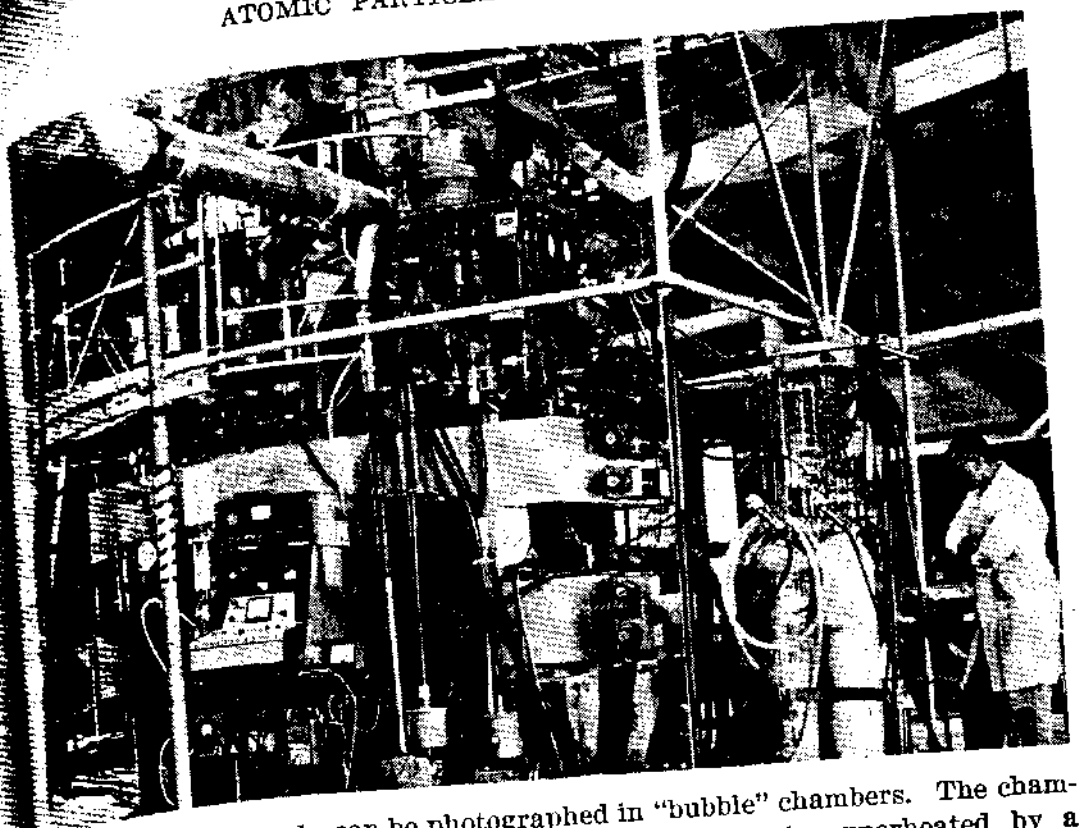
Other Accelerators and Equipment



Also located at Brookhaven and first operated in 1952, the 3 Bev Cosmotron is the oldest of the Commission's multi-Bev accelerators. The 60-foot diameter 2,200-ton ring magnet was the first manmade device to accelerate protons to velocities above a billion electron volts. Two of the 12 vacuum pumps which exhaust all air from the particle beam passageway can be seen. By removing rows of lead bricks (dark objects) from the massive concrete block shield, tunnels can be formed through which the secondary particles produced by atomic collisions within the accelerator can pass and be detected by research instruments located behind the shield.

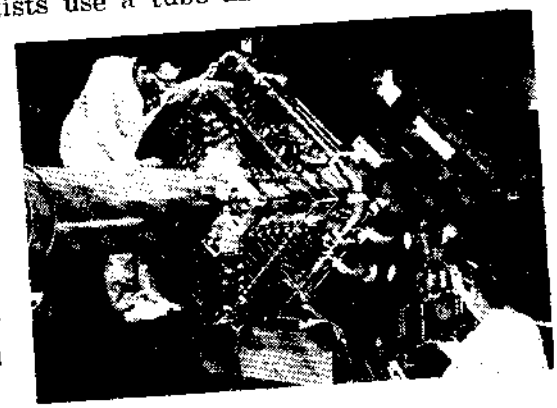
To make more ac[illegible] accelerated partic[illegible] in extracting the [illegible] the Cosmotron. I[illegible] sets, known as a "[illegible] which intensifies [illegible] much the same n[illegible] glass" intensifies [illegible] focusing the partic[illegible] the particles to [illegible] scientists can ma[illegible] number of the me[illegible] the Cosmotron.

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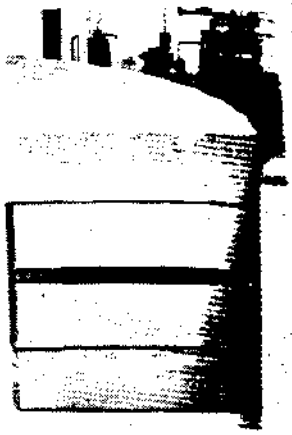
Energized particle tracks can be photographed in "bubble" chambers. The chambers are normally filled with liquid hydrogen which is superheated by a sudden reduction in pressure timed to coincide with the billionth of a second that pulsed particles from an accelerator enter the chamber. The particles leave trails of tiny bubbles or "tracks" which are photographed by high-speed cameras. The characteristics of tracks indicate the mass, electric charge, momenta, and other properties of the particles. Early experimenters had to use "cloud" chambers which produced less definitive results. Photo shows the 20-inch bubble chamber used with the Cosmotron at Brookhaven; a 72-inch chamber is located at the Commission's laboratory on the University of California campus; and an 80-inch chamber is planned for the Alternating Gradient synchrotron facility.

To make *more accurate* determinations of the interactions occurring among accelerated particles, Brookhaven scientists use a tube and a pair of magnets to extracting the mesons produced in the Cosmotron. Photo shows the magnets known as a "strong focusing pair", which intensifies the meson beam in much the same manner as a "burning glass" intensifies the sun's rays. By focusing the particle beam and allowing the particles to bombard atom nuclei, scientists can make use of a greater number of the mesons produced within the Cosmotron.



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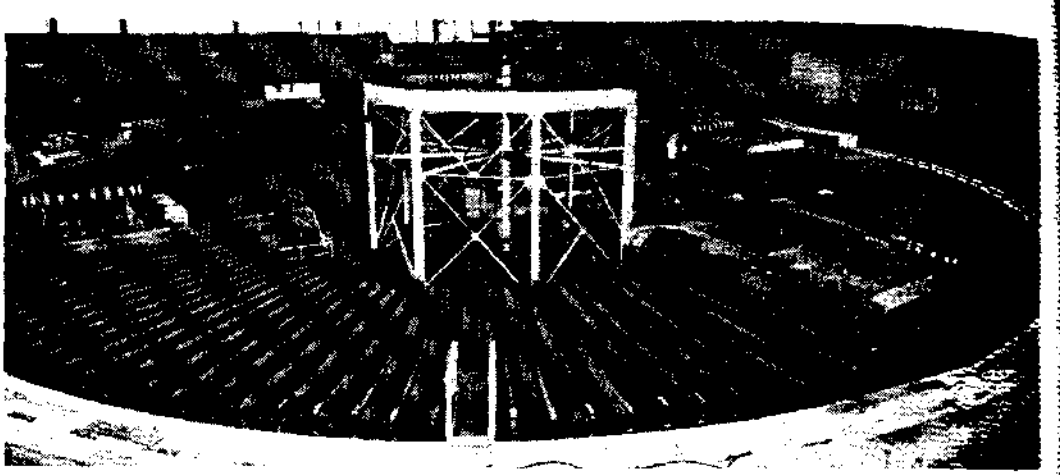
the 3 Bev Cosmotron
The 60-foot diameter
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The 6.2 billion electron volt Bevatron, located at the Commission's E. O. Lawrence Radiation Laboratory at the University of California, has been a prolific contributor of new basic knowledge for nuclear science. First operated in 1954, research with the Bevatron has since led to discovery of at least three important high energy particles—the anti-proton, the anti-neutron, and the neutral cascade hyperon called "Xi-zero". Photo shows the Bevatron building (center) located in the hills above the university campus. In the background is the circular building housing the 184-inch cyclotron, a 730 Mev accelerator. In the distance is the city of Berkeley.

The Van de Graaff ... oldest type of ... useful in high ... research—the Cockc... oldest. Shown at ... column of the new ... installed at the ... Alamos Scientific ... this column is the ... the electrical charg... of the machine to ... head. A portion of ... at the top of the ... machine is in opera... of photo) is lower... and a gas separatic... vessel fits snugly ... column. When co... erator has ten secti... column instead of ... stands 20 feet high.





The Bevatron (below), with a diameter of 125 feet and a ring magnet containing 9,700 tons of steel, was the Commission's highest energy accelerator until the new AGS went into operation. Accelerators such as the Bevatron, Cosmotron and AGS use a series of magnets, which are pulsed on a synchronized pattern of increasingly greater strength, to accelerate proton particles as they orbit within a vacuumed passageway located within the magnet sections. The crane (top of photo) was used to lift the heavy magnets and sections of the concrete shielding (foreground) during recent repairs to the Bevatron.

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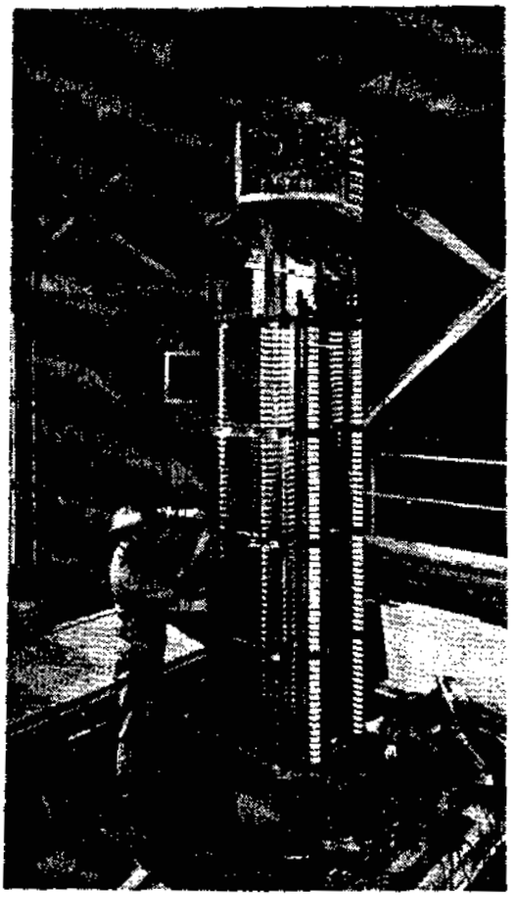


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The Van de Graaff generator is the second oldest type of accelerator to still be useful in high energy physics research—the Cockcroft-Walton is the oldest. Shown at right is the inner column of the new Van de Graaff being installed at the Commission's Los Alamos Scientific Laboratory. Inside this column is the belt which carries the electrical charge from the bottom of the machine to the high-potential head. A portion of the belt can be seen at the top of the column. When the machine is in operation, the vessel (top of photo) is lowered over the column and a gas separation column inside the vessel fits snugly around the inner column. When completed, this accelerator has ten sections in the insulating column instead of the four shown, and stands 20 feet high.

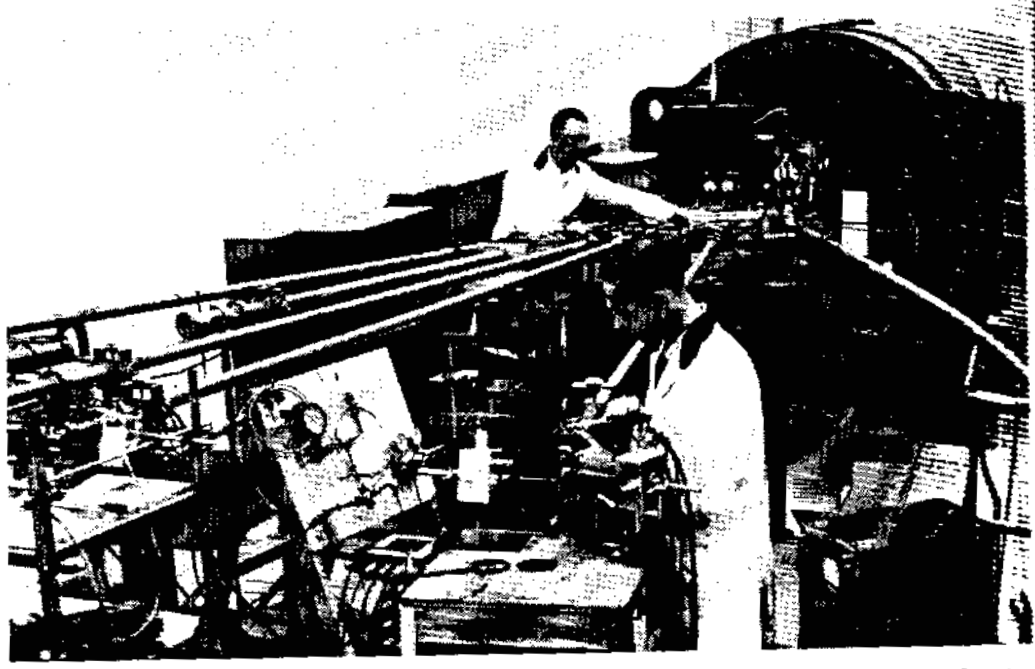




The separation column of the Los Alamos Van de Graaff machine with its interpotential shells removed is shown in photo at right. This type of accelerator uses the electrostatic generator principle of a rotating belt that builds up a tremendous electrical potential—in the same manner that a static electricity charge is created by running a comb through a person's hair. Since a hollow body will accept any available electrical charge, irrespective of its own voltage, it is possible to build up the potential by continually supplying an electrical charge to the semi-sphere atop the machine. For high energy physics research, the electron discharge is drawn off the top of the generator by means of a hollow tube, allowing high-voltage ions to strike an atomic target at energies up to 10 Mev.

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Some high energy physics research can best be done by accelerators of medium energy. *Photo above* shows the 18-inch cyclotron (background) used at Brookhaven for measuring neutron energies by "firing" 2.8 Mev protons at targets of various materials. In the cyclotron the particles circulate between the poles of a magnet and within two hollow D-shaped electrodes placed back-to-back, between which is applied a radiofrequency voltage. *Photo below* shows a 3 Mev electrostatic generator (cylindrical object) used at Brookhaven to "fire" deuterons (double-weight nuclei of hydrogen atoms) down the tubes at complex atoms such as carbon and beryllium, scattering them in patterns which can prove meaningful to physicists studying the structure and energy of matter.



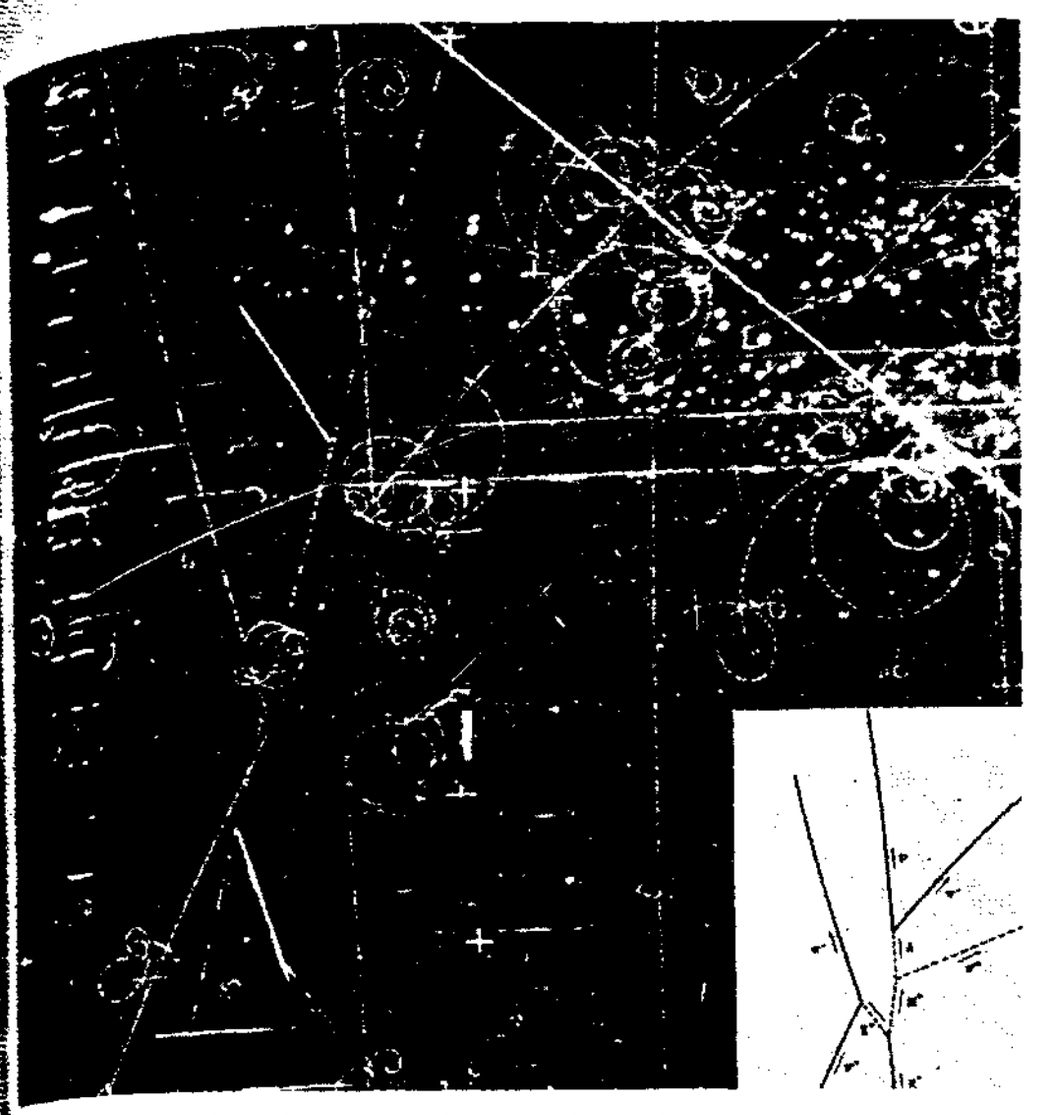
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The "bubble" chamber photograph above, made at the Commission's Lawrence Radiation Laboratory, led to the announcement in March 1959, of the discovery of a previously predicted ghostly atomic particle, the "Xi-zero", a neutral cascade hyperon. The unique discovery—involving analysis of two invisible tracks"—was made after more than a year of effort during which the Laboratory's 15-inch bubble chamber was bombarded with negative K mesons produced by the Bevatron, and some 70,000 photographs had been taken. On the basis of earlier discoveries, scientists foresaw that such a particle could exist and that since it would not have an electrical charge it could not be photographed but would have to be deduced from other tracks. This is the only photo that positively showed the anticipated event. The diagram inset helps explain the action. The entering negative K meson (K—) shows a track that suddenly ends, having collided with a proton and producing two neutral particles. Some distance from the track's end are the characteristic V-shaped tracks formed by decay of the neutral particles into charged particles. However, the upper "V" is not at a normal angle, leading to the scientific conclusion that the K—-proton collision produced the predicted Xi zero(Ξ°) which decayed into a lambda (Λ) and Pi meson (Π°). In turn, the decaying lambda became a proton (P) and a negative Pi meson ($\Pi-$) which formed the visible "cocked" angle tracks. The whirls are the tracks of low-energy electrons.

500b 15

Other Accelerators

Cosmotron

The 3 Bev Cosmotron proton synchrotron at Brookhaven Nati... Laboratory, initially completed in 1952, was the world's first parti... accelerator to operate in the billion electron volt range. Exte... modifications and improvements were undertaken on the Cosmo... during 1958 and 1959 to increase its efficiency.

The machine still has minor operational difficulties, but a numb... of extensive experiments were carried out in late 1959 and dura... 1960. The improvements are designed to permit most experime... to be carried out with high intensity proton beams external to the ri...

Bevatron

A major improvements program of the 6-Bev Bevatron at Lawren... Radiation Laboratory, Berkeley, is being planned, which, over ... period of some 4 years, will almost completely overhaul and moder... ize the machine. Its beam intensity will be increased, the exper... mental facilities expanded (including external beams), and th... general reliability and flexibility of the machine's performan... improved.

Three New Accelerators

Three multi-Bev synchrotrons are at present in various stage... of development.

Construction of the 10–15 Bev *Zero Gradient Synchrotron* (ZG... at Argonne National Laboratory is proceeding approximately o... schedule with completion of the basic machine expected in the sum... mer of 1962. Extensive expansions of the experimental facilities a... this project are to be carried out concurrent with the construct... and following completion, of the basic synchrotron machine.

Completion dates of late 1961 are now indicated for the 3-Be... *Princeton-Pennsylvania Proton Accelerator* (*PPA*) at Princeto... N.J., and the 6-Bev *Cambridge Electron Accelerator* (*CEA*) at Cam... bridge, Mass.

Stanford University Accelerator Project

The Atomic Energy Commission's 1961 Authorization Act include... $3 million for start of design and engineering work on a 2-mile lon... linear electron accelerator at Stanford University. The Commissio...

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...approved the selection of Actron, Blume, and Atkinson as architect-engineer subcontractor under Stanford University. The project, ...estimated to cost more than $100 million and to require 6 years to build, ...the subject of detailed hearings in 1959 and 1960 before the Joint ...committee on Atomic Energy. The advantage of such an accelerator ...that it can provide a high-intensity, well collimated beam of ...trons.

Results of additional cost studies and conceptual design work ...rried out during 1960 are to be placed before the Congress early ...1961.

...celerator Models

Work on assembly of a 30–50 Mev electron model of the Midwestern ...niversities Research Association (MURA) *clashing beam accelerator* ...was completed at Madison, Wis., and test operations began early in ...1960. Simultaneous acceleration of beams traveling in opposite direc...ions was successfully carried out. This model should provide basic ...formation during the spring of 1961 as to whether or not such an ...celerator is technically feasible. If the experiments are successful, ...URA probably will submit a proposal to the Government for con...truction of a large-scale accelerator.

An electron cyclotron model, the *Cyclotron Analogue II*, is being ...built at Oak Ridge National Laboratory. It will have a maximum ...energy of about 450 kev and is designed to study the dynamics of the ...proposed Oak Ridge 850 Mev fixed-frequency proton cyclotron, par...ticularly with respect to beam extraction.

...ndem Van de Graaff Accelerators

The Commission in November 1959 signed a contract for purchase ...three 10 Mev tandem Van de Graaff accelerators to be delivered in ...summer of 1961.

Two accelerators will be installed at Commission research centers, ...at *Argonne* and one at *Oak Ridge*. The third machine will be ...talled at *The Rice Institute*, Houston, Tex.

Research Facilities

...del C Stellarator

Princeton University operates one of four major laboratories carry...g out Commission research to determine the feasibility of using

controlled thermonuclear reactions to produce power. A research program initiated in 1951 at Forrestal Research Center focuses on the "stellarator concept" employing a device in which ionized gas is confined within an endless tube by means of a very strong external applied magnetic field.

A number of small stellarators have been constructed in succession beginning in 1952. Stellarators, with their novel magnetic field configurations and methods of heating the gas plasma, are complex devices and require a great deal of careful design and fabrication.

Because the small stellarators have limited and specialized capabilities, a larger facility known as the Model C complex has been under construction for several years. Completion now is scheduled for 1961, a year later than originally planned. Model C will be strictly a research facility designed to yield scientific information, and is not expected to be a net power producer. The initial cost of Model C, including buildings and supporting facilities, is expected to be above $35 million.

High Flux Research Reactors

High neutron flux reactors are needed for producing very heavy elements for research purposes—californium 252 and other transplutonium isotopes—for conducting radiation damage experiments, for producing intense neutron beams, and for other specialized research. The neutron flux required is in the range of 10^{15} to 10^{16} (one million billion to 10 million billion) neutrons per square centimeter per second. While for certain uses, fluxes in the 10^{16} and higher are desirable, current technology is adequate only for construction of reactors with a flux not higher than 3 to 5 x 10^{15}. Reactors of this type, with supporting facilities, are estimated to cost between $10 and $15 million each.

The Commission has been authorized to construct two high-flux reactor facilities, one at Brookhaven National Laboratory, and one at Oak Ridge National Laboratory. Design work is under way.

The *Brookhaven High Flux Beam Reactor* (HFBR), scheduled to be completed in 1963, will be used for general nuclear research activities; the *Oak Ridge High Flux Isotope Reactor* (HFIR), scheduled to be completed in 1964, will be optimized for the production of transplutonium elements and special isotopes of lighter elements. It is expected to serve as a national facility for producing transplutonium isotopes.

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...ials Research Facilities

...Federal Council for Science and Technology has recommended ...part of the natural materials research program, establishment on ...versity campuses of interdisciplinary laboratories for materials re... in order to foster training of students in this important field. ...Council has further asked that Federal agencies which support ...erials research determine which institutions they were prepared to ...port.

The Congress has authorized the Commission to provide a facility ...this kind at the *University of Illinois*. The Illinois facility would ...sist of a laboratory building and equipment for basic research in ...ce related to materials development at advanced graduate and ...graduate levels.

Other Construction Activities

Among additional research facility projects, the Commission is ...soring construction of two high current cyclotrons of novel de... the *Oak Ridge Isochronous Cyclotron* (ORIC) Oak Ridge Na... Laboratory and the *88-inch Cyclotron* at Lawrence Radiation ...oratory.

Also being built or designed are new *Central Research Labora...* and *Transuranium Facilities* at Oak Ridge National Labora..., special *Hot Laboratory Facilities*, Argonne National Laboratory ...a new *Research Reactor* at Ames Laboratory. New *Physics* and ...*mistry* buildings are being built or planned at Brookhaven Na... Laboratory and Lawrence Radiation Laboratory.

Various physical plant facilities for nuclear research also are being ...sored by the Commission at university sites, including *Columbia* ...*Yale Universities* and at *Massachusetts Institute of Technology*. ...*California Institute of Technology* for many years has been ...rating a 1 Bev electron synchrotron provided by the Commission. ...Commission also, in cooperation with the Office of Naval Re...rch, helped fund the 1 Bev synchrotron at *Cornell University* and ...1 Bev Mark III linear electron accelerator at *Stanford Univer...*

Biology and Medicine

...research in the medical and biological fields—life sciences—the ...mission expended $50 million for the fiscal year that ended June ...960, including about $2 million for construction. Some $34 mil-

lion of this total was for research and operating expenses of Govern ment-owned or financed laboratories operated for the Commission b universities or industrial organizations, and some $16 million was f research in universities, colleges, and other nonprofit institutions c ried out under 593 research contracts. This Annual Report to t Congress describes selected major activities during the past year p taining to studies of nuclear civil effects and fallout. Results of ba research in the life sciences at major Commission installations w described in a special report to Congress.[11]

FALLOUT STUDIES

During 1960, studies of the mechanisms of radioactive fall showed a revision of the trends in fallout rates and related uptake o radioactivity in foods; during the period since November 1959, n tests of large-scale weapons (French tests were not of this type) ha been conducted and it was possible to follow the curves without int ruptions due to new detonations. The total fallout studies progra was described in detail in a previous report.[12] The Commission's re search program in this field is not designed to monitor fallout radi activity throughout the United States, but to support specific proje in biology and medicine related to fallout. The responsibility fo monitoring environmental levels of radioactivity resulting from fall was assigned to the Department of Health, Education, and Welfare b Executive order in August 1959, which gave that agency primar responsibility within the executive branch of the Federal Gover ment for the collation, analysis, and interpretation of such data.

Current studies provide a body of data on levels of fallout at sit throughout the world but the main purpose of the measurements w to establish a base for continuing collection of data to improve unde standing of fallout distribution, rate of deposition, and residence tim in atmosphere.

With issuance of the Commission's April Quarterly Statement o Fallout (April 28, 1960), the Commission ceased to publish thes statements directly; instead, the Commission supplies all such type of information to the U.S. Public Health Service, Department o Health, Education, and Welfare, for such publication as Public Heal Service wishes to make in connection with its compilations includi radiological health data from other Federal and State agencies, an

[11] "Atomic Energy Research in Life and Physical Sciences—1960", a Special Report to Congress by the United States Atomic Energy Commission, January 1961. Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., $1.25.

[12] See pp. 239–266, Annual Report to the Congress for 1959 (January–December 1959).

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...ther sources. The Public Health Service issues these reports ...nthly; at quarterly intervals the reports include information sum... ...aries of the type previously made public through the Commission's ...uarterly Statement on Fallout. The Commission has continued to ... technical reports on its fallout program.

Soil and Air Measurements

...l Samples

...Strontium 90 levels in soil were sampled at locations throughout ...e world during 1958 cooperatively by the Commission's Health and ...fety Laboratory (New York, N.Y.) and the U.S. Department of ...griculture. These measurements provide information in the total ...rontium 90 deposition to specific dates from past weapons tests.

...During 1959, soil samples were taken from nearly all the United ...tates as compared with only 17 locations in previous years.

The increase in strontium 90 in the soil from 1958 to 1959 agrees ...th findings from monthly collections of fallout during that time. ...nthly collections (steel pots, ion-exchange columns, precipitation) ...the world-wide network of stations showed the highest rate of fall... ...d to be early in 1959; this was followed by a lower rate. In the ...st quarter of 1959 a few collections in the United States showed a ...nd toward some increase in fallout but readings were below the ...west rate observed earlier in 1959. Too few data for 1960 were ...ailable at the time of this report to warrant conclusions as to sea... ...al variations.

...spheric Studies

...Rhodium 102 produced in tracer amounts at a high altitude by weap... ...tests, and tungsten isotopes produced in other shots during the ...U.S. Eniwetok Proving Ground tests, provided means of study... ...transport and rate of fall of radioactive debris placed in the ...sphere by these United States tests. These studies are being ...by the Air Force Cambridge Research Center with partial sup... ...by the Commission. Results obtained so far imply that the time ...ed for material to move from the high stratosphere to the sur... ...is much longer than for material placed initially in the low ...sphere. Comparisons between rhodium and tungsten tracers in ...indicate different histories of the debris mixing in upper and ...stratospheres. However, the information so far collected is not ...nt to establish either the distribution or the residence time of ...Rh 102 in the total atmosphere.

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In addition to these studies to analyze stratospheric patterns, balloon sampling of stratospheric quantities of fission products was continued at San Angelo, Tex., during 1960 in cooperation with the Air Force under the technical direction of the U.S. Weather Bureau. Current results from this program are not yet available.

Levels of gross or total fallout beta radioactivity in surface air continued to decrease or remained about the same during the period July 1959 to June 1960 in both hemispheres. Levels in the Southern Hemisphere remained relatively stable during this period.

During late February and spring of 1960, transient increases in radioactivity in air and in precipitation samples were found at some stations. Identification of radioisotopes indicates that this debris apparently originated about mid-February and early April 1960, from the tests held by France in the Sahara Desert. These data show relatively small increases in fallout, persisting for a few days only at levels much lower than observed in the spring of 1959. This fresh debris will add about 0.1 to 0.2 percent to total world-wide fallout of long-lived fission products.

At Argonne National Laboratory detailed studies of gamma radiation in air and soil have been made for several years.

The peak monthly levels of radioactivity from fallout at Argonne due to past tests occurred during April and May 1959. The rate diminished in a few months to a few percent of the peak rate. Cesium 137 still is accumulating slowly and had reached a value of about 200 millicuries per square mile in early 1960. Based on Argonne's calculated ratio of 1.6 between the amounts of cesium 137 and strontium 90 from fallout the amount of strontium 90 in soil would be about 125 millicuries per square mile. Radioactivity from French tests was observed in snow during late February, but no activity from this source was found in either soil or air samples.

Based upon these measurements integration of the whole-body dose from fallout in the Chicago area shows an expected increase of 1.1 to 3.3 percent greater than that which arises from natural radiation of that area.

Test Site Area

The Los Alamos Scientific Laboratory and University of California at Los Angeles have studied fallout at the Nevada Test Site and adjacent areas during all test activities there. The most recent work involved the 1959 test of Kiwi-A (a nuclear reactor for propulsion of unmanned vehicles, a part of the Rover Project).[13] In this device

[13] See p. 77, Annual Report to Congress (Jan.–Dec. 1959).

propellant is heated through a jet nozzle the resultant particu radioactive substan the reactor core. showed wide variat than predicted from The pattern of co and off-site deposit with meteorologica not be explained by of dispersion is und

Fallout

Studies were con through collection vegetables, forage c have been reported ent, January and Quarterly Reports.

Strontium 90 in W

Wheat samples Health and Safety the maximum level and milling produc of radioactivity in fallout, which is amount, which is te ponent contributes with agricultural p A study of milling the highest averag and the lowest in intermediate betwee

Carbon 14 in Oils

Studies at Los A from a number of

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propellant is heated in the reactor core and ejected to the atmosphere through a jet nozzle. Studies were undertaken to measure in detail the resultant particle sizes, air concentration, and ground deposition of radioactive substances resulting from passing the propellant through the reactor core. Deposition velocities calculated at certain points showed wide variations from point to point and generally were larger than predicted from particle sizes.

The pattern of contamination was very narrow, levels were erratic, and off-site deposition was negligible. Attempts to combine the data with meteorological measurements indicated that the pattern could not be explained by existing models and a new model for this kind of dispersion is under investigation.

Fallout Measurements In Foods And In Man

Studies were continued on uptake of fallout material in foods through collection and analysis of milk, animals, certain fresh vegetables, forage crops, and wheat. Detailed results of these studies have been reported in the Commission's Quarterly Statements on Fallout, January and April 1960, and Health and Safety Laboratory Quarterly Reports. In this report, selected findings are described.

Strontium 90 in Wheat

Wheat samples collected in 1958 and 1959 and analyzed by the Health and Safety Laboratory continue to show average levels near the maximum levels previously observed, and analyses of both wheat and milling products have produced new maximum figures. Levels of radioactivity in foods are believed to depend on both the rate of fallout, which is tending to decrease, and the total accumulated amount, which is tending to increase, although the amount each component contributes is not yet known. Further, levels in foods vary with agricultural practices, seasons and types of agricultural products. Study of milling products from 1958 wheat from 9 States showed the highest average levels of strontium 90 and calcium in the bran and the lowest in patent flour. Levels in other types of flour were intermediate between bran and patent flour.

Carbon 14 in Oils

Studies at Los Alamos of carbon 14 in lemongrass and citrus oils from a number of locations have shown an increase of carbon 14 con-

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tent in these oils. By mid-1959, carbon 14 activity in the tropospl... and in lemongrass and citrus oils appears to have increased by a... 27 percent in the Northern Hemisphere and 20 percent in the Sout... Hemisphere.

Fallout Measurements in Man

Studies of cesium 137 in humans and in cow's milk have contin... at the Los Alamos Scientific Laboratory since 1956. Levels have ri... slowly and irregularly during this time. Irregular peaks and trou... occurred in milk levels due to fluctuations in tropospheric fallou... seasonal changes in diets of dairy herds. A similar pattern is obser... in humans but is less pronounced. Maximum and minimum level... people lag behind those of milk by about three months.

Studies of human bone levels of strontium 90 were continued ... Lamont Geological Observatory, Columbia University, during 19... The results of analysis through 1959 have been evaluated relative ... dietary levels of strontium 90 and predictions of future levels ha... been made. The concentration of strontium 90 in human bone co... tinued to increase in 1958 and 1959. The concentration of stronti... 90 in adult bone is independent of the age of the individual where... levels in children vary with age. The average level in the Northe... Hemisphere for Western culture adults is about 0.30 micromicrocur... of strontium 90 per gram of calcium for 1959. The 1958 level w... about 0.20 micromicrocuries. The highest average concentration f... any age group in 1958 was about 2.1 micromicrocuries for one-yea... olds.

RESEARCH RELATED TO WEAPONS

Nuclear Civil Effects

Group Shelter Study

Holmes and Narver, Inc., Los Angeles, Calif., under contract w... the Commission, has completed an engineering study of a gro... shelter successfully tested during the 1957 test series in Nevada. T... engineering included modifications based on analysis of test resu... to improve the protective characteristics of the structure, and to i... prove interior arrangements, services, utilities and management.

In addition to architect-engineering drawings, the contractor pr... pared a brochure, a set of specifications, and a shelter operati...

manual. The broc... the Commission as ... Designed to pro... buried, corrugate... minimum of three ... radiation intensity ... also provides prote... square inch and pro...

Instruments

Several models l... forms for a simple, ... strument for home ...

A pilot model ... conventional radio ... "Do-it-yourself" ki... radiation instrume... register a particula...

Shielding Studies

Furthering the ... the shielding again... the measurement o... Building at Germa... homes at Oak Ridg...

The study is repo... the Radiation Pro... against Distributed ... of open field expos... ranged in all house... in the basements, e...

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[1] Available from Office ... D.C., price $0.50.

[2] CEX–58.1, "Experim... tal Structures against D... and H. E. Menker. Av... Commerce, Washington 2...

[3] CEX–59.1, "An Exp... Large Modern Concrete O... Available from the Office ... 25, D.C. Price $0.60.

[4] Available from Office ... 25, D.C. Price $0.50

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manual. The brochure and operating manual have been published by the Commission as a single report, CEX 58.7, "*Group Shelter Study.*" [14]

Designed to protect 100 persons for 14 days or more, the shelter is a buried, corrugated metal arch structure on a concrete slab. With a minimum of three feet of earth cover over, the shelter attenuates the radiation intensity inside of about 1/10,000th of intensity outside. It also provides protection against blast pressures up to 35 pounds per square inch and protection against thermal radiation.

Instruments

Several models have been made by the Commission and by private firms for a simple, easy-to-use radiation detection and measuring instrument for home protection in a radiation emergency.

A pilot model prepared by a Commission contractor includes a conventional radio receiver assembled from a commercially available "do-it-yourself" kit. A switch allows a choice between radio and radiation instrument circuit. A selector will set the instrument to register a particular radiation level and sound a continuous warning.

Shielding Studies

Furthering the research accomplished during the measurement of the shielding against radiation afforded by typical residences [15] and the measurement of the shielding in the Commission's Headquarters Building at Germantown, Md.,[16] studies were made of nine selected houses at Oak Ridge, Tenn.

The study is reported in CEX 59.13 "Experimental Evaluation of the Radiation Protection Afforded by Typical Oak Ridge Homes against Distributed Sources." [17] The protection factor, i.e., the ratio of open field exposure dose rate to exposure dose rate in the house, ranged in all houses from 2 to 5 on the main floor and from 5 to 30 in the basements, except in a fallout shelter in one house where the

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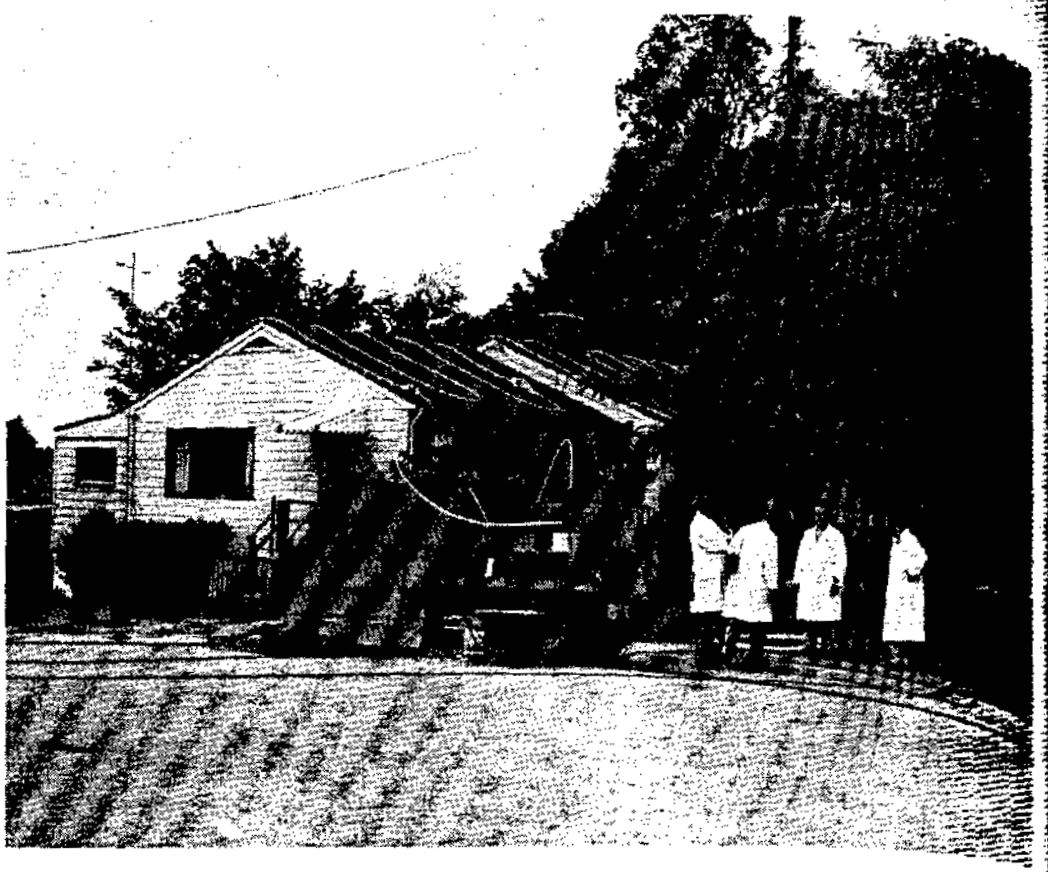
Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C., price $0.50.

[15] CEX-58.1, "Experimental Evaluation of the Radiation Protection Afforded by Residential Structures against Distributed Sources." J. A. Auxier, J. O. Buchanan, C. Eisenhauer, and E. E. Menker. Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Price $2.75.

[16] CEX-59.1, "An Experimental Evaluation of the Radiation Protection afforded by a Typical Modern Concrete Office Building." J. F. Batter, Jr., A. L. Kaplan, and E. T. Clarke. Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Price $0.60.

[17] Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Price $0.50.

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Protection Test. Work conducted at Oak Ridge National Laboratory has shown that the average home will offer a certain amount of protection against fallout radiation that might result from a nuclear war. The tests were conducted by surrounding each of several types of homes with a plastic hose through which a radioactive source was pumped to simulate radiation from wartime fallout. Inside the house, radiation detection instruments were placed in all rooms and at all levels to record the amount of radiation penetrating the structure to a specific area.

protection factor was greater than 100. On sloping lots, the protection factors were typically lower than in basements built on level lots.

During July, an experimental evaluation was made of the shielding in a modern medical laboratory building at Brookhaven National Laboratory; in September, measurements were made of the shielding afforded by a typical southwestern residence in Las Vegas, Nev., and at the request of the Office of Civil and Defense Mobilization, measurements were made on a new 20 by 100-foot, underground metal arch shelter at that agency's Region III headquarters in Thomasville, Ga.

Dosimetry Studies

Field experiments conducted during weapons tests in operations Plumbbob, (1957) and Hardtack, Phase II (1958) provided data to

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...check the reliability of the estimates of the neutron and gamma ray ...exposures as estimated for survivors of the Hiroshima and Nagasaki ...explosions in Japan. In Japan, through the program of the Atomic ...Bomb Casualty Commission, shielding histories of individuals are ...being obtained so that it may be determined for each case how much ...shielding against radiations there was between the subject and the ...sources of radiation.

To improve understanding of the shielding effect of various con...structional materials and structures under field conditions, plans are ...being made to simulate emission of bomb neutrons and gamma rays by ...suspending a small, low-power, unshielded reactor from a balloon ...above the Nevada Test Site.

To provide accurate, early data on neutron and gamma ray emis...sions in the event of a criticality accident, a Nuclear Accident Dosim...etry system was put into effect in mid-1959 for the use of Commis...sion laboratories and plants.

Regional Surveys

...rial Measurements

An extensive program of Aerial Radiological Measurements and ...surveys, called the ARMS Program, has been conducted by the Com...mission to measure and map background radiation levels for selected ...areas. Under contract, U.S. Geological Survey aircraft have com...pleted surveys of some 23 areas.

Another element of the program is the Extended Source Calibra...tion Area at the Nevada Test Site. This consists of a 2,000 by 2,000-...foot square on which 565 small cesium 137, cobalt 60 and other isotope ...sources can be arrayed so that the plane sources are "seen" by air...borne instruments. The low intensity field will be used for intercali...bration of aerial radiometric instruments.

Facilities For Research On Blast Biology

The Lovelace Foundation for Medical Education and Research, Al...buquerque, N. Mex., has been engaged in research on the biological ...effects of blast from nuclear weapons. Studies have been made of (*a*) ...physical phenomena related to blast to determine hazardous environ...mental variations, and (*b*) the biological responses associated with ...exposure to forces generated by large-scale explosions. The Com...mission has furnished the primary support for this work at its facil...ities at Sandia Base, at the Lovelace Foundation laboratories in

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Albuquerque, and at the Nevada Test Site during the nuclear test series in 1953, 1955, and 1957.

The facilities at Sandia Base include shock tubes of 12, 24, and 6 inch diameters used to study primary blast effects associated with variations in pressure. Concurrent studies are being carried out on secondary effects as damage from penetrating and nonpenetrating missiles and from test subjects being projected through space by blast-produced winds.

Research In Blast Biology

Specific accomplishments of the blast biology program over the last 12 months are described in this report.

One study established mortality curves for mice, rats, guinea pigs, and rabbits exposed to shock waves accompanying "instantaneously" rising overpressures 6 to 8 seconds in duration. Variations in mortality with the magnitude of the incident and reflected overpressures were summarized in a report.[18]

A laboratory study on the effects of sharply rising pressures of 2 to 4 milliseconds (*msec*) duration on mice, rats, guinea pigs, and rabbits was completed during the reporting period. The results indicated that the tolerance of these four species to such pressures was the same as that when the duration was 6 to 8 seconds. A series of experiments on the effects of "sharp" rising pressures of 400 *msec* duration on dogs was partially completed.

The tolerance of different animal species is expressed as the P_{50}, or the pressure that kills 50 percent of a particular species. Data indicate that under the conditions of the experiments the magnitude of the pressure was the significant factor in injury and the duration of the wave less important for small laboratory animals.

A secondary blast missile can be any object from the local environment, such as fragments of glass from windows, building debris, stones, etc. By specially-devised trapping techniques, the velocities and masses of more than 20,000 secondary missiles—factors that affect the injuries caused—were determined from data obtained in 1955 and 1957 nuclear weapons tests in Nevada. A mathematical model was

[18] "Shock Tube Studies of the Effects of 'Sharp'-rising, 'Long'-duration Overpressures on Biological Systems," D. R. Richmond, R. V. Taborelli, F. Sherping, M. B. Wetherbe, R. J. Sanchez, V. C. Goldizen, and C. S. White, AF Document SWR–TM–59–2, pp. 171-18[illegible] Proceedings of the Third Shock Tube Symposium, 10–12 March 1959, Hqs., Air Force Special Weapons Center, ARDC, Kirtland Air Force Base, New Mexico.

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vised which made these results generally applicable to weapons of
r yield and in varying atmospheric conditions.
To determine the consequence of a body being hurled through space
blast winds, anthropometric dummies were placed on two shots in
field tests, and one successful attempt was made to record the
mmies' motion by means of high-speed photography. Under condi-
s of the blast and site, the dummy was thrown 22 feet, attaining a
ximum velocity of 22 feet per second in one-half second. This indi-
ed that the same mathematical model used to predict the velocity
d displacement of secondary missiles could be used to predict the
avior of the dummy.

Nuclear Effects Information

sion of "The Effects of Nuclear Weapons"

The 1957 edition of the handbook, "The Effects of Nuclear
apons" is being revised again jointly by the Department of Defense
d the Commission. Publication is scheduled for late 1961.

mparative Nuclear Effects Data

A brochure is being prepared to summarize unclassified data to
plify the appraisal of the impact on man of a range of nuclear
sions. The information is of value to those concerned with
alty estimates, protective construction, and post-attack medical
irements. The brochure is based on data presented in "The
fects of Nuclear Weapons" and subsequent field and laboratory ex-
ments and will be issued by the Commission as CEX 58.8 "Com-
ative Nuclear Effects of Biomedical interest." [19]

Radioisotope and Radiation Development

ghlights in 1960 of the Commission's program to expand and accel-
the growing beneficial applications of radioisotopes include:
an increase in the number of byproduct licensees, now numbering
, as compared with 5,417 at the same date in 1959, including a 11
ent increase in industrial licenses.

[19] Available from the Office of Technical Services, U.S. Department of Commerce, Wash-
e 25, D.C.

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Continuing high demand for radioisotopes as reflected in sales of 191,122 curies valued at $1.9 million although sales declined 14 percent and 1.6 percent, respectively, over the previous year owing to remodeling of production facilities.

Negotiation of 32 contracts for research and development on such projects as isotopic power production, water resource development, environmental contamination control, sensitive analytical techniques, and other promising applications of radioisotopes.

Development of isotopes production facilities through improvement of fission product separation processes and beginning construction of a radioisotope process development laboratory.

Price reductions for widely used carbon 14 and cobalt 60.

Advances in the development of high intensity radiation as a potential industrial processing agent with negotiation of 15 research and development contracts related to radiation technology, and initiation of construction of a new facility to study the engineering problems associated with the application of large isotopic radiation sources.

Establishment of a food irradiation processing program to demonstrate the technical and practical feasibility of this method of extending the refrigerated shelf life of certain foods.

Expansion of educational opportunities for radioisotope technology training with the award of 36 equipment grants totaling $224,107 to 37 colleges and universities in 22 States.

LICENSING, PRODUCTION AND SALES

Radioisotope Licensing

During the year ending November 30, 1,713 byproduct material licenses and 5,151 amendments and renewals of existing licenses were issued. Included in this number are 947 licenses which were issued to new licensees: 357 in the field of medicine, 284 to industrial firms, 252 to Federal and State laboratories, and 54 to users in other fields. As of November 30, 5,907 organizations and individuals in the United States possessed byproduct material licenses. There was a net increase of 490 licensees during the past year, of which 40 percent were for industrial use (after eliminating all licenses expired and not renewed). Appendix 4 shows all byproduct material licenses and new licensees by State and type of user. Thirteen licenses were

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issued, pursuant to Section 30.24(f) of Part 30, to authorize distribution of various types of gaging, ion generating and chromatography analytical devices under general licenses.

Production And Sales

During 1960, the number of curies of radioisotopes shipped from Oak Ridge National Laboratory, the Commission's principal supplier, showed a decline as a result of the 9-month shutdown of the Fission Product Pilot Plant (F3P). During the shutdown, the plant was remodeled for increased production capacity. At the year's end, when the F3P was ready to resume operation, a substantial backlog of orders for radioisotopes existed, including orders for 150,000 curies of cesium 137 and 1,000,000 curies each of cerium 144 and strontium 90.

As of November 30, a total of 191,122 curies had been shipped during 1960, as compared with the 222,703 curies shipped for the same period in 1959. A parallel decline in gross income from radioisotope sales also was shown, $1.9 million for the first 11 months of the year as against the $2 million in 1959. Sales of radioisotopes from Oak Ridge since the beginning of public distribution in 1946 now total 1,105,026 curies. The number of individual shipments made during 1960 totaled 11,773, down somewhat from the 12,028 of the previous year. Total shipments since August 1946 reached 143,578.

Sales of carbon 14 during the past year were up 50 percent over the 1959 figure, reflecting price reductions on carbon 14, cobalt 60, and other radioisotopes during early 1960.

During the year, the first private production of radioisotopes for commercial sale was announced. Abbott Laboratories, using a commercially owned reactor, began the production of iodine 131. The General Electric Co. and Westinghouse Electric Corp. both announced the intention of using their test reactors for the commercial production of cobalt 60. These actions are consistent with the Commission's announced policy of encouraging private industry to provide services previously available only from Commission facilities.

Shipments of radioisotopes to foreign countries continued to increase. The Commission and private processors, combined, made 4,857 shipments during 1960 as compared with the 3,252 during

Foreign suppliers also were making sales to United States industry. Belgium, France, and Israel joined Canada and the United Kingdom as the main sources. The following figures, supplied by the Bureau of Census, show the trend of the export-import dollar volumes for radioisotopes:

	U. S. EXPORTS	U. S. IMPORTS[a]
1952	$239,298	$85,6[illegible]
1953	521,788	169,7[illegible]
1954	536,476	148,7[illegible]
1955	1,288,017	188,7[illegible]
1956	905,995	514,4[illegible]
1957	1,367,067	822,3[illegible]
1958	1,533,859	907,8[illegible]
1959	1,282,575	1,145,1[illegible]

[a] Import values include containers, encapsulation charges, devices in which the radioisotopes are employed, insurance, shipping and other costs, and thus are not a true comparison with Commission sales which refer only to unfabricated radioisotopes.

ISOTOPES DEVELOPMENT PROGRAM

Emphasis in the isotope program is placed on development of basic technology that may be widely applied, particularly to matters of public, State and municipal concern such as improving water resources, combating atmospheric pollution, assuring proper treatment of industrial wastes before discharge to the environment, and detecting crime.

During 1960, 32 research and development contracts in this field were negotiated with research centers, universities, industrial organizations and other government agencies.[20]

Isotope Electric Power Production

During 1960, the Commission made progress toward safe application of strontium 90 in programs to develop equipment that will generate electricity directly by applying the heat of radioactive decay

[20] Reports issued under these contracts are annotated in *Nuclear Science Abstracts* in which their availability also is indicated. Final reports issued to date are listed in Appendix 6. For a general review of activities in isotope technology development to the beginning of 1960, see "Radioisotopes in Science and Industry; A Special Report of the U.S. Atomic Energy Commission." Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.25.

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U.S. EXPORTS	U.S. IMPORTS
$239,298	$85,849
521,788	169,782
536,476	149,779
1,288,017	188,725
905,995	514,471
1,367,067	823,206
1,533,859	907,851
1,282,575	1,145,105

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thermocouples. Thermocouples are bimetallic devices which generate a small current of electricity when one end is maintained at a higher temperature than the other end. Strontium 90 is especially useful in such devices. It is available in large quantities from the waste products of chemically processing fuel elements of reactors. Its beta radiation will not penetrate outside the heat chamber and consequently the generator can be handled readily. Since strontium 90 is long-lived, the generator could operate for some years without recharging, and with only gradual loss of power. Removal of strontium 90 from wastes, if the radioisotope should be used in great volume, would somewhat reduce the problems of waste disposal since strontium 90, with cesium 137, is the chief long-lived hazard of these wastes.

An important technical advance during 1960 was the successful development by The Martin Co. under a Commission contract of a method for safely containing strontium 90 by "locking it up" chemically in a ceramic material, strontium titanate. Strontium titanate is chemically inert—that is, it will not corrode or enter into other chemical reactions—and it has the proper physical properties such as heat transfer, tensile strength, etc. Encased in stainless steel, the corrosion-proof strontium titanate can ensure against the release of strontium to the environment for at least 500 years, by which time its radiation would be reduced to 1/250,000th of its initial level.

With this accomplished, a second phase of the program was initiated under the Martin contract to prove that a strontium 90 thermoelectric generator could be constructed which would continue to provide 5 watts of electricity for as long as 10 years without recharging.

In a cooperative program with the U.S. Weather Bureau, the Commission has constructed a thermoelectric device to power an unmanned weather station for transmission of weather information from remote locations. The station was completed and testing was begun during late 1960. It will make possible continuous collection of weather data from previously unreported regions such as the Arctic.

The successful technological developments under this program have led the Navy and Coast Guard to authorize construction by the Commission of four additional units to prove their applicability in light buoys and floating weather stations (see section on Aircraft Reactors Program).

Other work to apply similar devices to provide auxiliary power for man-made satellites of the earth is reported elsewhere in this report in the section on the Aircraft Reactors Program.



Remote Weather Station. Artist's conception of the remote automatic weather station, designed for the Commission and the U.S. Weather Bureau by Martin Co., as it might appear in the Arctic snow. The unmanned station operate 2 years without human attention. The cylinder shown in the cutaway form is 8 feet high and 32 inches in diameter. The smaller cylinder inside tains about a pound of radioactive material, surrounded by thermoelectric ments to convert heat directly into electricity for operation of the weather measuring instruments and a radio transmitter.

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Water Resource Development

The Commission is working with the U.S. Geological Survey and other groups in developing nuclear techniques to solve water resource problems. Radioisotopes offer unique means for helping to increase understanding of underground flows of water and other water reserve factors such as rainfall, runoff, ground reservoir recharge and waste disposal.

Lake McMillan, an underground reservoir in New Mexico, is being tested with very low quantities of tritium to measure its volume. Accurate knowledge of the quantity of stored water in the reservoir will permit more efficient utilization of the water for irrigation. Other technology being developed in such studies may find wide application in water resource development and conservation.

Environmental Contamination Control

Air Pollution

For quick collection of data and implementation of control procedures in smog control, the Commission, in conjunction with the Air Pollution Foundation of California, is developing a trace analyzer using krypton 85 to measure instantaneously and continuously the concentration in the atmosphere of the contaminant, sulfur dioxide. In this device, chemically inert krypton 85 is bound in a material which, on contact with sulfur dioxide, releases minute amounts of the radioactive gas which then can be detected and measured.

This development is based on research begun early in the isotopes development program to explore new radiochemical analytical methods. After the instrument is completed, it will be field tested by the Air Pollution Foundation for an additional year.

A second atmospheric analyzer has been evolved as a result of the original research. A proof-of-principle model of an analyzer to measure ozone content of the upper atmosphere has been tested successfully. A test instrument flown by the Air Force in a high-altitude weather balloon proved that the technique can be used to measure ozone from the earth's surface up to 100,000 feet altitude. Development work to develop a rugged model is being carried out by the

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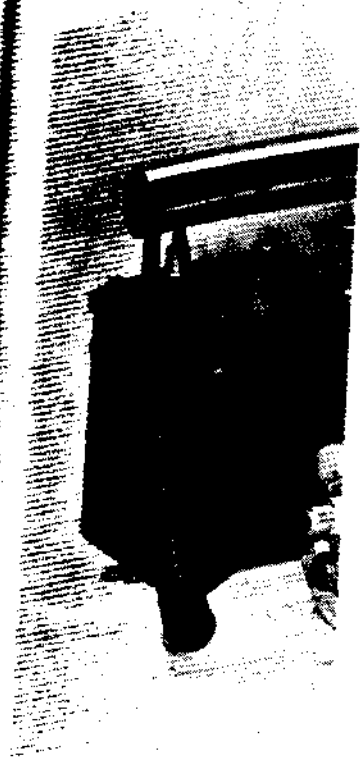
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Smog Control. Working with the Air Pollution Foundation of California the Commission is sponsoring development of devices which may help control smog problems such as is shown in the *above photo*, taken on a smoggy day in Los Angeles. *Opposite photo* is a portable air pollution sampler developed for monitoring the sulfur dioxide content of atmosphere within industrial plants. The detector (cylinder) contains an inert gas which, upon contact with sulfur dioxide, releases measurable amounts of radioactivity that can be "read" on the dial. Similar, but larger, devices are being developed for continuous monitoring of atmosphere over cities.

Water Pollution

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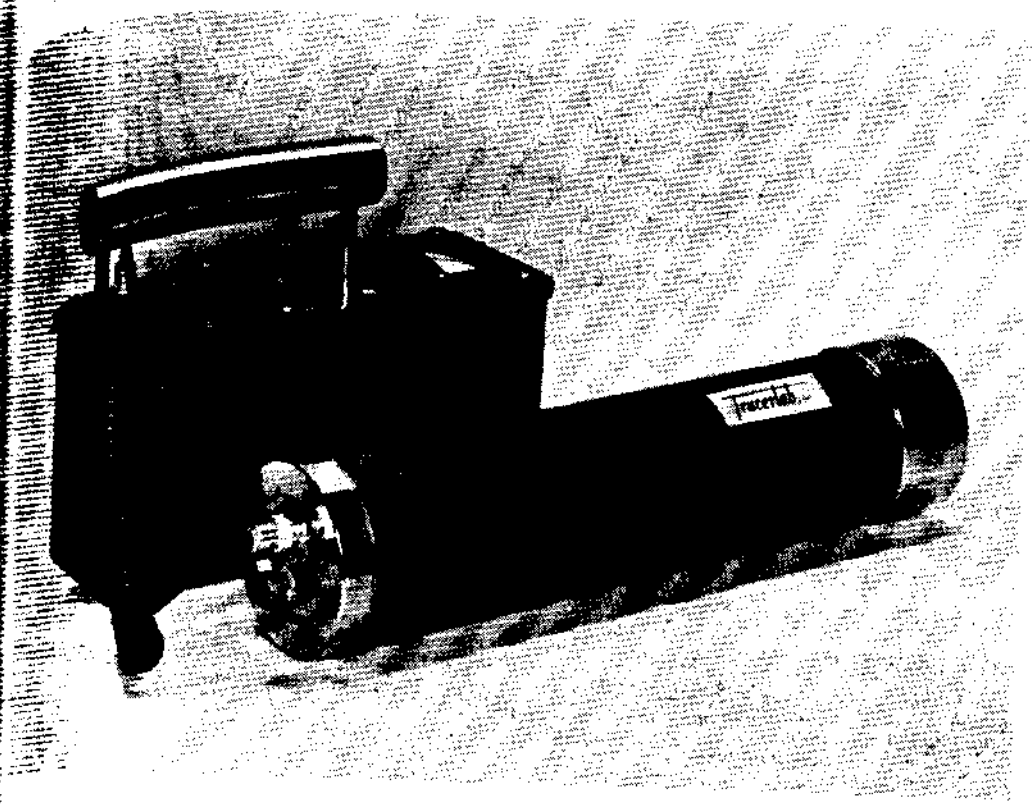
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Water Pollution

Control of water pollution is the object of other isotope technology investigations. A representative study in this field is application of tracer methods to research on degradation of detergents by sewage disposal plants with a view to controlling excessive frothing which



inhibits sewage treatment, and entry of incompletely degraded detergents into public water supplies.

Radioisotope tracer methods also can identify the origin of industrial stream pollutants and help to develop control methods.

Isotopic Analytical Procedures

Isotope techniques are being developed for application to a wide variety of analytical and bioassay methods potentially useful in food and drug industries. This research is based on a survey study carried out by Massachusetts Institute of Technology that outlined areas of research in which potential radioisotope techniques might be used.



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Drugs and Foods

A double isotope dilution method is being developed for amphe-
mine, an important medicament for stimulation of the nervous sys-
tem. The technique uses carbon 14 labeled amphetamine and
iodine 131 labeled reagent, and is potentially capable of determining
the presence of as little as 0.05 micrograms of amphetamine in pro-
duction samples. The technique is 200 times more sensitive than
conventional methods.

Use of radioisotopes as indicators of biological activity is being
investigated to make possible more rapid bioassay methods to test
pharmaceutical products. Measurements of uptake of sodium 22, zinc
65 and phosphorus 32 by tissues of laboratory animals after injection
of estrogens, androgens and growth hormones appear to offer rapid
and inexpensive methods of assuring accurate composition of these
drugs.

This investigation completes Commission studies in this area since
it has been proved that radioisotopes offer a useful technique for measuring small quantities of medicaments in complex mixtures. A final report has been prepared.[21] Future work in this area will be carried out by private industrial or research laboratories.

The Commission is continuing developmental studies on using radioisotope techniques to detect in foods the residues of agricultural chemicals, of detergents used in washing fresh vegetables, and of the derivatives of wrapping materials.

Neutron Activation Analysis

Neutron activation analysis, based on measurement of radiation induced in certain elements by neutron bombardment from a small neutron source, is capable of great sensitivity and accuracy. In some cases, this technique may substitute for conventional methods that lack sensitivity. Currently neutron activation analysis is being applied as a research tool: in medicine, to determine trace metals in tissues;

[21] "Development and Expansion of Radioisotope Applications in Pharmaceutical and Allied Industries" (NYO-2635). Nuclear Science and Engineering Corp., Pittsburgh, Pa. November 1960, 245 pages. Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C., $3.00.

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...ery, to analyze oil well cores and determine trace impurities in ...leum products, chemicals, and semiconductor materials; and in ...gy, oceanography, agriculture, meteorology, public health and ...sciences, for a variety of tests. Limitations in the properties of ...ing neutron sources, nuclear reactions that interfere with analysis, ...chemical problems of source preparation are being studied.

...lated projects deal with development of automatic systems and ...puter data handling that should permit analysis of large numbers ...amples at high speed—a development important in using this ...nique with rock cores and water, soil and biological samples. ...analog and digital computer devices to handle activation analysis ...are being tested. High speed computers also should increase ...racy of analysis by making possible application of statistical ...niques to data.

...active beam. Under contract with the Commission, Catholic ...ersity of America is studying the possibility of detecting hidden ...ives, as in airplane luggage, by neutron beam examination. In ...eration with the Treasury Department, an investigation is check- ...the possibility of identifying the origin of opium to facilitate ...l of drug traffic. Identification of minute amounts of unique ...nts absorbed during growth of plants, thus identifying origin, ...een proved feasible for tobacco. In related industrial use, the ...e of nylon thread produced at separate plants has been identified ...arly.

Process Control

...dioisotope tracer techniques are being investigated as methods of ...variables within an industrial process to control or regulate the ... A laboratory setup of a nickel refining process has been built ...ermine the feasibility of controlling iron removal from process ...by measuring changes in activity of incorporated radioactive ... and automatically adjusting chemical, temperature and other ...eters.

...his method proves out, it will have application in many other ...rial processes. Operations that could be automatically con- ...d by radioisotope tracer techniques are being studied.

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RADIOISOTOPE PRODUCTION DEVELOPMENT

Improved Production

Continuing progress is being made in research and development efforts to produce new isotopes, improve quality, increase availability and reduce costs to meet the changing needs of science and technology for a wide variety of radiomaterials.

The Commission's Fission Product Pilot Plant at Oak Ridge National Laboratory was modified during 1960 to improve its capability for large-scale separation and purification of fission products. The plant is directed to research on fission products separation technology and for production of kilocurie amounts of strontium 90, technetium 99, cesium 137, cerium 144 and promethium 147.

New ion exchange and solvent extraction techniques were developed to achieve high purification of fission products used in isotope-powered thermoelectric generators. Equipment of new design was constructed for shipment of massive quantities of radioactive materials, and processes are under development to convert fission products into forms safe for shipment.

Construction of a new $1.5 million, 40,000 square foot laboratory for radioisotope process development has been started at Oak Ridge. Completion of this laboratory will facilitate research on providing a wider variety of radioisotopes of improved quality at lower cost.

The Oak Ridge Research Reactor, which has up to 300 times the neutron flux of the reactor previously used, now is contributing to radioisotope production. The greater flux makes possible larger production of short-lived isotopes and of high specific activity materials.

Several new radioisotopic materials have been made available. Krypton 85 of high specific activity and highly enriched carbon 14 containing 85 percent radioactive atoms, have been produced for the first time by thermal diffusion. Increased availability of high purity iodine 131 has been assured by a new production technique in which enriched uranium 235 is irradiated.

At Hanford, considerable work is being done in the separation of strontium, cesium, and cerium radioisotopes from production plant chemical effluents under the radioisotope production development program.

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The price of carbon 14, the most important tracer used in biological research, was reduced 27 percent during 1960, following a 50 percent reduction the previous year. Major reductions, ranging up to 70 percent were made in the price of certain forms of cobalt 60, particularly for large shipments and material of high specific activity. Quantities greater than 100,000 curies now are priced at $1.00 per curie.

The stable isotope helium 3 was made available for sale to the public on July 1 from the Commission's Mound Laboratory, operated by Monsanto Chemical Co. at Miamisburg, Ohio. Development of efficient gaseous thermal diffusion process for separation and purification of the isotope made it available in quantity for the first time. The price for helium 3, with 99 plus percent isotopic purity, was reduced from $1,500 to $150 per liter. The isotope has a wide number of uses, but is especially useful in low temperature research.

INDUSTRIAL PROCESS RADIATION DEVELOPMENT

The Commission's program for applications of radiation sponsors research and development directed toward utilization of massive quantities—millions of curies—of radiation energy in industrial processes. Evaluations made on the current state of the technology and research and development requirements for using radiation showed the following needs:

1. The mechanisms by which radiation interacts with molecules and the excited species thus produced need to be better understood;
2. Means of increasing yields of desired products by changing experimental variables such as temperature, pressure, etc., need to be further studied;
3. Design of radiation sources and facilities so as to increase efficiency of radiation use and assure safety requires more thorough investigation;
4. Availability of radiation sources must be increased;
5. Costs of radiation must be reduced.

During 1960, 15 research and development contracts and interagency agreements were negotiated toward accomplishment of these purposes.

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Process Research

Silicon Production

A representative study demonstrated that silicon of a semiconductor grade could be produced by irradiation of silane (SiH_4) at temperatures well below that now necessary in thermal production techniques; this established the possibility of future development by private industry of a radiation process for this product. Success also was achieved in adding acrylonitrile to cotton by radiation techniques, improving its resistance to attacks of microorganisms.

Other Projects

Successful applications of radiation have resulted primarily from fundamental projects. Accordingly, Commission contracts emphasize projects aimed at developing basic information on effects of temperature, pressure, phase, purity, and other variables on radiation reaction yields and kinetics for chemical systems of potential industrial interest. Studies include mechanism of radiation halogenation of aromatic compounds, effect of solid absorbents on radiation yields in organic systems, relation of molecular structure to radiation graft copolymerization, increasing efficiency in the radiation vulcanization of rubber compositions, improvement of properties of textiles through radiation modification and use of radiation to improve sedimentation of sewage.

Fundamental investigations include determination of the nature and distribution of ions produced by impact of high-energy radiation on gas-phase molecules and extension of current theories of radiation phenomena.

Source Development

Radiation source development, including accumulation of the engineering knowledge essential to effective and safe design of practical irradiators, also is being advanced.

Gamma Ray Sources

Brookhaven National Laboratory is a center for this type of work, carrying out studies on economic evaluations, source development (other than source production), increased source efficiency, and development of associated engineering equipment to meet radiation processing requirements, and radiation physics studies necessary to

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development of radioisotopic sources and evaluation of their properties and potential industrial usefulness as sources of ionizing radiation. A new facility which will contain 500,000 curies of cobalt 60 is being constructed to permit studies on the engineering problems associated with use of high intensity isotopic sources. The new facility to be completed by late 1961 will cost an estimated $1.6 million. Experimental work has resulted in improved design concepts for large cesium 137, cobalt 60 and sodium 24 irradiators.

In a cooperative research program with the U.S. Bureau of Mines, the Commission will furnish a 100,000 curie cobalt 60 radiation source for research on the use of coal as a raw material for production of industrial chemicals through irradiation, development of improved metallurgical processes utilizing radiation, and similar research on other natural resources.

The Commission also will furnish 50,000 curies of cobalt 60 to the National Bureau of Standards for use in a cooperative research program on effects of radiation on polymeric substances, gamma ray dosimetry and extension of gamma ray standards.

Beta Sources

Beta-emitting radioisotopes represent a considerable resource of radiation energy that might effectively supplement the more penetrating radiation from gamma emitters. Ultimate use of abundant fission products such as strontium 90 is the aim of studies now under way on the technology and applications of large beta radiation sources.

Electron Beam Applications

Commercial firms have continued to produce electron beam irradiated materials, including a transparent polyethylene food wrapping, improved wire and cable insulation that has been accepted for the Navy's missile electronic system, and irradiated plastic parts with superior strength, lightness, and temperature resistance particularly suitable for weapons and missile systems.

Many commercial radiation-produced products are based on technology developed under Commission-sponsored research.

Radiation Processing of Food

The Commission's program on radiation preservation of food is aimed at developing the technology to demonstrate technical and prac-



Better Product. Subjecting plastic materials to nuclear radiation may cause chemical or physical changes which result in a superior product. Above photo shows the results of a General Electric Co. experiment in which pieces of irradiated and nonirradiated polyethylene film were subjected to 300° F. heat. The irradiated film (left) retained its form, while the nonirradiated piece (right) "flowed" and lost its original characteristics.

tical feasibility of using relatively low amounts of radiation to extend the refrigerated shelf life of perishable foods. Product and market development to establish low dose radiation processing of foods as a routine commercial method would be the responsibility of private industry.

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Low dose radiation processing—in this case less than 1 million rad contrasted with 3 to 5 million rad high dose radiation for long-term preservation without refrigeration—promises to be the most immediately useful civilian application of ionizing radiation for food processing purposes. If successful, it could assist food distribution by making foodstuffs available in as near fresh condition as possible and minimizing processing effects on quality. It could have economic value by making it possible to distribute near-fresh perishable foods in distant markets.

The Department of the Army Quartermaster Corps program is concentrated on high dose radiation sterilization of foods—to destroy virtually 100 percent of the spoilage organisms and permit long-term storage without refrigeration.

At Commission request, the American Institute of Biological Sciences has established a committee of scientists to consult with the Commission's Division of Biology and Medicine and Office of Isotopes Development on technology, nutrition and wholesomeness factors in radiation processing of food.

Preliminary Studies

Two specific areas of low dose processing have been investigated by the Commission preliminary to detailed research. Under contract, Stanford Research Institute has reviewed all technical aspects of low-dose processing of fruits and vegetables, and made a market analysis of the potential role of radiation processing and its economics.

A companion technical study on radiation preservation of fish has been completed by Massachusetts Institute of Technology, and related marketing factors and economics are being studied by the Bureau of Commercial Fisheries, Department of the Interior.

Next Steps

These studies, plus information developed during the Quartermaster Corps experiments, have provided a basis for programing specific experiments.

Special low dose food research irradiators are being designed at Brookhaven National Laboratory, and the first, using 25,000 curies of cobalt 60, was completed during 1960. Brookhaven will start continuing design studies on other specialized irradiation facilities with larger radiation sources.

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RADIOISOTOPE TRAINING AND EDUCATION

The Commission's radioisotope technology training activities are intended to help incorporate appropriate background and techniques into existing and new courses in the physical sciences and engineering. The program includes equipment grants, faculty training, and course development.

Under its equipment grant program, the Commission during 1960 made 36 awards totaling $224,107 to 36 institutions in 22 States. Funds went for acquisition by colleges and universities of radiation detection devices, radioisotope handling equipment, and related laboratory demonstration apparatus. Emphasis in use of the equipment is on teaching, as distinct from research.

In cooperation with the National Science Foundation, the Commission during 1960 supported three faculty training institutes on use of radioisotopes, radiation principles, and safe handling techniques, at the Oak Ridge Institute of Nuclear Studies, Massachusetts Institute of Technology and the University of California at Berkeley. The institutes were attended by 97 members of 75 college faculties.

In developing laboratory radioisotope manuals and training aids, tested radioisotope experiments have been compiled for use in the college chemistry curriculum, together with instructors' notes. The experiments are particularly appropriate for use by institutions with limited equipment. A set of experiments on chemical use of high-intensity radiation has been developed as has a cobalt 60 irradiator suitable for laboratory experiments in advanced graduate and undergraduate courses.

The Commission also assists in training senior technical personnel of industry in radioisotope technology and, during 1960, industrial isotope courses at the Oak Ridge Institute of Nuclear Studies were attended by 135 persons.

An educational film, "Industrial Applications of Radioisotopes," in color and approximately 57 minutes in length, was prepared under Commission contract. Directed to industrial management, engineers, and technicians, the film illustrates industrial applications of radioisotopes in tracing, radiography, and gaging. The film may be borrowed for nonprofit showing from any Commission film library (see Appendix 7).

The Commission also has cooperated with various educational and industrial organizations in a series of regional conferences covering radioisotope techniques, safety practices and regulatory controls. During 1960, conferences were held in 7 locations and were attended by 1,100 industrial personnel.

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International Activities

...elopments during 1960 in international atomic energy activities ...lude:

...*International Atomic Energy Agency.* The Fourth General Con... of the Agency accepted principles and procedures to serve as ... foundation for an international safeguards system against di... of special nuclear materials and equipment from peaceful uses. ... member states offered to place nuclear facilities under Agency ...guards as soon as the Agency is ready to assume these responsibili... Arrangements were made for agreements under which the ...cy will act as an agent in providing special nuclear materials to ...land and Norway, and heavy water to Yugoslavia. The ...cy met an increased number of requests for technical assistance ...ly from allotted funds but also with special assistance from addi... funds provided by the United Nations Expanded Program for ...nical Assistance, and from those offered by the United States in ... for equipment in kind valued up to $192,000.

...Progress was achieved toward resolving the *public liability* ques... by the IAEA, Organization for European Economic Cooperation ...EC), the European Atomic Energy Community (Euratom), and ... individual nations by reaching a clearer understanding and ...ment on national, regional, and international levels of this major ...lem. Sixteen member states of the OEEC signed an agreement ...blishing uniform standards governing civil liability for nuclear ...rds.

...In the Euratom-United States joint program, research and develop... work was continued and the second round invitation for con...tion of two nuclear power plants to be completed by 1965 was ...to be issued early in 1961.

...Exchange of scientific and technical personnel and unclassified ...mation was initiated between the Union of Soviet Socialist Re... and the United States under the McCone-Emelyanov Mem...um of Cooperation signed in November 1959.

...Visits and discussions of developments in the peaceful uses of ... energy were arranged between scientific and technical person... of the United States and those of India and Yugoslavia.

...Peaceful nuclear energy developments in the Western Hemisphere ... promoted through the Second Inter-American Nuclear Energy

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Commission meeting, the Third Inter-American Symposium on the Peaceful Uses of Atomic Energy, and through use of the Puerto Rico Nuclear Center where a 1,000 kw (thermal) reactor was dedicated in August for nuclear training and research.

INTERNATIONAL AND REGIONAL COOPERATION

International Atomic Energy Agency (IAEA)

Fourth General Conference

The fourth annual General Conference of the International Atomic Energy Agency took place at the Agency's headquarters in Vienna from September 20 through October 1. Sixty-three of the 70 member states were represented and five additional countries became members during the Conference.

As head of the United States delegation, U.S. Atomic Energy Commission Chairman John A. McCone urged in his general statement that all members increase their contribution in support of Agency programs. He also recommended a strengthening of the Agency's technical programs, continued action on international problems of health, safety and waste disposal, and the endorsement of the detailed IAEA safeguards system that had been developed by the Board of Governors.

The provisionally approved Agency safeguards were endorsed by the General Conference. Implementation of these procedures will carry out the safeguard function specified in the Agency's statute and enable the Agency to administer safeguards under U.S. bilateral agreements at the request of the Nations concerned. Seven countries announced during the Conference their willingness to have such bilateral safeguards transferred to the Agency for administration.

In further sessions the Conference approved a 1961 budget totaling nearly $8 million and adopted resolutions strengthening the program of technical assistance, development of nuclear power, and distribution of scientific information.

Safeguards. In April, the Agency Board of Governors provisionally approved for consideration by the Fourth General Conference, recommendations on the Agency's initial safeguards principles and detailed implementing procedures as well as on the rights, privileges and immunities of safeguards inspectors. The United States figured prominently in the development of these procedures.

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The September action of the Fourth General Conference was the approval of a 15-country resolution that the Board of Governors take into account, as appropriate, the views expressed in the General Conference before giving effect to the Agency safeguards principles and procedures. The Board of Governors was invited to report to the future General Conference on the Agency's implementation of safeguards.

During the Fourth General Conference also, the United States offered to place four reactors in this country under Agency safeguards. This offer was made to demonstrate that Agency safeguards do not infringe upon national sovereignty, and to provide in effect, a field laboratory in which the safeguards principles and procedures could be tested and improved. The Brookhaven Medical Reactor, the Brookhaven Graphite Research Reactor, the Piqua Organic Moderated Reactor, and the Experimental Boiling Water Reactor were included in the four-facility offer. During the period in which safeguards would be attached to these facilities, the provisionally approved safeguards principles and procedures would be applied, including verification of appropriate accounts and records, and visits by the Agency's inspectors.

Highlights of 1960 in activities of the International Atomic Energy Agency are described in the following sections.

Funds

The payment by the United States to the International Atomic Energy Agency's total regular assessed budget of $5,843,000 was $1.9 million. Voluntary contributions to the Agency's operating budget during 1960 were $957,837, of which the United States provided $500,000 that had been pledged unconditionally. The U.S. pledge to match additional contributions up to $1 million was not utilized since voluntary payments by other countries did not match the basic $500,000 contribution of the United States.

Technical Equipment and Experts

The Agency authorized two preliminary technical survey missions. One went to Greece, the Ivory Coast, the Federation of Mali, Morocco, the Sudan, and Tunisia; the other visited El Salvador, Guatemala, Mexico, Paraguay, and Peru. These missions assessed the needs for assistance in developing nuclear energy activities such as training, education, equipment, or technical experts.

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As of November 30, some 170 requests were received from 33 member states for technical equipment or experts. The Agency sent about 30 experts to these countries for periods ranging from 6 months to 1 year to provide assistance in education, training, and planning research reactor and radioisotopes programs. In addition, the Agency planned a field program under the U.N. technical assistance program, using the services of 26 experts. The United States furnished six consultants during the year.

The Agency's 1960 budget provided $552,000 for sending experts to member states as well as $47,190 for technical equipment. Funds totaling $599,610 were also received from the United Nations Expanded Program for Technical Assistance. In addition, the United States made available nuclear equipment valued at $192,000 under its offer to the Third General Conference in September 1959. Eight member states received assistance under this United States grant through the IAEA.

Training and Exchange of Scientists

The Agency allocated $800,000 for its training program in 1960. It had received by November 30, some 640 applications for training fellowships from 43 countries. Of these, about 424 had been selected for assignment to 23 foreign institutions, approximately 40 percent for training in the United States. More than 140 IAEA fellows already have completed training.

On the recommendation of the United States, the Agency is encouraging development of an independent training capacity in several member states. Plans were approved for regional radioisotopes training courses in Cairo and regional training courses in several other locations were under consideration.

Of the two mobile radioisotopes training laboratories presented by the United States in 1958, one was used first in four Western European countries, was later transferred to Korea, and subsequently moved to the Republic of China; the second was used during 1960 in Mexico and Argentina.

Health and Safety

Standards concerning health and safety measures to be used in conjunction with materials or equipment provided through the Agency were approved. Provisional regulations concerning transport of radioactive materials were also approved for application in Agency operations and for the guidance of member states.

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Management of radioactive wastes was discussed at the Agency-sponsored conference held in Monaco, November 16–21, 1959. Following this, the Agency undertook studies and prepared recommendations on the problems of waste disposal on land and in bodies of fresh and salt water.

Reactor Studies and Surveys

The Agency supported studies of different types of power reactors and of the economics of nuclear power to guide member states in planning their nuclear power programs. A power survey mission was sent to Finland to assist that country in evaluating its future needs, including the practical role to be played by nuclear stations. A similar mission, in which the U.N. Technical Assistance Administration cooperated, was sent to the Philippines.

The United States invited Agency staff representatives to observe several small and medium power reactor projects in this country. Agency personnel have visited these project sites and will regularly receive information on reactors of particular interest to less-developed countries.

The first reactor hazards evaluation of a proposed reactor was completed for Switzerland, and the Swiss Government announced evaluations would be requested for future reactors.

Nuclear Materials Distribution

In response to a request from Finland, the Agency completed arrangements to provide that country with enriched uranium for a SWIMGA Mark II research and training reactor purchased by Finland in the United States.

The United States also agreed to make available, through the Agency, uranium fuel elements for use in a cooperative research project to be conducted in Norway to obtain basic nuclear data for power reactor design. Fuel for the first core of the Seibersdorf, Austria, research reactor was supplied through the U.S.-Austrian Agreement for Cooperation; however, it is expected that future cores will be obtained through the Agency.

The first request for Agency assistance in obtaining heavy water was made by Yugoslavia for a research reactor at Boris Kidric Institute. The material is to be supplied by the United States under an Agreement which is in process.

The United States suggested that Agency member states with which the United States has bilateral agreements obtain all or part

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of their future reactor fuel supplies through the Agency. Several countries subsequently made informal inquiries and were expected to submit firm requests for fuel requirements from the Agency during 1961.

Public Liability

The Agency sponsored discussions of public (third party) liability protection against claims for damages arising from nuclear accidents involving land-based reactors, and a draft convention was prepared for consideration by IAEA member states. Agency efforts were encouraged by the success of the Organization for European Economic Cooperation (OEEC) and the European Atomic Energy Community (Euratom) in preparing similar conventions for application to their respective members.

The Agency held two panel meetings for drafting a related international convention on public liability applying to nuclear propelled vessels. A conference has been called for April 1961 to consider the draft convention.

Publications

Included in the documents released by the Agency during the year were the "International Directory of Nuclear Reactors" (Volumes II and III), "International Directory of Radioisotopes" (Volume II), and the first issue of the quarterly "Journal on Plasma Physics and Thermonuclear Fusion."

Bibliographies on different phases of work in atomic energy and proceedings of Agency-sponsored conferences and symposia held in 1958–59 also were published. A Scientific Reference Catalog was established for use in preparing, upon request by any member states, detailed information on special subjects in atomic energy. The Agency library was expanded during the year by donations from member states, and the United States provided all additional unclassified technical publications of the Commission in 1960 as part of the updating of the Atoms-for-Peace library donated by the United States to the Agency in 1958. It is estimated that the United States has supplied, to date, more than 29,000 unclassified reports and publications to the IAEA library.

Research

Through November 30, the Agency awarded some 41 research contracts to scientific institutions in 15 countries.

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The United States provided additional support to the program by ...ing research contracts through the IAEA totaling $125,319 with ...foreign institutions.

...nstruction was underway on the Agency's central analytical ...oratory at Seibersdorf where research projects are to be under... Supplementing contributions of equipment from other coun... the United States provided $600,000 in 1959 to assist in con...ting and equipping this laboratory, to be completed in early 1961.

...ferences

The Agency sponsored two major international scientific confer... in 1960; one in Vienna, September 5–9, "Small and Medium ...er Reactors," and the other on "Use of Radioisotopes in Physical ...ce and Industry," held in Copenhagen, September 6–17. In ad... the Agency sponsored 10 scientific symposia on such subjects as ...mical Effects of Nuclear Transformation," "Nuclear Ship Pro...," and "Fuel Element Fabrication." The Agency also spon... numerous expert panels and seminars to consider matters such ...nsportation of radioactive materials, safe and effective use of ...rch reactors and critical assemblies, reactor economics, and codes ...actor computations.

...Dosimetry Experiment

...United States assisted in an Agency-sponsored experiment at ...ris Kidric Institute in Yugoslavia to obtain data on the bio... effects of an accidental high level radiation exposure to six ...ists. The experiment, conducted by France, the United King... and the United States was aimed at assessing more precisely the ...on doses received by the scientists during a brief, uncontrolled ... the Vinca zero-power reactor on October 15, 1958.

European Atomic Energy Community (Euratom)

...joint reactor program of the European Atomic Energy Com... (Euratom) and the United States entered its second phase ...1960 with preparations to issue an invitation for a second round ...posals for power reactors to be completed by the end of 1965. ...acceptable proposal for a power reactor to be in operation by ...er 31, 1963, was received in response to the first invitation. ... negotiations involved in this first project were progressing ...torily.

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An additional Agreement for Cooperation between the United States and Euratom, which became effective July 25, 1960, supplements the original joint program agreement of February 18, 1958. It provides, subject to Congressional authorization, for the United States to make available special nuclear materials to meet certain urgent needs outside the scope of the United States-Euratom joint program.

In its Third Annual Report, Euratom estimated that by 1980 about 30 percent of total Western European electricity requirements can and should be met from nuclear sources. This would amount to over 40,000,000 electrical kilowatts of installed capacity.

Power Reactor Program

An invitation for proposals to construct two power reactors by December 31, 1965 is scheduled to be issued by the Atomic Energy Commission and Euratom in early 1961. A date is to be stipulated for submission of proposals, and interested groups are expected to provide satisfactory assurances that proposed reactors will be in operation by the end of 1965.

Commission and Euratom acceptance of the definitive power reactor proposal by an Italian utility, Societa Elletronucleare Nazionale (SENN), submitted in response to the 1959 invitation closed out the first phase of the program for reactors to be constructed by December 31, 1963.

The SENN proposal was for a 150,000 ekw boiling water reactor near the mouth of the Garigliano River in Italy. This proposal was determined by the Joint Reactor Board to meet the specified conditions and criteria of the invitation and was subsequently approved by the United States and Euratom as an acceptable basis for developing necessary arrangements such as contracts for fuel cycle guarantees, fuel supplies, and chemical reprocessing services. Contract negotiations are in progress for a Euratom SENN Basic Contract and the Atomic Energy Commission-SENN Fuel Cycle Guarantee Eligibility Contract. The reactor is already under construction.

The Societe Nucleaire Franco-Belge des Ardennes (SENA) group, comprised of French and Belgian companies, has indicated that it will propose construction of a 240,000 ekw pressurized water reactor under the second invitation of the joint program for reactors to be completed by the end of 1965. Under the special status of a "Joint Enterprise" accorded SENA by Euratom, the group will receive special economic advantages such as exemption from certain taxes. The prime contractor for the project would be the Westinghouse International Electric Co.

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The German group, formerly AKS, now the *Kernkraftwerk Baden-Wuerttemberg Planungsgesellschaft* will study the economies and technical prerequisites for construction of a 150,000 ekw atomic power plant and plans to build as a first step a small 15,000 ekw pilot power plant to obtain accurate data on construction and operation costs.

Research and Development Program

The United States-Euratom research and development program is limited to projects closely related to nuclear reactors constructed under the joint program. It is principally concerned with improving the economics of these reactors.

The Atomic Energy Commission and Euratom will issue an invitation in early 1961 for research and development work specifically related to various phases of work and technology of the SENN boiling water project. By November 30, the Joint Research and Development Board had received 311 research and development proposals of which 164 were from the United States, 147 from Euratom countries, and 82 were joint proposals by groups in the United States and Euratom countries. Fifteen of these contracts had been authorized so far in the United States and 38 contracts in Euratom countries. When proposals are accepted for construction of other types of reactors, research and development will be expanded to cover these concepts.

Supply Agency

On June 1 the Euratom Supply Agency was formally established to administer transactions involving the supply of nuclear materials to Euratom member states. Euratom control over special nuclear materials began on that date; its control over source material began December 1. Responsibilities include preparation of estimated requirements, review of offers and selection of suppliers, allocation of source materials, and specification of terms and conditions of sale.

Euratom Research Program

The agreement under which Euratom will assume control of the nuclear research center at Ispra, Italy was ratified by the Italian Government on July 19. Euratom will concentrate its main nuclear research effort at Ispra, and Italy will gradually relocate its national research work to other installations.

Under the agreement, Euratom will operate the Joint Center for Nuclear Research for 99 years and will contribute substantial funds

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toward operation and further development of the facilities. T
United States has presented an unclassified technical depository l
brary to the Center.

Euratom agreements for research programs were also negotiat
with West Germany and The Netherlands to provide for nuclear r
search at Karlsruhe, Germany, and Petten, The Netherlands. A
other arrangement permits Euratom to use the materials testing rea
tor at Mol, Belgium.

Safeguards

Euratom representatives conducted their first safeguards inspe
tion on use of nuclear material and facilities at Mol, Belgium.

Organization For European Economic Cooperation (OEEC)

During 1960, the United States enlarged its participation in the
activities of the Organization for European Economic Cooperation
which are concerned with peaceful uses of atomic energy.

Third Party Liability Convention

The OEEC convention on public liability to provide financial pro
tection against nuclear hazards, a significant step forward in remov
ing an obstacle to atomic energy industrial growth, was approved by a
special council of experts and all member states signed the conven
tion by November 30, when it became effective.

Drafted by the European Nuclear Energy Agency of OEEC dur
ing 1959, this convention is the first joint attempt by the Western
European countries to remove a major obstacle to development of nu
clear power. In general, the convention provides that absolute lia
bility be placed on the operators of nuclear facilities, and that
suppliers be freed from any claims. It provides that each adhering
country will have a maximum liability per incident of at least $5
million, with the proviso that each country could, through govern
mental intervention, alter this liability level by domestic legislation
or further international convention, but not to provide less than $5
million coverage.

DRAGON Project

In April, the Commission and the United Kingdom Atomic Energy
Authority (UKAEA), acting as agent for the DRAGON Project

the OEEC, signed
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the OEEC, signed an Agreement providing for exchange of detailed information on high temperature gas-cooled reactors.

The DRAGON Project, a joint undertaking of the UKAEA and other members of the European Nuclear Energy Agency of the OEEC, involves construction and operation of an experimental 20 Mw (thermal) high temperature gas-cooled reactor at Winfrith Heath, England. The corresponding United States project is the 40,000 ekw power reactor of the same type to be built by Philadelphia Electric Co. and General Dynamics Corp. under the Commission's Power Demonstration Reactor Program.

Eurochemic Project

Through exchange of visits and long-term assignment of personnel the Commission provided the *Company for Chemical Processing of Irradiated Fuels* (*Eurochemic*) assistance in planning the design and construction of a small plant.

Construction of the chemical processing facility at Mol, Belgium, began in July under direction of the European Nuclear Energy Agency. The Eurochemic Co. is a semi-governmental, semi-private international shareholding company with members from 13 Western European countries.

Food Irradiation Studies

The Commission participated with 13 Western European countries and international organizations in meetings held under sponsorship of the European Nuclear Energy Agency to examine prospects and problems in food preservation by irradiation. The Agency was directed to undertake studies of United States progress in this area and to determine how irradiation could be applied to food processing in Western Europe with a view to establishing formal projects.

Inter-American Nuclear Energy Commission (IANEC)

The second annual meeting of the Inter-American Nuclear Energy Commission was held in Petropolis, Brazil, July 11–15, with representatives from 14 of the 21 members of the Organization of American States (OAS), including the United States. Admiral Octacilio Cunha, Brazil, was elected Chairman for 1960–61 and Dr. Carlos Martinoya, Chile, Vice-Chairman for the same term.

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General Manager A. R. Luedecke presented the U.S. Reactor gra
check at the dedication of the Venezuelan reactor, at Caracas,
November. Assistant General Manager Dwight Ink accompani
members of the Joint Congressional Committee on a tour of a numb
of European nuclear establishments.

The delegates approved resolutions calling for increased exchan
of nuclear scientists and engineers, establishment of a permanent ad
visory committee to develop a comprehensive plan for coordinatin
education, training, and research in nuclear sciences and technolog
and to undertake a preliminary study of public liability problems
the nuclear energy industry. Also approved were recommendation
that IANEC representatives open negotiations with the Internationa
Atomic Energy Agency for formal arrangements for cooperation;
that the Organization of American States make its fellowship and ex
change and technical assistance programs more flexible so as to bett
meet IANEC needs; and that a survey under IANEC auspices b
made of available nuclear information facilities and services in th
Americas.

The third IANEC meeting will be held May 9–13, 1961, in Washing
ton, D.C.

The Inter-American Commission was established April 22, 1958,
under the OAS as an outcome of President Eisenhower's proposal a
the July 1956 meeting of the Chiefs of State of the American Repub
lics in Panama for cooperation of the Inter-American countries in fur
thering the beneficial uses of nuclear energy.

Third Inter-American Symposium

Held July 18–22 at Petropolis, Brazil, the Third Inter-American
Symposium on the Peaceful Applications of Nuclear Energy was spon
sored by the Inter-American Nuclear Energy Commission and the
Government of Brazil. The United States provided financial sup
port through a grant from Mutual Security Program funds, and
Brazil acted as host.

More than 75 participants from 14 member states of the OAS at
tended the Symposium, the theme of which was "Industrial Applica
tions of Nuclear Energy."

Advisory And Consultant Services

The Commission increased during 1960 its furnishing of consultants
and experts to other countries to provide assistance on programs of

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[2] See pp. 97–98, Annu

jects for development of peaceful uses of atomic energy. In all, ... consultants and experts were provided by the Commission to ... countries and to projects sponsored by IAEA, EURATOM, ...EC, and IANEC.

BILATERAL COOPERATIVE ACTIVITIES

Cooperation With The U.S.S.R.

The reciprocal unclassified exchanges of visits by nuclear scientists ...ween the United States and the Union of Soviet Socialist Republics ...re completed in May and July as the first formal steps in imple... ...entation of some provisions of the U.S.-Soviet Memorandum of Co... ...eration in the Peaceful Uses of Atomic Energy which was signed on ...ember 24, 1959.[22]

The possibilities of United States and Soviet cooperation in peace... ...uses of atomic energy were first raised by U.S. representatives and ...re the subject of informal discussions between Chairman McCone ... Professor Vasily S. Emelyanov during the latter's visit to the ...ited States in September 1959 with Premier Nikita Khrushchev, ...S.S.R. Preliminary agreement was reached at that time on an initial ...procal exchange of visits to unclassified facilities. In October ..., a United States delegation headed by Chairman McCone visited ...viet atomic energy facilities, and the exchange was completed in ... following month with a visit to U.S. unclassified facilities by a ...iet delegation headed by Professor Emelyanov.

Following the Soviet visit in November 1959, the formal memoran... ... to cover future exchanges of personnel, information, and other ...peration in unclassified atomic energy fields was signed in Washing... ... by Chairman McCone and Professor Emelyanov. It is being im... ...mented within the framework of the U.S.-U.S.S.R. Scientific, ...hnical, Educational, and Cultural Exchange Agreement for ...-61.

Under the memorandum, provision is made for cooperation in the ...owing areas: Reciprocal exchanges of visits by U.S. and Soviet ...ists in controlled thermonuclear research, nuclear power reactor ...lopments, high energy physics, nuclear physics, neutron physics, ...structures of nucleons; and for exchange of unclassified technical ...rmation; and discussions of the feasibility of engaging in un... ...ified joint projects in the peaceful uses of atomic energy. The

[22] pp. 97–98, Annual Report to Congress of the Atomic Energy Commision for 1959.

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International Atomic Energy Agency will receive copies of all ex changed reports and memoranda on results of exchanges of visits. The Agency also will be invited to participate in U.S. and Soviet con sideration of possible joint projects.

During the Fourth General Conference of the IAEA in Vienna, Chairman McCone announced that as a result of further discussions with Professor Emelyanov of the U.S.S.R., there would be a new exchange of visits by experts for exploratory talks and exchange of information in the field of waste disposal. Exchanges on fast reactor technology, originally scheduled for the fall of 1960, have been deferred until the spring of 1961.

Five U.S. scientists participated in the first formal visit in May 1960 to Soviet high energy physics facilities. At approximately the same time, the first team of five Soviet scientists visited U.S. controlled thermonuclear research installations. In July 1960, the second group of five U.S. scientists visited the U.S.S.R. and toured Soviet controlled thermonuclear facilities. Also in July, five Soviet scientists toured U.S. high energy physics laboratories.

Details of further exchanges of visits under the 1959 memorandum of cooperation as well as the possible addition of other areas of exchange are being considered by U.S. and U.S.S.R. representatives.

Agreements For Cooperation

Status of Civil Agreements

Three new bilateral Agreements for Cooperation in peaceful use of atomic energy became effective during 1960. They were with Austria, Indonesia, and Venezuela. The new research agreement with Austria superseded and modified the terms of a previous research accord. The agreement with Indonesia is of the research type. The agreement with Venezuela was for power reactor development, superseding an existing research agreement.

During the year, the Agreements for Cooperation with Chile, Colombia, Lebanon, and Pakistan expired through mutual agreement of the countries concerned. The expectation is that these countries will seek assistance in their atomic energy programs from the International Atomic Energy Agency. Amendments came into effect modifying and extending in most cases for 2 years the agreements with Argentina, Brazil, the Republic of China, Greece, Israel, Portugal and the Philippines. These agreements are for a limited period on the assumption that within that period the parties would reach a

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understanding on placing their bilateral activities under Agency safeguards or would work through the IAEA for future materials transactions. Other amendments that came into effect expand and modify the terms of existing agreements with Canada, New Zealand, and Thailand.

As of November 30, 41 agreements were in force with 39 countries (including 2 with Switzerland) and the city of West Berlin—14 for power reactor cooperation and 27 for research. These are in addition to special agreements with the International Atomic Energy Agency and Euratom (see Appendix 14).

Progress In United States Reactors Abroad

One power reactor constructed by a United States company in the Federal Republic of Germany went into operation in November 1960. Five other power reactors were being planned for construction abroad or were under construction by U.S. companies.

A contract was signed by Japan and General Electric in September for construction of a 12,500 ekw demonstration boiling water reactor at the Japan Atomic Energy Research Institute's center at Tokai. Startup date is set for early 1963.

During 1960, 8 United States-manufactured research, training and test reactors went into operation in foreign countries, bringing the total to 27. An additional 17 research, training and test reactors were being built abroad by U.S. companies as of November 30, and more were being planned for construction. (See Part IV, Appendix 12).[1]

Research Reactors And Equipment Grants

Reactors

The Commission approved during 1960 research reactor project grants up to $350,000 to Pakistan and Turkey and $200,000 to Yugoslavia. These grants bring the total number committed since the establishment of the program in 1956 to 22 with a total value of $7.55 million. (See Appendix 16, Research Reactor Grants).

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[1] The apparent discrepancy between the figure of 20 research reactors shown as operable in the 1959 Annual Report and the figures of 27 reactors operable with 8 going into operation in 1960 given in this report results from a change in the definition of "Startup". In this and succeeding Annual Reports "Startup" as shown in Part IV, Appendix 12 will indicate startup date in the location shown by the table. Previously, "Startup" referred to startup date in any location.

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Aid for Yugoslavia. Photo shows Commission Chairman John A. McC... (right) handing to Slobodan Nakicenovic, Secretary of the Yugoslav Feder... Nuclear Energy Commission and Yugoslav Undersecretary of State, a letter ... commitment for a $200,000 research reactor grant. At the same time, Mr. M... Cone informed Secretary Nakicenovic that the Commission had approved ... $150,000 equipment grant for Yugoslavia to assist in acquisition of a hot labor... tory for the Boris Kidric Institute.

During the year, payments were made of research reactor gra... previously committed to Austria, Denmark, Japan, and Venezue... raising the number of grants paid to eight for a total of $2.45 milli... Other countries which have received grants are Brazil, the Federa... Republic of Germany, Italy, and Spain. Grants are limited to o... half the cost of the reactor project, but not to exceed $350,000, and ... paid upon completion of the project.

Requests received subsequent to June 30, 1960, are to be evalua... by the International Cooperation Administration in competition wi... other requests for assistance from the requesting country and are ... be financed with funds available under the ICA's Technical Assista... Program.

Equipment

By the end of the ... mission for the ac... ment with a total ... number approved ... inauguration of the ... Commission also m... Energy Agency cont... a total value of appr...

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...terials and Fuel

During 1960, 321 ... ...search and develop... ...le or lease basis, ...and Sweden. The 19... ...ipments dating fro... ...and bring the total to ... ...also were shipped dur... ...ing a total of 468 ton... ...other materials shippe...

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...se of its facilities to ...foreign reactors for w... ...the United States. T... ...the charges and condit... ...ence no commercial ... ...ease the amount of h... ...ent in foreign reactor...

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Under existing bilate... ...ce and assistance to ... ...systems to insure ... ...and control of nuclea... ...ited States. Agreem...

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...ipment

...r the end of the year, six countries received grants from the Com...sion for the acquisition of nuclear research and training equip... with a total value of $756,116. These grants bring the total ...der approved by the Commission to 21 for 18 countries since ...guration of the program in June 1958. As reported above, the ...mission also made available through the International Atomic ...gy Agency contributions of nuclear equipment to 8 countries with ...al value of approximately $192,000.

Materials And Bilateral Safeguards

...ials and Fuel Assistance

...ring 1960, 321 kilograms of uranium 235 for use in reactors and ...rch and development programs were provided other countries on ...or lease basis, with major shipments going to France, Germany, ...Sweden. The 1960 materials transfers exceed the total of previous ...ments dating from the inception of the program in September 1955 ...ring the total to 630 kilograms. Sixty-two tons of heavy water ...were shipped during the year to France, Norway, and Japan, mak... total of 468 tons of heavy water as well as smaller quantities of ...materials shipped abroad since September 1955.

...cessing heavy water. In May 1960, the Commission authorized ...d its facilities to reprocess degraded heavy water used in four ...n reactors for which heavy water originally was purchased from ...ited States. The Commission will perform this service under ...arges and conditions now in effect for United States companies ...o commercial facilities are available. This service will de... the amount of heavy water that must be purchased for replace... foreign reactors.

...l Safeguards Administration

...r existing bilateral agreements, the United States has provided ...nd assistance to cooperating countries in establishment of con...tems to insure adequate accountability for nuclear materials, ...ntrol of nuclear reactors and equipment obtained from the ...States. Agreements contain provisions in most cases for the

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reactor gra... nd Venezue... $2.45 millio... l, the Feder... imited to on... 50,000, and ar...

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possible transfer of safeguards activities to the International Atomic Energy Agency.

The Commission conducted safeguards inspections of 33 facilities in 12 foreign countries and the City of West Berlin during 1960. Inspections consisted of audit and verification of nuclear materials inventories, examination of accountability records, and physical inspections of nuclear reactors and equipment of United States origin. Countries visited were Australia, Belgium, Denmark, France, the Federal Republic of Germany, Israel, Italy, Japan, Norway, Spain, Sweden, and Switzerland. (See Appendix 15, Foreign Reactors and Critical Assemblies Subject to U.S. Safeguards.)

Education and Training

More than 275 foreign nationals from 27 countries participated in the Commission's formal training programs in nuclear sciences and technology during the year. Individual on-the-job training assignments at Commission facilities were made for 700 persons.

Guidance was given in response to several hundred requests from foreign nationals regarding educational opportunities and financial assistance for training in nuclear science and technology in United States colleges, universities, and private industrial facilities.

Since establishment of the International School of Nuclear Science and Engineering at the Commission's Argonne National Laboratory in 1955, a total number of 416 foreign students from 45 countries and 100 United States Citizens had received training at the school by December 1959.

During the year's three sessions 164 students from 20 countries and the United States attended 175 student-terms. Forty-five students were "affiliates" (individuals capable of independent research and collaborating in a full time research problem for 1 year).

Since the beginning of the *radioisotope techniques course* at the Oak Ridge Institute of Nuclear Studies in 1947, a total of 429 foreign nationals from 56 countries have received training in the use of radioisotopes in research and in industrial applications of radioisotopes. During 1960, 60 students from 27 foreign countries participated in separate sessions.

The second 9-month *course in nuclear reactor operations supervision held by* the Oak Ridge National Laboratory ended June 29, 1960, with 12 foreign students from 9 countries enrolled. The third course, which began November 7, 1960, was extended to 12 months to permit additional on-the-job reactor operating experience. Eight foreign nationals were enrolled in the extended course.

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In October, the Oak Ridge National Laboratory completed its sec- 12-month *nuclear reactor hazards evaluation course* in which 10 ents from 9 foreign countries were enrolled. The third course November 7 with 7 participants from foreign countries.

During 1960, the *Puerto Rico Nuclear Center* offered courses in ear science and technology, nuclear medicine, and radiological ics for more than 16 students from 12 Spanish speaking countries 57 from Puerto Rico and other parts of the United States. Estab- in 1958 by the Commission under contract with the University Puerto Rico, the Center offers instruction at the graduate level. John C. Bugher, formerly Director of the Commission's Division iology and Medicine, was appointed Director of the Center as of 1, 1960. On August 23, dedication ceremonies were held for 1,000 kilowatt research reactor at Mayaguez.

Exchange of Information

Exchanges of scientific and technical personnel and information ed to the development of the peaceful uses of atomic energy were nded during 1960.

nical Depository Libraries

ring 1960, the Commission provided an unclassified technical de- ory library to France and another to the Euratom Research r at Ispra, Italy, bringing to 85 the total number of libraries nted to 58 foreign countries and 5 international or regional or- tions. These libraries are kept up to date through periodic ittal of new documents.

ents and Visits

angements were made for unclassified visits to Commission fa- by 1,097 foreign representatives, and approximately 381 Com- representatives visited foreign atomic energy establishments 11 months of 1960.

United States continued its program of exchanging scientific nical documents with other countries.

than 56 prints of 12 new unclassified films were made available the year to foreign countries through the Commission's liaison

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offices in Argentina, Belgium, Japan, and the United Kingdom. A additional 52 copies of the 12 new and other unclassified films were provided other foreign countries and international organizations as supplements to film sets previously provided during the International Conference on the Peaceful Uses of Atomic Energy held in Geneva in 1958.

Visits and Technical Exchanges

Highlights of visits and technical exchanges during 1960 are given in the following sections.

Chairman McCone, other Commissioners and high Commission officials participated in international activities to an increasing extent during the year. In addition to events previously noted, Chairman McCone took part in disarmament and test suspension discussions in England and France and visited atomic energy installations in a number of European countries. Commissioner Graham was a member of the United States Delegation to the Fourth General Conference of IAEA in Vienna; participated in the opening of the United States exhibit at New Delhi, India, in December 1959, and also visited European atomic energy installations.

Commissioner John Floberg (resigned June 23, 1960) represented the Commission at the opening of the atomic energy exhibit in Cairo, Egypt, in May. Along with Commissioners Olson and John Wilson he attended the semiannual meeting of United States and United Kingdom atomic energy officials held in Britain in May. Commissioners Wilson and Graham spoke at the ground-breaking ceremonies for the experimental power reactor in Puerto Rico and at the dedication of the Puerto Rico Nuclear Center in August. At the invitation of Canadian Research Director W. B. Lewis, Commissioner Wilson also visited the Canadian atomic energy establishment at Chalk River, Ontario.

Canada. The United States and Canada reached agreement on a cooperative program for development of heavy water moderated power reactors to be carried out under the terms of a memorandum of understanding pursuant to the United States-Canada Agreement for Cooperation in the Civil Uses of Atomic Energy, as reported in Part 3, Progress in Power Reactor Technology.

France. Chairman McCone and other United States officials visited French atomic energy centers at Chinon, Saclay, and Marcoule during April in response to an invitation extended by French representatives after their visit to the United States in November 1959.

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Chairman McCone and French officials discussed the nuclear programs of their respective countries and considered expanded cooperation between the two countries. Specific agreement was reached on exchange of information and personnel and joint uses of facilities related to use of beryllium oxide in gas-cooled reactors.

India. A United States technical mission visited India in February and March to tour atomic energy and industrial facilities and to discuss India's plan for nuclear power developments. This visit was a followup to visits to a number of nuclear laboratories and power reactor projects in the United States during the fall of 1959 by Dr. Homi J. Bhabha, Chairman of the Indian Atomic Energy Commission, and other Indian officials.

United Kingdom. Sir Roger Makins, Chairman of the United Kingdom Atomic Energy Authority, and other United Kingdom officials visited United States atomic energy installations in August at the invitation of Chairman McCone. Discussions were held on cooperation between the two countries.

On November 16, 1959, the United States and the United Kingdom agreed on an expansion for a period of 5 years from that date of the cooperative program on gas-cooled reactors established in 1957. The reactors covered under this exchange are the UKAEA's Windscale advanced gas-cooled reactor and HERO (zero energy gas-cooled experiment at Windscale) and the Atomic Energy Commission's Oak Ridge gas-cooled reactor.

Yugoslavia. Exchange visits and discussions of cooperation in developing peaceful applications of nuclear energy were carried out in 1960 by Yugoslavia and United States delegations of atomic energy representatives. Understanding was reached on areas of mutual interest, including channeling cooperative activities through the International Atomic Energy Agency.

Conferences and Exhibits

International Conferences

During 1960, the Commission participated in the Euratom-sponsored International Symposium on Legal and Administrative Problems of Protection in the Peaceful Uses of Atomic Energy held in Brussels, Belgium, in September, and in the Tenth International

Conference on High Energy Physics held in August in Rochester, N.Y.

The United States also was represented at the Fifth Nuclear Congress held in Rome, Italy, in June in conjunction with the Seventh International Electronics and Nuclear Exhibition sponsored by the Italian National Committee for Nuclear Research. In addition to these conferences, the Commission participated in numerous bilateral meetings and other symposia and conferences sponsored by the International Atomic Energy Agency.

U.S.-Supported Conferences

Twelve international atomic energy conferences held in 1960 received support by Commission funds. Six convened outside the continental limits of the United States:

"International Symposium on Comparative Effects of Ionizing, Ultraviolet, Visible and Near Visible Radiations," San Juan, Puerto Rico, February 15–19.

"Third International Congress for Photobiology," Copenhagen, Denmark, July 31–August 5.

"Symposium on Effects of Ionizing Radiation on Seeds and Their Significance on Crop Improvement," Karlsruhe, Germany, August 8–12.

"Seminar on Use of Vital and Health Statistics for Genetic and Radiation Studies," Geneva, Switzerland, September 5–9.

"International Conference on Uses of Radioisotopes in the Physical Sciences and Industry," Copenhagen, Denmark, September 6–17.

"International Conference on Atomic Masses," Hamilton, Ontario, Canada, September 12–16.

Six topical conferences receiving financial support from the Commission occurred in the continental United States:

"International Conference on Organic Scintillation Detectors," Albuquerque, N. Mex., August 15–17.

"Seventh International Soil Science Congress," Madison, Wis., August 15–[illegible]

"International Symposium on the Use of Radioisotopes in the Study of Bone," Princeton, N.J., August 28–September 3.

"Fifth International Congress on Nutrition," Washington, D.C., Sept. [illegible]

"International Conference on the Biological Aspects of Metal Binding," State College, Pa., September 6–9.

"International Symposium on Response of the Nervous System to Ionizing Radiation," Evanston, Ill., September 7–9.

International Nuclear Energy Exhibits

World Agriculture Fair. A daily average of 35,185 people, and a total of 2,850,000 viewed the Commission exhibit at the New Delhi World Agriculture Fair.

United States Info[illegible] plays were featured [illegible] odical publications— *New York Times.*

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A gamma ray irra[illegible] of seeds, cuttings, pha[illegible] work in India.

Eleven seminars wer[illegible] bers of the medical pro[illegible]

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Cairo. The Commissi[illegible] ple. Scheduled for M[illegible] June 9, upon a formal

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The cobalt 60 facility [illegible] which included insects, [illegible] bacteria.

At the Technical Inf[illegible] distributed in English ar[illegible]

Four patients underw[illegible] at the request of a local [illegible] the Isotopes in Medici[illegible]

Rio de Janeiro. "Atom[illegible] was presented in Rio de [illegible] Brazilian Nuclear Energ[illegible] the Third Inter-America[illegible] of Atomic Energy.

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United States Information Service reported that the nuclear displays were featured in approximately 180,000 column inches in periodical publications—equal to more than 30 average copies of the *New York Times*.

A TRIGA research reactor, operated at the exhibit in cooperation with the Indian Atomic Energy Commission, produced a total of 132 isotopes during its 66 days of operation. The first medical radioactive sodium used for diagnosis in India was produced in the reactor.

A gamma ray irradiation facility treated 4,700 group specimens of seeds, cuttings, pharmaceuticals, and micro-organisms, for research work in India.

Eleven seminars were held for scientists, science students, and members of the medical profession.

On June 13, the Government of India formally accepted a gift of a cobalt 60 gamma facility, the fly-rearing facility, and the fly sterilization model featured at the Commission's exhibit. Research work will continue in Indian research centers.

Cairo. The Commission exhibit at Cairo was viewed by 136,344 people. Scheduled for May 8–30, the exhibit was extended through June 9, upon a formal request from the United Arab Republic.

Nine UAR scientists received instruction in operating the American Standard UTR reactor; four engineers received certificates of competence after completing their training program. Commission scientists, in cooperation with those of the UAR, irradiated 20 samples in the reactor and performed 10 reactor experiments. Twenty-two students participated in a similar training program at the reactor simulator.

The cobalt 60 facility was used to irradiate 2,300 groups of samples, which included insects, seeds, chickens, chemical fungi, and yeast bacteria.

At the Technical Information Center, scientific publications were distributed in English and Arabic editions.

Four patients underwent examination by the scintillation scanner at the request of a local physician. The scanner was being displayed in the Isotopes in Medicine section of the exhibit.

Rio de Janeiro. "Atoms at Work," a small nuclear energy exhibit, was presented in Rio de Janeiro, July 16–23, in conjunction with the Brazilian Nuclear Energy Exposition and shown simultaneously with the Third Inter-American Symposium on the Peaceful Applications of Atomic Energy.

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Vienna. A three-panel display illustrating the scope of United States agricultural research with radioisotopes was displayed at the 1960 General Conference of the IAEA in September.

Lahore exhibit. The exhibit shown at Cairo in May was moved to Lahore, Pakistan, and displayed November 6–28.

Over 30 displays composed the exhibit, among which were an operating research and training reactor, a reactor simulator, mechanical manipulators, a technical information center, and demonstrations of radioisotope use in medicine, industry, and agriculture.

Pakistani and United States scientists conducted cooperative research programs at the reactor. Young scientists and engineers assigned by Pakistan received training in reactor installation and operation.

South American exhibit. A mobile exhibit that will travel to four South American countries opened November 1 in Buenos Aires, Argentina. Housing the exhibit was a duel envelope, portable, air-supported structure.

Films were used to present the benefits and potential services of nuclear energy. A technical area of the exhibit contained an operating research and training reactor manufactured by Lockheed Aircraft Corp., a gamma facility designed by Brookhaven National Laboratory, and a reactor simulator. A technical information center contained a complete unclassified library, a technical film library, and conference space.

Scientists and students of Argentina were invited to conduct demonstrations and experiments at the operating reactor and the gamma facility. Lectures and seminars were held for scientists, engineers, physicians, and advanced technical students; science demonstration programs were performed for groups of high school students.

After the exhibit closes at Buenos Aires on December 15, it will be shown in Rio de Janeiro in March 1961; in Lima, Peru in July; and in Caracas, Venezuela in November.

United Nations Cooperation

Committee on Effects of Radiation

The United Nations Scientific Committee on Effects of Atomic Radiation held its Seventh Session at United Nations Headquarters, New York, January 11–22, 1960. Dr. Shields Warren was United States representative; Dr. Austin Brues and Merril Eisenbud served as alternates. Six Uni
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Licensing, Reg

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Facilities Licenses

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alternates. Six United Nations agencies directly interested in the work of the committee sent observers.

A major part of the Seventh Session was devoted to a detailed consideration of three problems: the occurrence, distribution, and movement of fallout from nuclear weapons tests; uptake of radioactive isotopes from soil through the food cycle to man; and effects of low levels of radiation on individuals. A panel of experts from the World Meteorological Organization reported on the current state of knowledge pertaining to the transport and distribution in the atmosphere of radioactive debris from weapons tests.

After discussion of General Assembly Resolution 1376 XIV, requesting the Committee, in conjunction with certain United Nations agencies, to study arrangements for disseminating information and data, two subgroups were established, one dealing with physical data and the other with biological information. They were given responsibility for recommending proposals to implement the General Assembly Resolution. As an interim measure, the Committee requested the Secretariat to communicate to governments of the member nations the Committee's need for certain specific information and data.

Major subjects for discussion at the Eighth Session of the Committee, September 19–30, in Geneva, were genetics, carbon 14, and dose computations.

Licensing, Regulation and Indemnification

LICENSING IN 1960

Facilities Licenses

During 1960, permits were issued authorizing construction of 5 power reactors, 13 research reactors, and 2 critical experiment facilities. One power reactor, 10 research reactors and 2 critical experiment facilities were licensed to operate. Licenses also were issued authorizing export of 3 research reactors (2 to Japan and 1 to Australia). Two companies filed applications for licenses to construct and operate demonstrational power reactors. Applications also were filed requesting authorization to construct and operate 10 research reactors, 2 critical experiment facilities and 1 production facility.

Following hearings held in April and May, the hearing examiner on June 14, 1960 issued his intermediate decision authorizing the operation of the Vallecitos Boiling Water Reactor with internal modifica-

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tions, new fuel and control rod arrangements, and both turbine
electrically driven coolant pumps, and amending the procedure
followed by the licensee in making changes in the reactor or its
tion. On August 18, the Commission isssued a memorandu
order denying exceptions filed by General Electric Co. to the
mediate decision in regard to the procedure for operational or
changes incorporated in the license. Subsequently the Commis
agreed to reconsider the memorandum and order, and oral argu
on licensee's petition for reconsideration was heard on Octobe
On November 2, the Commission issued a memorandum and
which directed the issuance of a license amendment incorporati
change procedure which had been jointly proprosed by Commis
staff and the licensee. Under the amended license, the licensee
freedom to make changes within the limits of the technical speci
tions, provided no unreviewed safety question is involved.
change involving unreviewed safety questions and all changes in
technical specifications must be referred to the Commission.
Director, Division of Licensing and Regulation, may authorize
changes if they present no significant new hazards considera
Otherwise, referral to the Advisory Committee on Reactor Safegu
and scheduling of a public hearing is required.

As was reported last year, the Commission issued its opinion
final decision in the Power Reactor Development Co. (PRDC)
involving construction of the Enrico Fermi reactor near Mon
Mich., on May 26, 1959; in July 1959, the intervenors in the ma
(International Union of Electrical, Radio, and Machine Wor
AFL–CIO; United Automobile, Aircraft and Agricultural Imp
ment Workers of America; and United Papermakers and Pa
workers) appealed the Commission's decision to the United St
Court of Appeals for the District of Columbia Circuit. On Jun
1960, a two-judge majority of a panel of the Court of Appeals
aside the Commission's grant of a provisional construction per
to PRDC. The Government's and PRDC's petitions for rehear
en banc were denied on July 25. Petitions for *certiorari* were
in the United States Supreme Court by PRDC and the Govern
on August 12 and September 29, respectively. The judgment o
Court of Appeals has been stayed. On November 14, the Sup
Court announced it would review the lower court's ruling. O
vember 18, the Commission granted PRDC's request for extensi
the completion date specified in their construction permit. The C
mission order specified July 15, 1961 as the new completion date,
ject to such order as may be entered in the case by the Sup
Court.

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request for extensi
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The power reactor license issued by the Commission, the third issued thus far, authorized Yankee Atomic Electric Co. to operate its pressurized light water nuclear reactor at Rowe, Mass. A Second Intermediate Decision and Order dated July 9, 1960, directed the issuance of an interim license authorizing operation of the Yankee reactor at power levels not in excess of 5 thermal megawatts, solely for the purpose of initial fuel loading and low power testing. Pursuant to the Third Intermediate Decision of July 19, 1960, the limited license was amended on July 29 to authorize steady state operation at power levels not to exceed 110,000 ekw, subject to another hearing to be held to review operations at such power level. On August 8, 1960, Yankee filed an exception to the Third Intermediate Decision with respect to the requirement that all proposed changes in the technical specifications be subject to a public hearing. On August 18, 1960 the Commission denied the exception and remanded the matter to the Hearing Examiner for further proceedings and appropriate decision with respect to the scope of the technical specifications, and other relevant matters. On November 15, 1960, Yankee filed a motion asking that the hearing be reconvened to conform the provisions of the license to the views expressed by the Commission in the Memorandum and Order of November 2, 1960 in Docket No. 50–18 (General Electric-Vallecitos Boiling Water Reactor). A hearing was scheduled for December 12, 1960, convened on that date and recessed to December 13, when it was reconvened. Proposed findings and conclusions have been filed by Yankee and the Staff, and a decision by the Hearing Examiner is pending.

By license amendment dated June 2, 1960, Commonwealth Edison Co. was authorized to operate Dresden nuclear power station at power levels up to 180,000 ekw, design capacity, but not in excess of, or at this steady state power level, without further order of the Commission. An amendment license authorizing steady-state capacity operation was issued October 14, after a public hearing was held September 26–27. Pursuant investigation of control-rod difficulties in the Dresden plant, the Commission, on November 23, 1960, granted a motion to extend to December 16 the period within which the Commission might review the Third Intermediate Decision. When it became clear that the investigation would extend beyond December 16, the AEC staff moved that the Commission further extend the review period until January 31, 1961. The motion was granted by the Commission on December 16.

By license amendment dated January 8, 1960, Westinghouse Electric Corp. was authorized to operate the Westinghouse Test Reactor at Waltz Mill at power levels up to 60,000 thermal kilowatts; operation had

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previously been limited to 20,000 thermal kilowatts. Westinghouse subsequently reported an operating incident which occurred on April 3, involving partial destruction of a fuel element through overheating and subsequent melting. By Commission Order dated June 30, Westinghouse was ordered not to load or start up the reactor without prior approval pending filing of a report by Westinghouse of measures taken to prevent recurrence of the April operating incident. A Commission amendment to the June 30 Order was issued July 25 authorizing partial loading with instrumented experiments. On September 7, Westinghouse was authorized to load, start up, and operate the WTR with a modified venting system subject to specified power level, minimum coolant flow conditions, and also subject to fuel element inspection procedures. Westinghouse also was authorized to fuel and operate the WTR modified high-pressure experimental loop.

Permits were issued authorizing construction of five developmental power reactors by:

Saxton Nuclear Experimental Corp., on February 11, 1960, for construction of a 5,000 ekw light water-moderated and -cooled, pressurized water reactor at Saxton Station, near Altoona, Pa.

Carolinas Virginia Nuclear Power Associates, Inc., on May 4, 1960, for construction of a 17,000 ekw vertical pressure tube nuclear reactor at Parr, S.C.

Northern States Power Co., on May 12, 1960, for construction of a 66,000 ekw Controlled Recirculation Boiling Reactor near Sioux Falls, S. Dak.

Consumers Power Co., on May 31, 1960, for construction of a 75,000 ekw, high power density, single cycle, boiling water reactor at Big Rock Point, Charlevoix County, Mich. (Initial output estimated at 50,000 ekw.)

Pacific Gas and Electric Co., on November 9, for construction of a 50,000 ekw, direct cycle, internal circulation, boiling water nuclear reactor at the applicant's Humboldt Bay Plant near Eureka, Calif.

Prior to issuance of each permit, the application was reviewed by the Commission's Advisory Committee on Reactor Safeguards and was the subject of a public hearing before a Commission hearing examiner.

An application filed by *Philadelphia Electric Co.* for the proposed construction and operation of a 40,000 ekw, helium-cooled, graphite-moderated, developmental power reactor at Peach Bottom, York County, Pennsylvania, has not yet been scheduled for public hearing.

The year's licensing actions and hearings are summarized in Appendices 9 and 10, respectively.

Operator Licenses

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As of November 3
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Westinghouse Elect

One company, Co
manufacturing fuel
has requested a licen

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erator Licenses

For the period January 1 through November 30, there were 190 erator licenses issued authorizing manipulation of reactor controls. of November 30, there were 538 operator licenses in effect.

erial Nuclear Material

For the period January 1 through November 30, 1960, there were ew licenses issued authorizing the possession and use of special clear material; as of November 30 there were 356 special nuclear erial licenses in effect.

As in two previous years, four companies were engaged during 1960 nversion of uranium hexafluoride obtained from Commission ocks to firms needed for fabrication of fuel elements and for re- rch and development. They were the Davison Chemical Co., win, Tenn.; Mallinckrodt Chemical Works, Hematite, Mo.; Nuclear erials and Equipment Corp., Apollo, Pa.; and Spencer Chemical , Kansas City, Mo.

As of November 30, 17 concerns were licensed to fabricate fuel ele- ts in their own facilities, for sale, for their own use, or for re- rch purposes. This is in addition to work performed under Com- sion contract, which does not require a license. One new licensee, Mathieson Chemical Co., was added during 1960. The licensed erators are:

Aerojet-General Corp., San Ramon, Calif.
The Babcock & Wilcox Co., Lynchburg, Va.
Battelle Memorial Institute, Columbus, Ohio.
Carborundum Co., Niagara Falls, N.Y.
Cerite Corp., Cleveland, Ohio.
Davison Chemical Co., Erwin, Tenn.
Engelhard Industries, Inc., D. E. Makepeace Div., Plainville, Mass.
General Dynamics Corp., General Atomic Div., San Diego, Calif.
General Electric Co., Atomic Power Equipment Dept., San Jose, Calif.
L & C Nuclear, Inc., Attleboro, Mass.
The Martin Co., Middle River, Md.
National Lead Co., Albany, N.Y.
Nuclear Materials and Equipment Corp., Apollo, Pa.
Nuclear Metals, Inc., Concord, Mass.
Olin Mathieson Chemical Co., New Haven, Conn.
Pyrania Corning Nuclear Corp., Hicksville, N.Y.
Westinghouse Electric Corp., Blairsville, Pa., and Forest Hills, Pa.

One company, Combustion Engineering, Inc., Windsor, Conn., is ufacturing fuel elements under contract with the Commission, but quested a license to authorize commercial fabrication.

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The following companies continued to serve in their licensed ca... ities to reclaim unirradiated enriched uranium from scrap gener... in fuel fabrication and fuel material preparation:

Davison Chemical Co., Erwin, Tenn.
Engelhard Industries, Inc., Baker Platinum Div., Newark, N.J.
Mallinckrodt Chemical Works, Hematite, Mo.
Nuclear Materials and Equipment Corp., Apollo, Pa.
Spencer Chemical Co., Kansas City, Mo.

Source Material

Licenses issued for the period January 1 through November ... 1960, including renewals, authorizing possession and use of so... materials totaled 1,653. This figure includes 644 licenses issued to ... porters. As of November 30 there were 1,175 source material lic... in effect (exclusive of export licenses).

Byproduct Material (Radioisotopes)

Nearly 7,000 byproduct licensing actions were taken during ... Details are reported in the section on Radioisotopes and Radia... Development.

Waste Disposal Licensing

As of the end of 1960, there were nine organizations licensed to ... duct commercial disposal services involving the disposal of low ac... ity, packaged radioactive waste at sea. No new organizations w... licensed during 1960, current waste disposal services licensees are:

Crossroads Marine Disposal Corp., Boston, Mass.
California Salvage Co., San Pedro, Calif.
American Mail Line, Seattle, Wash.
The Walker Trucking Co., New Britain, Conn.
Isotopes Specialties Co., Burbank, Calif.
New England Tank Cleaning Co., Cambridge, Mass.
Nuclear Engineering Co., Pleasanton, Calif.
Coastwise Marine Disposal Co., Long Beach, Calif.
Ocean Transport Co., San Francisco, Calif.

In addition, eight organizations are authorized to dispose of ... own low-activity, packaged radioactive waste at sea. They are:

National Institutes of Health, Bethesda, Md.
U.S. Naval Radiological Defense Laboratory, San Francisco, Calif.
Socony Mobile Oil Co., Paulsboro, N.J.
California Research Laboratory, Richmond, Calif.

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U.S. Naval Medical Research Laboratory, New London, Conn.
U.S. Fish & Wildlife Service, Beaufort, N.C.
University of Georgia, Sapelo Island, Ga.
University of Hawaii, Honolulu, Hawaii.

License amendments authorizing commercial waste disposal services including land burial at Commission-owned sites near Oak Ridge, Tenn., and Idaho Falls, Idaho, were issued to Crossroads Marine Disposal Corp., Isotopes Specialties Co., and Ocean Transport Co. In addition, Industrial Waste Disposal Corp., Houston, Tex., and Nuclear-Chicago Waste Disposal Corp., Long Island, N.Y., were licensed to provide this type of service. The issuance of the license to Industrial Waste Disposal Corp. was appealed to the United States Court of Appeals for the Fifth Circuit on August 19, 1960, by Harris County, Texas, one of the intervenors in the licensing proceeding before the Commission. Radiological Services Co., Long Island, N.Y., was licensed previously to receive prepackaged radioactive wastes for transfer to Oak Ridge National Laboratory for land burial.

INDEMNITY AND REGULATIONS

Financial Protection and Indemnity

Two amendments to the Commission's financial protection and indemnity regulations in 10 CFR Part 140 became effective on May 7, 1960. Part 140 applies to reactor projects subject to licensing by the Commission.

The first effective amendment supersedes the original Part 140. In substance, this amendment (*a*) adds a population factor to the formula prescribed for computing amounts of financial protection required for the larger reactor projects; (*b*) provides fixed amounts of financial protection, according to power level, for the smaller reactors; (*c*) requires a holder of a reactor construction permit desiring to possess more special nuclear material at his reactor site for subsequent use as reactor fuel to have financial protection in the amount of $1 million before the materials license is issued (indemnification is provided such licensees as of the date of issuance of the materials license); (*d*) clarifies information to be submitted by licensees relying on their own resources as financial protection; and (*e*) incorporates procedures for the exemption of nonprofit educational institutions and Federal agencies from the financial protection requirement. In the latter two categories, Federal agencies are indemnified against all public liability, and nonprofit educational institutions are protected for public liability in excess of $250,000. Both cases, of course, are subject to the stat-

utory limit of $500 million of indemnity protection per nuclear incident.

The second effective amendment to Part 140 approves, as proof of financial protection, the Nuclear Energy Liability Policy (Facility Form) currently offered by the stock and mutual insurance syndicates, Nuclear Energy Liability Insurance Association and Mutual Atomic Energy Liability Underwriters, respectively.

In addition to the two effective amendments, two proposed forms of Commission licensee indemnification agreements were published in the *Federal Register* for public comment on April 7, 1960. These forms are revisions of one proposed in August 1958 and republished May 1, 1959. Further opportunity for comment regarding the revised indemnity agreements was considered appropriate because of the importance and the significance of changes made in the form originally published for comment.

Prior to publishing the effective revision of Part 140, the Commission met in January 1960 with representatives of the insurance industry who proposed, among other things, a financial protection formula differing from that adopted by the Commission. In issuing the effective Part 140, the Commission requested comments regarding the proposal of the insurance industry and stated the Commission's intention to re-evaluate, no later than the end of 1960, the financial protection provisions of Part 140.

The Commission was completing a study on extension of Price-Anderson indemnification to licensees possessing and using substantial quantities of special nuclear material.

During 1960, the Commission entered into interim indemnity agreements covering operation of nuclear reactors by 2 private organizations, 5 nonprofit educational institutions, and 1 Federal agency. An additional 7 agreements protect holders of reactor construction permits also licensed to possess and store special nuclear material for ultimate use as reactor fuel when the Commission authorizes operation of the reactor.

New Regulations

New regulations and major amendments to existing regulations adopted by the Commission during 1960 were:

10 CFR Part 20—*Standards for Protection Against Radiation*

A comprehensive amendment to Part 20, effective January 1, 1961, prescribes numerical values and radiation exposure limits consistent both with the Radiation Protection Guides recommended by the Fe

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Radiation Council, approved by the President on May 13, 1960, with the corresponding values recommended by the National Committee on Radiation Protection in National Bureau of Standards Handbooks 59 (revised) and 69.

A second amendent, also effective January 1, 1961, provides additional permissive methods of determining "calendar quarter;" amends the definition of "Restricted area" and "Unrestricted area;" modifies requirements for posting of Form AEC–3, "Notice to Employees;" and adds a concentration limit specifically applicable to uranium ore dust in air.

A third amendment, effective February 17, 1961, prohibits issuance of licenses authorizing receipt of radioactive waste materials from other persons for disposal on land not owned by the Federal or State governments.

10 CFR Part 30—*Licensing of Byproduct Material*

An amendment, effective September 16, 1960, exempts from Commission licensing requirements the possession and use of products containing small residual amounts of byproduct material not exceeding specified low concentrations. However, the person who introduces byproduct material into a product may do so only as authorized under a specific license. The products in which license-exempt concentrations would be introduced for quality control purposes include chemicals, plastics, petroleum products, and similar items where ingestion or inhalation is unlikely.

A further amendment to Part 30, effective January 12, 1961, exempts from Commission regulatory control the possession, distribution, and use of luminous dial watches and clocks containing specified small quantities of hydrogen 3 (tritium) as the luminescing material.

In addition, an amendment, effective December 29, 1960, established specified criteria for specific licenses for industrial radiography (nondestructive testing of materials to determine defects). This amendment was issued in conjunction with the adoption of the new regulation in 10 CFR Part 31, described below.

10 CFR Part 31—*Radiation Safety Requirements for Radiographic Operations*

Identified as a new regulation, Part 31 becomes effective February 27, 1961. It establishes supplementary radiation safety standards for persons using sealed sources of byproduct material for radiography and is designed to lessen the need for routine incorporation into licenses of special provisions applicable to radiographic operations.

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10 CFR Part 40—*Control of Source Material*

An amendment, effective July 8, 1960, exempts from licensing [illegible] receipt or possession of uranium contained in aircraft counterweig[illegible] installed in aircraft.

10 CFR Part 50—*Licensing of Production and Utilization Facili[illegible]*

An amendment, effective March 7, 1960, added a definition of [illegible] "testing facility" and incorporated provisions concerning review [illegible] the Advisory Committee on Reactor Safeguards and formal hearin[illegible] in power and testing reactor cases.

Two additional amendments, effective October 10, 1960, (*a*) cla[illegible] the extent of work permitted or prohibited prior to issuance of a [illegible] actor construction permit, and (*b*) add procedures and criteria wi[illegible] by, under certain circumstances, a provisional operating license [illegible] be issued.

These amendments are two of the three proposed rules publi[illegible] in the *Federal Register* for public comment on February 11, [illegible] The Commission has taken no action concerning the third prop[illegible] which would revise the criteria for issuance of provisional constru[illegible] permits.

10 CFR Part 70—*Special Nuclear Material*

Two amendments added reporting requirements. The first, [illegible] tive February 25, 1960, requires the semiannual reporting by lic[illegible] of the status of special nuclear material received, possessed or tr[illegible] ferred. The second, effective January 12, 1961, provides for [illegible] mission of reports of individual shipments and receipts of spe[illegible] nuclear material by licensees.

Proposed Amendments

A proposed amendment to 10 CFR Part 20, *Standards For P[illegible] tion Against Radiation*, published in the *Federal Register* on A[illegible] 16, would establish design and packing criteria for containe[illegible] for disposal into the sea of licensed low-level waste byproducts, [illegible] and special nuclear materials.

A proposed overall revision of 10 CFR Part 40, *Control of S[illegible] Material*, was published in the *Federal Register* for public co[illegible] on September 7, 1960. The proposed revision contains, among [illegible] things, procedures and criteria for the issuance of specific li[illegible] and sets forth certain general licenses and exemptions from li[illegible] requirements.

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A proposed new rul[illegible] *Against Accidental C[illegible] ment of Irradiated Fue[illegible]* March 17, 1960. Th[illegible] fuel element cask [illegible] Commission special nuc[illegible] The proposed 10 CFR [illegible] *Nuclear Reactors Exem[illegible]* in the FEDERAL R[illegible] The proposed reg[illegible] opted in 1959 of provi[illegible] Commission-owned pow[illegible]

Reactor Safety

During the first 11 mo[illegible] reviews of the safety [illegible] addition, advisory ser[illegible] construction in Yugo[illegible] Philippines, Austria, Tu[illegible] and the Euratom pr[illegible] During the same perio[illegible] boards held 10 meetings [illegible] referred to the Committe[illegible]

Compliance Actions

Orders were issued to [illegible] clear material licenses [illegible] requiring that the license[illegible] mission regulations. The [illegible] require that licensees po[illegible] periodic leak tests of the c[illegible] Atomic Energy Waste Dis[illegible] Wisconsin, Specialty S[illegible] Henry N. Beets Co. [illegible] Three Commission orde[illegible] In the Matter of *Housto[illegible]* actions was issued req[illegible] radiography license shoul[illegible] preliminary motions.

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a proposed new rule, 10 CFR Part 72, *Regulations To Protect ... Accidental Criticality and Radiation Exposure in Shipment of Irradiated Fuel Elements* was published in the *Federal Register* March 17, 1960. The proposal would establish criteria for irradiated fuel element cask design and shipping procedures; it applies to ...mission special nuclear (fissionable) material licensees.

...proposed 10 CFR Part 115, *Procedures for Review of Certain ... Reactors Exempted From Licensing Requirements*, was published in the FEDERAL REGISTER for public comment on December 2, ... The proposed regulations would implement Commission policy ...ed in 1959 of providing for public hearings on safety aspects of ...mission-owned power reactors not located at Commission-owned

...er Safety

...ring the first 11 months of the year, the Commission conducted ...views of the safety of licensee-and-Government-owned reactors. ...dition, advisory service was provided regarding reactors planned ...struction in Yugoslavia, Argentina, Indonesia, Republic of the ...ppines, Austria, Turkey, Iran, Israel, Tunisia, Pakistan, Colom... ...d the Euratom program.

...ring the same period, the Advisory Committee on Reactor Safe... ... held 10 meetings to consider and report on reactor projects ...d to the Committee by the Commission.

...nce Actions

...ers were issued to 143 holders of source, byproduct, and special ... material licenses for revocation or modification of license, or ...ng that the licensee take specific actions to comply with Com... ... regulations. These included 134 orders amending licenses to ... that licensees possessing cobalt 60 teletherapy units make ... leak tests of the cobalt 60 sealed sources; and orders issued to ...-Energy Waste Disposal Co., Dr. E. S. Gilifillen, Jr., University ...consin, Specialty Steel Products Co., University of Pittsburgh ...ary N. Beets Co.

... Commission orders were contested by licensees as follows: ... Matter of *Houston Gamma Ray Co.*, an order alleging willful ...s was issued requiring the licensee to show cause why its ...phy license should not be revoked. Following the filing of ...eliminary motions, and a prehearing conference, a stipulation

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between the licensee and the staff was filed agreeing to an order by t
hearing examiner revoking the outstanding license, denying a pendi
application for license renewal, and providing that the licensee, af
1 year, could seek a new license upon showing its ability to fully co
ply with the Commission's regulations.

In the Matter of *Coastwise Marine Disposal Co.*, an order was is
requiring the licensee to show cause why its license authorizing the
posal of low-level radioactive wastes at sea should not be revo
Subsequent alleged violations of the license led to the issuance of a fu
ther order suspending the company's operations pending a hearing. I
December, the presiding officer issued an intermediate decision rec
ing the license.

In the Matter of *Sarnia Inspection Co.*, an order was issued requ
ing the company to conduct no further radiography operations exc
under specified conditions. After preliminary motions and a pr
hearing conference, the company stipulated that the order sho
be made effective by the presiding officer.

Resolution of Pending Cases

In the Matter of *X-Ray Engineering Co.*, an order alleging wil
violations of the Commission's regulations and license conditions w
issued requiring the licensee to show cause why its radiogra
license should not be revoked. The presiding officer delivered
intermediate decision in July 1960, which ordered revocation of
license. Exceptions were filed by the licensee. After review of
submitted briefs, the Commission sustained the intermediate dec
and directed that the company could file a new license applic
which would receive timely consideration contingent upon a dem
stration that adequate provision for the public health and safety w
be provided and maintained in complete compliance with Commi
regulations. The applicant sought a stay of the order of revoca
until such an application for license could be filed. The Commi
denied the motion for stay.

In the Matter of *Mines Development, Inc.*, an order was issu
the operator of a uranium mill alleging the failure to conduct ade
surveys to determine compliance with the regulations. (The ca
in this case was similar to orders issued to other uranium m

...officer's intermediate
...gram which would a
...corrective action tal
...December, and briefs
...A final decision in t
...rics, Inc.*, delivered
...is matter.[24] The
...erations but inco
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...with the Commission'
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Inspe

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...The inspection, audit
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...ve checks and revi
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...Summary appraisal
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...reactors was trans
...ly organized Divi

intermediate decision ordered the licensee to institute a pro- which would assure that adequate surveys are made and other ective action taken. Exceptions were filed by the licensee in ember, and briefs were submitted by both parties.

final decision in the Matter of *Advance Industrial X-Ray Labora- Inc.*, delivered in January 1960, culminated proceedings in matter.[24] The decision permitted continuation of radiography ations but incorporated certain additional provisions in the including a monthly report of scheduled operations.

full report on the status of compliance of the uranium mills the Commission's regulations was filed with the Joint Committee tomic Energy.

Inspection and Compliance

AEC and Contractor Inspection

inspection, audit and appraisal programs affecting the Commis- and its contractor operations were monitored during 1960 through checks and reviews of their adequacy. Generally, inspection ems provided management with program evaluations and with information necessary to determine whether or not contractors, s and employees complied with the Atomic Energy Act of 1954 with appropriate rules and regulations of the Commission. Sev- improvements in the inspection systems provided responsible s with performance evaluation data in both administrative and rammatic areas.

new program of formal evaluation of the performance of opera- offices was initiated in September through a series of briefings of eneral manager. The evaluations were based largely on findings established Commission inspection and appraisal programs.

mmary appraisals of the overall performance of 44 major cost- ursable contractors were prepared by the operations offices which ister them.

e responsibility for day-to-day inspection of licensed materials actors was transformed from the Division of Inspection to the organized Division of Compliance on June 13 and August 1, respectively. Responsibility for evaluating the adequacy of the inspection program remains in the Commission's Division of ction. Policies and standards governing the reporting and in-

[24] Page 479, Annual Report for 1959.

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vestigation of all incidents have been developed; and indep
investigations of all serious incidents and independent insp
of Commission operations have been carried out.

Licensee Compliance

Licensed Facilities

Inspection of licensed nuclear facilities, and those being cons
under construction permits, continued during 1960 with more fre
visits to sites of power and test reactors just coming into oper
Visits were made less frequently to facilities found generally
factory on previous inspections.

No substantial licensee noncompliance with rules and regula
were found. In a number of cases, inspection resulted in improve
of operational safety through relatively minor changes or addi
to equipment or procedures and organizations.

The Commission assigned to its Division of Compliance respo
bility for inspection of the N.S. *Savannah* and of power rea
under the second-round invitations of the Power Demonstra
Reactor Program, although these are Federal, not licensed, rea

Licensed Materials

As of July 1, 1959, a changeover was made to establish a pri
system for scheduling inspections to assure adequate review of
operations which experience showed were potentially the most ha
ous. The licenses in the highest priority constituted 7 percent of
total and 23 percent of all inspections reported to headquarters
ing the year were in this group. Eight field offices participate
this program (Albuquerque, Chicago, Hanford, Idaho, New Y
Oak Ridge, San Francisco, and Savannah River) and reported
inspections and 367 investigations and inquiries completed d
the year ended June 30, 1960. The number of active licenses in
7 percent during the fiscal year.

Professional personnel for this work in field offices was in
from 39 to 59.

The Commission has streamlined reporting of inspections w
noncompliance was not found. Formal reports are not prep
these cases, but form notices are issued to the licensees and supp
files of information are maintained.

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Procurement Regulati

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The Commission is in
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nal. They will be
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Agreement has been
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gulations, issued und
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Federal Procurem
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Contract Practices

...ment Regulations

...Federal Procurement Regulations System has been established ...Administrator, General Services Administration, under the ...al Property and Administrative Services Act of 1949 to elimi... needless inconsistencies between procurement policies and pro... of Federal Government agencies, and to help make the agen... procurement regulations more readily available to the public and ...siness representatives. The system consists of the Federal Pro... Regulations (FPR) which are for Government-wide ap..., and also the policies and procedures of each Federal agency ... constitute implementation, supplementation or, in some cases, ...ry and approved deviations from the Federal Procurement ...ations to meet unique situations.

...Commission is integrating into the Federal Procurement Regu... System AEC procurement and contracting policies and pro... (including those for construction and related engineering ...heretofore set forth in *Volume 9000—Contracting* of the AEC ... They will be designated Atomic Energy Commission Pro... Regulations (AECPR).

...ement has been reached with the Administrator of General ... with respect to the relationship of Federal Procurement ...ions, issued under the Federal Property and Administrative ... Act, and the specific authority to negotiate contracts granted ... Commission by the Atomic Energy Act of 1954, as amended. ...reement recognizes the principle that authority delegated to ...mission by the Administrator of General Services to negotiate ... under the Federal Property and Administrative Services ... Federal Procurement Regulations pertaining to such au..., are in addition to and not a limitation or restriction upon the ...sion's statutory authority to negotiate contracts under the ... Energy Act of 1954, as amended. With this understanding, ...mission, in furtherance of the objective of establishing uni... procurement policies and procedures throughout the Govern... will follow the Federal Procurement Regulations in all areas ...those in which the special nature of its programs requires ...

...Federal Procurement Regulations (FPR) and the Atomic ... Commission Procurement Regulation (AECPR), is being ...d in the *Federal Register*. An annual accumulation of both ...egulations will be published under Title 41—Public Contracts ...de of Federal Regulations.

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Cost Principles

The Commission's cost principles governing payments under [illegible] reimbursable contracts were revised and issued as a new Chapter [illegible] of the AEC Manual effective March 22, 1960. Chapter 9111, [illegible] tract Forms and Provisions, was also revised and issued effec[illegible] April 8, 1960, to provide standard contract language reflecting [illegible] cost principles. These two chapters were integrated into the Fe[illegible] Procurement Regulations System as Atomic Energy Commission P[illegible] curement Regulations 9–15.50 and 9–7.50, respectively. They [illegible] published in the *Federal Register*, Vol. 25, No. 180, Thursday, S[illegible] tember 15, 1960.

Small Business

The Commission's small business program emphasizes maxi[illegible] practicable small business participation in the subcontracts of [illegible] Commission's prime contractors. In the fiscal year that ended J[illegible] 30, 1960, small business' share of Commission subcontracts incr[illegible] to 42.1 percent or $263 million out of $624 million total subcon[illegible] awards, as compared with 41.6 percent for fiscal year 1959 and [illegible] percent average for the 10-year period 1951–1960.

Classification and Declassification

A new "Classification Policy Guide" was made effective by the C[illegible] mission in January 1960. It incorporates simplified broad state[illegible] of policy on classification of various phases of the atomic energy p[illegible] gram agreed upon between the United States, the United Kin[illegible] and Canada. This new guide, like previous guides, was prepare[illegible] line with the Commission's practice of continuously reviewing [illegible] classification guides in view of the rapid pace of scientific pro[illegible] and the wide scope of declassification activity.

Entire areas of information, previously classified in whole or [illegible] part, were released from classification restrictions. The "Cla[illegible] tion Guide for Use in the Civilian Application Program," for e[illegible] ample, was greatly expanded and revised. Its list of unclas[illegible] reactors and critical experiments now includes 86 Commission [illegible] Government-owned plants and 129 reactors owned privately [illegible] country or built for other nations—an increase of 19 Com[illegible] reactors and 37 other reactors since June 1958. Another exam[illegible] the Guide's effects was the declassification of the entire chemica[illegible] neering division of the Argonne National Laboratory whic[illegible]

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energy. This step[illegible]
nearly 3,000 were d[illegible]
The new Guide [illegible]
the classified Acce[illegible]
categories was red[illegible]
-Plutonium Produc[illegible]
the Civilian Appli[illegible]
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EXHIBITS A[illegible]

Exhibits

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The Commission'[illegible]
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[illegible]oms in Action,"
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[illegible]lso renovated du[illegible]
[illegible]s Atomic Worl[illegible]

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...ends every chemical engineering activity pertaining to nuclear ...ery. This step required review of 3,665 documents, of which ...rly 3,000 were declassified.

The new Guide also permitted a reduction of the areas covered by ... classified Access Permit Program. The number of classified ...gories was reduced from 37 to 2—"Nuclear Technology" and ...tonium Production." The entire body of classified documents in ... Civilian Application Program was reviewed again. Of 4,961 ...nts studied, nearly half were declassified and the remainder, by ...m of subject matter, were placed in the two classified categories.

The Commission's review of classification policy included the ...pons field and has resulted in adoption of a revised Atomic ...apons Classification Guide which better defines classification guid... and permits declassification of some additional information.

The Commission conducts a continuous review of the local classifica... and declassification programs in Commission and contractor or...zations to insure that its policies with respect to release of the ...imum amount of information are effectively carried out and to ...ove and strengthen the programs where possible. The appraisal ...ow run through its first cycle and has demonstrated that classi...on is, in general, being applied correctly and only where it is ...ed and that information is being reviewed and declassified ...ptly when its protection is no longer warranted. In this latter ... an active and continued effort is being made in releasing informa... for publication.

Information

EXHIBITS AND EDUCATIONAL INFORMATION

...the Commission established its traveling exhibits program 5 ...ago, the exhibits have been viewed by 31,923,182 persons in the ...tes. Always shown under nonprofit sponsorship, the 27 manned ...manned units were viewed by 8,873,837 persons in 48 States ...the past 12 months.

... Commission's ten large, unmanned package exhibits titled ...ary of Atomic Energy," were withdrawn from tour in June ...se since 1957. All were redesigned and reconstructed, retitled ...s in Action," and returned to tour in time for the fall county ...

... renovated during the reporting period were the six manned ...Atomic World" units used to demonstrate the basic principles

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of atomic energy before secondary school assemblies and science cla... The refurbished units were used in programs at summer camps ... the Smoky Mountains area before starting the school-year tour ... September.

Hawaii received its first traveling atomic energy exhibit in May, ... extensive tour of "The Useful Atom" under the sponsorship of t... Library of Hawaii. One of three package units designed s... cifically for library and school display, "The Useful Atom," ... scheduled for showings in 11 different libraries on the three ... islands.

The Commission's two large manned "You and the Atom" exhi... which feature lecture demonstrations on fission principles, nuc... power, radioisotopes applications, and remote handling equipm... continued in heavy demand at State fairs and in large populat... centers. Five manned "Atoms at Work" mobile units, contain... scaled-down versions of the larger exhibits and mounted in wa... through self-propelled vans, continued their tour of smaller U.S. co... munities under schedules sponsored jointly by the National Univer... Extension Association and the United States Junior Chamber ... Commerce.

In 1960, the Commission's American Museum of Atomic Energy ... Oak Ridge, Tenn., had a record attendance of 95,707 visitors, brin... the attendance total during its 12 years of operation to 933,566 visi... from all of the States and from foreign countries. The Museum ... traveling exhibits program are administered for the Commission ... the Oak Ridge Institute of Nuclear Studies.

Information Exhibits

"Nuclear Information for Science and Industry," a manned exh... featuring Commission technical information materials and servi... was presented at the Atomic Exposition, New York, in April, and ... the Western Atomic Industry Fair, San Francisco, in December.

The SNAP–3, a radioisotope-fueled thermoelectric generator, ... demonstrated at the 1960 Aerospace Medical Assocation meeting ... Miami, May 6–12, and at the Topsfield Fair, Topsfield, Mass., Sept... ber 4–10. In the demonstrations, the device was used to powe... amateur radio station and an apparatus to measure changes in h... beat and respiration during physical activity—a simulated s... application.

Educational Literature

Approximately 70,521 kits of atomic energy information liter... were distributed during 1960 in response to requests from co...

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...dary school, and elementary school students, teachers, and guid... counselors; from adult study groups, teachers' institutes and ...; and from the general public.

FILMS

...uring the reporting period, the Commission's 10 domestic motion ...ture libraries, stocked with 160 popular and professional-level films, ...ed them for more than 68,000 showings viewed by an estimated ...,000 persons. The film libraries and the geographical areas they ...ply are listed in Appendix 7.

Approximately 65 professional-level films were on loan from the ...mission's liaison offices in London, Tokyo, Brussels, and Buenos ...es, with French and Spanish versions of about 45 films available ...ugh the latter two offices.

The Commission added 12 films to its motion picture libraries ...ng the reporting period. Motion pictures added were:

...essional

FABRICATION OF PLUTONIUM DISKS, 13 minutes, black and white, ...duced by Los Alamos Scientific Laboratory; describes glove-box ... in shaping toxic material.

...ONNE FAST SOURCE REACTOR, 9 minutes, color, produced by ...ne National Laboratory; describes the reactor's assembly and ...fulness in laboratory work.

... COOLED REACTOR EXPERIMENT, 39 minutes, color, produced ...gh Idaho Operations Office by Lookout Mountain Air Force ...m for the Commission and U.S. Army Corps of Engineers; ...bes design, development, component fabrication, assembly, test- ... and initial criticality.

...OTE MAINTENANCE OF MOLTEN SALT REACTORS, 20 minutes, ...produced by Oak Ridge National Laboratory; describes arrange- ... of a mock-up fluid fuel reactor system and the remote use of ...lized equipment.

...ional and Popular

... FIGHTING IN THE NUCLEAR AGE, 14 minutes, color, produced by ... Operations Office.

...STRIAL APPLICATION OF RADIOISOTOPES, 57 minutes, color, pro- ... by the Army Pictorial Center for the Commission's Office of

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Isotopes Development; describes the principles and techniques of ... dustrial gaging, radiography and radioisotope tracing.

SNAP–III: Operational Tests, 22 minutes, color, produced ... Martin Nuclear for the Commission; describes operational tests ... SNAP–III isotopic power unit.

Group Shelter, 10 minutes, color, produced by Department of A... riculture Motion Picture Service for the Commission; describes ... underground shelter for protection of 100 persons, and results of ... nuclear effects tests at Nevada Test Site.

Technical Information Services of the AEC, 22 minutes, co... produced by the Department of Agriculture Motion Picture Ser... for the Commission.

Popular

Under Way, 20 minutes, color, produced by the U.S. Mari... Administration and the Commission; describes design and constru... tion of the NS *Savannah* and its nuclear components and safe... features.

Living With the Atom, 18 minutes, color, produced by the U... Information Agency. Explains in nontechnical terms the radiat... safety devices and procedures that protect workers at atomic inst... tions and communities.

The New Power, 39 minutes, color, produced by Lookout Mou... Air Force Station for Idaho Operations Office; describes the mi... of the National Reactor Testing Station and some of its reactor ... other facilities.

TECHNICAL INFORMATION ACTIVITIES

Technical Journals

Nuclear Science Abstracts

During the past 12 years the annual number of abstracts pub... in "Nuclear Science Abstracts" has increased from the 4,000 pr... in 1948 to 26,000 in 1960. The steadily increasing volume i... primarily to expanded atomic energy activities at home and a... programs of exchange with foreign scientific sources, and of sc... translations.

The Commission, in 1959, applied advanced machine proc... techniques to preparation of this journal so that each issue now ...

...ains a subject inde... ...weeks rather than ... "Nuclear Science ...ent reports publis... ...ations in 73 count... ...pment reports, and ... ...ons received in ex... ...racts" and made ... ...braries, Commissi... ...from the library of ... Commission receive... ...ring 1960.

...hnical Progress

Cumulative index ... ...ission's quarterly ... ...0 and distribute ... ...tor Technology;" ... November 1960 ... "Nuclear Safety" ... the June 1961 iss... June 1962 issue ... ...nd year of publi...

During the repor... ...s of papers pres... ...s and conference... The Commission ... describing proce... ...tractors were spo... participants. T... ...tings, 1950–1958 ...rmation Extens... ...O. Box 62, Oak Ri...

...A brochure, "Technica... ..." describes the sco... ...: "Nuclear Scienc... ...r Reactor Technolo... ...r Safety." Copies ... ...tion Extension, US... ...ailable by subscripti... ...($0.55), Superinten... ...C.

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a subject index. Cumulative indexes now are published within weeks rather than several months later.[25]

Nuclear Science Abstracts" and unclassified research and develop- reports published by the Commission are supplied to 706 organ- ions in 73 countries in return for monographs, research and devel- reports, and scientific journals from those sources. Publica- received in exchange are abstracted for "Nuclear Science Ab- s" and made available through the Commission's depository ries, Commission-contractors' libraries, or by inter-library loan the library of the Oak Ridge Institute of Nuclear Studies. The mission received 350 exchange research and development reports 1960.

nical Progress Reviews [26]

umulative indexes for the first 3 years of publication of the Com- on's quarterly Technical Progress Reviews were published during and distributed as follows: September 1960 issue, "Power Re- Technology;" October 1960 issue, "Reactor Fuel Processing;" November 1960 issue, "Reactor Core Materials." The first index Nuclear Safety" will be the index for Volumes I and II, available June 1961 issue. A three-year cumulative index will appear in June 1962 issue—Vol. III, No. 4. "Nuclear Safety" entered its d year of publication in September.

Technical Symposia

ring the reporting period the Commission published 24 collec- of papers presented at scientific and technical symposia, meet- and conferences.

Commission also issued during the past year, a catalog listing scribing proceedings of meetings of which the Commission or its tors were sponsors or co-sponsors, or in which they were ma- articipants. This 29-page catalog, "Proceedings of Technical gs, 1950–1958" is available on request to Office of Technical mation Extension, United States Atomic Energy Commission, ox 62, Oak Ridge, Tenn.

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[25] hure, "Technical Journals Published by the United States Atomic Energy Com- describes the scope and content of the five technical periodicals published by the "Nuclear Science Abstracts" and four quarterly Technical Progress Reviews: Reactor Technology," "Reactor Core Materials," "Reactor Fuel Processing," and Safety." Copies of the brochure are available on request from Office of Technical Extension, USAEC, P.O. Box 62, Oak Ridge, Tenn.

[26] ble by subscription (domestic, $2 a year; foreign, $2.50 a year), or by individual 55). Superintendent of Documents, U.S. Government Printing Office, Washington

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Technical Books

Under the Commission's program of preparing and arranging [illegible] the publication of handbooks, monographs, and other reference [illegible] on atomic energy subjects, four volumes were published during [illegible]

"Volume 1, Materials," of the "Reactor Handbook" (2nd ed.).
"Management of Nuclear Materials".
"The Metallurgy of Hafnium".
"Controlled Thermonuclear Reactions".

As the year ended, five volumes were in press: "Metallurgy and F[illegible] rication of Fuel Elements," "Rare Earth Alloys," and "Reactor H[illegible] book," (2nd ed.), *Vol. 2, Fuel Reprocessing, Vol. 3 Physics a[illegible] Shielding*, and *Vol. 4, Engineering*.

Contracts were awarded for revising and updating Samuel G[illegible] tone's "Principles of Nuclear Reactor Engineering;" for prepar[illegible] a plutonium handbook, a sourcebook and a one-volume encyclop[illegible] on atomic energy in the life sciences; for writing a text on vario[illegible] technology, and for preparing a summary of special topics in elect[illegible] magnetic radiation. A revision of the "Effects of Nuclear Weap[illegible] was undertaken in cooperation with the Department of Defense. A[illegible] rangements also were made for the preparation and publication of [illegible] planned third edition of the "Reactor Handbook."

Distribution of Reports

A total of 4,400 copies of classified reports were sold during [illegible] to those authorized to receive them, and 150,085 unclassified repor[illegible] were sold to the public. A total of 5,328 new unclassified reports w[illegible] placed on public sale through the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

Engineering Materials

During 1960, the Commission signed a contract with Cooper-Tr[illegible] Blueprint and Microfilm Corp. of Arlington, Va., for that firm to [illegible] full-size blueline prints of engineering materials pertaining to [illegible] atomic energy program to industrial concerns, U.S. Governm[illegible] organizations and their contractors, and to the general public. P[illegible] are 17 cents per square foot with substantial discounts for qu[illegible] orders. This service previously was provided from the Office [illegible] Technical Information Extension, Oak Ridge, Tenn.

The contractor [27] [illegible] photographs, and bi[illegible] Materials List," (TI[illegible] supplied by the Comm[illegible]

During 1960, a new [illegible] reports was establis[illegible] mission, Pan Amer[illegible] organization of Am[illegible] depository libraries in t[illegible] library for the Eurat[illegible] raised the total in [illegible] meetings.)

The Commission c[illegible] the reporting p[illegible] announced in "Nucl[illegible] were produced und[illegible] monographs on subj[illegible] Compounds", "Magn[illegible] Problems of Dynam[illegible] Problems of Radioa[illegible] Dosimetry of Ionizin[illegible]

The Commission a[illegible] Public Law 480, sec[illegible] of foreign currencies[illegible] this agricultural co[illegible] initiated by the Na[illegible] Russian "Journal o[illegible] Russian "Advances [illegible] were made in Israel. [illegible] Polish articles appe[illegible]

Although emphas[illegible] Japanese, Hungaria[illegible] translated and made

[27] Inquiries concerning p[illegible] from Blueprint and Micro[illegible] Materials not announc[illegible] which should be addressed [illegible] Oak Ridge, Tenn.

[illegible] a catalog, "Engineerin[illegible] Program, available on req[illegible] Oak Ridge, Tenn.

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the contractor[27] will prepare prints of drawings, specifications, photographs, and bills of materials as announced in "Engineering Materials List," (TID–4100)[28] and supplements, from reproducibles supplied by the Commission.

Depository Libraries

During 1960, a new depository collection of unclassified Commission reports was established at the Inter-American Nuclear Energy Commission, Pan American Union, Washington, D.C., for use by the Organization of American States. This brought to 85 the total depository libraries in the United States. Establishment of a depository library for the Euratom Research Center at Ispra, Italy (near Milan) raised the total in other countries to 85. (See Appendix 6 for listings.)

Translations

The Commission continued to expand its translation program during the reporting period. Over half of more than 600 translations announced in "Nuclear Science Abstracts" in the course of the year were produced under Commission sponsorship. These include 20 monographs on subjects such as "The Chemistry of Fluorine and Its Compounds", "Magnetic Emission of High Temperature Plasma", "Problems of Dynamic Theory in Statistical Physics", "Toxicology Problems of Radioactive Materials", and "Research in the Field of Dosimetry of Ionizing Radiation."

The Commission also participated in the translation program under Public Law 480, section (k), which authorizes use for this purpose of foreign currencies accruing to the United States from sale of surplus agricultural commodities. Under this program, which is coordinated by the National Science Foundation, translations of the Russian "Journal of Inorganic Chemistry", vol. 2, 1957, and the Russian "Advances in Physical Sciences", vol. 61, 62, and 63 (1957) were made in Israel. In Poland, translations were made of original research articles appearing in "Nucleonics", vol. 2, 1957, vol. 3, 1958. Although emphasis was on publications from the Soviet Union, Japanese, Hungarian, and Serbo-Croatian publications also were translated and made available.

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[27] Inquiries concerning prices for this reproduction service should be addressed to Cooper-Trent Blueprint and Microfilm Corp., 2701 Wilson Blvd., Arlington 1, Va.; queries regarding materials not announced in "Engineering Materials List," (TID–4100), and its supplements, should be addressed to Office of Technical Information Extension, USAEC, P.O. Box 62, Oak Ridge, Tenn.

[28] Catalog, "Engineering Materials List," (TID–4100, rev.), and periodic loose-leaf supplements, available on request, Office of Technical Information Extension, USAEC, P.O. Box 62, Oak Ridge, Tenn.

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All these translations are announced in "Nuclear Science Abstracts" and placed on sale through the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Photocopies may be obtained from the Library of Congress, Washington 25, D.C., and from the special Libraries Association Translation Pool maintained at the John Crerar Library, Chicago, Ill.

Education and Training

The findings of the survey of employment in the atomic energy field described in Part One of this report, indicate a continuing demand for scientists, engineers, skilled workers, and technicians. This also is the general trend of American industry.

The Commission during 1960 extended through June 30, 1964, its programs of assistance for nuclear education in nonprofit educational and medical institutions in the United States. Some of these programs originally were scheduled to terminate on June 30, 1961.

Other aspects of the Commission's educational and training programs are described in sections of this report dealing with Radioisotope and Radiation Development, International Activities, and Health and Safety.

LIFE SCIENCES

Assistance to Schools

Faculty Training

Summer faculty training in radiation biology was conducted during 1960 through 8-week courses, 16 for high school teachers, 5 for college faculty, and 2 for high school and college faculties combined. Attendance of 347 high school and 113 college faculty members during 1960 brought the total, since the beginning of the program in 1952, to 1,087 high school teachers and 153 college teachers.

In September, two in-service sessions for 20 high school teachers each were inaugurated in the radiation biology institute program. These institutes consist of lectures and laboratory courses scheduled nights and Saturdays.

Equipment Grants

During 1960, 180 nonprofit educational institutions requested grants of funds for equipment to be used in radiation life science courses.

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The Commission awarded 122 grants for $1.128 million to 119 educational institutions.

Since the beginning in 1957 of the life science equipment grants program 352 grants totaling $3.7 million have been awarded to 213 schools.

Effect of Programs

Reports from schools receiving grants show that approximately 83 courses have been expanded to include instruction in aspects of nuclear technology related to medicine, public health, agriculture, pharmacy, veterinary medicine, and general biology. Twelve of 117 institutions enlarged laboratories and/or general teaching facilities for use of grant equipment and approximately 13 new faculty members have been added or assigned in the subsequent programs. Enrollment in courses relating to radiation biology during the academic year 1959–60 increased by 400 or 25 percent.

Fellowships

Industrial Fields

Four physicians were awarded fellowships for graduate training in *industrial medicine* for the academic year 1960–61. Three additional fellows were awarded a second year of training. The fellows are at the medical schools of Pittsburgh, Yale, Rochester and Harvard Universities.

Sixty fellowships have been awarded in this program since 1950.

Five *industrial hygiene* fellowships were awarded for the academic year 1960–61 bringing the total number of awards to fifty-four.

There are 62 *health physics* fellows for the coming academic year 1960–61. Thirteen of last year's fellows are continuing graduate study. More than 500 fellows have received this specialized graduate training since 1950 at one of the universities and one of the Commission laboratories now cooperating in the program: Vanderbilt, Puerto Rico, Rochester, Harvard, Michigan, Kansas, Washington (Seattle), California (Berkeley), together with Oak Ridge, Brookhaven and Argonne National Laboratories, General Electric Co. (Hanford, Wash.), National Reactor Testing Station (Idaho), and E. O. Lawrence Radiation Laboratory, University of California (Berkeley and Livermore, Calif.).

The program for *advanced training in health physics*, to equip experienced health physicists for senior positions, was begun in academic year 1959–60, with five graduate fellows. One obtained his

doctorate from the University of Michigan and fellowship renewa
have been granted to the other four. Five new fellows will b
training in the academic year 1960–61.

The fellowship program is administered for the Commission by th
Oak Ridge Institute of Nuclear Studies.

PHYSICAL AND ENGINEERING SCIENCES

Faculty Training

For five consecutive years summer institutes have been conducte
under the joint sponsorship of the Commission and the Americ
Society for Engineering Education to provide opportunities for fa
ulty members to learn the latest developments in nuclear and nuclea
related technology. In 1960, 97 faculty members attended 6 institute
3 in basic nuclear technology—at North Carolina State College wit
Oak Ridge National Laboratory, at Pennsylvania State University
with Argonne National Laboratory and at Purdue University wit
Argonne National Laboratory; intermediate reactor physics at Nort
Carolina State College; specialized nuclear studies at Argonne Na
tional Laboratory; and radiation effects at University of Michiga
Since inception of the program a total of 581 enrollees have repr
sented 154 institutions in 28 summer institutes.

Temporary Appointments at Laboratories

During the year, approximately 94 faculty and 197 graduate and
undergraduate students were given temporary appointments at Ar
gonne National Laboratory for periods of from 3 months to 1 year.
At Oak Ridge National Laboratory there were 70 faculty participants
in the summer of 1960. A similar program is carried on at Brook
haven National Laboratory.

Fellowships

A total of 177 graduate fellowships in nuclear science and engine
ing were in effect for the 1960–1961 academic year, bringing to 3
the total fellowships since the program began in 1957.

Equipment Grants and Materials Loans

In 1960, the Commission made grants totaling $1 million to
universities and colleges for purchase of specialized nuclear equ

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such as subcritical assemblies, pulsed neutron generators, reactor
ators, and instruments for radiation detection, monitoring, and
ting. The Commission also approved loans to 74 schools,
out charge, of neutron sources, natural uranium reject
and enriched uranium for nuclear instructional purposes. Since
program was initiated in 1956, a total of $13.78 million has been
ded to 167 institutions and nuclear materials valued at $11.14
on have been loaned or authorized for loan to 154 institutions.
is stated in an August 16, 1960, announcement extending the
tional assistance program, the Commission no longer will pro-
dollar grants for teaching reactors (grants were awarded for
ch reactors during the period 1956–58).
addition, the emphasis of the training equipment grant program
been changed from furnishing equipment for use in the education
actor engineering specialists to furnishing equipment needed for
al nuclear education in colleges of arts and sciences as well as
neering schools.

ersity Research Reactor Assistance

1960, the Commission agreed to lend enriched uranium and
water and pay fuel fabrication costs for the Georgia
research reactor now under construction, bringing to nine the
er of universities assisted in this manner. Under this program
ommission assists reactor projects at nonprofit educational and
al institutions by loaning special nuclear material and heavy
without charge for use and normal loss, and by providing funds
rices without charge for the fabrication of fuel elements and
n sources and reprocessing of fuel after use. The program is
d out in cooperation with the National Science Foundation
provides grants toward the construction of university research
facilities.

INDUSTRIAL PROGRAMS

Contractors Training Programs

training and education requirements at Commissioned-owned
hments—as in industry generally—are determined largely by
nsiderations.
keeping up with a changing technology by expansion of em-
scientific knowledge.
d, recruitment and training of new personnel and upgrading
ning of employees to meet shifting requirements.

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Third, adequately trained replacements for work force lo... Turnover is relatively low at Commission-owned establishme... however, those leaving Commission employment do help staff p... vate atomic energy activities.

The training programs reported in this section, based on a st... during 1959 of Government-owned plants operated by contractors ... a cost reimbursable basis for the Commission, assist both employ... and non-employees. Training of employees is authorized when t... training is directly related to the operations of the contractor. N... employees' training is authorized to assist in the Commission's ... of helping to develop a pool of trained personnel for the future at... energy industry.

Training Contractor Employees

The following tabulation estimates the number of employees gi... training during 1959 through different systems, not includi... specialized training in radiation safety which is required in vari... degrees for all employees:

System	Nu... emplo...
Tuition Assistant Plans	2...
Selected Vocational Level Training Activities	2...
Undergraduate Level Training Courses	1...
Graduate Level Courses Given on Site	1...
Graduate Level Special Outside Training Courses	...
Combined Work-Study Graduate Plans	...
Professional Research, Advanced Study and/or Teaching Leave	...
Total	5...

Tuition assistance plans. The tuition assistance plan is offered a... educational levels. In general, the scientific and engineering subj... are covered, although the plans may be extended as part of empl... improvement and upgrading programs. All school work under t... plans is on the employee's own time, usually off hours, although ... without pay is sometimes granted.

Vocational level training. The added nuclear specialties requir... the vocational level are frequently interwoven in basic craft skill tra... ing. Apprentice programs and related skill development for wor... and technicians are general throughout Commission installations. T... Department of Labor has estimated that current apprentice prog... throughout all industry are adequate to meet not more than 1... cent of the need for skilled workers. Accordingly, Commission ... tractors, like other industrial operators, have established a varie...

...kill training progr... ...kills. This is essent...

...ndergraduate level ...echnical training is ... Most of the courses ...sicians to professio... through tuition aid.

...raduate training. ... the graduate leve... ...osely related to th... ...given either during ... the employee draws ... ...ar time in class.

Each year a numb... ...ourses and seminars ...are directly related t... ...ew programs. The ...ransportation, living ...

Three contractors ...nder which young e... ...n undergraduate w... ...raduate work while ...

Leave for advance st... ...are among Commi... ...elected senior memb... ...spend a period of ti... ...earch advanced stu... ...onal development a...

Contractor Training ...

The following tab... ...ants in training pr...

Cooperative Educati...	
Summer Employm...	
Contractors	...
Formal Research an...	
by AEC Contract...	
Training of Employ...	
Total	...

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training programs of which a portion cover specialized nuclear This is essentially on-the-job training.

Undergraduate level training. Relatively little undergraduate level technical training is carried on directly by Commission contractors. Most of the courses are a part of programs to help upgrade technicians to professional positions. Assistance is provided chiefly through tuition aid.

Graduate training. The greatest amount of training by contractors at the graduate level is on site and pointed to particular subjects closely related to the employee's work assignment. Courses may be taken either during work hours or afterward. If during work time, the employee draws regular salary. If after hours, no pay is received for time in class.

Each year a number of contractor employees are sent to outside courses and seminars of greater than 16 hours duration. The studies are directly related to jobs and frequently cover subjects needed for graduate programs. The cost of this type of training includes salaries, transportation, living expenses, tuitions, books, etc.

Three contractors have combined work and study graduate plans under which young engineers and scientists with outstanding records in undergraduate work are provided stipend or other assistance in graduate work while employed on Commission work.

Leave for advance study or teaching. This type of training activity, used among Commission contractors, is designed to allow a few selected senior members of the professional staffs an opportunity to spend a period of time—not to exceed one year—in professional research advanced study or teaching. The objective is broad professional development and stimulation of creative abilities.

Contractor Training for Others

The following tabulation shows categories and number of participants in training programs for others not its own employees:

System	*Total No. of participants*
Cooperative Education Participation by AEC Contractors	140
Summer Employment Activities Among AEC Cost-Reimbursed Contractors	178
Formal Research and Engineering Participation Activities Carried on by AEC Contractors	632
Training of Employees of Other Organization by AEC Contractors	578
Total	1,528

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Cooperative educational participation. Under these plans, two under-graduate students who take similar courses in engineering schools with established cooperative programs alternate between school and work, thereby providing continuous coverage of a single position. Employment of these students provides practical engineering experience; increases student interest and knowledge in fields of atomic energy technology; and provides a source of prospective employees upon graduation. All the students are given actual work assignments and their productive work compensates in large part for the salaries paid.

Summer employment. A number of Commission contractors offer summer employment to students and faculty members at various educational levels. Work assignments vary with capacity and participants join actual work groups. At secondary school level, the objective of summer employment is vocational guidance.

Formal research and engineering participation. Somewhat formalized arrangements to provide for participation by college students and faculty in Commission research and engineering projects have been established at a number of installations. Those participating in these programs are teaching faculty or students working for a degree rather than part-time employees. The general purpose of these programs is to develop superior graduate students into well-qualified nuclear scientists, and to assist universities in strengthening their programs in nuclear courses by providing research opportunities. The work assignments involve actual work on projects within approved Commission programs. Most participants are compensated like regular employees on similar assignments. This program either combines part-time university attendance with part-time laboratory assignments, or provides alternate periods of university attendance and Commission research.

Training for other organizations. Upon request of the Commission, contractors provide opportunities for specialized work experience at Government-owned facilities for: (*a*) scientific, engineering and other employees of private firms and institutions and of other Government agencies; (*b*) foreign nationals; and (*c*) fellows in approved Commission fellowship programs. Salaries are paid by the sponsoring organization, and administrative costs are absorbed in contractor operating funds.

Ass

Industrial Courses

During the year,
Commission contract
sation courses coveri
for radioisotope wor
and maintenance per
Institute also drew u
sistent with training
In its research to d
and magnitude of t
expected to arise as a
generation systems an
The effectiveness of t
ducted in adult vocat
odified to incorpor
ors' guides were dev
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nd to various univers
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California, Minnesota
several technical ins
The course materia
d for radioisotope
—has been distril

*Publications for sale by S
shington 25, D.C., includ
tenance Personnel in Nu
y of Nuclear Energy a
lear Energy Training
eration for Nuclear En
ation Safety Training P
tructor's Guide: Radiati
ard," $0.35; "Develop
dustry," $0.75; "Instructo
estions in Industry," $0

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Assistance To Vocational Schools

Industrial Courses

During the year, Stanford Research Institute completed under 3 Commission contracts development of three 32-hour basic adult education courses covering: (*a*) radiation safety training; (*b*) training for radioisotope workers in industry; and (*c*) training for operating and maintenance personnel in nuclear power generating systems. The Institute also drew up general plans for more advanced courses consistent with training needs.

In its research to develop these courses, Stanford assessed the scope and magnitude of training needs that now exist or that may be expected to arise as a consequence of the development of nuclear power generation systems and the increasing use of radioisotopes in industry. The effectiveness of the courses was tested in trial presentations conducted in adult vocational educational programs and the courses were modified to incorporate results of the trial presentations. Instructors' guides were developed to cover nuclear energy and power plant applications; radiation safety and, nuclear fundamentals and radioscope applications in industry.[29]

The courses for operating and maintenance personnel in nuclear power generation systems was distributed to Directors of Vocational Education of the 50 States, to all utility companies interested in nuclear power generation, to companies interested in production of components of nuclear power generation systems, to the labor unions that will represent employees of nuclear power generation stations,

of the 50 States and to approximately 250 industrial companies interested in atomic energy.

Public Safety Courses

To expand and integrate nuclear energy training courses for firemen into vocational education systems of the States, the Commission and the Office of Education have jointly consulted with the National Professional Curriculum Materials Committee for Trade and Industrial Education, for State Directors of Vocational Education, and four trainers of firemen. Acting as a working committee, this group reviewed course material in use and recommended development of courses for vocational schools and methods for encouraging use of the material. The committee proposed development of a 4-hour orientation course for all firemen, and a 12-to-15-hour basic course for firemen selected because of their specific assignments. Using the Stanford Research Institute "Instructor's Guide: Radiation Safety" and other material, the two courses recommended by the committee are being prepared for distribution early in 1961 to the 50 States and to larger cities and fireman organizations that operate independently of State vocational training systems.

This training, an integral part of the Commission's Radiological Assistance Program, replaces the earlier training program for public safety personnel carried out directly by the Commission.

To date, over 2,000 public safety instructors from State and municipal organizations across the country have attended Commission courses. Sampling inquiries indicate that thousands of firemen and police have attended classes conducted by these instructors.

In addition, seminars have been conducted for executives in industry, fire protection engineers, safety engineers, personnel of other Federal agencies, and others with an interest in obtaining a layman's understanding of the relationship of the radiation problem to their specific field of interest.

Two publications growing out of this work have been placed on sale at the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. More than 17,000 copies have been sold of "Living With Radiation" Part I, Fundamentals ($0.45), a layman publication for laymen. "Living With Radiation" Part II, Fallout Service Problems ($1.00), was published just before the end of the year.

"Living With Radiation" Part I is being made into a motion picture for distribution through the Commission's film libraries (see Information Section of this report).

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Health and Safety

...ker its organization for directing its health and safety programs, ...Commission during 1960:

...augurated a program of regular reports by Commission con...ctors operating major installations to provide data to the public ...environmental radiation levels.

...completed most of the preliminaries, in cooperation with States ...d interested organizations to assist States that wish to share in ...gulation and enforcement of radiation safety.

...eceived requests from 8 States for comments on proposed State ...islation or regulations, and held discussions with 4 States in...ested in assuming regulatory responsibility.

...ontinued and expanded academic and on-the-job training for State ...cials and orientation of local employees who might have to deal ...th radiation hazards.

...sponded to 60 requests for radiological assistance in suspected ...diation incidents, and broadened its capability for meeting re...sts. A map has been published establishing service points for ...ographical areas.

...viewed the radiation protection guides established by the Presi...nt on the basis of Federal Radiation Council recommendations and ...ermined their impact on Commission and licensee operations.

...nducted an annual survey of industrial exposures to radiation in ...mmission installations, broadened to include 12,000 additional ...kers with results that showed the number of people exposed to ...re than 5 rems during 1959 was 60 percent below the number ex...ed to this amount in 1958.

...is report includes a table listing radiation incidents during the ...l years beginning July 1, 1958, and extending through June 30, ... in both Commission installations and in licensed operations.

...prime function of the Commission's Office of Health and Safety, ...lished September 12, 1959, is to accomplish continuous review and ...ation of health and safety programs within Commission's facil...s and to assist in developing appropriate health and safety policies, ...s and criteria.

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Immediate responsibility for health and safety in the operation of Commission facilities lies with the operator, generally a contractor, who must maintain a staff of competent, professional industrial health and safety specialists. This staff has the first responsiblity for anticipating and solving health and safety problems.

Responsibility for contractor performance lies with the Operations Office Manager. His staff provides the data used by the contracting administrator to determine that prescribed standards and policies are being followed.

Staff evaluations of the overall program are made by Commission headquarters staff on the basis of periodic visits, routine and special reports, and other exchanges of information.

This triple surveillance of safety and health protection problems within Commission contract activities has helped to maintain the Commission's health and safety record as one of the best in the country.

Commission submissions for Hearings on Radiation Protection Standards and Criteria: Their Basis and Use, held in May and June by the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy of the Congress, included several appendices dealing with the application of radiation protection standards at major production plants, and a report on the economics of radiation protection for reactors.

PUBLIC REPORTING ON RADIOACTIVITY

In view of increased public interest in levels of radiation exposure, the Commission has undertaken to publish periodically full information on environmental radioactivity resulting from Commission operations. Beginning July 1, environmental data were reported quarterly from all Commission installations where radioactivity reaches the environs in amounts sufficient to justify environmental monitoring or surveys. In the past, data of this kind usually have been made available on request.

Under the Commission's new arrangements, each prime contractor operating a Commission installation prepares, on a quarterly basis, a summary report of all available data on environmental levels of radioactivity resulting from the operations of the particular installation. With the first quarterly report each year, the contractor also will submit summaries of data for the preceding calendar year.

These reports are distributed to local news media, to State and municipal public health officials, and to the U.S. Public Health Service.

STATE-FED

Cooperation betw
arranging for State
energy operations w
Commission and th
results:

Criteria were deve
in determining co
view by State rep
negotiating agreem

Draft of suggeste
operatively with t
the Council as part

Suggested radiati
were drafted as a
Governments, and
circulated for publ

Training program
expanded.

During 1960, nine
and legislation.
The first formal p
regulatory responsib
Kentucky at which
with New York for
with New Jerse
A study on the co
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with representa
Angeles Harbor,
Preliminary work
agreement.

Crite

As an initial step
were developed
determining the c
with that of
ding the Atomi

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STATE-FEDERAL RADIATION COOPERATION

operation between the Federal Government and the States in ing for States to share responsibility for assuring safe atomic operations was carried forward during 1960 jointly by the mission and the States and interested organizations with these

teria were developed for guidance of the Commission and States determining compatibility of regulatory programs, and after re- by State representatives, these are being used as a basis in otiating agreements.

ft of suggested legislation prepared by the Commission co- atively with the Council of State Governments, was adopted by Council as part of the legislative program it will sponsor in 1961.

gested radiation control and licensing regulations for States drafted as a cooperative project with the Council of State ernments, and the U.S. Public Health Service, and are being ulated for public comment.

ining programs for State personnel were continued and are being anded.

ing 1960, nine States requested comments on proposed regula- nd legislation.

first formal proposal by a State for an agreement to assume tory responsibility was submitted on September 20, 1960, by ky at which time informal discussions had been under way New York for several months. Preliminary discussions were ith New Jersey and Maryland about entering into agreements. udy on the community impact of atomic energy was completed American Municipal Association, and discussions have been ith representatives of municipalities: for example, Cincinnati, eles Harbor, and New York City, officials.

minary work started on a draft of a model Commission-State ent.

Criteria For Regulatory Programs

s initial step in preparing for negotiation of agreements, cri- ere developed for guidance of the States and the Commission mining the compatibility of the regulatory programs of the with that of the Commission. Under Public Law 86–373 ng the Atomic Energy Act of 1954, the agreements may cover

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the control of (*a*) byproduct materials (radioisotopes), (*b*) source materials (uranium and thorium), and (*c*) special nuclear materials (uranium 233, uranium 235 and plutonium 239) in quantities less than a critical mass.

On April 11, President Eisenhower wrote the Governors pointing out that the law was enacted in response to recommendations by the Joint Federal-State Action Committee, and stressing the need to increase the functions and responsibilities of the States. On April 15 the Commission forwarded copies of the proposed criteria to the State Governors requesting their comments. The proposed criteria also were circulated for comment to interested Federal agencies, and other public and private groups and individuals.

To provide a more detailed explanation of the proposed criteria, the Commission conducted four regional meetings: Atlanta, May 19, sponsored by the Regional Advisory Council on Nuclear Energy of the Southern Governors' Conference, and in Chicago June 23, New York City June 24, and San Francisco July 11, sponsored by the Council of State Governments. The four regional meetings were attended by approximately 150 persons representing 37 States.

In addition, at the request of State coordinators, advisory commissions, committees and officials, meetings were held in 13 States (California, Connecticut, Illinois, Kansas, Massachusetts, Missouri, Nevada, New York, New Jersey, Rhode Island, South Dakota, Oregon and Arizona) and the District of Columbia, to discuss the proposed criteria and problems related to various aspects of the program. At Commission headquarters in Germantown, Md., similar discussions were held with representatives of Hawaii, Kentucky and Maryland. Follow-up conferences were held with representatives of a number of States. Additional conferences were held with representatives of industry, labor and other interested groups.

Commission staff also discussed the proposed criteria before the Committee on Atomic Energy of the National Association of Attorneys General, the Conference of State Sanitary Engineers, the Midwest States Public Health Association, the Atomic Energy Committee of the National Conference of Commissioners on Uniform State Laws and the National Legislative Conference, as well as at a hearing before a committee of the California legislature.

Prior to drafting the proposed criteria, informal discussions were held with State health officials in meetings sponsored by the U.S. Public Health Service at Las Vegas, Nev., on December 5, 1959, and Montgomery, Ala., on February 12, 1960.

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On August 22 and 23, the Commission's Advisory Committee of State Officials met in Washington, D.C. to assist in evaluating comments on the proposed criteria, which then were rewritten in part. They now are being used in negotiating agreements with the States.

Suggested Control Act

Through a cooperative effort between the staffs of the Council of State Governments and the Commission, a suggested State Radiation Control Act was drafted. The purpose of the act is to provide suggested basic enabling legislation for radiation control programs compatible with the Commission program, as well as for other radiation problems within the States. Primarily through the mechanism of the Council of State Governments, this draft of a suggested act was prepared for comments and criticism to representatives of the National Association of Attorneys General, the State and Territorial Health Officials, the American Public Health Association, Federal agencies, municipal organizations, industry, labor and other interested groups. The act, also reviewed by the Advisory Committee of State Officials, has been included in suggested State legislation sponsored by the Council of State Governments for 1961.

Suggested Regulations

To aid States in developing radiation safety regulations compatible with Federal program, the Commission is working with the Council of

Training courses include both one-year and 10-week training courses in health physics and on-the-job training and orientation in the Commission's licensing and inspection programs. In the past 2 years, State employees have attended the one-year courses which include 9 months at the University of Michigan or Harvard University, followed by 3 months experience in Commission facilities. The Commission formerly paid stipends in addition to tuition, but stipends no longer are authorized.

A 10-week pilot course in health physics was initiated by Oak Ridge National Laboratory and Oak Ridge Institute of Nuclear Studies in January 1960. The pilot course was attended by 16 State and municipal health officers and 4 Federal personnel. It will be repeated in the spring of 1961.

Similar courses have been developed at the Commission's Health and Safety Laboratory, which presented its first course in New York City in October. Argonne National Laboratory at Argonne, Ill., and the University of California plan to start courses in March and summer of 1961, respectively.

On-the-job training in licensing activities and orientation in inspection is provided at Commission headquarters; detailed training in inspection is provided by operations offices. Operations offices have expanded their programs to include orientation in general aspects of inspection.

The State of New York was the first State to send personnel for orientation. Other States which have taken advantage of this training include New Jersey and Connecticut.

RADIOLOGICAL ASSISTANCE PLAN

During 1960, the Commission's operations offices and headquarters responded to about 79 requests under its Radiological Assistance Plan in connection with incidents that were believed to involve radioactive materials. Of these incidents, 54 were found actually to involve radioactive materials. Commission offices replied to about 126 additional requests for information, advice and guidance on emergency radiological assistance matters.

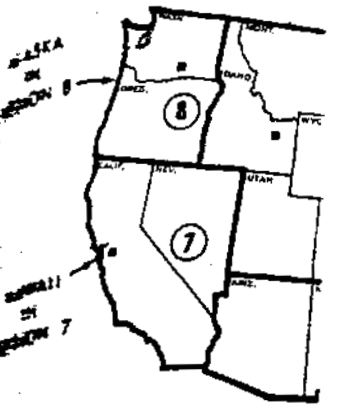
The Radiological Assistance Plan provides for nation-wide emergency radiological monitoring teams including an appropriate organization [80] "to make available, upon request from an AEC [illegible] contractor, Federa[illegible] person cognizant of [illegible]rial, such advice an[illegible] may be appropriate [illegible]rty damage, to cop[illegible] health and safety.

[80] See p. 268–70. Annual Report to Congress for 1959.

[illegible] AEC Manual Chapter 05[illegible]

J.

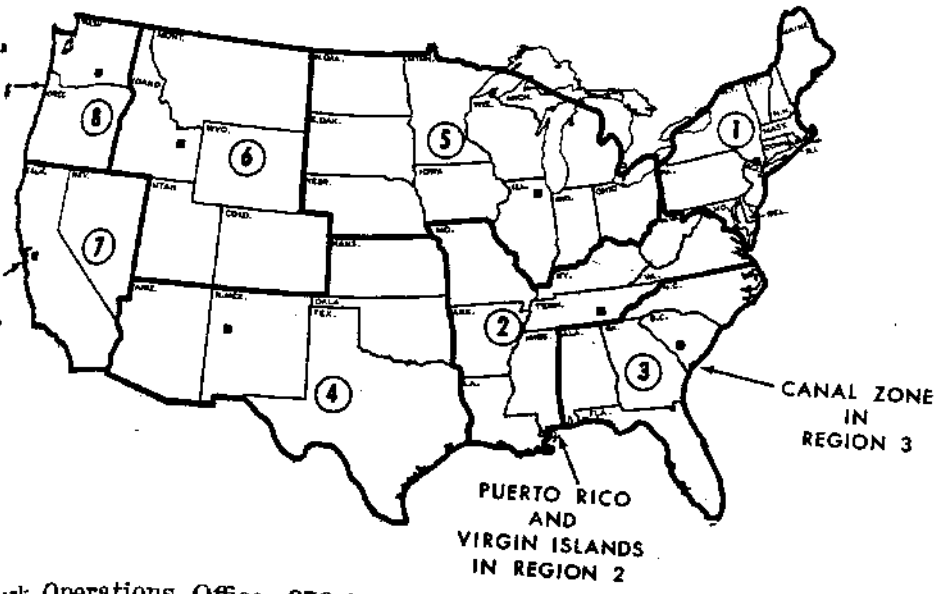
AEC REGIONAL A[illegible]
IN INCIDENTS



[illegible] York Operations C[illegible]
Yukon 9–1000.
[illegible] Ridge Operations [illegible]
Ridge 5–7486, ext. 760
Savannah River Operati[illegible]
[illegible]-6211, ext. 3333 (thro[illegible]
Augusta, Ga.).
[illegible]buquerque Operations
ALpine 6–4411, ext. 382
[illegible]icago Operations Offic[illegible]
[illegible]ater 7–7711, ext. 2111
[illegible]aho Operations Office,
[illegible]-6640.
[illegible] Francisco Operations
THornwall 1–5620.
[illegible]anford Operations Offi[illegible]
[illegible]all 2–1111, ext. 6–5441.

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AEC REGIONAL AREAS FOR RADIOLOGICAL ASSISTANCE
IN INCIDENTS INVOLVING RADIOACTIVE MATERIALS



York Operations Office, 376 Hudson St., New York 14, N.Y., phone: ...tion 9-1000.

...Ridge Operations Office, P.O. Box E, Oak Ridge, Tenn., phone: Oak ...ke 5-7486, ext. 7607; or Oak Ridge 5-8611, ext. 7607.

...annah River Operations Office, P.O. Box A, Aiken, S.C., phone: MIdway ...-611, ext. 3333 (through Aiken, S.C.), or PArk 4-6311, ext. 3333 (through ...ugusta, Ga.).

...uerque Operations Office, P.O. Box 5400, Albuquerque, N. Mex., phone: ...ane 6-4411, ext. 38267.

...go Operations Office, 9800 South Cass Ave., Argonne, Ill., phone: CLear- ...ner 7-7711, ext. 2111 or 541.

... Operations Office, P.O. Box 2108, Idaho Falls, Idaho, phone: JAckson ...240.

...Francisco Operations Office, 2111 Bancroft Way, Berkeley, Calif., phone: ...Thornwall 1-5620.

...d Operations Office, P.O. Box 550, Richland, Wash., phone: WHite- ...2-1111, ext. 6-5441.

...ntractor, Federal, State or local official, private organization ...n cognizant of an incident suspected to involve radioactive ... such advice and radiological assistance from AEC resources ...e appropriate to minimize injury to people, to minimize ... damage, to cope with radiological hazards and to protect the ...alth and safety.[31]

[31] Manual Chapter 0526, Radiological Assistance Program.

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Information is made available to interested organizations on a ... tine basis which identifies Commission offices that will provide ... gency radiological assistance, advice, or information and ... receive reports of radiation accidents believed to be of interest to ... Commission or to the Department of Defense.[32] More than ... copies have been distributed of a map showing geographical ... responsibility for radiological assistance activities of Commi... operations offices.

Through the operations offices, 584 personnel are routinely ... able for radiological assistance team work. The teams include ... cialists in administration, radiation safety, public information, and ... diation medicine. These specialists are sent out in teams or indi... ually in accordance with requirements of the particular situation. ... is estimated that 80 requests for radiological assistance could be ... simultaneously with three-man teams of appropriate specialists. ... reserve of more than 300 persons would remain available as ...

It is intended to increase total capability for areas that now have ... coverage so that teams could arrive at the incident site in not ... than 2 to 3 hours.

The Interagency Committee on Radiological Assistance (ICR... approved a final draft of the proposed Interagency Radiological ... sistance Plan (IRAP). The thirteen agencies currently partici... on the ICRA have received the IRAP for consideration and appro... Each agency that finds the IRAP acceptable will officially be... participating agency under the plan on the date of approval.

FEDERAL RADIATION COUNCIL

On May 13, 1960, the President approved seven recommend... concerning radiation exposure to persons contained in the first ... orandum submitted by the Federal Radiation Council, establish... Executive Order 10831, August 14, 1959, and made a statutory ... by amendment of the Atomic Energy Act of 1954 in Public La... 373.[33] (See Appendix 8.) Also on May 13, the Council issue... Staff Report No. 1 on background information for the memoran...

[32] See p. 270, Annual Report to Congress for 1959, Joint Nuclear Accident ... Center and basic agreement.

[33] See p. 268, Annual Report to Congress for 1959.

The memorandum ... ends as the making ... exposure to radiatio... are associated with i... that there should b... level set without re... Then, the memoran... term "Radiation P... level resulting from ... as Radiation Protec... mations.

Radiation protect... body and special or... somatic (whole boc... average for large ... guides differ very li... suggested by the N... measurements, and t... mation. To that e... ates is expected.

The new radiatio... use by agencies of ... look to the recomm... guidance.

Radioactivity con... might be inhaled or ... diation Council. F... that Federal agenci... FRP, which the C...

The Atomic Ene... award for the contr... the Commission r... largest number of i... the winner until the ... Sandia Laborato... the AEC safety ... record was broken o...

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The memorandum views the setting of radiation protection standards as the making of a judgment on the extent to which the risks of exposure to radiation may be accepted in order to realize the benefits associated with incurring the exposure. The Council emphasizes that there should be no single "permissible" or acceptable exposure level set without regard to the reasons for permitting the exposure. Instead, the memorandum recommends adoption for Federal use of the concept of "Radiation Protection Guide" to designate an exposure dose level resulting from application of this principle. Values to be used as Radiation Protection Guides are given for normal peacetime operations.

Radiation protection guides developed so far pertaining to whole body and special organ exposure under industrial conditions, and to genetic (whole body) genetic exposure to individuals, and as an average for large populations. The rem-dose values given by the guides differ very little from the most recent values recommended or suggested by the National Committee on Radiation Protection and Measurements, and the International Commission on Radiological Protection. To that extent, no immediate effect on Commission activities is expected.

The new radiation protection guides were promulgated for official use by agencies of the Federal Government. The Commission will look to the recommendations of the memorandum for its primary guidance.

Radioactivity concentration guides for radioactive materials that may be inhaled or ingested are being developed by the Federal Radiation Council. Pending their issuance, the Council recommends that Federal agencies continue to follow the recommendations of the NCRP, which the Commission has followed for some years.

SAFETY AWARD

The Atomic Energy Commission has established a new safety award for the contractors or operations offices achieving the best all-time Commission record for prevention of occupational injury—the largest number of injury-free man-hours. A trophy will be held by each winner until the record is superseded.

Sandia Laboratory at Albuquerque, N. Mex., accumulated an all-time AEC safety record total of 14,936,169 man-hours before its record was broken on September 6, 1960, by a disabling injury. Sandia

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exceeded the old AEC record of 11,175,509 man-hours achieved by the General Electric Co. at the Commission's plant at Evendale, Ohio, in 1957. This places Sandia Laboratory among the National Safety Council's best records known in industry.

Radiation Exposure Of AEC Contractor Personnel

The Commission's annual survey of rates of exposure to external radiation among workers in Commission installations, designed as a check on adequacy of safeguards and enforcement, showed that of more than 75,000 contractor personnel, some 99.9 percent were exposed from none to less than 5 rems per year, and only 5.17 percent had exposures of between 1 to 5 rems. This compares to 99.73 percent in the 0 to 5-rem range during 1958 for some 66,000 employees, and 9.52 percent in the 1- to 5-rem range. The number of people exposed to more than 5 rems in 1959 was reduced by more than 60 percent despite the greater number of people involved.

The following table gives details for the 2 years:

TABLE 1—EXPOSURES OF CONTRACTOR PERSONNEL TO PENETRATING RADIATION, SUMMARIZED FOR 1958 AND 1959

Range of annual total exposure in rem [a]	1958 Number of workers	1958 Percent of total number of workers	1959 Number of workers	1959 Percent of total number of workers
0–1	59, 455	90. 21	71, 630	
1–5	6, 271	9. 52	3, 912	
5–10	159	. 24	66	
10–15	10	. 01	2	
15	12	. 02	[b] 1	
	65, 907	100. 00	75, 611	

[a] The rem is a measure of the dose of any ionizing radiation to body tissues in terms of its estimated biological effect relative to a dose of one roentgen of high voltage X-rays.
[b] This overexposure is noted in table 5.

Industrial Safety And Property Protection

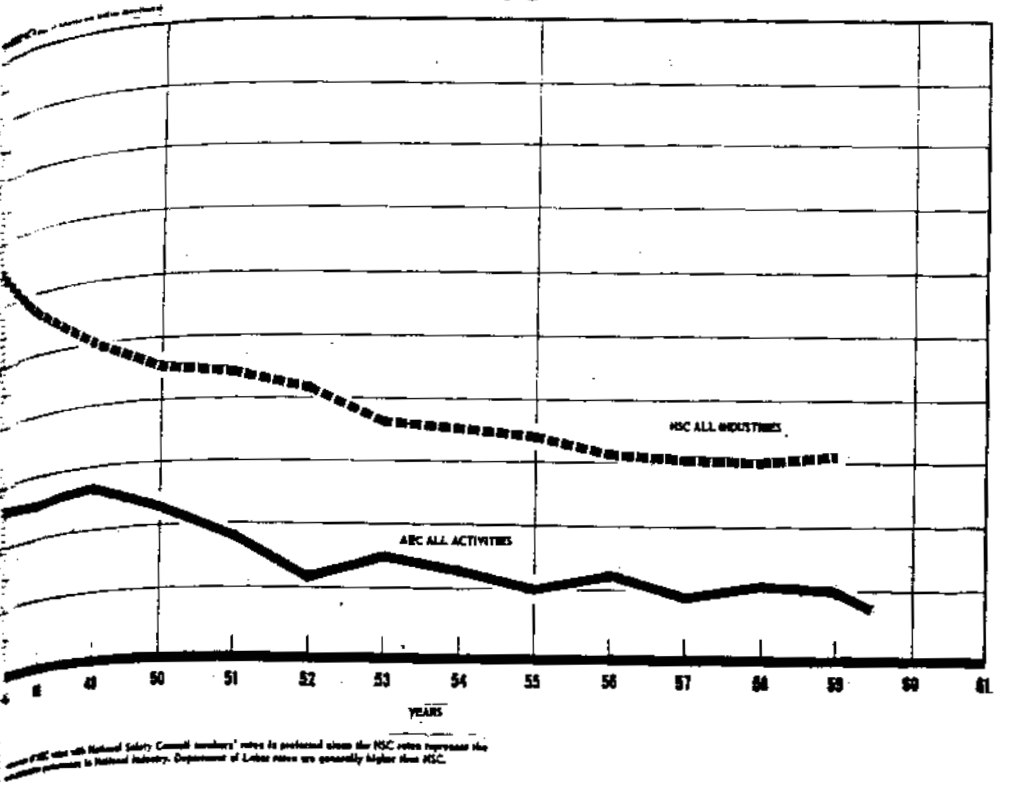
Industrial Safety

The Commission's 1960 record in safety and fire protection was surpassed by the 1959 record (the latest available) of only one of the industries in the United States as reported to the National Safety Council, which compiles and publishes annually the average in-

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...quency rates. The one having the best record was the communica-
... industry.

PERSONNEL INJURY RATES
1947-1960



...Commission showed a reduction of 24 percent in its injury rate ... 1959 to 1960. Based on number of injuries per million man-... of employment, the over-all rate dropped from 2.11 to 1.70 ...own in the following table:

AEC INDUSTRIAL INJURY FREQUENCY RATES[a]

Type of work	1959	Jan. thru November 1960	Percent increase or decrease
...tion	1.07	0.73	−32
...	1.94	1.57	−19
...	2.88	2.24	−22
... Construction	4.32	3.85	+11
...am Construction	16.72	14.10	−16
...-Engineering	2.05	1.64	−20
...ment	2.14	0.76	−65
...	2.11	1.70	−24

[a] ... of lost time injuries per million man-hours.

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Fire, Explosion and Property Damage

Fire and explosion have been the principal causes of Commission property damage and loss during each of the 17 years the Government's industrial nuclear facilities have been in operation. Approximately 11 percent of total damage resulted from hazards classed as specific to nuclear activities.

Serious Accidents

Thirty-seven serious accidents occured in atomic energy facilities January 1 to November 1, 1960 inclusive, and are summarized in Table 1. A "serious accident" means an accident required to be reported immediately to Commission headquarters, and includes any of the following: (*a*) fatalities, (*b*) Government property damage of $5,000 or more, (*c*) an external radiation exposure greater than 25 rems received over a short period of time, (*d*) other injury or industrial illness, no matter how slight, of five or more persons in one accident, and other defined accidents. (AEC Manual Chapters 0502–04 and 0523–052 give full definitions of immediately reportable accidents.) Four workers were killed in accidents that did not involve radiation.

TABLE 1.—SERIOUS ACCIDENTS[a]

January 1—November 1, 1960

HS No.[b]	Date	Operations Office	Injury and loss	Remarks
60-3	1-16	COO	$30,000	Two boilers in a reactor power house exploded due to [illegible] of fumes in firebox while an attempt was being made to start unit manually.
60-4	1-29	ALOO	1 killed	Professional skin diver drowned while performing [illegible] duties at the Eniwetok Proving Ground.
60-5	2-12	COO	13,115 2 injured	A reactor vessel holddown plug assembly dropped [illegible] being lifted and moved by means of a hand winch. [illegible] riggers injured.
60-7	3- 3	SAN	12,500	During the pressing of an experimental high explosive [illegible] detonation occurred.
60-8	3- 8	OROO	1 exposed	An employee was exposed to radiation from Co [illegible] cleaning up a cell. The exposure was 5,550 rads to the [illegible] (beta dose).
60-9	1-26	OROO	20,000	Explosion occurred in a uranium sintering furnace.
60-10	3-18	SROO	170,000	A hydrogen-sulfide gas release from a process [illegible] condenser caused a fire.
60-11	3-30	SROO	6,000	During an electrical storm, lightning struck two [illegible] pump motors.
60-12	3-18	ALOO	1 killed	While a kitchen employee, helping to pour 15 [illegible] of soup into a kettle, slipped and spilled the soup on [illegible]. Died 20 days later from first and second degree burns.

[a] In Compliance with AEC Manual Chapters 0502 and 0523.
[b] Office of Health and Safety, USAEC Headquarters, File Number.

TABLE

Jan

HS No.[b]	Date	Operations Office
60-13	4-13	NYOO
60-14	4-17	HOO
60-15	4-26	OROO
60-16	4- 5	SROO
60-18	6-15	ALOO
60-19	6-11	LARO
60-20	6-24	IDOO
60-21	6-28	OROO
60-22	7-11	ALOO
60-23	7-15	OROO
60-24	7- 6	ALOO
60-25	8-31	IDOO
60-26	9-13	SROO
60-27	9-29	SROO
60-28	6/2-6/6	SROO
60-29	8- 4	OROO
60-30	10- 7	ALOO
60-32	9-13	LAROO
60-33	7-12	HAOO

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TABLE 1.—SERIOUS ACCIDENTS—Continued

January 1—November 1, 1960—Continued

[illegible] No.[a]	Date	Operations Office	Injury and loss	Remarks
[illegible]	4-13	NYOO	1 killed	20-foot fall.
[illegible]	4-17	HOO	$250,000	A fire of pyrophoric metal and excess pressurization of equipment in a chemical dissolver caused damage and contamination.
[illegible]	4-26	OROO	39,500	While an irradiated graphite-clad reactor fuel element was being dry cut inside a hot cell with a remotely operated saw, a change in air pressure forced contaminated graphite dust from the cell. No overexposures.
[illegible]	4- 5	SROO	216,285	A leak in an outlet nozzle on a reactor was caused by cracks around the circumference of the nozzle.
[illegible]	6-15	ALOO	9,950	Breaking of sling in removal of astrodome from a 20-foot camera tower dropped dome 10 feet.
[illegible]	6-11	LARO	6,000	Failure of overload switches during a severe electrical storm caused burnout of transformer.
[illegible]	6-24	IDOO	1 injured	Employee seriously injured while using an explosive powder-actuated power tool.
[illegible]	6-28	OROO	12,000	The stainless steel lining of a new liquid nitrogen storage tank collapsed during an acceptance test.
[illegible]	7-11	ALOO	12,000	A 15 kilovolt switchgear damaged by fire.
[illegible]	7-15	OROO	5,000	Hydrogen gas explosion in gas furnace enclosure in metal plant; one employee injured.
[illegible]	7- 6	ALOO	$31,360	The accidental discharge of radioactive material into a room as a result of pressure buildup in a drybox. This was due to an inlet solenoid being locked in the open position and a venting solenoid being closed due to a malfunction. The pressure built up to a point that one of the drybox gloves blew out, thereby releasing radioactive particulate material into the room. Eleven persons received minor exposures.
[illegible]	8-31	IDOO	1 killed	Employee killed in fall while painting handrails around a silo.
[illegible]	9-13	SROO	250,000	Contaminated cooling water was discharged from canyon onto floor. No overexposures.
[illegible]	9-29	SROO	8,300	Water leaking through roof during heavy rainstorm damaged transformer.
[illegible]	6/2-6/6	SROO	24,000	During shipment, of irradiated fuel elements, 30 to 40 gallons of contaminated water leaked from the cask.
[illegible]	8- 4	OROO	18,132	During violent storm, severe power system disturbance caused oil circuit breaker failure.
[illegible]	10- 7	ALOO	16,500	Beechcraft Drone Aircraft, which was to be used for air sampling, crashed in desert when radio control was lost.
[illegible]	9-13	LAROO	12,000	During an electrical storm lightning damaged transformer.
[illegible]	7-12	HAOO	6,000	15-mile per hour breeze spread a grass fire over 3,000 acres of AEC property.

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Radiation Incidents

Radiation incidents occurring in the atomic energy program, i... in Commission and licensee operations, during fiscal years ended J... 30, 1959 and 1960 are summarized in Tables 2 and 3.

For Commission operations, the criteria for inclusion in the li... are as follows:

a) A dollar cost of recovery (decontamination, repair, etc.) or d... age or loss associated with the incident of $5,000 or more.

b) Radiation exposures to one or more persons of several rem... more, usually delivered in a short time.

c) Potential radiation exposure as in (b) which did not in fact o... cur (for example, an incident involving the spillage of ... quantities of plutonium).

d) An incident which, for reasons of possible public interest, ... been reported previously to the public.

For licensee operations, the criteria for inclusion in the listing ... those given in AEC Regulations as stated in 10 CFR Part 20 wh... defines incidents requiring (*a*) immediate or (*b*) 24-hour notific... of Commission, plus criterion (*d*) as stated above for Commis... activities.

10 CFR Part 20 requires immediate notification to the Com... sion of any incident which may have caused or threatened to ca...

"(1) Exposure of the whole body of any individual to 25 rems ... more of radiation; exposure of the skin of the whole body of ... individual of 150 rems or more of radiation; or exposure of the ... ankles, hands or forearms of any individual to 375 rems or more ... radiation; or

"(2) The release of radioactive material in concentrations wh... if averaged over a period of 24 hours, would exceed 5,000 times ... limits specified for such materials in Appendix B, Table II; or

"(3) A loss of one working week or more of the operation of ... facilities affected; or

"(4) Damage to property in excess of $100,000."

It is also required by 10 CFR Part 20 that:

"Each licensee shall within 24 hours notify the Manager of the ... appropriate Atomic Energy Commission Operations Office listed ... Appendix D by telephone and telegraph of any incident involv... licensed material possessed by him and which may have caused ... threatened to cause:

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(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, averaged over a period of 24 hours, would exceed 500 times the quantity specified for such materials in Appendix B, Table II; or

(3) A loss of one day or more of the operation of any facilities affected; or

(4) Damage to property in excess of $1,000."

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TABLE 2.—INCIDENTS INVOLVING RADIATION IN AEC OPERATIONS

July 1, 1958—June 30, 1960

Date	Location	Number of persons involved	Extent of exposure	Nature of incident
Dec. 4, 1958	Miamisburg, Ohio	1	Estimated 3.5 times the maximum continuous body burden for polonium 210.	An employee inhaled polonium 210 during the handling and counting of a polonium-alpha source. The source was odd-sized, and it was being counted in an unorthodox manner.
Dec. 30, 1958	Los Alamos, N. Mex.	3	1—Died 35 hours later from the effects of a radiation dose estimated to be several thousand rems to the midportion of the body. 2—Received whole body radiation doses ranging up to 118 rems.	As the result of certain chemical operations, the plutonium suspended in an emulsion in a 225-gallon tank assumed a critical configuration. The results of the accident have been the subject of several technical and scientific reports.
Jan. 6, 1959 HS-59-103	Livermore, Calif.	7	1—Received exposure dose of 41 rems. 1—Received exposure dose of 400 millirems. 5—Received less than 50 millirems.	Malfunction of remote controls on an electron accelerator caused exposure to personnel.
Mar. 31, 1959 HS-59-7	Richland, Wash.	6	Negligible.	While two employees were doing experimental machining with plutonium in a glove box, an explosion occurred inside the box, spreading plutonium. The principal cost was the replacement of alpha monitoring instrument, $1,449.
Apr. 2, 1959 HS-59-8	Aiken, S.C.	0	None.	While solvent containing radioactivity was being transported to underground storage tanks in the burial ground, a small volume (estimated at less than one gallon) of the solvent leaked from the forward hatch of the solvent trailer and dripped onto the plant roadway. Cleanup cost, $8,700.
July 8, 1959 HS-59-18	Berkeley, Calif.	0	None.	Overpressurization of a box for helium cooling at an accelerator installation blew out a thin experimental foil, containing about 0.05 curies of curium 244, causing it to disintegrate. The cost was $58,500 for cleanup and lost time of operation.
July 11, 1959 to be filed	Los Alamos, N. Mex.	0	None.	A unit filtering system was in process of revision when the filter caught fire from sparks or hot metal from a welding torch. Alpha radiation emitting dust spread but remained to approximately 40 feet in the decontamination room.
Aug. 6, 1959 HS-59-26	Miamisburg, Ohio	0	None.	While a test pressure pot was contaminated, hydrogen gas was found present and precautionary to transferring the gas to a high pressure system, the gas was inadvertently released through the exhaust system. Loss of tritium gas amounted to $10,000.
Aug. 21, 1959 HS-59-27	Aiken, S.C.	0	None.	A spontaneous explosion occurred in a dry box, causing 39 curies of polonium to be spread into the room and corridor. The cost of the accident was $1,900.
Oct. 16, 1959 HS-59-36	Idaho Falls, Idaho	21	7—Received whole body exposures ranging	During an attempt to locate the source of stoppage in a chemical separations plant, hot liquid in an evaporator vaporized through an open connection. A remotely operated crane was contaminated with high level radioactive solution. Decontamination costs amounted to $130,000. A nuclear reaction in an underground waste collection tank resulted

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July 3, 1959 HS-59-18	Berkeley, Calif.	0	None	cost, $8,700. Overpressurization of a box for helium cooling at an accelerator installation blew out a thin experimental foil, containing about 0.05 curies of curium 244, causing it to disintegrate. The cost was $58,500 for cleanup and lost time of operation.
[illegible]	[illegible]	0	None	A unit filtering system was in process of revision when the filter caught fire from sparks or hot metal from a welding torch. Alpha radiation emitters were spread, and resulted in approximately $1,000 to $1,500 decontamination costs.
[illegible]	[illegible]	0	None	[illegible]
Aug. 21, 1959 HS-59-27	Aiken, S.C.	0	None	A spontaneous explosion occurred in a dry box, causing 39 curies of polonium to be spread into the room and corridor. The cost of the accident was $1,900.
Oct. 16, 1959 HS-59-33	Idaho Falls, Idaho	21	7—Received whole body exposures ranging up to 6 rems. Of these, two received skin exposures of 50 rems and 32 rems. 14—Negligible.	During an attempt to locate the source of stoppage in a chemical separations plant, hot liquid in an evaporator vaporized through an open connection. A remotely operated crane was contaminated with high level radioactive solution. Decontamination costs amounted to $130,000.
Nov. 11, 1959 HS-59-259	Oak Ridge, Tenn.	0	None	A nuclear reaction in an underground waste collection tank resulted from the accidental transferring of fissionable material into the tank.
Nov. 20, 1959 HS-59-37	Oak Ridge, Tenn.	0	No persons were directly affected by the explosion. In subsequent survey and cleanup operations employing several hundred people, several persons had sufficient exposure to plutonium to result in measurable excretion of 1 percent of the maximum permissible body burden.	Particles of radioactive elements, principally ruthenium 106 and rhodium 106 were accidentally released from a stack and settled to the ground in the immediate vicinity. As the result of an explosion in a processing vessel during a cleanup procedure, about six tenths of a gram of plutonium was blown out of a concrete cell onto nearby buildings, vehicles, roadways and grounds in an area of about 4 acres. Cost of cleanup was $350,000.
Nov. 30, 1959 HS-59-272	Miamisburg, Ohio	2	1—3.9 times the permissible body burden of polonium 210. 1—2.05 times the permissible body burden of polonium 210.	Routine monitoring of two employees servicing radioactive equipment disclosed exposure to polonium. Detailed circumstances of exposure could not be determined.
Nov. 30, 1959 HS-59-267	Idaho Falls, Idaho	0	None	Rupture in a reactor core section of an inpile tube caused spread of highly contaminated liquid (approximately 25 rep at 1 foot). Cost for cleanup of contaminated area and replacement of damaged instruments was $4,720.
Dec. 12, 1959 HS-59-40	Aiken, S.C.	0	None	During railroad transportation of a burial box containing pipe jumpers, radioactive particulate matter was shaken loose from the box, resulting in spread of contamination along the railroad right-of-way within site. The diesel locomotive and several spacer cars were also contaminated. Cost for cleanup $5,200.

TABLE 2.—INCIDENTS INVOLVING RADIATION IN AEC OPERATIONS—Continued
July 1, 1958—June 30, 1960

Date	Location	Number of persons involved	Extent of exposure	Nature of incident
Mar. 8, 1960 HS-60-8	Oak Ridge, Tenn.	1	5,550 rads to the hand (beta dose)	Personnel exposure. See table of "Serious Accidents" for description.
Apr. 5, 1960 HS-60-16	Aiken, S.C.	0	None	Reactor leak. See table of "Serious Accidents" for description.
Apr. 17, 1960 HS-60-14	Richland, Wash.	2	Negligible	Dissolver explosion. See table of "Serious Accidents" for description.
Apr. 26, 1960 HS-60-17	Richland, Wash.	1	Survey indicated 90,000 disintegrations per minute in the wound.	The right forefinger was pricked by a splinter of plutonium through the rubber glove employee was wearing while arranging equipment in a hood.
Apr. 26, 1960 HS-60-15	Oak Ridge, Tenn.	8	Highest exposure was 120 millirems of penetrating radiation.	Ventilation change. See table of "Serious Accidents" for description.
June 2-6, 1960 HS-60-28	Baltimore, Md. & Corning, N.Y.	0	None	Shipping cask leak. (See table 4, Serious Accidents, for description.)

[illegible] July 1, 1958—June 30, 1960

Date	Location	Number Persons Involved	Extent of Exposure b	Nature of Incident
Aug. 1958	Vallejo, Calif.	1	Film badge exposure 4.8 rems during month	Engaged in radiography work.
Aug. 5-6, 1958	Portsmouth, N.H.	4	Film badge exposures ranging 600 millirems to 7.5 rems.	Exposures occurred as a result of mechanical failure of a radiographic camera containing a 7 curie iridium 192 source.
Sept. 5, 1958	St. Louis, Mo.	0	None	Two phosphorus 32 spills occurred, one when an employee placed an open-top lead shield holding a bottle containing 10 cc of precipitate

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Date	Location	Number Persons Involved	Extent of Exposure a	Nature of Incident
Aug. 1958	Vallejo, Calif	1	Film badge exposure 4.8 rems during month	Engaged in radiography work.
Aug. 5–6, 1958	Portsmouth, N.H	4	Film badge exposures ranging 600 millirems to 7.5 rems.	Exposures occurred as a result of mechanical failure of a radiographic camera containing a 7 curie iridium 192 source.
Sept. 5, 1958	St. Louis, Mo	0	None	Two phosphorus 32 spills occurred, one when an employee placed an open-top lead shield holding a bottle containing 10 cc of precipitate wash water on a hotplate. The liquid boiled over onto the hotplate. The loss was estimated to be from 5 to 10 millicuries of phosphorus 32. Secondly, about 30 minutes later, a centrifuge tube containing approximately 100 millicuries of end product turned over in the water bath and resulted in a loss of 2.58 millicuries of phosphorus 32.
Sept. 15–29, 1958	Ithaca, N.Y	1	Calculated exposure of 10 rems	It was mistakenly believed that a cobalt 60 source consisting of 5 metal slugs of 5 curies each was no longer present in a stack of bricks and the shield was removed while realigning some furniture.
Sept. 22, 1958	Houston, Tex	2	1—Film badge exposure of 3.6 rems 1—Film badge exposure of 1.5 rems	The exposures occurred when the employees were retaping the extension cable of a radiographic device.
Oct. 29, 1958	Arlington, Mass	1	Film badge exposure of 1.435 rems whole body and a calculated hand exposure of 1,000 rems.	Individual was engaged in experiment with one 200-curie cobalt 60 source and one 400-curie iridium 192 source. Malfunction of equipment resulted in failure of iridium 192 source to return to shielded position.
Oct. 29, 1958	Cambridge, Mass	1	Negligible	A spill of approximately 5 millicuries of polonium 210 occurred in a laboratory when a glass ampule containing polonium solution exploded while being opened.
Nov. 6, 1958	Boston, Mass	0	Calculations showed the average 24-hour concentration of effluent discharged through the stack amounted to 6.6×10^{-3} microcuries per milliliter.	During the transfer of several hundred curies of tritium from a shipping container to a vacuum manifold, a valve was inadvertently left open and 200 curies of tritium were lost.
Nov. 12, 1958	Bronx, N.Y	0	None	A leak in a 1,000 curie cobalt 60 sealed source contained in a teletherapy unit. Contamination confined to unit head. Unit was decontaminated, and leaking source replaced.

See footnotes at end of table.

TABLE 3.—INCIDENTS INVOLVING RADIATION—LICENSEES [a]—Continued

Date	Location	Number Persons Involved	Extent of Exposure [b]	Nature of Incident
Nov. 14, 1958	Houston, Tex	8	Radiation doses calculated from 130 millirems to 1 rem whole body and 4 rems to 560 rems (hand).	A radioactive sealed source was found at the head of a filter casing near a pump on a pipeline. Before the source identified, eight individuals were exposed. All employees were given medical examination and no biological effects were noted.
Nov. 17, 1958	Pittsburgh, Pa	1	Film badge exposure of 9.975 rems for week beginning Nov. 15, 1958.	Employee had been conducting industrial radiography activities using a 17-curie iridium 192 source. Exposure probably caused by failure to close and lock camera between shots.
Nov. 21, 1958	Tonawanda, N.Y.	0	None	Leaking source caused contamination of equipment in a hot cell. Hot cell decontaminated.
Dec. 3, 1958	Cambridge, Mass.	1	Film badge exposure of 6 rems whole body	A radiographer apparently became confused in his routine, neglected to crank the source back into the camera, and walked into the radiation area where the 52-curie iridium 192 source was exposed.
Feb. 4, 1959	Shrewsbury, Mass.	8	Negligible	Approximately 35 millicuries of carbon 14 lost when a beaker containing 80 millicuries of sodium acetate in alcohol boiled over.
Feb. 9, 1959	Waltham, Mass.	0	None	Flask shattered containing approximately 50 millicuries of carbon 14. Investigation revealed smears on the order of 1,000 counts per minute outside the laboratory, smears taken in the immediate vicinity of the accident were in excess of 10,000 counts per minute, while those on the surface of overhead pipes and ducts were between 500 and 1,000 counts per minute.
Mar. 2, 1959	Albany, N.Y.	0	None	While uranium was being melted, a mold fractured, allowing molten normal uranium to flow into a mold tank and onto the floor of the furnace area. Property damage amounted to about $7,000.
Mar. 19, 1959	Durango, Calif.	0	None	A fire occurred in a uranium refinery (yellow cake preparation only) caused by a momentarily unattended open flame used for drying the final mill product. Damage amounted to $5,000.
Mar. 31, 1959	New York, N.Y.	1	Calculated upper limit of exposure to approximately 300 square centimeters; of skin was approximately 1.50 rad.	Spill of 0.1 millicurie of phosphorus 32 as a result of filling centrifuge tubes too full. Licensee's clothing was contaminated and disposed of.
Apr. 17, 1959	Bloomsburg, Pa.	1	Calculated whole body dose of approximately 9 rems. Urine was found to contain 668 microcuries of tritium per liter.	While transferring defective tritium gas-filled tubes into closed containers, an employee was exposed.
May 5, 1959	Hempstead, N.Y.	1	Negligible	An employee spilled between 100 and 200 microcuries of iodine 131.
July 23, 1959	Syracuse, N.Y.	0	None	A process loss of approximately 25 curies of krypton 85 up an exhaust stack.
Sept. 10, 1959	Fort Worth, Tex.	6	Calculated exposures ranged from 800 millirems to 11 rems.	While setting up a camera, a 28-curie iridium 192 source was blown out of end of tube.
Oct. 1, 1959	Vallecitos, Calif.	2		

Mar. 19, 1959	Durango, Calif.	0	None	furnace area. Property dam- A fire occurred in a uranium refinery (yellow cake preparation only) caused by a momentarily unattended open flame used for drying the final mill product. Damage amounted to $5,000.
Mar. 31, 1959	New York, N.Y.	1	Calculated upper limit of exposure to approximately 300 square centimeters; of skin was approximately 1.50 rad.	Spill of 0.1 millicurie of phosphorus 32 as a result of filling centrifuge tubes too full. Licensee's clothing was contaminated and disposed of.
Apr. 17, 1959	Bloomsburg, Pa.	1	body particle. Calculated whole body dose of approximately 9 rems. Urine was found to contain 668 microcuries of tritium per liter.	While transferring defective tritium gas-filled tubes into closed containers, an employee was exposed.
May 5, 1959	Hempstead, N.Y.	1	Negligible	An employee spilled between 100 and 200 microcuries of iodine 131.
July 23, 1959	Syracuse, N.Y.	0	None	A process loss of approximately 25 curies of krypton 85 up an exhaust stack.
Sept. 10, 1959	Fort Worth, Tex.	6	Calculated exposures ranged from 800 millirems to 11 rems.	While setting up a camera, a 28-curie iridium 192 source was blown out of end of tube.
Oct. 1, 1959	Vallecitos, Calif.	2	1-calculated exposure of 70–100 rems to one hand; 100–300 millirems to the whole body. 1-calculated exposure of 7–17 rems to one hand, 90 rems to the other hand and 200–400 millirems to the whole body.	The exposures occurred when the employees removed radioactive sample holders from a pool which was loaded with irradiated samples of europium.
Oct. 27, 1959	Azusa, Calif.	0	None	Due to a malfunction during the loading of a sample into an irradiator containing a 10,000-curie cobalt 60 source, the sample was released prematurely and dropped onto the irradiator. The sample rack directly above the source was damaged to the extent of more than $1,000.
Oct. 28, 1959	Burlington, Mass.	1	Film badge exposures of 1.4 rems whole body, and a calculated 100–700 rems exposure to tips of fingers of right hand.	Employee pushed accidentally protruding source back into its container with his bare hand.
Dec. 18, 1959	Oak Ridge, Tenn.	1	Calculated total integrated dose of 106 rems to the thyroid.	Due to mechanical failure of a hood during the preparation of material containing iodine 131, an employee was exposed and a laboratory contaminated.
Dec. 21, 1959	Jamaica, N.Y.	1	Film badge exposure 170 millirems beta (whole body), 13.25 rems to hand (over 13-day period).	Employee exposed while dismantling and removing heavy mechanical apparatus from a glove box contaminated with strontium 90.
Jan. 5, 1960	Dayton, Ohio	1	Film badge exposure 4 rems beta (Dec. 15 to 29, 1959); and 23 rems beta (Oct. 6, 1959 to Jan. 5, 1960).	Making instrument calibration checks with a cobalt 60 source.
Jan. 29, 1960	Everett, Mass.	1	Calculated exposure of 130 rems to one hand.	An employee performing radiographic shots was exposed to radiation when he neglected to return source to shielded position.
Mar. 10, 1960	Pleasanton, Calif.	7	1-dose to thyroid at 48 rads 6–1.875 rems to 7.06 rems dose to the thyroid (calculated).	Exposed to gaseous iodine 131 and iodine 133 from a fission gas bubble released from a defective loop element.

See footnotes at end of table.

TABLE 3.—INCIDENTS INVOLVING RADIATION—LICENSES [a]—Continued
July 1, 1958—June 30, 1960

Date	Location	Number Persons Involved	Extent of Exposure [b]	Nature of Incident
Mar. 14, 1960	Portsmouth, N.H.	1	Film badge exposure of 6.515 rems.	An employee while performing industrial radiography, using a 40-curie iridium 192 source, was exposed when a malfunction of the camera occurred.
Mar. 29, 1960	Madison, Wis.	12	1-estimated 80-100 rems 11-estimated 200 millirems to 25 rems.	A student removed some samples from an irradiator unaware that a 200-curie cobalt 60 source had become detached and had fallen into the flask holding the samples.
Apr. 8, 1960	Pittsburgh, Pa.	0	None	A release of mlted fission products to the primary coolant of reactor caused by rupture of fuel element.
Apr. 10, 1960	do	1	Film badge exposure of 120 rems.	Exposure occurred while making radiographic shots with 5.2-curi iridium 192 source. Exposure resulted from use of faulty camera.
Apr. 27, 1960	St. Louis, Mo.	0	None	A 174-curie cobalt 60 sealed source contained in a teletherapy unit leaked.

[a] A & B type incidents plus all other incidents receiving press notices.
[b] Exposures of less than 1 rem are expressed in millirems (1,000 millirems=1 rem).

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SPECIAL HAZARDS UNDER STUDY

Contamination Containment in Glove Boxes

Glove boxes are widely used in atomic energy activities to prevent spread of contamination. Glove boxes are closed, ventilated compartments with rubber gloves sealed into the side into which worker inserts his hands. Experience has shown that the protection afforded by glove box containment is substantially reduced in case of accidents involving fire and explosion. During 1959, a committee was formed for the purpose of collecting the best Commission experience and practices on glove box design. A draft guide on glove box design, construction and use, will be prepared for publication during 1961.

High Efficiency Filters

In many cases, high efficiency filters on air ventilating systems serve as the final means for preventing inadvertent spread of radioactive contamination to external environment. The occurrence of several unexpectedly severe filter fires made it necessary to develop filters that were more nearly noncombustible. Such filters have been developed during the past 3 years and have found widespread acceptance and use throughout Commission installations.

Arrangements were made during 1959 so that Commission contractors could have the performance characteristics of filters checked before installation at one of two testing facilities. A simple, economical, practicable means for checking banks of filters as a unit remains to be developed. Other areas currently being studied include methods for further increasing filter heat resistance, and development of more efficient dry filters to remove radioactive iodine.

Metal Pyrophoricity

Basic research to obtain improved understanding and means for more effective prevention or control of fires and explosions caused by pyrophoric metals (such as plutonium, uranium, thorium and zirconium), the National Laboratory found that certain mixed halogen organic derivatives appear effective in retarding or preventing zirconium combustion in air. Stanford Research Institute found that uranium foils could be ignited by exposure to shock waves. A. D. Little, Inc. tests to evaluate the relative effectiveness of various metal extinguishants are nearing completion.

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Air-Oil Explosions

Under certain conditions, air-oil mixtures explode. Four accidents of this kind occurred in Commission installations during 1959, the most serious at West Milton on October 30, 1959, in a hydraulic system for a prototype reactor. A survey failed to reveal the West Milton type of hazard in any other Commission location. The cause and means for preventing such accidents have been studied and the results published by the Commission.

Electronic Computer Fire Protection

A fire in the Department of Defense Pentagon headquarters in Washington, D.C. in 1959 resulted in national recognition of fire risks associated with computer systems. A Commission engineer is surveying this type of risk in Commission installations where many computers are in use, and is representing the Commission on the National Fire Protection Association Committee on Electronic Computers. The survey is to be concluded in 1961.

Liquid Hydrogen Hazards

Bubble chambers used in research work with particle accelerators contain relatively large quantities of liquid hydrogen under great pressure. Hazards of these devices have been studied at Commission-supported laboratories—Lawrence Radiation Laboratory, University of California, Argonne National Laboratory, and Brookhaven National Laboratory. These findings, with that resulting from extensive liquid hydrogen hazard work performed under contract to the U.S. Air Force, are being studied by the Commission with a view to strengthening safety precautions covering this area.

Nuclear Materials Management

Review of Nuclear Materials Control System

The Commission's system for controlling source and special nuclear materials was established in 1947, and since that time has been subject to continuing critical review by staff. Late in 1960, the Commission requested proposals from private consultant firms for an objective evaluation of the system and procedures.

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Standard Reference

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The purpose of the review is to assure the public, the Congress, and the Commission that proper administration is being maintained over source and special nuclear materials. The review is designed to ensure the suitability of the existing system of control to present conditions. In addition, the review should provide assurance, or recommend corrective measures to assure, that the system will detect significant diversions of source and special nuclear materials, and that the system is sufficiently flexible to permit development of peaceful applications of atomic energy. The study should provide advice and guidance on such problems as ascertaining the special nuclear material content of unirradiated fuel elements, and of irradiated fuel elements returned by licensees for chemical reprocessing and subsequent payment.

Recommended Measurement Methods

Through a special advisory committee and through seminars, the Commission is establishing suitable methods for measuring the properties and quantities of source and special nuclear materials transferred between the Commission and private industry or foreign governments. Measurement methods now in use for atomic energy operations are being reviewed and evaluated at a series of seminars among recognized authorities in various fields of measurement. The seminars, divided into six sections, were held during 1960 as follows:

Mass Spectrometry Section, February 9–10, Argonne National Laboratory.

Uranium Chemistry Section, February 25–26, and September 15, New Brunswick Laboratory.

Emission Spectroscopy Section, February 29–March 1, Pittsburgh, Pa., and November 1, New York, N.Y.

Plutonium Chemistry Section, March 24–25, Los Alamos Scientific Laboratory and August 17–18, Dow Chemical Co., Rocky Flats Plant, Denver, Colo.

Radiochemistry Section, May 9, Oak Ridge National Laboratory and October 13, Gatlinburg, Tenn.

Sampling Section, June 7–8, Washington, D.C.

Standard Reference Materials

The Commission-National Bureau of Standards cooperative program which has provided 15 uranium isotopic standards, was continued. Preliminary investigations for preparation and certification of uranium 236 isotopic standard and of isotopic plutonium standards are underway.

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Samples of high purity plutonium metal are being prepared at the Los Alamos Scientific Laboratory for distribution to six laboratories for analysis. These results will be used for certification of this material when made available as a plutonium chemical standard from the National Bureau of Standards.

Non-destructive Analysis of Reactor Fuels

A program was initiated to develop techniques for non-destructive analysis of reactor fuel materials. Primary emphasis was placed on gamma ray scintillation spectrometry, which has been proved feasible.

A portable gamma ray spectrometer has been developed and after final field trials, all the Commission's operations offices will be furnished instruments for inventory verification, for quality control in core manufacture, and for other uranimum measurement problems which may arise.

Meetings

The annual meeting of Commission and contractor personnel concerned with nuclear materials management was held in Columbus, Ohio, June 22–24, in conjunction with the first annual meeting of the Institute of Nuclear Materials Management.

Construction and Supply

Construction Costs

As of December 31, 1960, the Nation's investment in atomic energy facilities was $7.4 billion before depreciation reserves.

Costs incurred by the Commission for additional plant and equipment during fiscal year 1960 amounted to $332 million, an increase of about 11 percent over similar costs incurred in the previous fiscal year. The following table shows capital costs incurred during the previous 5 years:

Fiscal year	Plant construction	Equipment
	(In millions)	
1960	$231	$101
1959	212	87
1958	210	80
1957	260	57
1956	264	38

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Design Criteria for Shelters

Design criteria for Commission structures were expanded during [illegible] by the addition of Chapter 6316 to the AEC Manual with accompanying Handbook Parts I, II, and III establishing guidelines for [illegible] of fallout resistant personnel shelters and blast resistant [illegible] emergency relocation centers, when these are authorized by the Congress. The criteria include such factors as space allocations in relation to number of personnel, living and sanitary facilities, ventilation, strength of structure and radiation attenuation.

Mobilization Planning

The Commission continued its full participation in the activities of the Office of Civil and Defense Mobilization (OCDM). Assistance was provided to OCDM in development and review of annexes and appendixes to the National Plan for Civil Defense and Defense Mobilization and in modifications to Federal Emergency Plan Annus.

The Commission carried out a comprehensive program of exercises during Operation Alert 1960. Emergency operating plans were successfully followed in simulating conduct of postattack functions from the Headquarters Relocation Center and from field relocation centers. Commission representatives also were active at the OCDM Main Relocation Site and at OCDM regional locations.

As part of Operation Alert 1960, the Commission's entire succession command was briefed on headquarters emergency planning and facilities, and on postattack responsibilities.

A high-speed, especially-designed teletype printer was installed at the Commission's Headquarters Emergency Relocation Center. This teletype is capable of quickly receiving information about the postattack condition of facilities directly from the National Resources Evaluation Center computer.

Radiation Seminars for Transportation Industry

With the increase in the number of shippers of radioactive materials which has accompanied the growth of the atomic energy industry, the Commission has embarked on a program to provide transportation organizations of motor and rail carrier groups with detailed information concerning the transportation characteristics of atomic energy materials and products. Radiation protection seminars were sponsored and conducted, and carrier groups were encouraged to conduct

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$231	$101
212	87
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260	57
264	38

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similar training sessions, or to develop other means to instruct operating personnel. The seminars also provide a means of informing the transportation industry concerning the Radiological Assistance Program (see section of this report on Health and Safety).

Records Management

During fiscal year 1960, the Commission and its cost-reimbursement contractors disposed of 98,000 cubic feet of records having no further value, or 9,000 feet more than in 1959. At the end of the fiscal year, 228,000 cubic feet, or about 39 percent, of Commission records were housed in low-cost records centers or storage areas.

Community Activities

OAK RIDGE AND RICHLAND

During 1959 and 1960, the Government completed turning over to designated entities all municipal services and facilities of the former Commission-operated atomic energy communities of Oak Ridge, Tenn., and Richland, Wash. The sale of all Government-owned buildings for residential, commercial, and nonprofit use was largely completed. Built during the war to provide homes and facilities for employees of the atomic energy enterprises at Oak Ridge and the Hanford plant, the communities for years were operated as Government towns, with municipal services and administration supplied by contractors and with all buildings either rented or leased by concessionaires. Until February 1949, there was a security fence around the Oak Ridge Community and public access was restricted.

Public Law 84–221 was enacted August 4, 1955, and on August 8, 1955, the Commission requested the Federal Housing Administration (FHA) to make the necessary appraisals. Assistance in the reorganization of local government and the classification of property for sale began immediately after the passing of the enabling legislation in 1955. Except for some 100 leased residential lots in Oak Ridge, the first of which was sold in December 1955, all properties classified for sale were placed under the jurisdiction of the Housing and Home Finance Administration (HHFA). The first offering of houses was made in Oak Ridge on September 7, 1956, and in Richland on June 5, 1957. Sale of property, up to November 30, returned a total of

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Municipal installations with a book value of $60 million have been ...nsferred, and the Commission is now making annual assistance ...yments as provided in the Atomic Energy Community Act of 1955. ...t of the Community operating costs incurred at Oak Ridge and ...hland during fiscal year 1960 were in the form of assistance pay... to local municipal entities. At Oak Ridge, assistance payments ...organization and establishment of city government and for opera... ...of the city government (including the schools) totaled $1,453,746. ...Richland, assistance payments for organization and establishment ...the city government, as well as operation of the city government, ...hospital, and the school district totaled $1,354,799. It is estimated ...this time that steady-state annual assistance payments to the enti... as required, in the future might approximate the following:

City of Oak Ridge (including schools)	$1,400,000
City of Richland	425,000
Richland School District	700,000
Total	2,525,000

...hapter 8 of the Community Act, authorized the Commission to ...erate with and assist residents of the communities in preparation ...and establishment of, local self-government and to transfer munic... ...installations and responsibilities to local entities. This authority ...ed as of August 3, 1960, the purpose thereof having been ful...

...*Ridge*

...of November 30, the only remaining Government property of... ...for sale but remaining unsold were some 313 out of 1,741 vacant ...and parcels, and one commercial property reclassified from Gov... ...ent use and offered for sale. All buildings for residence (includ... ...partments), and nonprofit uses, except as indicated, had been ... Five commercial properties remained to be sold. Sales of ...erty returned a total of $26.5 million as of November 30.

	Dec. 31, 1959		*Nov. 30, 1960*	
	Units offered	*Percent sold*	*Units offered*	*Percent sold*
...and duplex houses	4,360	99	4,360	100
...ments (4 or more family units)	257	99	257	100
...lots and parcels	1,585	66	1,741	82
...cial properties	103	97	115	97
...	33	100	33	100

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School facilities and real property were transferred to the city of Oak Ridge on January 1, 1960, and all remaining municipal functions, facilities, and utilities, together with operational responsibility, were transferred to the city of Oak Ridge on June 1, 1960. Construction of the new Oak Ridge Hospital at Federal expense was completed and accepted by the Commission on January 22, 1960. Transfer of the new building to the Oak Ridge Hospital of the Methodist Church, Inc., was effective June 1, 1960, and on July 1, 1960, the hospital began operation independent of the Commission.

The population of Oak Ridge, as of 1960, was placed by the Census Bureau at 27,009.

Richland

All residential properties, except apartments and certain Wherry Act developments, have been sold in Richland, as have 89 percent of all residential lots. However, some 86 commercial properties remain to be sold as do several nonprofit properties. Sales of properties returned a total of $33.7 million as of November 30.

	Dec. 31, 1959		Nov. 30, 196	
	Units offered	Percent sold	Units offered[a]	Percent sold
Single and duplex houses	4,806	99	4,806	
Apartments (4 or more family units)	17	00	17	
Residential lots	205	75	292	
Commercial properties	151	32	232	
Nonprofit	7	42	13	

[a] All properties offered except two which are held up by court action.

The transfer of municipal facilities to the city of Richland was completed during 1960. Population in 1960, according to the Census Bureau, was 23,521.

LOS ALAMOS AND SANDIA

Los Alamos

Development and sale by the Commission of residential lots for privately owned homes continued at Barranca Mesa in Los Alamos, N. Mex. The original 72 lots offered have been increased by development of 47 additional lots during the year. Twenty-five homes were occupied during 1960, 27 more were under construction, and 51 additional lots have been sold for home construction. Engineering for

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additional 72-lot development, provided for in the 1960–1961 construction program, is underway.

The $1 million housing modification project authorized in 1958 was completed during 1960, and another similar $1 million program is underway. Approximately 240 Government-owned houses will have been modified when the programs are complete.

Several long-term leases on unimproved commercial real estate were awarded on the basis of competitive bids, and construction is underway at some sites. Included in the new commercial activities are a privately owned trailer court, and three multi-purpose sites with a variety of commercial enterprises proposed such as a grocery store, barber shop and laundry.

The Los Alamos Planning Committee, an official advisory group to the Manager of Albuquerque Operations, submitted a report recommending that the Commission, its contractors, and the residents, increase their activities toward the goals of greater local self-government, increased commercial enterprise, and elimination of the housing shortage.

Sandia Base Housing

Housing constructed at the Sandia base, Albuquerque, N. Mex., in the early 1950's to provide homes, not otherwise available, for Commission and contractor employees, was determined, during 1960, to be excess to Commission needs. This fact was reported to the General Services Administration with the information that the Department of Defense is interested in obtaining the housing.

Industrial Relations

Developments during 1960 in Commission contractor employment, patterns of earnings, collective bargaining, and related matters included the following:

Average employment for the first 11 months of 1960 for 29 prime reimbursable contractors operating 38 Government-owned installations, employing 50 or more persons, and engaged in operations, research, development, maintenance and service, continued at about the same level (91,126) as in 1959 (91,304).

The proportion of exempt salaried workers [34] in the work force of

[34] Exempt salaried workers includes all personnel "employed in a bonda-fide executive, administrative or professional capacity" who are exempt from the overtime provisions of the Labor Standards Act.

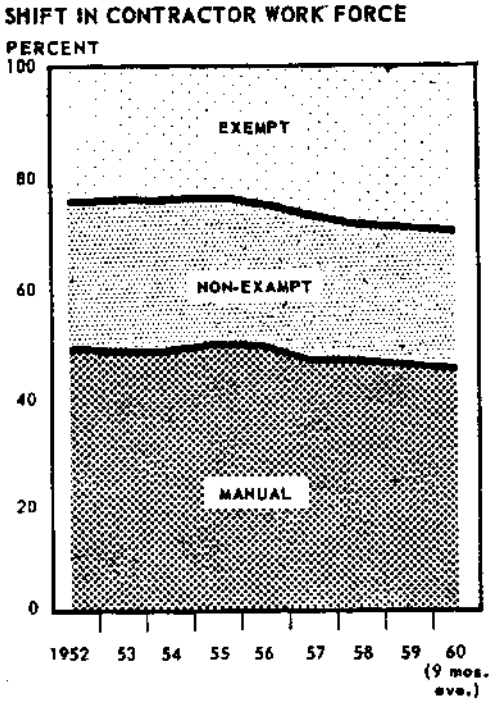
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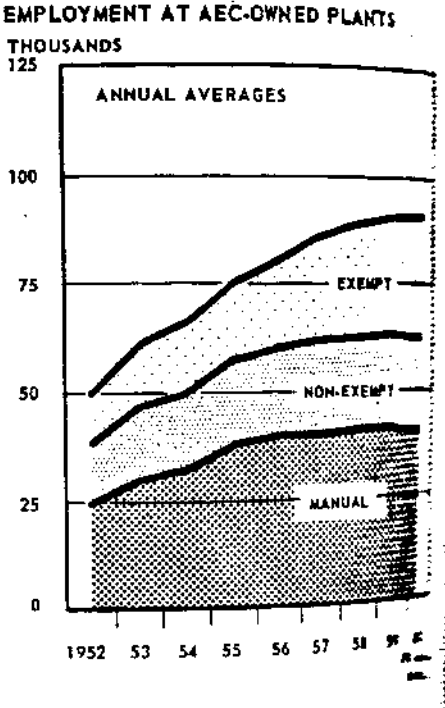
these contractors, the segment that includes scientists and engineers, continued to increase during 1960. This group constituted about one-fourth (24.7 percent) in 1952, approached one-third (30.2 percent) in 1959, and continued in 1960 with the percentage at 32.0 percent.

A 1960 occupational survey of contractors operating Government-owned facilities revealed that scientists and engineers comprise about one-fifth (18.8 percent) of the work force; skilled trades one-fifth (20.7 percent); clerical and office workers 15.2 percent; technicians and related occupations 15.1 percent; and managerial and administrative about one-tenth (10.3 percent). The remaining workers are in production and service occupations.

Earnings of contractor exempt salaried employees (consisting primarily of scientists and engineers) have increased at about the same rate as national averages since 1952, based on the limited industry information available.

Earnings of production (manual) workers in the Petroleum and Coal Industry and the Industrial Inorganic Chemical Industry—generally similar in process and equipment to Commission installations—have more or less paralleled earnings for comparable Commission contractor employees from 1952 through June 1960. However, in October 1960, contractor manual employee earnings for the first time rose above the $2.83 gross earnings less overtime preliminary figure reported for the petroleum industry.





Source: AEC

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Earnings of contractor nonmanual nonexempt salaried employees,[35] which bear a relationship to manual workers in the timing and amount of wage adjustments, have advanced since 1952 at a rate of 4.9 percent compared to 5.0 percent per year for contractor manual workers.

Contractor fringe benefit expenditures for nonexempt manual employees [36] amounted to 19.7 percent of gross payroll in 1959, compared with 19.3 percent in 1958.

EMPLOYMENT AND EARNINGS

Contractors [37] Work Forces

Increase in Scientists and Engineers

The shift toward an increasing proportion of exempt salaried workers in the work force of contractors operating Commission facilities continued during 1960 (see chart, Shift in Contractor Work Force Composition). Offsetting this increase are declines in the nonexempt salaried component from 26.9 percent in 1952 to 24.1 percent in 1959, and in the nonexempt manual sector from 48.4 percent to 44.6 percent over the same period.

This trend parallels a similar development observed by the Bureau of Labor Statistics in both manufacturing and nonmanufacturing sectors of the U.S. economy.[38] In Commission establishments, this shift reflects in part the increasing emphasis placed on research and development activities, with a consequent increase in scientific and engineering workers. The reduced percentage in manual and nonexempt salaried segments of the contractor work force may be attributed in part to technical improvements, ranging from installation of electronic data processing equipment for payroll preparations to minor modifications in plant and machinery and improved methods. All three work force groups have increased from 1952 through 1959 (see chart, Employment in AEC-owned Plants). Total employment reached 91,126 in 1960, based on a 11-month average continued at about the same level as in 1959 when the total was 91,304.

[35] Nonmanual nonexempt salaried employees include all personnel performing essentially managerial duties who are subject to the minimum wage and overtime provisions of the Fair Labor Standards Act.

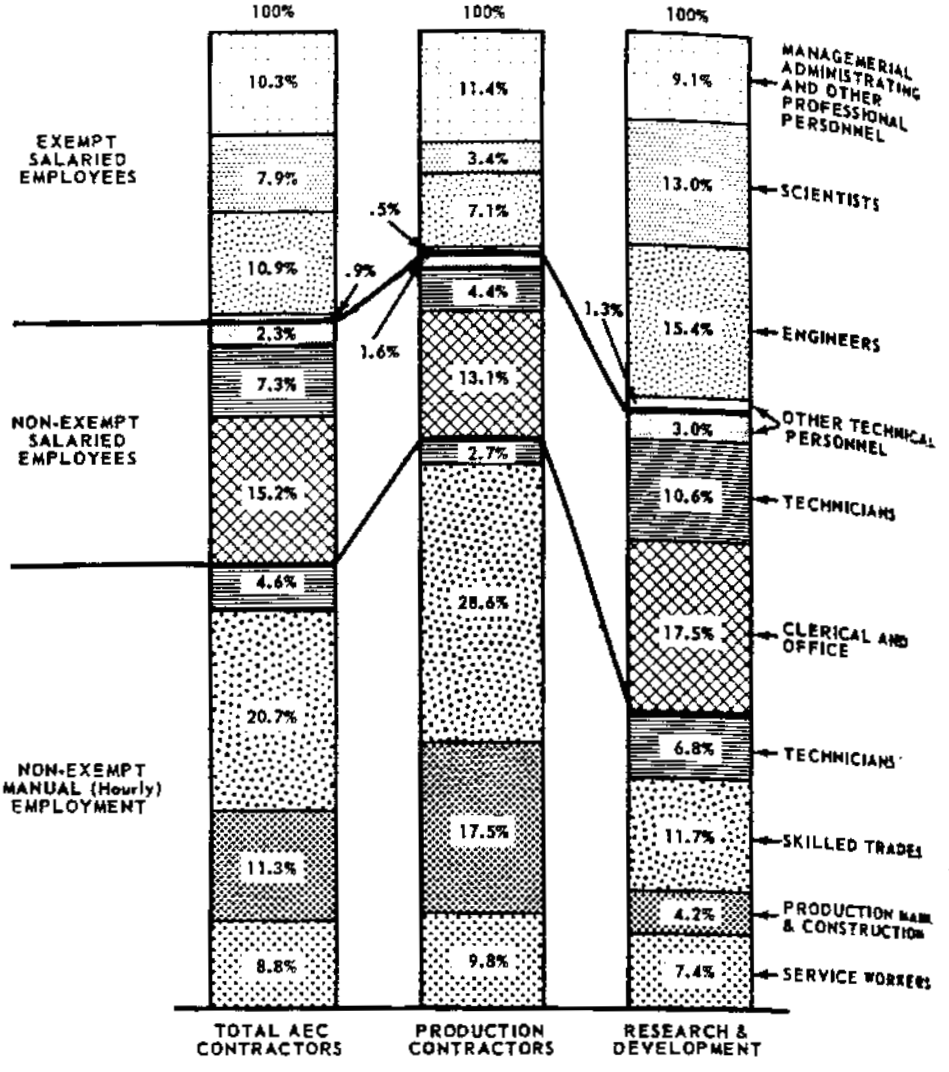
[36] Nonexempt manual employees include all personnel performing essentially manual work who are subject to the minimum wage and overtime provisions of the Fair Labor Standards Act.

[37] These include prime cost-type operations, research, development, maintenance and construction contractors employing 50 or more persons at AEC installations. Excluded are the operations of construction and architect-engineering firms. The number of contractors from whose reports are obtained has increased from 26 in 1952 to 29 in 1960 with the number of establishments reported in 1960 standing at 38.

[38] "Employment and Earnings," Sept. 1958, published by the Bureau of Labor Statistics, Department of Labor.

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CONTRACTOR WORK FORCE BY OCCUPATIONAL GROUPS*
(JANUARY 1960)



*The graph views the work force from two frames of reference, viz., an occupational viewpoint and a Fair Labor Standards Act viewpoint. The latter is directed at determining the degree of manual and routinized content to an occupation which in turn determines, along with other criteria, whether minimum wages and overtime payments are legally required.

Source: Based on Bureau of Labor Statistics Survey of "Employment in the Atomic Energy Field," January 1960.

Occupational Groups

When divided between production contractors and research and development contractors,[39] total AEC employment reveals a slightly larger production contractor work force, 46,045 workers, compar-

[39] *Production Contractors* include the following industrial segments: production of materials; production of special materials for use in reactors; fuel element fabrication and recovery activities and atomic energy defense production facilities. *Research and development contractors* include the following industrial segments: reactor and nuclear component design and manufacturing; private research labs and centers engaged in atomic energy work and Commission laboratory and research facilities.

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...h 42,538 workers employed by research and development contrac... (see chart, Contractor Work Force by Occupational Groups). ... occupational composition of these two contractor groupings is ...ply different. Among production contractors 58.6 percent of ...power is found in the blue collar segment of the work force con...ing of technicians, skilled trades, production, maintenance and con...ction, and service workers, compared with 30.1 percent among re...rch and development contractors.

The research and development work force included 28.4 percent ...ntists and engineers compared with 10.5 percent among produc... contractors.

The emergence of technicians as an important sector of the work ...ce is clearly apparent. Approximately 12 percent of total AEC ...loyment is in this category; production contractors employ about ... percent compared with 17.5 percent in research and development ...blishments. The proportion of clerical and other office workers is ...larly higher—17.5 percent—among research and development con...ctors than the 13.1 percent for production contractors.

Among production contractors, 11.4 percent of the work force con... of managerial, administrative and other professional employees ...pared to 9.1 percent among research and development contractors.

Contractor Employee Earnings

...ried Employees

Base monthly earnings of contractor exempt and nonexempt salaried ...loyees since 1952 are shown in the chart, AEC Contractor Base ...thly Earnings of Salaried Personnel.[40] In the exempt salaried ... approximately 66 percent are scientific, engineering and related ...nical employees. The scientific and engineering payroll has domi... the exempt earnings average since 1952. The exempt group ...ades also the payroll of executive, administrative and other ...scientific professional personnel.

...sed on the Los Alamos Scientific Laboratory annual national ...ey of average scientific and engineering salaries in research and ...lopment, salary levels for this group since 1952 have advanced ... rate of approximately 5.5 percent a year. This parallels the 5.5 ...ent average annual rate of increase observed for the Commission's

[40] ...plicable to prime cost type operating, research, development, maintenance and ... contractors employing 50 or more persons at Commission-owned installations.

contractor exempt salaried group. The actual level of base pay for Commission contractor exempt employees was $805 a month in November 1960.

In the nonmanual nonexempt salaried group, base monthly earnings have increased from $310 in 1952 to $471 in November 1960 (see same chart). The average annual rate of increase of salaries for this group from 1952 through 1959 was 4.9 percent. The average 4.2 percent a year increase in base pay for nonmanual nonexempt salaried workers compares favorably with the 5.0 percent a year increase for nonexempt manual employees.

Manual Work Force

The contractor average from 1952 until June 1960 for nonexempt manual work force earnings has fallen between the higher rate in the products of petroleum and coal industrial sector and the lower industrial inorganic chemicals industrial sector which use generally similar processes and equipment. In August 1960, Commission contractor earnings for the first time rose above the $2.83 figure for petroleum workers (see chart, Straight-time Average Hourly Earnings, Manual Workers). However, wage negotiations within the petroleum industry are scheduled for late 1960 and early 1961.

Fringe Benefits

The Commission's annual survey of "fringe" benefit expenditures by contractors operating AEC-owned plants covers a number of categories of supplementary remunerations considered as paid to, or for the benefit of nonexempt manual employees.[41] These fringe benefit expenditures amounted to 19.7 percent of gross payroll in 1959, the last year for which information is available, compared with 19.3 percent in 1958 (see Table 1—Contractor Fringe Payments as Percent of Payroll—1959).

The figures in the following table are necessarily an approximation, but help provide an estimate of the total cost to the contractor of an hour of manual labor, compared with those in other segments of industry:

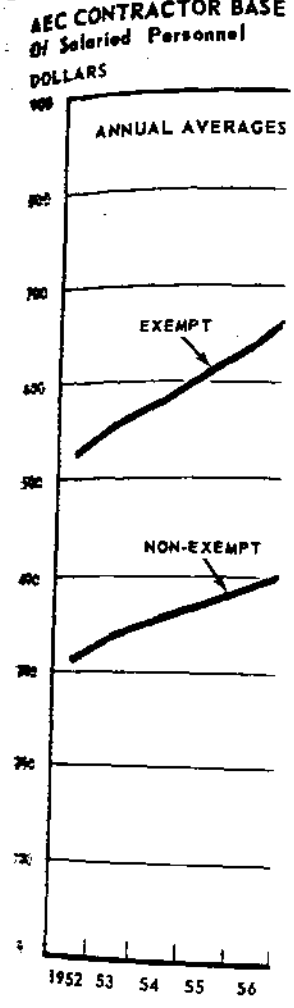
[41] Based on "Fringe Benefits 1959" by the Economic Research Dept. of Chamber of Commerce of the United States, Washington 6, D.C., 1960.

Gross average hourly e
Fringe cost (less pay f
worked)[a]

Estimated tot
labor cost

[a] Pay for time not worked co
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[b] Comparing AEC contractor an
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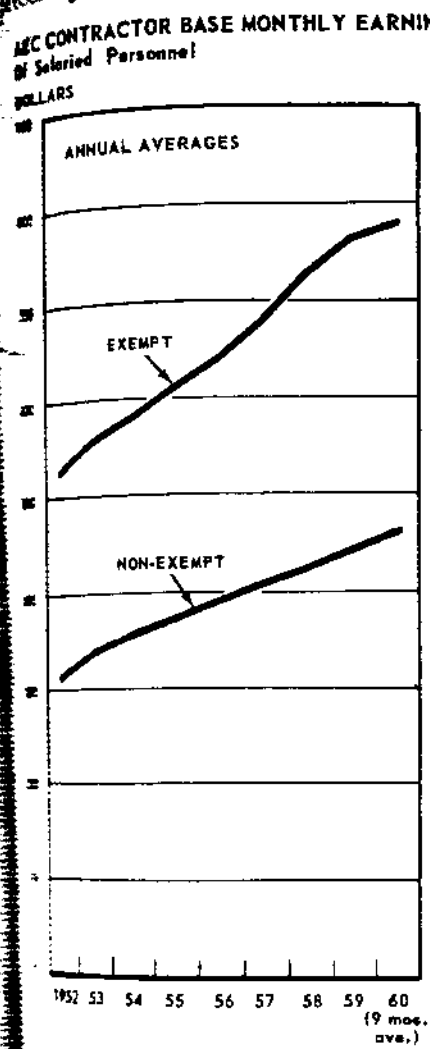
[c] AEC earnings (Source: AEC
Source: Bureau of Labor Sta

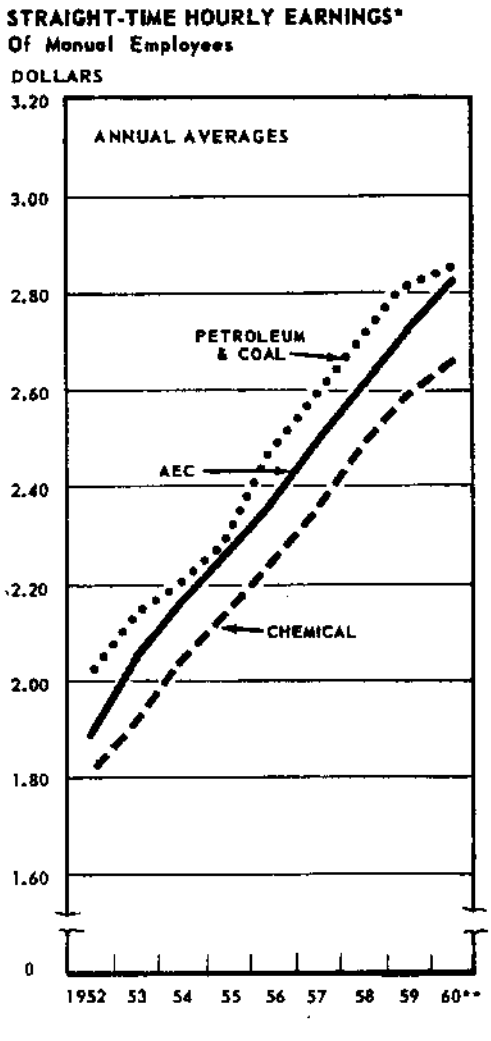
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	Total AEC contractors	*All manufacturing*	*Petroleum industry*	*Chemicals and allied*
Gross average hourly earnings	$2.819	$2.454	$2.954	$2.464
Fringe cost (less pay for time not worked)*	.261	.300	.508	.345
Estimated total hourly labor cost	$3.080	$2.754	$3.462	$2.809

*Pay for time not worked consisting of paid rest periods, lunch periods, washup time, travel time, clothes change time, get ready time, paid vacations, paid holidays, paid sick leave and similar payments is considered in gross average hourly earnings and therefore has been deducted from the "Fringe Cost" category above to avoid double counting in the total.

The Commission as a matter of policy recognizes that contractor white collar employees including Clerical and Professional Groups are entitled to fringe benefits of the same kind and level as prevail across industry. There is substantial evidence that those employees presently enjoy the fringe benefits that prevail generally in industry.





*Comparing AEC contractor employee earnings with those in the products of petroleum and coal, and industrial organic chemicals industries.

**AEC earnings (Source: AEC Form 341) based on average through September; petroleum and coal, and chemical earnings (Source: Bureau of Labor Statistics) earnings based on average through August.

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TABLE 1.—CONTRACTOR FRINGE PAYMENTS AS PERCENT OF PAYROLL—1959

Type of payment	Total AEC	Chamber of Commerce data [d]		
		All manufacturing	Chemicals and allied products	Petroleum industry
	Percent	*Percent*	*Percent*	*Percent*
TOTAL FRINGES AS PERCENT OF PAYROLL	[c] 19.7	21.6	25.6	[illegible]
1. Legally required payments:				
a. Old-age Survivors and Disability Insurance	1.8	2.3	2.2	[illegible]
b. Unemployment compensation	.7	1.2	1.1	[illegible]
c. Workmen's compensation	.5	.9	.7	[illegible]
d. Railroad Retirement Tax: R.R. Unemployment Ins.; State Sickness Benefits Ins., etc	.5	.1	.1	[illegible]
Total	3.5	4.5	4.1	[illegible]
2. Pension and other agreed-upon payments:				
a. Pension plan premiums and noninsurance type pension plans	3.3	3.3	4.3	[illegible]
b. Life insurance premiums; death benefits, etc	1.4	2.4	2.4	[illegible]
c. Contributions to privately financed unemployment benefit funds	[a]	.1	[b]	[illegible]
d. Separation or termination pay allowances	.1	[b]	.1	[illegible]
e. Discounts on goods and services, etc	[a]	.1	.1	[illegible]
f. Miscellaneous payments	.8	.2	.3	[illegible]
Total	5.6	6.1	7.2	[illegible]
3. Paid rest periods, lunch periods, washup time; travel time; clothes-change time, etc	1.9	2.7	3.4	[illegible]
4. Payments for time not worked:				
a. Paid vacations and bonuses in lieu of vacation	4.3	4.0	4.2	[illegible]
b. Payments for holidays not worked	2.6	2.3	2.4	[illegible]
c. Paid sick leave	1.4	.3	.6	[illegible]
d. Payments for State or National Guard Duty, jury, witness and voting allowances, payments for time lost due to death in family or other personal reasons, etc	.3	.1	.2	[illegible]
Total	8.6	6.7	7.6	[illegible]
5. Other items:				
a. Profit-sharing payments	[b]	.9	1.4	[illegible]
b. Christmas or other special bonuses, service awards, suggestion awards, etc	.1	.5	.9	[illegible]
c. Special wage payments ordered by courts, payments to union stewards, etc	[b]	.2	.4	[illegible]
Total	.2	1.6	2.7	[illegible]

[a] Indicates no expenditures reported.
[b] Less than 0.05 percent.
[c] Not additive due to rounding.
[d] From a study of "Fringe Benefits 1959" conducted by the Chamber of Commerce of the United States.

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Metal Trades Councils (
International Association
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(AFL-CIO)
Miscellaneous unions (
crafts, etc.) (AFL-CIO
Miscellaneous guard unio

[a] Metal Trades Councils are lo
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and conditions of employment.

Only about 6 perc
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Office Employees Internat
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General

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delivery of components

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LABOR-MANAGEMENT ACTIVITIES

Collective Bargaining Units

sion Representation

Of 39,565 nonexempt manual employees reported in August, 1960 the 29 Commission's cost reimbursable contractors engaged in operations, research, development and maintenance and service activities employing 50 or more workers at Commission-owned facilities, approximately 70 percent are represented by unions under collective bargaining agreements. The great majority of these employees are affiliated with the AFL–CIO.

The following table gives representation in the nonexempt manual work force by selected labor organization groupings:

	Approximate representation	*Percent*
al Trades Councils (AFL–CIO)[a]	12, 823	46. 4
rnational Association of Machinists (AFL–CIO)	6, 087	22. 0
Chemical and Atomic Workers International Union AFL–CIO)	5, 072	18. 4
llaneous unions (excluding guards, but including nits, etc.) (AFL–CIO)	2, 488	9. 0
llaneous guard unions (independent unions)	1, 166	4. 2
	27, 636	100. 0

[a] al Trades Councils are local bargaining units, consisting of two or more local chartered affiliated or cooperating International Unions, which negotiate as a unit with an employer over the terms conditions of employment.

ly about 6 percent of approximately 22,300 office and related al workers are represented by unions as follows:

	Approximate representation
Employees International Union (AFL–CIO)	1, 349
tady Draftsmen's Association (Indep.)	84
	1, 433

General Industrial Relations Problems

Stoppages and AEC Programs

ain Commission programs and projects during 1960 were de- for varying periods by labor-management disputes. The strike steel producers and disruption in supply and scheduled de- of components were somewhat noticeable in reactor projects.

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The 5-month strike of the Marine and Shipbuilding Workers (AFL-CIO) against Bethlehem Shipbuilding Corp. slowed naval reactor projects considerably.

Work stoppages in industrial establishments or among Commission contractors may affect Commission programs in various ways. These range from a clearly direct impact measurable in quantitative terms where physical units of end-product must be foregone until work resumes, to more indirect and less measurable effects, such as loss of scientific skills in research and development programs due to a strike affecting an experimental tool (i.e., a research reactor). During a strike of reactor operators at Brookhaven National Laboratory and another strike of maintenance and auxiliary operators at the ETR-MTR facilities operated by Phillips Petroleum Co. at the National Reactor Testing Station, it was necessary for professional and technical personnel to operate these reactors to maintain continuity of experimentation.

Through November, bargaining activity affected approximately 21,600 employees in the course of 55 negotiated settlements resulting from initial contracts, renewals or reopeners. Most settlements were reached without a work stoppage.

Policies on Contracting Out Work

Problems have arisen between labor representatives and Commission contractor management over placing work with outside contractors in three types of situations: (*a*) Situations where work is contracted out to commercial suppliers, particularly in the reactor field, in order to help develop a private source of supply for the private reactor program; (*b*) Situations in which Government policy calls for using commercial facilities where feasible in preference to Government plants; and (*c*) Situations in which normal methods and expectations relating to the application of the Davis-Bacon Act affect certain types of work that is border line between construction activities and operational activities in Government plants.

With respect to the first category, the problem seems well understood by employees and their representatives and not likely to be a source of misunderstanding if the contracting out does not result in reductions in employment.

No strikes have occurred over actions in the second category, but there have been serious threats of such action. Difficulties arose over publicity given the application of the policy in some Government-owned, Government-operated plants.

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The third category involving application of the Davis-Bacon Act received much attention during the year. This act requires the payment of wage rates determined by the Secretary of Labor for all work classed as construction. In general, it has been the practice of the Secretary to use rates paid by construction contractors as a basis for his determination. The line is not easily drawn between maintenance work, which is not covered, and minor construction work which is covered. Similarly, in a field of changing technologies such as atomic energy, it is difficult to distinguish between construction of a facility for experimentation, which is covered by the Act, and the setting up of an experiment which normally is not covered. The general practice of the Commission has been to contract out to construction contractors work covered by the Davis-Bacon Act. Work not covered by the Davis-Bacon Act normally is assigned to an operating contractor. On a variety of work items conflict frequently arises as to which contractor, which employees and which union will thus retain cognizance of the work.

During 1960 a joint project between the Department of Labor and the Commission was directed toward development of criteria to be used in distinguishing construction work items from research, maintenance or other operative items. Labor unions, the Commission, and contractors participated in the project, and the final document, when approved by the Labor Department, will be issued as part of the Atomic Energy Commission Procurement Regulation.

Consultant Policy Revised

During 1960 the Commission revised its policy regarding the use by contractors of consultants who are regularly employed by other Commission contractors.

Prior to this revision there were instances where employees of one contractor were employed by a second contractor through private consulting agreements at rates which, at times, exceeded the individual's regular salary.

The new policy recognizes the desirability of utilizing the special-ized skills possessed by contractor employees within the Commission's program. To facilitate the use of these specialists, Managers of Commission Operations Offices may authorize cost-reimbursable contractors to enter into agreements with other contractors for consultation by qualified specialists who are primarily identified as regular Commission contract work employees. These agreements will be either on a reimbursable cost or nonreimbursable loan basis. In the first case,

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the consultant's regular employer would be reimbursed for the ... he spends on consultant activities; under the second, the regular ... ployer would loan the services of the employee to the contractor ... questing specialized service.

Panel Activities

During 1960 the Atomic Energy Labor-Management Rela... Panel continued to keep fully informed on collective bargaining ... velopments in the Commission program. Where disputes arose ... contract terms, the Panel had frequent consultations with the C... mission, the Federal Mediation and Conciliation Service and, ... necessary, with the parties involved in the dispute. The Panel ... jurisdiction in three cases during 1960, involving Federal Servi... Inc., (NTS) and Independent General Association of Nevada; ... Zia Company, Los Alamos and nine craft unions, General Electri... Hanford and the Hanford Atomic Metal Trade Council.

In February, the President designated Charles O. Gregory, P... fessor of Law, University of Virginia, as an additional membe... the Panel.

AMENDMENTS TO STATE WORKMEN'S COMPENSATION LAWS

During calendar year 1960 less than half the State Legisla... met in regular session. Some important changes in State laws ... enacted. Additional coverage affecting radiation injury or di... occurred in three States.

An amendment to the Rhode Island Law recognized the po... latent characteristics of injury or disease induced by radiation. T... 1960 revision provides that the time limit (two years) for filing cl... in such cases does not begin until the claimant knew, or should ... known, of the existence of an impairment and the casual relation... to employment or until after disablement, whichever is later.

A similar amendment to the Virginia Law provides that the ... limit (one year) does not begin until a diagnosis is communicate... the worker.

Kentucky broadened its coverage under the second injury pr... sions of its law by making them applicable to occupational dis...

Second or subsequent injury arrangements—usually fund... within a workman's compensation system to insure that a handi...

worker suffering a sec... compensation to cove... suring that the em... cond injury. The ... that the worker acti... would have received ... ior disability.

During 1960, the Co... 's compensation s... Committee. A group ... an advisory body to ... conduct a compreh... State workmen's co... various States.

Organ

Personnel Changes

During the January- ... jor personnel chang... Robert E. Wilson, fo... ittee, was appointed ... firmed by the Sena... pired term of Comm... 59) that ended June ... 30, 1965.

Commissioner John ... Loren K. Olson, for... sident and confirme... Commissioner for t... will end June 30, 1... Commissioner John ... Dr. Willard F. Libby ... rgy Commissioner, ... eral Advisory Com... son that will end A... Philip Hauge Abelso... y Committee for th... ive July 14, 1960 a... will expire August ... Dr. Paul W. McDani... h, was appointed I...

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worker suffering a second injury or disease on the job will receive full compensation to cover the resultant disability, and at the same time ensuring that the employer need pay only the benefits due for the second injury. The "second injury" fund pays the difference between what the worker actually receives from the employer and what he would have received for his resulting condition if there had been no prior disability.

During 1960, the Council of State Governments established a workmen's compensation subcommittee of the State Legislative Advisory Committee. A group of experts in the field has also been appointed as an advisory body to the subcommittee. These groups are expected to conduct a comprehensive review of the radiation injury coverage in State workmen's compensation law and to make recommendations to various States.

Organization and Personnel

Personnel Changes

During the January–December 1960 reporting period, the following major personnel changes took place:

Robert E. Wilson, formerly a member of the General Advisory Committee, was appointed Commissioner by the President on March 18, confirmed by the Senate, and sworn in March 22, 1960 for the unexpired term of Commissioner Harold S. Vance (deceased August 31, 1959) that ended June 30, 1960 and for a 5-year term that will end June 30, 1965.

Commissioner John F. Floberg resigned effective June 23, 1960.

Loren K. Olson, formerly General Counsel, was appointed by the President and confirmed by the Senate, and sworn in on June 23, 1960 as Commissioner for the unexpired term of Commissioner Floberg that will end June 30, 1962.

Commissioner John H. Williams resigned effective June 30, 1960.

Dr. Willard F. Libby, University of California, and former Atomic Energy Commissioner, was appointed on June 13, as a member of the General Advisory Committee for the unexpired term of Robert E. Wilson that will end August 1, 1962.

Philip Hauge Abelson was appointed as a member of General Advisory Committee for the unexpired term of the late James W. McRae, effective July 14, 1960 and ending August 1, 1960, and for a new term that will expire August 1, 1966.

Mr. Paul W. McDaniel, formerly Deputy Director, Division of Research, was appointed Director, effective May 20, 1960.

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Morse Salisbury, formerly Director, Division of Information Ser... ices, was appointed Assistant to the General Manager, effecti... May 27, 1960.

Duncan C. Clark, formerly Assistant Director for Public Info... mation Service, Division of Information Services, was appointed D... rector, Office of Public Information, effective May 27, 1960.

Melvin S. Day, formerly Assistant Director for Technical Info... mation Service, Division of Information Services, was appointed D... rector, Office of Technical Information, effective May 27, 1960. H... left the Commission effective August 27, to the National Aeronauti... and Space Administration.

Lawrence D. Low, formerly Chief, Materials Inspection Branc... Division of Inspection, was appointed Director, Division of Compli... ance, effective May 27, 1960.

Neil D. Naiden, formerly Deputy General Counsel, was appoint... Acting General Counsel, effective July 12, 1960, and General Couns... effective December 19.

Harry Gorman, formerly Manager, Lockland Aircraft Reactor... Operations Office, resigned June 5, 1960, to go to the National Aero... nautics and Space Administration, Marshall Space Flight Center... Huntsville, Ala. He was succeeded by John L. Wilson, former... Deputy Manager at Lockland.

Robert H. McCulloh, Manager, Portsmouth Area Office, retire... effective July 29, 1960. He was succeeded by Robert H. Thalgo... formerly Chief, Operations Branch, Portsmouth Area Office, effecti... July 30, 1960.

Donald F. Musser, formerly Director, Division of Nuclear Materia... Management, was appointed Technical Advisor of the United State... Delegation to the Conference of the Ten-Nation Committee on Di... armament, Geneva, Switzerland, effective March 7, 1960.

Douglas E. George was designated Acting Director of the Divisi... of Nuclear Materials Management.

Amasa S. Bishop, Scientific Representative at Brussels, Belgiu... resigned effective March 18, 1960. He was succeeded by Nelson F... Sievering, who had been serving as Reactor Technology Advisor ... the Brussels Office.

Edward J. Brunenkant was designated Acting Director, Office ... Technical Information, effective August 29, 1960.

John R. Moore, formerly Director, Office of Contract Policy, tran... ferred to Oak Ridge Operations Office as Assistant Manager for Ad... ministration, effective September 18, 1960. He was succeeded by Jo... V. Vinciquerra, formerly Assistant Director for Safeguards, Divisi... of International Affairs, effective October 31.

Organization

Effective February ... Assistant General M... each for the other, t... positions. The chang... Effective May 27, th... ed into two new orga... were assigned to a ... tion, responsible to ... functions were assigne... formation, responsib... Administration.

Effective August 1, ... facility licenses were ...

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Organization

Effective February 24, the titles "Assistant General Manager" and "Assistant General Manager for Administration" were exchanged, each for the other, to cover more suitably the functions of the two positions. The change was one of title only.

Effective May 27, the Division of Information Services was reorganized into two new organization elements. Public information functions were assigned to a newly established Office of Public Information, responsible to the General Manager. Technical information functions were assigned to a newly established Office of Technical Information, responsible to the Assistant General Manager for Administration.

Effective August 1, the activities involving the direct inspection of facility licenses were transferred to the Division of Compliance.

APPENDIX 1

Organization and Principal Staff of U.S. Atomic Energy Commission

Atomic Energy Commission	John A. McCone, *Chairman*[1] John S. Graham Loren K. Olson Robert E. Wilson *Vacancy*
General Manager	Alvin R. Luedecke
Special Assistant to General Manager (Congressional)	Richard X. Donovan
Assistant to the General Manager	Morse Salisbury
Deputy General Manager	Robert E. Hollingsworth
Assistant General Manager	Dwight A. Ink
Assistant General Manager for Administration	Harry S. Traynor
Assistant General Manager for International Activities	John A. Hall
Assistant General Manager for Manufacturing	E. J. Bloch
Assistant General Manager for Regulation and Safety	William F. Finan
Assistant General Manager for Research and Industrial Development	A. Tammaro
Hearing Examiner	Samuel W. Jensch
Controller	Don S. Burrows
General Counsel	Neil D. Naiden
Secretary to the Commission	W. B. McCool
Director, Office of Contract Policy	John V. Vinciguerra
Director, Office of Headquarters Services	Edward H. Glade
Director, Office of Health and Safety	Nathan H. Woodruff
Director, Office of Industrial Relations	Oscar S. Smith
Director, Office of Isotopes Development	Paul C. Aebersold

[1] John A. McCone was chairman during period covered by this report. He resigned effective January 20, 1961. Glenn T. Seaborg was nominated to succeed him.

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...tor, Office of Operations Analysis and Forecasting	PAUL C. FINE
...tor, Office of Personnel	ARTHUR L. TACKMAN
...tor, Office of Plans	JOHN L. MCGRUDER
...tor, Office of Public Information	DUNCAN C. CLARK
...tor, Office of Special Projects	EDWARD R. GARDNER
...tor, Office of Technical Information	EDWARD J. BRUNENKANT, *Acting*
...tor, Division of Biology and Medicine	CHARLES L. DUNHAM, M.D.
...tor, Division of Classification	C. L. MARSHALL
...tor, Division of Compliance	LAWRENCE D. LOW
...tor, Division of Construction and Supply	JOHN A. DERRY
...tor, Division of Inspection	CURTIS A. NELSON
...tor, Division of Intelligence	C. H. REICHARDT
...tor, Division of International Affairs	ALGIE A. WELLS
...tor, Division of Licensing and Regulation	HAROLD L. PRICE
...tor, Division of Military Application	MAJ. GEN. ALFRED D. STARBIRD
...tor, Division of Nuclear Materials Management	DOUGLAS E. GEORGE, *Acting*
...tor, Division of Production	GEORGE F. QUINN
...tor, Division of Raw Materials	JESSE C. JOHNSON
...tor, Division of Reactor Development	FRANK K. PITTMAN
...tor, Division of Research	PAUL W. MCDANIEL
...tor, Division of Security	JOHN A. WATERS, Jr.

MANAGERS OF OPERATIONS OFFICES AND AREAS

...querque (N. Mex.) Operations Office	KENNER F. HERTFORD
Burlington (Iowa) Area	E. W. GILES
Dayton (Miamisburg, Ohio) Area	WILLIS B. CREAMER
Kansas City (Mo.) Area	WALTER C. YOUNGS, Jr.
Los Alamos (N. Mex.) Area	PAUL A. WILSON

ATOMIC ENERGY

...CONE, *Chairman*
...RAHAM
OLSON
... WILSON

LUEDECKE

X. DONOVAN

...LISBURY
E. HOLLINGSWORTH
A. INK

S. TRAYNOR

. HALL

...OCH

I F. FINAN

MARO
W. JENSCH
BURROWS
. NAIDEN
McCOOL
. VINCIGUERRA

H. GLADE
H. WOODRUFF

S. SMITH

. AEBERSOLD

his report. He resigned, effective
ucceed him.

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San Antonio (Tex.) Area	H. JACK BLACKWELL
Pinellas (Fla.) Area	HENRY A. NOWAK
Rocky Flats (Colo.) Area	SETH R. WOODRUFF, JR.
Sandia (N. Mex.) Area	CHARLES C. CAMPBELL
South Albuquerque (N. Mex.) Area	WALTER W. STAGG
Chicago (Ill.) Operations Office	KENNETH A. DUNBAR
Canoga Park, (Calif.) Area	JOEL V. LEVY
Grand Junction (Colo.) Operations Office	ALLAN E. JONES
Hanford (Wash.) Operations Office	J. E. TRAVIS
Idaho (Idaho Falls) Operations Office	ALLAN C. JOHNSON
Lockland (Ohio) Aircraft Reactors Operations Office	JOHN L. WILSON
Hartford (Conn.) Area	CLIFFORD E. MCCOLLEY
New York (N.Y.) Operations Office	JOSEPH C. CLARKE
Brookhaven (Long Island, N.Y.) Area	E. L. VAN HORN
Princeton (N.J.) Area	ENZI DE RENZIS
Oak Ridge (Tenn.) Operations Office	S. R. SAPIRIE
Fernald (Cincinnati, Ohio) Area	CLARENCE L. KARL
New Brunswick (N.J.) Area	C. J. RODDEN
Paducah (Ky.) Area	KENNEDY C. BROOKS
Portsmouth (Ohio) Area	ROBERT H. THALGOTT
Puerto Rico (Mayaguez) Area	JOHN I. THOMAS
St. Louis (Mo.) Area	FRED H. BELCHER
Pittsburgh, (Pa.) Naval Reactors Operations Office	LAWTON D. GEIGER
San Francisco (Calif.) Operations Office	ELLISON C. SHUTE
Savannah River (Aiken, S.C.) Operations Office	ROBERT C. BLAIR
Schenectady (N.Y.) Naval Reactors Operations Office	STANLEY W. NITZMAN

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Joint Committee

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Representative CHE
Senator CLINTON P.
Senator RICHARD B.
Senator JOHN O. PAS
Senator ALBERT GORE
Senator HENRY M. J
Senator BOURKE B. H
Senator HENRY C. DY
Senator GEORGE D. AI
Senator WALLACE F.
Representative MELVI
Representative WAYN
Representative ALBER
Representative JAMES
Representative CRAIG
Representative WILLI
Representative JACK
Representative THOM
JAMES T. RAMEY,

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APPENDIX 2

MEMBERSHIP OF COMMITTEES

STATUTORY COMMITTEES AND BOARD

Joint Committee on Atomic Energy—Eighty-seventh Congress

committee was established by the Atomic Energy Act of 1946, and con- under the Atomic Energy Act of 1954, to make "continuing studies of activities of the Atomic Energy Commission and of problems relating to development, use, and control of atomic energy." The committee is kept and currently informed with respect to the Commission's activities. Legis- relating primarily to the Commission or to atomic energy matters is ferred to the committee. The committee's membership is composed of 9 Mem- of the Senate and 9 Members of the House of Representatives.

Representative CHET HOLIFIELD (California), *Chairman.*
Senator CLINTON P. ANDERSON (New Mexico), *Vice Chairman.*
Senator RICHARD B. RUSSELL (Georgia).
Senator JOHN O. PASTORE (Rhode Island).
Senator ALBERT GORE (Tennessee).
Senator HENRY M. JACKSON (Washington).
Senator BOURKE B. HICKENLOOPER (Iowa).
Senator HENRY C. DWORSHAK (Idaho).
Senator GEORGE D. AIKEN (Vermont).
Senator WALLACE F. BENNETT (Utah).
Representative MELVIN PRICE (Illinois).
Representative WAYNE N. ASPINALL (Colorado).
Representative ALBERT THOMAS (Texas).
Representative JAMES E. VAN ZANDT (Pennsylvania).
Representative CRAIG HOSMER (California).
Representative WILLIAM H. BATES (Massachusetts).
Representative JACK WESTLAND (Washington).
Representative THOMAS G. MORRIS (New Mexico).
JAMES T. RAMEY, *Executive Director.*

Military Liaison Committee

section 27 of the Atomic Energy Act of 1954, "there is hereby estab- Military Liaison Committee consisting of—*a.* a Chairman, who shall be thereof and who shall be appointed by the President, by and with the ad- consent of the Senate, who shall serve at the pleasure of the President, shall receive compensation at the rate prescribed for an Assistant Secre- Defense; and *b.* a representative or representatives from each of the ents of the Army, Navy, and Air Force, in equal numbers as determined retary of Defense, to be assigned from each Department by the Secre- of, and who will serve without additional compensation. The Chairman committee may designate one of the members of the Committee as Acting to act during his absence. The Commission shall advise and consult

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with the Department of Defense, through the Committee, on all atomic e... matters which the Department of Defense deems to relate to military a... tions of atomic weapons or atomic energy including the development, ma... ture, use, and storage of atomic weapons, the allocation of special ... material for military research, and the control of information relating t... manufacture or utilization of atomic weapons; and shall keep the Depart... of Defense, through the Committee, fully and currently informed of a... matters before the Commission. The Department of Defense, through the ... mittee, shall keep the Commission fully and currently informed on all ... within the Department of Defense which the Commission deems to relate ... development or application of atomic energy. The Department of De... through the Committee, shall have the authority to make written recom... tions to the Commission from time to time on matters relating to military ... cations of atomic energy as the Department of Defense may deem appro... If the Department of Defense at any time concludes that any request, ... proposed action, or failure to act on the part of the Commission is adverse t... responsibilities of the Department of Defense, the Secretary of Defense ... refer the matter to the President whose decision shall be final."

Hon. HERBERT B. LOPER, *Chairman.*
Maj. Gen. BRUCE K. HOLLOWAY, United States Air Force.
Rear Adm. FRANK A. BRANDLEY, United States Navy.
Brig. Gen. RALPH L. WASSELL, United States Air Force.
Brig. Gen. DAVID C. LEWIS, United States Army.
Brig. Gen. JOHN T. SNODGRASS, United States Army.
Capt. JOHN N. SHAFFER, United States Navy.

General Advisory Committee

This committee was established by the Atomic Energy Act of 1946 (Sec. ... and is continued by Section 26 of the Atomic Energy Act of 1954. The ... civilian members are appointed by the President to advise the Commis... scientific and technical matters relating to materials, production, and ... and development. Under the Atomic Energy Act, the committee shall ... least four times in every calendar year.

Dr. KENNETH S. PITZER, *chairman;* professor of chemistry, Univer... California, Berkeley, Calif.
Dr. PHILIP H. ABELSON, Director, Geophysical Laboratory, Carnegie In... tion, Washington, D.C.
Dr. MANSON BENEDICT, professor of nuclear engineering, Massachus... stitute of Technology, Cambridge, Mass.
Dr. WILLARD F. LIBBY, department of chemistry, University of Cali... Los Angeles, Calif.
EGER V. MURPHREE, president, Esso Research & Engineering Co., Linde...
Dr. J. C. WARNER, president, Carnegie Institute of Technology, Pitts... Pa.
Dr. EUGENE P. WIGNER, Palmer Physical Laboratory, Princeton Uni... Princeton, N.J.
(*Two vacancies*)
Dr. ROBERT A. CHARPIE, *secretary;* Oak Ridge National Laborat... Ridge, Tenn.

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Patent Compensation Board

Board was established in April 1949 pursuant to Section 11 of the Atomic Act of 1946, and is the Board designated under Section 157a of the Atomic Act of 1954. Section 157 provides that upon application for just compensation or awards or for the determination of a reasonable royalty fee certain proceedings shall be held before such a board.

JESPER W. OOMS, chairman; firm of Ooms, McDougall, Williams & Hersh, Chicago, Ill.

LAWRENCE E. KINGSLAND, Kingsland, Rogers & Ezell, St. Louis, Mo.

GEORGE SIPKIN, Barr Building, Washington, D.C.

Advisory Committee on Reactor Safeguards

committee reviews safety studies and facility license applications referred and makes reports thereon, advises the Commission with regard to the ds of proposed or existing reactor facilities and the adequacy of proposed safety standards, and performs such other duties as the Commission may The committee's reports on applications for facility licenses become a of the record of the application and available to the public, except for se- material. Members are appointed by the Commission for a term of 4 each, and one member is designated by the committee as its chairman. statutory committee replaced the former Advisory Committee on Reactor ards in 1957.

LESLIE SILVERMAN, chairman; professor of engineering in environmental hygiene, director of radiological hygiene program, Harvard University, School of Public Health, Boston, Mass.

R. L. DOAN, vice chairman; manager, atomic energy division, Phillips Petroleum Co., Idaho Falls, Idaho.

HARVEY BROOKS, dean of engineering and applied physics, Harvard University, Cambridge, Mass.

WILLARD P. CONNER, Jr., technical assistant to director of research center, research department, Hercules Powder Co., Wilmington, Del.

WILLIAM K. ERGEN, principal physicist, Oak Ridge National Laboratory, Oak Ridge, Tenn.

FRANKLIN A. GIFFORD, Jr., meteorologist in charge of the Oak Ridge Office, U.S. Weather Bureau, Oak Ridge, Tenn.

C. ROGERS MCCULLOUGH, director of reactor safeguards (for foreign reactors) and scientific adviser to board of directors, Nuclear Utility Services, Washington, D.C.

HENRY W. NEWSON, professor of physics, Duke University, Durham, N.C.

R. OSBORN, chief engineer, general chemical division, Allied Chemical Corp., New York, N.Y.

L. ROGERS, manager of project analysis, Central Research Laboratory, Allied Chemical & Dye Corp., Morristown, N.J.

C. STRATTON, consulting engineer, Hartford, Conn.

ABEL WOLMAN, consulting engineer and professor emeritus, sanitary engineering, The Johns Hopkins University, Baltimore, Md.

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Dr. CHARLES R. WILLIAMS, assistant vice president, Liberty Mutual I... ance Co., Boston, Mass.

Dr. DICK DUFFEY, technical secretary; professor of nuclear engine... University of Maryland, College Park, Md.

J. B. GRAHAM, executive secretary; U.S. Atomic Energy Commission, W... ington, D.C.

Dr. THEOS J. THOMPSON, director, MIT nuclear reactor, Massachusetts In... tute of Technology, Cambridge, Mass.

ATOMIC ENERGY LABOR-MANAGEMENT RELATIONS PANEL

The members of this panel were selected by the President to assist in arri... at peaceful adjustments of labor-management disputes which would impe... Government's atomic energy program when the normal processes of collec... bargaining and mediation have been fully utilized without constructive r... The panel operates under procedures designed to accomplish this purpo...

CYRUS S. CHING, chairman; industrial relations consultant and f... Director of the Federal Mediation and Conciliation Service, Washi... D.C.

Rev. LEO C. BROWN, S.J., professor of economics and director of the Ins... of Social Order, St. Louis University, St. Louis, Mo.

Vice Adm. O. S. COLCLOUGH, USN, Retired, dean of faculties, the G... Washington University, Washington, D.C.

ROBBEN W. FLEMING, professor of law, University of Illinois, Urbana

GEORGE FRANKENTHALER, attorney, firm of Frankenthaler and Kohn... York, N.Y.

CHARLES O. GREGORY, professor of law, University of Virginia, Charl... ville, Va.

RUSSELL A. SMITH, professor of law and secretary of University of Mic... Law School, Ann Arbor, Mich.

ADVISORY BODIES TO THE ATOMIC ENERGY COMMISSION

Advisory Committee for Biology and Medicine

The Advisory Committee for Biology and Medicine was created in Sept... 1947, on the recommendation of the Commission's Medical Board of Re... The committee reviews the programs in medical and biological researc... health and recommends to the Commission general policies in these fields.

Dr. JOHN C. BUGHER, chairman; director, Puerto Rico Nuclear Centr... Piedras, Puerto Rico.

Dr. H. BENTLEY GLASS, professor of biology, Johns Hopkins Univ... Baltimore, Md.

Dr. FRED J. HODGES, professor and chairman of radiology, departm... radiology, University of Michigan Medical Center, Ann Arbor, Mich.

Dr. JAMES G. HORSFALL, director, Connecticut Agricultural Experim... tion, New Haven, Conn.

Dr. ROBERT F. LOEB, bard professor of Chemistry, Columbia Universi... York, N.Y.

Dr. LEONIDAS D. MARINELLI, associate director, radiological physics d... Argonne National Laboratory, Argonne, Ill.

Dr. CARL V. MOORE, ... Washington Univ...

Dr. JAMES H. STE... N.Y.

Dr. HARLAND G. Wo... Western Reserve ...

Dr. HENRY L. KOHN... radiology, Univer...

H

... Historical Advisor... ...ary, 1958, to advi... ...ing to the preparat...

Dr. JAMES P. BAXTE... town, Mass.

Dr. JOHN M. BLUM... Conn.

Dr. JAMES L. CATE, ... Ill.

Dr. ARTHUR H. COMP...

Dr. FRANCIS T. MILES...

DON K. PRICE, Jr., D... University, Cambri...

Dr. GLENN T. SEAB... Calif.

Dr. RICHARD G. HEW... Energy Commissio...

Advisory C

...committee, formed in ... Atomic Energy Com...

S. A. TUCKER, chairm... of Mechanical Engi...

BERNARD M. FRY, dep... tional Science Foun...

Dr. ALLEN G. GRAY, ... Cleveland, Ohio.

EUGENE J. HARDY, N... D.C.

KEITH HENNEY, consu... Publishing Co., Inc. ...K.Y.

HERMAN H. JACOBSON, ... Chicago, Ill.

ANDREW W. KRAMER, ... rington, Ill.

JOHN W. LANDIS, assi... & Wilcox Co., represe...

FREDERIC A. PAWLEY, ... Washington, D.C.

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Dr. CARL V. MOORE, professor of medicine, department of internal medicine, Washington University, Barnes & Wohl Hospital, St. Louis, Mo.
Dr. JAMES H. STERNER, medical director, Eastman Kodak Co., Rochester, N.Y.
Dr. HARLAND G. WOOD, director, biochemistry department, school of medicine, Western Reserve University, Cleveland, Ohio.
Dr. HENRY I. KOHN, scientific secretary; clinical professor of experimental radiology, University of California Medical Center, San Francisco, Calif.

Historical Advisory Committee

The Historical Advisory Committee was established by the Commission in January 1958, to advise the Commission and its historical staff on matters relating to the preparation of the history of the Atomic Energy Commission.
Dr. JAMES P. BAXTER, III, chairman; president, Williams College, Williamstown, Mass.
Dr. JOHN M. BLUM, department of history, Yale University, New Haven, Conn.
Dr. JAMES L. CATE, department of history, University of Chicago, Chicago, Ill.
Dr. ARTHUR H. COMPTON, Washington University, St. Louis, Mo.
Dr. FRANCIS T. MILES, Brookhaven National Laboratory, Upton, N.Y.
Don K. PRICE, Jr., Dean, Graduate School of Public Administration, Harvard University, Cambridge, Mass.
Dr. GLENN T. SEABORG, chancellor, University of California, Berkeley, Calif.
Dr. RICHARD G. HEWLETT, AEC representative; chief historian, U.S. Atomic Energy Commission, Washington, D.C.

Advisory Committee on Industrial Information

The committee, formed in 1949, advises and assists in the planning and execution of the Atomic Energy Commission's industrial information program.
C. A. TUCKER, chairman; publications business manager, American Society of Mechanical Engineers, New York, N.Y.
LEONARD M. FRY, deputy head, Office of Science Information Service, National Science Foundation, Washington, D.C.
ALLEN G. GRAY, editor, *Metal Progress*, American Society for Metals, Cleveland, Ohio.
EUGENE J. HARDY, National Association of Manufacturers, Washington, D.C.
JOHN HENNEY, consulting editor, *Nucleonics and Electronics*, McGraw-Hill Publishing Co., Inc.; American Institute of Radio Engineers, New York, N.Y.
NORMAN H. JACOBSON, *Electric Light and Power*, Haywood Publishing Co., Chicago, Ill.
ANDREW W. KRAMER, editor, *Atomics*, The Technical Publishing Co., Barrington, Ill.
JOHN W. LANDIS, assistant manager, atomic energy division, The Babcock & Wilcox Co., representing American Nuclear Society, Chicago, Ill.
FRANCIS A. PAWLEY, research secretary, American Institute of Architects, Washington, D.C.

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KARL T. SCHWARTZWALDER, director of research, A-C spark plug div... General Motors Corp., representing The American Ceramic Society, I... Columbus, Ohio.

GEORGE F. SULLIVAN, editor, *The Iron Age*, Chilton Publication, Inc., I... delphia, Pa.

E. E. THUM, editor-in-chief, *Metal Progress*, American Society for M... Cleveland, Ohio.

OLIVER H. TOWNSEND, Office of Atomic Development, State of New Y... New York, N.Y.

JOHN W. WIGHT, vice president McGraw-Hill Book Co., Inc., New Y... N.Y.

EDWARD J. BRUNENKANT, secretary; acting director, office of technical i... mation, U.S. Atomic Energy Commission, Washington, D.C.

Advisory Committee on Isotope and Radiation Development

This committee was established by the Commission in July 1958 to advi... means of encouraging widescale industrial use of radioisotopes and ... radiation.

Dr. PAUL C. AEBERSOLD, chairman; director, office of isotopes develo... U.S. Atomic Energy Commission, Washington, D.C.

Dr. JAMES F. BLACK, products research division, Esso Research and E... neering Co., Linden, N.J.

SAMUEL E. EATON, Arthur D. Little, Inc., Cambridge, Mass.

Dr. HENRY J. GOMBERG, director, Memorial-Phoenix Project, Univers... Michigan, Ann Arbor, Mich.

Dr. THORFIN R. HOGNESS, director, Chicago Midway Laboratories, U... sity of Chicago, Chicago, Ill.

JOHN L. KURANZ, vice president, Nuclear-Chicago Corp., Des Plaines, I...

JOHN J. MCMAHON, manager, marketing research, American Mach... Foundry Atomics, Greenwich, Conn.

HOMER S. MYERS, vice president for marketing, Tracerlab, Inc., Wal... Mass.

Dr. LEONARD REIFFEL, director of physics research, Armour Research F... dation, Illinois Institute of Technology, Chicago, Ill.

Dr. GLENN T. SEABORG, chancellor, University of California, Berkeley, C...

Dr. LAURISTON S. TAYLOR, chief, atomic and radiation physics div... National Bureau of Standards, Washington, D.C.

Advisory Committee on Medical Uses of Isotopes

This committee was established in 1958 and replaces the Subcommittee o... man Applications of the Advisory Committee on Isotope Distribution. ... committee will advise the Commission on policies and standards for the ... tion and licensing of medical uses of radioisotopes in humans.

Dr. WALLACE D. ARMSTRONG, professor, University of Minnesota M... School, Minneapolis, Minn.

Dr. REYNOLDS F. BROWN, department of radiology, University of Cali... Medical School, San Francisco, Calif.

Dr. DONALD S. CHILDS, Jr., section of therapeutic radiology, May... Rochester, Minn.

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Dr. JOHN A. D. COOPER, assistant dean, Northwestern University Medical School, Chicago, Ill.
Dr. GEORGE V. LEROY, associate dean, Division of Biological Sciences, University of Chicago, Chicago, Ill.
Dr. EDITH H. QUIMBY, associate professor of radiology, College of Physicians and Surgeons, Columbia University, New York, N.Y.
Dr. RULON W. RAWSON, Memorial Hospital, New York, N.Y.

Plowshare Advisory Committee

Plowshare Advisory Committee was established in September 1959. The committee's function is to advise the Commission and the General Manager on ...ing and carrying out particular Plowshare Projects; developing and making available various applications of Plowshare; and determining the general ...ation and policies of the Plowshare program.

Mr. SPOFFORD G. ENGLISH, chairman; special assistant to the General Manager, U.S. Atomic Energy Commission, Washington, D.C.
Dr. PHILIP H. ABELSON, director, geophysical laboratory, Carnegie Institution, Washington, D.C.
WILLARD BASCOM, technical director, The AMSOC Committee, National Academy of Sciences, Washington, D.C.
Gen. JAMES H. DOOLITTLE, Space Technology Laboratories, Inc., Los Angeles, Calif.
Dr. LOUIS H. HEMPELMANN, school of medicine and dentistry, University of Rochester, Rochester, N.Y.
Dr. WILLARD F. LIBBY, department of chemistry, University of California, Los Angeles, Calif.
W. RANDOLPH LOVELACE, II, Lovelace Clinic, Albuquerque, N. Mex.
DONALD H. MCLAUGHLIN, president, Homestake Mining Co., San Francisco, Calif.
PHILIP C. RUTLEDGE, partner, Moran, Proctor, Mueser & Rutledge, New York, N.Y.
PAUL B. SEARS, chairman, conservation program, Yale University, New Haven, Conn.
ABEL WOLMAN, professor, sanitary engineering, The Johns Hopkins University, Baltimore, Md.

Advisory Committee on Reactor Physics

...mittee is appointed to consider the status of the development of reactor ...nformation required for the development of reactor concepts and the ...d construction of reactors. Nuclear physics data and reactor physics ...equired for the design and development of reactors are reviewed and ... The committee's recommendations and advice are used in planning ...rch and development work in the field of reactor physics.

...A F. ZARTMAN, chairman; chief, reactors physics branch, division of ...ctor development, U.S. Atomic Energy Commission, Washington, D.C.
... RICHARD COHEN, research adviser, Atomics International, North ...erican Aviation, Inc., Canoga Park, Calif.
...NDE DE BOISBLANC, director, reactor physics and engineering, Phillips ...oleum Co., Idaho Falls, Idaho.

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Dr. GERHARD DESSAUER, director, physics section, E. I. du Pont de Nem... & Co., Inc., Aiken, S.C.

Dr. MILTON EDLUND, manager, physics and mathematics department, B... cock & Wilcox Co., Lynchburg, Va.

Dr. RICHARD EHRLICH, Knolls Atomic Power Laboratory, General E... Co., Schenectady, N.Y.

Dr. PAUL F. GAST, manager, physics and instrument research and d... ment, General Electric Co., Richland, Wash.

Dr. GORDON HANSEN, Los Alamos Scientific Laboratory, Los Alamos, N. ...

Dr. IRVING KAPLAN, professor of nuclear engineering, Massachusetts I... tute of Technology, Cambridge, Mass.

Dr. HERBERT J. C. KOUTS, experimental reactor physics group le... Brookhaven National Laboratory, Upton, Long Island, N.Y.

Dr. SIDNEY KRASIK, Astronuclear Laboratory, Westinghouse Electric C... Pittsburgh, Pa.

Dr. F. C. MAIENSCHEIN, Oak Ridge National Laboratory, Oak Ridge, Te...

Dr. THEODORE MERKLE, associate director, Pluto Project, "R" division, ... rence Radiation Laboratory, Livermore, Calif.

Dr. JOHN W. MORFITT, manager, nuclear development laboratory, G... Electric Co., Cincinnati, Ohio.

Dr. THOMA M. SNYDER, manager, physics—APED, Vallecitos Atomic La... ratory, General Electric Co., Pleasanton, Calif.

Dr. BERNARD I. SPINRAD, director, reactor engineering division, Ar... National Laboratory, Lemont, Ill.

Dr. JOHN J. TAYLOR, Westinghouse Electric Corp., Bettis Atomic P... Div., Pittsburgh, Pa.

Dr. PAUL F. ZWEIFEL, professor of nuclear engineering, Universi... Michigan, Ann Arbor, Mich.

Dr. ALVIN RAKOWSKY, secretary; division of reactor development, ... Atomic Energy Commission, Washington, D.C.

Advisory Committee for Standard Reference Materials and M... of Measurement

The committee was originally established by the Commission in March 19... the Committee for Uranium Isotopic Standards. The Commission approved ... reconstitution in January 1958 under its present title to reflect the broa... scope of its activities. The committee reviews, evaluates and recommends ... for providing standard reference materials (i. e., certified chemical and ... standards for uranium, plutonium, etc.) and approved methods of measu... for materials of special importance to atomic energy activities.

Dr. SAMUEL C. T. MCDOWELL, chairman; chief, chemistry and ... branch, division of nuclear materials management, U.S. Atomic E... Commission, Washington, D.C.

RALPH J. JONES, division of nuclear materials management, U.S. A... Energy Commission, Washington, D.C.

Dr. CHARLES F. METZ, group leader, analytical chemistry group, ch... and metallurgical research division, Los Alamos Scientific Labo... Los Alamos, N. Mex.

Dr. HORACE W. NORTON III, professor of statistical design and a... University of Illinois, Urbana, Ill.

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Dr. EDWIN F. ORL... University of Ca...

Dr. LEONARD P. P... ment Corp., Apol...

C. J. RODDEN, are... Commission, Nev...

CHARLES M. STEVE...

C. D. W. THORNTO... phone & Telegra...

Dr. EDWARD WICH... Department of C...

Advi...

This committee was e... means of obtaining the ... with the Atomic E... public health and safe... reader cross section of ... of the Commission's pro...

WILLIAM L. BATT... Harrisburg, Pa.

SALVATORE A. BON... Economic Develo...

JOHN D. BRECKINRI...

Dr. BERNARD BUC... Seattle, Wash.

Dr. R. L. CLEERE, ... Denver, Colo.

NORMAN A. ERBE, at...

CURTIS M. EVARTS, ... Health, Portland, ...

CARL FRASURE, dep... Morgantown, W. ...

JAMES G. FROST, d...

Dr. ALEXANDER GR... Radiation Protect...

Dr. ALBERT E. HEC... Health, Lansing, ...

Dr. HERMAN E. H... Health, Lansing, ...

C. W. KLASSEN, c... Springfield, Ill.

Dr. MORRIS KLEINFI... of Labor, New Yo...

W. T. LINTON, exec... Carolina State Bo...

HENRY M. MARX, c... Conn.

KARL M. MASON, d... Department of He...

Dr. EDWIN F. ORLEMANN, professor of chemistry and chemical engineering, University of California, Berkeley, Calif.
Dr. LEONARD P. PEPKOWITZ, vice president, Nuclear Materials and Equipment Corp., Apollo, Pa.
C. J. RODDEN, area manager, New Brunswick Area Office, Atomic Energy Commission, New Brunswick, N.J.
CHARLES M. STEVENS, Argonne National Laboratory, Lemont, Ill.
C. D. W. THORNTON, vice president, ITT Laboratories, International Telephone & Telegraph Corp., Fort Wayne, Ind.
Dr. EDWARD WICHERS, associate director, National Bureau of Standards, Department of Commerce, Washington, D.C.

Advisory Committee of State Officials

committee was established by the Commission in September 1955 as a of obtaining the views and advice of State regulatory agencies in connec- with the Atomic Energy Commission's regulatory activities in the field of health and safety. It was expanded in 1960 in order to draw on a cross section of experience in furnishing guidance in the implementation Commission's program with respect to State cooperation.

WILLIAM L. BATT, Jr., secretary, Department of Labor and Industry, Harrisburg, Pa.
SALVATORE A. BONTEMPO, Commissioner, Department of Conservation and Economic Development, Trenton, N.J.
JOHN D. BRECKINRIDGE, attorney general of Kentucky, Frankfort, Ky.
Dr. BERNARD BUCOVE, director of health, State Department of Health, Seattle, Wash.
Dr. R. L. CLEERE, executive director, State Department of Public Health, Denver, Colo.
NORMAN A. ERBE, attorney general of Iowa, Des Moines, Iowa.
CURTIS M. EVARTS, Jr., state sanitary engineer, Oregon State Board of Health, Portland, Oreg.
CARL FEASURE, department of political science, West Virginia University, Morgantown, W. Va.
JAMES G. FROST, deputy attorney general of Maine, Augusta, Maine.
Dr. ALEXANDER GRENDON, Coordinator of Atomic Energy Development and Radiation Protection, State of California, Sacramento, Calif.
Dr. ALBERT E. HEUSTIS, commissioner of health, Michigan Department of Health, Lansing, Mich.
Dr. HERMAN E. HILLEBOE, commissioner of health, State Department of Health, Lansing, Mich.
W. KLASSEN, chief sanitary engineer, Department of Public Health, Springfield, Ill.
Dr. MORRIS KLEINFELD, director, division of industrial hygiene, Department of Labor, New York, N.Y.
T. T. LINTON, executive director, water pollution control authority, South Carolina State Board of Health, Columbia, S.C.
LEWIS M. MARX, coordinator, Atomic Development Activities, Greenwich, Conn.
M. M. MASON, director, bureau of environmental health, Pennsylvania Department of Health, Harrisburg, Pa.

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Dr. JAMES E. PEAVY, commissioner of health, State Department of H... Austin, Tex.

WILLIAM J. PIERCE, University of Michigan Law School, Ann Arbor, ...

B. A. POOLE, director, bureau of environmental sanitation, Indiana ... Board of Health, Indianapolis, Ind.

RAYMOND I. RIGNEY, coordinator of atomic development, The Com... wealth of Massachusetts, Boston, Mass.

D. P. ROBERTS, chief industrial hygiene section, Tennessee Departm... Health, Nashville, Tenn.

ROBERT H. SOLOMONS, III, executive secretary, Regional Advisory C... on Nuclear Energy, Atlanta, Ga.

OLIVER TOWNSEND, director, Office of Atomic Development, New York ...

JAMES T. VOCELLE, chairman, Industrial Commission of Florida, Talla... see, Fla.

Committee of Senior Reviewers

The Committee of Senior Reviewers studies the major technical activiti... the Atomic Energy Commission program and advises the Commission on cla... fication and declassification matters, making recommendations with respe... the rules and guides for the control of scientific and technical information. ... Committee consists of six members appointed for a term of 5 years on a rota... basis.

Dr. ALVIN C. GRAVES, chairman; J. division leader, Los Alamos Scien... Laboratory, Los Alamos, N. Mex.

Dr. JOHN P. HOWE, chief research department, Atomics International, ... American Aviation, Inc., Canoga Park, Calif.

Dr. FRANK C. HOYT, Missiles System Division, Lockheed Aircraft C... Palo Alto, Calif.

Dr. WARREN C. JOHNSON, vice president, University of Chicago, Chic... Ill.

Dr. WINSTON M. MANNING, director, chemistry division, Argonne Natio... Laboratory, Lemont, Ill.

Dr. J. REGINALD RICHARDSON, professor of physics, University of Califo... at Los Angeles, Calif.

Metallurgy and Materials Advisory Panel

This panel was established in October 1955 to advise on the Commissi... research program on metallurgy, solid state physics, and ceramics.

Dr. HARVEY BROOKS, dean, division of engineering and applied phy... Harvard University, Cambridge, Mass.

Dr. MORRIS COHEN, department of metallurgy, Massachusetts Institu... Technology, Cambridge, Mass.

Dr. MAXWELL GENSAMER, department of metallurgy, Columbia Univer... New York, N.Y.

Dr. JOHN P. HOWE, chief, research department, Atomics Internationa... division of North American Aviation, Inc., Downey, Calif.

Dr. ALBERT R. KAUFMANN, vice president, Nuclear Metals, Inc., Cambr... Mass.

Dr. FREDERICK SEITZ, head, department of physics, University of Illi... Urbana, Ill.

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Dr. JOHN C. SLATER, department of physics, Massachusetts Institute of Technology, Cambridge, Mass.
Dr. DONALD K. STEVENS, division of research, U.S. Atomic Energy Commission, Washington, D.C.

Nuclear Cross Sections Advisory Group

This group is appointed on a yearly basis to make a continuing review of the Commission's program of nuclear cross-section measurements, and to evaluate the needs for cross-section information in the various activities of the Commission. The following members were appointed to serve from July 1959 to July 1960:

Dr. JOSEPH L. FOWLER, chairman; Oak Ridge National Laboratory, Oak Ridge, Tenn.
Dr. GEORGE L. ROGOSA, vice chairman; division of research, U.S. Atomic Energy Commission, Washington, D.C.
Dr. JACOB BENVENISTE, Lawrence Radiation Laboratory, Livermore, Calif.
Dr. LOWELL M. BOLLINGER, Argonne National Laboratory, Lemont, Ill.
Dr. TOM W. BONNER, department of physics, Rice Institute, Houston, Tex.
Dr. LAWRENCE CRANBERG, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
Dr. BENJAMIN C. DIVEN, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
Dr. JOHN E. EVANS, Phillips Petroleum Co., Idaho Falls, Idaho.
Dr. REX G. FLUHARTY, Phillips Petroleum Co., Idaho Falls, Idaho.
Dr. HERBERT GOLDSTEIN, Nuclear Development Corp. of America, White Plains, N.Y.
Dr. BOWEN R. LEONARD, General Electric Co., Richland, Wash.
Dr. HENRY W. NEWSON, department of physics, Duke University, Durham, N.C.
Dr. JACK M. PETERSON, Lawrence Radiation Laboratory, Livermore, Calif.
Dr. L. JAMES RAINWATER, department of physics, Columbia University, New York, N.Y.
Dr. VANCE L. SAILOR, Brookhaven National Laboratory, Upton, Long Island, N.Y.
Dr. ALAN B. SMITH, Argonne National Laboratory, Lemont, Ill.
Dr. JOHN A. HARVEY, secretary; Oak Ridge National Laboratory, Oak Ridge,

Patent Advisory Panel

The panel was appointed in January 1947. It makes informal reports and recommendations to the Commission and its staff on various questions of law and procedure relating to patents and inventions.

JOHN A. DIENNER, Brown, Jackson, Boettcher & Dienner, Chicago, Ill.
CASPER W. OOMS, firm of Ooms, McDougall, Williams & Hersh, Chicago, Ill.
JOHN C. STEDMAN, Universitay of Wisconsin Law School, Madison, Wis.

Personnel Security Review Board

The board was appointed in March 1949 primarily to review specific personnel security cases which arise under the Commission's administrative review pro-

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cedure and to make recommendations concerning them to the General Manager. The board also advises the Commission on the broader considerations regarding personnel security, such as criteria for determining eligibility for security clearance and personnel security procedures.

GANSON PURCELL, chairman; Purcell & Nelson, Washington, D.C.

Dr. PAUL E. KLOPSTEG, special consultant, National Science Foundation, Washington, D.C.

JOHN J. WILSON, firm of Whiteford, Hart, Carmody & Wilson, Washington, D.C.

Stack Gas Problem Working Group

The appointment of this group was authorized in May 1948 to advise the Atomic Energy Commission and its contractors on problems in the treatment and control of gaseous effluents. The group meets formally at irregular intervals but renders continuing assistance in the field of air cleaning through specific research and development work directly by individual members and by individual consulting advice to the various Commission installations.

Dr. PHILIP DRINKER, Professor of industrial hygiene, Harvard University School of Public Health, Boston, Mass.

Dr. LYLE I. GILBERTSON, director, research and engineering department, Air Reduction Co., Inc., Murray Hill, N.J.

A. E. GORMAN, consultant, U.S. Atomic Energy Commission, Washington, D.C.

Dr. H. FRASER JOHNSTONE, professor of chemical engineering, University of Illinois, Urbana, Ill.

Dr. CHARLES E. LAPPLE, Stanford Research Institute, Menlo Park, Calif.

Dr. J. A. LIEBERMAN, division of reactor development, U.S. Atomic Energy Commission, Washington, D.C.

Dr. WILLIAM P. YANT, director of research and development, Mine Safety Appliance Co., Pittsburgh, Pa.

Dr. ABEL WOLMAN, head, department of sanitary engineering and water resources, The Johns Hopkins University, Baltimore, Md.

MAJOR RESEARCH

Laboratory

Director
Associate Director
Assistant to Director
Assistant to Director
Business Manager

Argonne Cancer Res

Director
Associate Director

Argonne National L

Director
Deputy Director
Associate Director for E
Associate Director for Hi
Assistant Director
Business Manager
Manager, Technical Servi

Associated Midwest Univ
Battelle Memorial Insti
Carnegie Institute of T
Case Institute of Techn
Illinois Institute of Tec
Indiana University
Iowa State University
Kansas State University
Loyola University (Chic
Marquette University
Mayo Foundation
Michigan College of Min
Technology
Michigan State Universi
Northwestern University
Ohio State University
Oklahoma State Univers
Purdue University

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APPENDIX 3

Major Research and Development Installations of the U.S. Atomic Energy Commission

...es Laboratory (Iowa State University of Science and Technology, contractor), Ames, Iowa

...ector	Dr. Frank H. Spedding
...ociate Director	Dr. H. A. Wilhelm
...istant to Director	Dr. Adolf F. Voigt
...istant to Director	Morton S. Smutz
...siness Manager	Alex E. Edwards

...gonne Cancer Research Hospital (University of Chicago, contractor), Chicago, Ill.

...ector	Dr. Leon O. Jacobson
...ociate Director	Dr. Robert J. Hasterlik

...gonne National Laboratory (University of Chicago, contractor), Lemont, Ill.

...ector	Dr. Norman Hilberry
...ty Director	Dr. Louis A. Turner
...iate Director for Education	Dr. Frank E. Myers
...iate Director for High Energy Physics	Dr. Roger H. Hildebrand
...stant Director	Dr. James R. Gilbreath
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...as State University
...ia University (Chicago, Ill.)
...nette University
... Foundation
...igan College of Mining and ...chnology
...igan State University
...western University
... State University
...oma State University
...e University
St. Louis University
State University of Iowa
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Louisiana State University	University of North Carolina
Meharry Medical College	University of Oklahoma
Mississippi State College	University of Puerto Rico
North Carolina State College	University of South Carolina
North Texas State College	University of Tennessee
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Tuskegee Institute	Virginia Polytechnic Institute
Texas Woman's University	West Virginia University

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[illegible]stant Director ..... M. E. RAMSEY
[illegible]stant Director ..... A. H. SNELL
[illegible]stant Director ..... C. E. WINTERS

[illegible] Materials Development Laboratory (National Lead Co., contractor), Winchester, Mass.

[illegible]nical Director and Manager ..... CHARLES K. MCARTHUR

Sandia Laboratory (Sandia Corp., contractor), Sandia Base, Albuquerque, N. Mex.

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...istant Manager, Operations	J. P. LYON
...istant Manager, Technical	J. R. HUFFMAN
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...ject Manager	W. B. ALLRED
...er Administrator	E. W. WOOLLACOTT

Aerojet General Corp. and Aerojet General Nucleonics, San Ramon, Calif.

...erations Manager	R. H. CHESWORTH
...erations Superintendent	D. C. KING
...inistrative Supervisor	C. NEDROW

Nevada Test Site, Las Vegas, Nev.

Eniwetok Proving Ground, Marshall Islands

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APPENDIX 4

RADIOACTIVE ISOTOPES DISTRIBUTION DATA AND DEVELOPMENT CONTRACTS

RADIOISOTOPE DISTRIBUTION BY OAK RIDGE NATIONAL LABORATORY

(Includes Project Transfers, Subsidy Payments, etc.)

Radioisotopes	Aug. 2, 1946–Dec. 31, 1959		Jan. 1, 1960–Nov. 30, 1960		Total to Nov. [illegible]	
	Activity (Curies)	Shipments	Activity (Curies)	Shipments	Activity (Curies)	Shipments
Carbon 14	85	3,135	23	300	108	
Cesium 137	93,239	1,306	29,626	202	122,865	
Cobalt 60	678,565	2,038	141,037	146	819,602	
Hydrogen 3	92,900	1,008	5,203	115	98,103	
Iodine 131	6,590	44,031	503	2,327	7,093	
Iridium 192	30,862	763	8,538	109	39,400	
Krypton 85	6,636	284	3,290	116	9,926	
Phosphorus 32	1,656	26,453	141	1,957	1,797	
Promethium 147	1,270	332	2,285	64	3,555	
Strontium 90	561	745	302	107	863	
All others	1,541	51,510	173	6,330	1,714	
Total	913,905	131,605	191,121	11,773	1,105,026	

NOTE.—This table does not include several thousand curies of radioisotopes produced and [illegible] directly from other AEC facilities such as Mound Laboratory or Brookhaven National Laboratory [illegible] from reactors owned by private industrial firms and universitils. Radioisotopes made in other [illegible] and imported into United States are also not included.

RADIOISOTOPE SALES FROM OAK RIDGE NATIONAL LABORATORY

Type of sales	Aug. 2, 1946–Dec. 31, 1959	Jan. 1, 1960–Nov. 30, 1960	Total to [illegible]
Domestic	$11,533,508	$1,272,983	[illegible]
Foreign	1,492,812	246,782	[illegible]
Total commercial sales	13,026,320	1,519,765	[illegible]
Project transfers	1,752,713	172,439	[illegible]
Medical subsidy	3,216,763	213,117	[illegible]
Technical cooperation program	714,383	70,289	[illegible]
Local sales to ORNL			
Civilian defense			
Subtotal	5,683,859	455,845	[illegible]
Total	18,710,179	1,975,610	[illegible]

NOTE.—This table does not include sales by private commercial firms who act as secondary [illegible] other AEC facilities such as Mound Laboratory and Brookhaven National Laboratory, private [illegible] universities who own reactors, nor imports into the United States from other countries.

LOCAT[illegible]

No[illegible]

States	[illegible] In [illegible] Ph
[illegible]	[illegible]
Columbia	1
[illegible]	[illegible]
[illegible]	5
[illegible]	1
[illegible]	[illegible]
[illegible]	1
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

LOCATION AND TYPE OF NEW LICENSEES

November 30, 1959—December 1, 1960

States	Medical Institutes and Physicians		Colleges and universities	Industrial firms		Federal and State laboratories		Foundations and institutes	Other	Total
		P.P.*			I.R.†		C.D.‡			
	4	4	0	3	1	3	1	0	0	10
	0	0	0	0	0	3	1	0	0	3
	4	1	1	2	0	5	4	0	0	12
	3	3	0	1	0	1	1	0	0	5
	57	39	0	39	3	10	0	1	2	109
	4	2	1	6	0	7	5	0	1	19
	11	8	2	9	0	1	1	0	0	23
	2	1	0	0	0	2	2	0	0	4
	0	0	2	3	0	3	1	0	0	8
Columbia	15	13	1	1	1	6	3	0	0	23
	9	6	0	1	0	8	5	0	0	18
	1	1	0	1	0	1	0	0	0	3
	0	0	1	0	0	0	0	0	0	1
	10	7	1	20	2	5	3	1	1	38
	9	6	2	5	2	3	1	0	0	19
	8	3	0	1	0	5	4	0	1	15
	1	1	0	6	1	5	5	0	0	12
	5	3	1	3	0	8	5	0	0	17
	3	3	1	3	2	2	1	0	0	9
	6	5	0	0	0	1	0	0	0	7
	3	2	1	1	0	9	6	0	0	14
	18	10	6	8	1	3	3	0	0	35
	11	7	1	9	2	15	12	0	0	36
	2	2	2	0	0	8	8	0	0	12
	2	0	1	2	2	0	0	0	0	5
	12	10	0	3	0	3	1	0	0	18
	1	1	0	0	0	0	0	0	0	1
	5	3	0	2	0	3	0	0	0	10
	1	1	0	2	0	0	0	0	0	3
	0	0	0	0	0	0	0	0	0	0	0
shire	14	8	0	15	3	5	2	0	0	34
	3	3	0	2	0	1	0	0	0	6
	30	20	2	36	3	10	7	2	1	81
	1	1	1	3	0	7	6	0	0	12
	0	0	0	2	1	3	3	0	0	5
ina	19	11	2	22	4	12	8	0	1	56
	3	3	1	4	1	4	2	0	0	12
	8	8	0	1	1	14	13	0	0	23
	0	0	0	0	0	0	0	0	0	0
	19	9	3	22	7	11	6	0	1	56
	1	0	0	2	0	0	0	0	0	3
land	0	0	0	0	0	1	1	0	0	1
olina	4	3	0	3	2	8	1	0	0	15
ota	3	3	1	0	0	0	0	0	0	4
	3	2	0	6	0	3	2	0	0	12
	19	15	4	15	6	9	4	0	0	47
	0	0	0	4	0	0	0	0	0	4
	4	1	0	0	0	0	0	0	0	4
	3	2	1	3	0	4	1	0	0	11
	6	5	2	3	2	14	13	0	0	25
	4	4	0	4	0	17	16	0	0	25
	6	5	0	4	1	7	7	0	1	18
	0	0	0	2	0	2	2	0	0	4
	357	245	41	284	48	252	167	4	9	947

*—Private practice.
†—Industrial radiography.
‡—Civil defense.

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LOCATION AND TYPE OF LICENSEES

February 10, 1956 through November 30, 1960

States	Medical Institutes and Physicians		Colleges and universities	Industrial firms		Federal and State laboratories		Foundations and institutes	Other
		P.P.*			I.R.†		C.D.‡		
Alabama	31	16	3	21	11	14	9	1	
Alaska	1	1	1	0	0	12	8	1	
Arizona	17	11	3	6	0	13	12	0	
Arkansas	22	17	1	7	0	4	4	0	
California	300	189	15	226	49	62	23	4	
Colorado	32	10	6	26	3	29	24	1	
Connecticut	35	16	7	47	12	12	9	1	
Delaware	4	1	1	11	2	5	5	0	
District of Columbia	21	6	4	4	2	30	13	2	
Florida	81	52	4	17	7	17	11	0	
Georgia	40	17	5	11	8	20	16	0	
Hawaii	14	10	1	5	2	4	1	1	
Idaho	5	2	2	2	2	1	1	0	
Illinois	119	34	7	121	19	37	29	4	
Indiana	50	23	7	42	15	20	19	0	
Iowa	47	25	11	10	3	24	23	0	
Kansas	26	10	2	16	5	12	11	0	
Kentucky	29	16	4	13	3	20	17	0	
Louisiana	39	18	4	28	14	8	8	1	
Maine	14	6	2	8	2	10	9	0	
Maryland	33	15	7	23	7	31	21	2	
Massachusetts	77	27	20	99	16	16	11	5	
Michigan	95	37	10	62	18	49	42	0	
Minnesota	39	15	10	22	7	107	106	0	
Mississippi	10	3	3	8	4	9	8	0	
Missouri	80	37	6	31	8	27	25	0	
Montana	13	5	2	1	0	1	1	0	
Nebraska	21	9	1	4	1	26	25	0	
Nevada	6	3	1	3	1	4	3	0	
New Hampshire	12	2	3	6	2	9	8	0	
New Jersey	89	48	1	125	20	25	21	1	
New Mexico	16	8	4	13	1	5	1	0	
New York	313	151	32	180	29	50	37	12	
North Carolina	45	23	6	15	0	39	34	0	
North Dakota	6	3	2	2	1	10	9	0	
Ohio	139	65	13	112	35	51	41	4	
Oklahoma	38	29	3	30	11	9	7	1	
Oregon	30	19	4	8	6	27	24	1	
Panama	1	0	0	0	0	0	0	0	
Pennsylvania	133	47	15	153	58	112	97	6	
Puerto Rico	9	3	3	2	0	2	2	0	
Rhode Island	7	1	3	11	2	5	4	0	
South Carolina	15	8	2	6	3	11	8	0	
South Dakota	16	9	3	2	0	11	11	0	
Tennessee	38	17	5	26	4	11	8	0	
Texas	161	105	16	115	40	25	19	4	
Utah	9	1	4	11	2	14	10	0	
Vermont	11	8	1	2	0	1	1	0	
Virginia	32	12	7	32	6	19	11	0	
Washington	40	23	8	19	8	29	24	1	
West Virginia	23	12	1	16	2	35	34	0	
Wisconsin	61	22	4	36	16	20	18	3	
Wyoming	5	1	2	4	0	15	13	0	
Total	2,550	1,248	292	1,800	467	1,159	936	55	

*P.P.—Private practice.
†I.R.—Industrial radiography.
‡C.D.—Civil defense.

SHIPMENTS OF I

Country

Republic of.

American Republic

Federal Republic

Previously reported, i.e., H

SHIPMENTS OF RA

Kind of Isotope

RESEA

RADIOISOTOI

General Nuclec

Systems.

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SHIPMENTS OF RADIOACTIVE ISOTOPES TO FOREIGN COUNTRIES

Country	Dec. 1, 1959–Nov. 30, 1960	Total Jan. 1, 1947 to Nov. 30, 1960	Country	Dec. 1, 1959–Nov. 30, 1960	Total Jan. 1, 1947 to Nov. 30, 1960
[illegible]	24	195	Lebanon	1	32
[illegible]	179	419	Mexico	84	651
[illegible]	7	21	Monaco	0	51
[illegible] Congo	7	18	Netherlands	109	352
[illegible]	70	405	Netherlands, West Indies	1	7
[illegible]	3	23	New Zealand	25	50
[illegible]	297	1,322	Nicaragua	22	50
[illegible]	0	6	Norway	50	197
[illegible]	1,461	5,016	Pakistan	1	24
[illegible]	23	251	Panama, Republic of	22	52
[illegible] Republic of	49	132	Paraguay	8	15
[illegible]	113	222	Peru	89	308
[illegible]	11	26	Philippines	92	338
[illegible] Rica	128	993	Poland	11	13
[illegible]	129	540	Portugal	77	119
[illegible] can Republic	12	47	Russia	0	1
[illegible]	20	73	Saudi Arabia	1	3
[illegible]	4	28	Scotland	11	18
[illegible] ador	24	30	South-West Africa	5	16
[illegible]	20	73	Spain	5	43
[illegible]	146	491	Sweden	394	1,178
[illegible]y, Federal Republic	260	611	Switzerland	86	235
[illegible]	0	1	Syria	0	2
[illegible]	48	87	Thailand	16	57
[illegible]	1	3	Trieste	0	4
[illegible]	42	112	Turkey	3	12
[illegible]	1	5	Tunisia	3	3
[illegible]	0	5	Union of South Africa	69	133
[illegible]	18	123	United Kingdom	205	632
[illegible]	1	7	Uruguay	12	25
[illegible]	1	9	Venezuela	193	863
[illegible]	3	3	West Indies Federation—British	13	33
[illegible]	1	1	Yugoslavia	3	24
[illegible]	47	148	Others [1]	0	489
[illegible]	81	239			
[illegible]	347	1,467	Total	5,256	19,258
[illegible]	67	76			

[illegible]viously reported, i.e., Hawaii, Puerto Rico, etc.

[illegible]MENTS OF RADIOACTIVE ISOTOPES TO FOREIGN COUNTRIES

Kind of Isotope	Dec. 1, 1959–Nov. 30, 1960	Total Jan. 1, 1947 to Nov. 30, 1960	Kind of Isotope	Dec. 1, 1959–Nov. 30, 1960	Total Jan. 1, 1947 to Nov. 30, 1960
[illegible]	2,562	7,974	Calcium 45	52	292
[illegible] 32	178	1,608	Sulphur 35	15	206
[illegible]	299	1,312	Others	1,560	5,531
[illegible]	197	911			
[illegible]	311	1,055	Total	5,256	19,258
[illegible] 90	82	369			

RESEARCH AND DEVELOPMENT CONTRACTS

RADIOISOTOPES AND PROCESS RADIATION DEVELOPMENT

[illegible]—*General Nucleonics.* Radioactive, Independent Transducer-Receiver [illegible]ems.

5006915

Air Reduction Co., Inc. Promotion of Chemical Reactions Using Mag... Fields in Conjunction with Beta Radiation.

Armour Research Foundation. Research Study on Neutron Interactions in M... ter as Related to Image Formation.

Armour Research Foundation. Radiation Synthesis Involving Halogen... Compounds.

Armour Research Foundation. Feasibility Study of a New Mass Flow Sys...

Armour Research Foundation. Studies of Nuclear Resonant Absorption of G... ma Rays.

Army Pictorial Center. Production of a Training Film on Industrial Ap... tions of Radioisotopes.

Battelle Memorial Institute. Development of Process Control by Use of Intr... Radioactive Tracers.

Battelle Memorial Institute. Effect of Phase on the Radiation Induced Nitra... of Hydrocarbons.

Battelle Memorial Institute. Radiation Induced Graft Polymerization Stu...

Catholic University of America. Limiting Factors in Rapid Identificatio... Selected Materials by Nuclear Techniques.

University of Chicago (Chicago Midway Lab.). Radioisotope Research, Inst... ment and Related Activities.

Consolidation Coal Co. Development of Techniques for Tritium Labelin... Coal-product Hydrocarbon Mixtures of High Molecular Weight to be U... in Development of Methods for Applying Tritium Tracer Techniques to I... dustrial Problems in the Processing of Coal.

Curtiss-Wright Corp. Food Process Development Irradiator.

Evans Research and Development Corp. Development of a Beta Particle Ba... Scattering Technique for Small Particle Analysis.

Florida State University. Development of Neutron Activation and Ra... chemical Analytical Methods for Antimony and Bismuth.

Georgia Institute of Technology. Radioisotope Research, Development and R... lated Activities.

Goodyear Tire and Rubber Co. Isotopic Method for Age Determinations of I... dustrial Products.

Interior, Department of—Bureau of Commercial Fisheries. Analysis of Mar... Factors, Affecting Radiation Processing of Fish.

Interior, Department of—Bureau of Commercial Fisheries. Effect of Low Le... of Radiation on the Essential Amino Acids and B-Vitamins of Haddock Fi... lets and Soft Shell Clam Meats.

Interior, Department of—Bureau of Mines. Joint Research Project Inv... Coal, Metallurgical and Petroleum Investigations Using a High Int... Source of Gamma Radiation.

Interior, Department of—Geological Survey. Research and Development Pro... Involving Use of Radioisotopes in Various Hydrologic Investigations.

Internal Revenue Service. Joint Research Project for the Determination of ... of Distilled Spirits by Means of Radioactive Hydrogen.

Isotopes, Inc. Study of Potential Applications of Radioisotope Technique... Water Resource Investigations and Utilization.

Johnston, William H. Laboratories, Inc. Basic Studies in Radiation Techn... Fast Primary Ion Reactions from Electron Impact.

Johnston, William H. Laboratories, Inc. Basic Studies and Development in ... Application of Isotope Techniques, Especially *In Situ* Tracers.

...brary of Congress. ... Radioisotopes Appl...
... D. Little, Inc. ...
... Products of Organic...
...heed Aircraft Co...
...tion of the Compto...
...rtin Co. Design, F...
... Power Generator an...
... package.
...ssachusetts Institu...
... and Related Activiti...
...ssachusetts Institut...
... for College Teachers.
...tional Bureau of St...
...tional Canners Asso...
... to Detect and Measu...
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...er X-Ray Corp. De...
... and Other Applica...
...ue Research Found...
... for Moisture De...
...ation Applications, ...
... Product Separation and...
...ation Applications, I...
... Produced Using El...
...ation Applications, In...
... Factors of Organic I...
... Compounds.
...ation Applications, I...
... Polymer-monomer Mixtu...
...ation Applications, In...
... Products Beta So...
...rch Triangle Institu...
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... Factors.
...ical Research Group...
... by Radiation Induce...
... A&M Research Fou...
... Related Activities.
... Research Center. A...
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...ry of Congress. Monitoring-type Survey of World Literature on Industrial ...adioisotopes Applications.

... Little, Inc. Study of Effect of Electrophilic Additives on Radiolytic ...ffects of Organic Chain Reactions.

...ed Aircraft Corp. Investigation to Establish the Parameters of Utiliza... ...e of the Compion Backscattering Principle for Non-destructive Testing.

...on Co. Design, Fabricate and Test A Nominal 5-Watt Strontium-90 Fueled ...ower Generator and Design, Fabricate and Test a Data Processing Telemetry ...kage.

...husetts Institute of Technology. Radioisotope Research, Development ...d Related Activities.

...husetts Institute of Technology. Summer Institute in Isotope Technology ... College Teachers.

...al Bureau of Standards. Cooperative Radioisotope R&D Program.

...al Canners Association. Investigation of Radioisotope Tracer Techniques ...detect and Measure Detergent Residues on Washed Food Products and to ...timate Commercial Food Washing Practices.

...er-Chicago Corp. Exploration of Radiometric Methods for Control of ...mical Parameters in Industrial Processes.

...er-Chicago Corp. Preparation of Undergradute College Course in Industrial ...ver Techniques.

...r Research Corp. Development of Enhanced Light Emitting Phosphors ...e Thin Single Crystal Type for Use in Fluoroscopy.

...oma, University of. Study of Sequestration of Metal Ions in Brine Using ...isotopes.

...X-Ray Corp. Development of Beta Particle Focusing for X-Ray Genera... ...and Other Applications.

... Research Foundation. The Development of New Principles and Tech... ...s for Moisture Determination.

...on Applications, Inc. The Application of Foam Separation to Fission ...duct Separation and Purification.

...on Applications, Inc. Comparison of Radiation Induced Graft Copoly... ...Produced Using Electron Accelerators and Isotope Sources.

...on Applications, Inc. A Study of the Mechanism of Radiation Induced ...ers of Organic Polymers with Inorganic Salts and Organometallic ...ounds.

...on Applications, Inc. Mechanism of Radiation Induced Gelation in ...er-monomer Mixtures.

...n Applications, Inc. Study of the Technology and Application of Large ...Products Beta Sources.

... Triangle Institute of North Carolina, Inc. Radioisotope Research, ...pment and Related Activities.

... Research Institute. Radiation Processing Preservation of Selected ... and Vegetables—An Analysis of R&D Programming and Market ...

... Research Group (TRG, Inc). Synthesis of Semi-Conductor Mate... ...Radiation Induced Reactions.

...ll Research Foundation. Radioisotope Research, Development, and ...Activities.

...search Center. Applications of Nuclear Radiation and Radioisotopes ...e Materials and Processes.

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Tracerlab, Inc. Continued Development of Radiochemical Exchange Syste
and Study of Clathrate Compounds.

Tracerlab, Inc. Development of a Prototype SO_2 Monitor.

Tracerlab, Inc. Development of an Ion-Exchange Resin with Scintillat
Properties.

Tracerlab, Inc. Use of Radioisotopes as a source of X-Rays to I
Rayleigh Scattering Method for Analysis of Heavy Atoms in Low "Z" Ma

Treasury Department—Bureau of Narcotics. Research for Determining Ori
of Opium for Activation Analysis Techniques.

Universal Match Corp. An Investigation of the Effects of Ionizing Radia
on the Sedimentation of Sewage.

PATENTS ISSUED T

the following 259 U.S.
represented by the
patents listed in the 19
sensing. The total nu
are granted on a nonexcl

PATENT NO.	
	Thermocouple Vacu
	Method of Isotope C
	Linear Accelerator...
	Vacuum Trap.....
	Solid State Bonding
	num.
	Volume Compensati
	Pumps.
	Plutonium-Hydroge
	Method of Prepari
	Powder Therefrom
	Plutonium Cleaning
	Formation of Int
	Dispersions.
	Method of Making F
	Continuous Chelatio
	the Separation and
	Loaded Wave-Guides
	Tungsten Base Alloys
	Uranous Iodate as a C
	Separation of Fission
	Hexavalent Plutoni
	itation
	Method of Producing
	Method of Recovering
	of an Atomic Numb
	Method of Oxidizing
	Bismuthate Ion
	Separation of Plutoniu
	Fabrication of Uraniu
	Method of Increasing
	Slurry Particles
	Nuclear Reactor.....
	Neutronic Reactor Co
	Neutronic Reactor Co
	paratus
	Pressure Sensing Devi
	Radiation Detection a
	tem
	Geiger-Muller Type C
	Extraction of Plutoniu
	Solutions
	Uranium Decontamina

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for Patents, Office of the G
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APPENDIX 5

COMMISSION-OWNED PATENTS

PATENTS ISSUED TO THE COMMISSION WHICH ARE AVAILABLE FOR LICENSING [1]

The following 259 U.S. Letters Patents owned by the United States Government or represented by the Atomic Energy Commission are in addition to the 488 patents listed in the 1959 Annual Report. The patents listed are available for licensing. The total number of patents available for licensing is 2484. Licenses are granted on a nonexclusive, royalty-free basis.

TITLE	PATENTEE
Thermocouple Vacuum Gauge	G. W. Price, Cedar Rapids, Iowa.
Method of Isotope Concentration	J. S. Spevack, New York, N.Y.
Linear Accelerator	N. C. Christofilos, Berkeley, Calif.; I. J. Polk, Patchogue, N.Y.
Vacuum Trap	H. S. Gordon, Lafayette, Calif.
Solid State Bonding of Thorium with Aluminum.	S. Storchheim, Kingston, Pa.
Volume Compensating Means for Pulsating Pumps.	D. L. W. Weaver, Idaho Falls, Idaho; R. S. MacCormack, Jr., Westfield, N.J.
Plutonium-Hydrogen Reaction Product, Method of Preparing Same and Plutonium Powder Therefrom.	S. Fried, Chicago, Ill.; H. L. Baumbach, Pacific Palisades, Calif.
Plutonium Cleaning Process	M. Kolodney, New York, N.Y.
Formation of Intermetallic Compound Dispersions.	J. S. Bryner, Eastport, N.Y.
Method of Making Fuel Elements	C. H. Bean, Naperville, Ill.; R. E. Macherey, Villa Park, Ill.
Continuous Chelation-Extraction Process for the Separation and Purification of Metals.	H. W. Crandall, Berkeley, and T. E. Hicks, Los Angeles, Calif.; B. Rubin, Livermore, and J. H. Thomas, Albany, Calif.
Loaded Wave-Guides for Linear Accelerator	W. Walkinshaw, Abingdon, England; L. B. Mullett, Malvern Wells, England
Tungsten Base Alloys	D. H. Schell, and H. Sheinberg, Los Alamos, N. Mex.
Uranous Iodate as a Carrier for Plutonium	D. R. Miller, Richmond, G. T. Seaborg, Lafayette, and S. G. Thompson, Richmond, Calif.
Separation of Fission Product Values from Hexavalent Plutonium by Carrier Precipitation	T. H. Davis, Chicago, Ill.
Method of Producing Tetrafluoride	W. B. Tolley, Tucson, Ariz.; R. C. Smith, Richland, Wash.
Method of Recovering Transuranic Elements of an Atomic Number Below 95	G. T. Seaborg, Lafayette, Calif.; R. A. James, Chicago, Ill.
Method of Oxidizing Plutonium Ion with Bismuthate Ion	C. S. Garner, Los Angeles, Calif.
Separation of Plutonium	H. M. Feder, Park Forest, and R. L. Nuttall, Downers Grove, Ill.
Fabrication of Uranium-Aluminum Alloys	H. A. Saller (deceased)
Method of Increasing the Dispersibility of Slurry Particles	J. P. McBride, Oak Ridge, Tenn.
Nuclear Reactor	J. J. Grebe, Midland, Mich.
Neutronic Reactor Control	R. S. Dreffin, Glen Ellyn, Ill.
Neutronic Reactor Control Rod Drive Apparatus	L. C. Oakes, Knoxville, and C. S. Walker, Oak Ridge, Tenn.
Pressure Sensing Device	K. E. Pope, Albuquerque, N. Mex.
Radiation Detection and Telemetering System	H. K. Richards, Oak Lawn, Ill.
Geiger-Muller Type Counter Tube	I. L. Fowler and L. A. K. Watt, Deep River, Ontario, Canada
Extraction of Plutonium Values from Organic Solutions	G. T. Seaborg, Lafayette, Calif.
Uranium Decontamination	J. S. Buckingham and J. L. Carroll, Richland, Wash.

[1] Issued as of November 29, 1960. Applicants for licenses should apply to Assistant General Counsel for Patents, Office of the General Counsel, U.S. Atomic Energy Commission, Germantown, Md., giving the subject matter by patent number and title.

5006919

PATENT NO.	TITLE	PATENTEE
2,918,366	Decontamination of Neutron-Irradiated Reactor Fuel.	A. G. Buyers, Woodland Hills, E. [illegible], Canoga Park, and F. D. Rosen, [illegible], Calif.
2,918,700	Radioactive Concentrator and Radiation Source.	L. P. Hatch, Brookhaven, N.Y.
2,918,717	Self-Sintering of Radioactive Wastes	E. G. Struxness and K. Z. Morga[illegible], Ridge, Tenn.; J. R. Johnson, Wa[illegible], Minn.; T. N. McVay, Tuscaloosa, [illegible]
2,919,175	Process of Recovering Uranium	S. B. Kilner, Knoxville, Tenn.
2,919,186	Uranium Alloys	E. W. Colbeck, Northwich, England.
2,919,236	Nuclear Reactor Including a Package Safety Device.	W. H. Zinn, Dunedin, Fla.
2,919,710	Two-Way Freeze Valve	E. D. Lantz, Saratoga Springs, and [illegible] Clark, Scotia, N.Y.
2,919,972	Removal of Chloride from Aqueous Solutions.	M. L. Hyman and J. E. Savolain[illegible], Ridge, Tenn.
2,920,024	Molten Fluoride Nuclear Reactor Fuel	C. J. Barton and W. R. Grimes, Oak [illegible], Tenn.
2,920,025	Neutronic Reactor	J. B. Anderson, W. Hartford, Conn.
2,920,200	Ion Source	W. T. Ieland, Los Alamos, N. Mex.
2,920,234	Device and Method for Producing a High Density Arc Discharge.	J. S. Luce, Oak Ridge, Tenn.
2,920,235	Method and Apparatus for Producing Intense Energetic Gas Discharge.	P. R. Bell and J. S. Luce, Oak Ridge, [illegible]
2,920,236	Apparatus for Heating Ions	E. S. Chambers, Walnut Creek, and [illegible] Kippenhau, Castro Valley, Calif.; [illegible] Carren, W. A. S. Lamb, and R. J. [illegible], Jr., Berkeley, Calif.
2,921,007	Thermal Neutronic Reactor	B. I. Spinrad, Park Forest, Ill.
2,921,199	Method of Operating a Calutron	P. H. Davidson, Visalia, Calif.
2,921,850	Nickel-Base Alloy	H. Inouye, W. D. Manly and T. K. [illegible], Oak Ridge, Tenn.
2,922,036	Paralyzer for Pulse Height Distribution Analyzer.	E. Fairstein, Oak Ridge, Tenn.
2,922,044	Calutron	E. J. Lofgren, Albany, Calif.
2,922,048	High Coaxial Photomultiplier Tube	N. W. Glass, Los Alamos, N. Mex.
2,922,061	Particle Accelerator	L. C. Teng, Chicago, Ill.
2,922,711	Production of Purified Uranium	L. Burris, Jr., J. B. Knighton and [illegible] Feder, Orland Park, Ill.
2,922,882	Control System for Isotope Separating Apparatus.	S. W. Barnes, Rochester, N.Y.
2,922,886	Method and Apparatus for Testing the Presence of Specific Atomic Elements in a Substance.	J. L. Putman, Abingdon, England
2,922,890	Magnetic Method for Producing High Velocity Shock Waves in Gases.	V. Josephson, Palos Verdes Estates, [illegible]
2,923,588	Random Pulse Generator	W. C. Nielson, Albuquerque, N. Mex.
2,923,601	Method of Isotope Concentration	T. I. Taylor, Leonia, N.J.; W. Spind[illegible] York, N.Y.
2,923,607	Process of Separating Zirconium Values from Hafnium Values by Solvent Extraction with an Alkyl Phosphate.	D. F. Peppard, Chicago, Ill.
2,923,670	Method and Means for Electrolytic Purification of Plutonium.	C. W. Bjorklund, R. Benz, W. J. [illegible] and J. A. Leary, Los Alamos, N. [illegible]; K. A. Walsh, Lakeland, Fla.
2,923,822	Electromagnetic Separation of Isotopes	S. W. Barnes, Rochester, N.Y.; C. M. C[illegible] Bainbridge, Ga.
2,923,852	Apparatus for Producing High Velocity Shock Waves and Gases.	F. R. Scott, San Diego, Calif.; V. Jo[illegible] Palos Verdes Estates, Calif.
2,924,294	Apparatus for Cleaning Gases with Electrostatically Charged Particles.	H. F. Johnstone, Urbana, Ill.
2,924,483	Fuel Handling Mechanism	L. J. Koch, Clarendon Hills, Ill., E. [illegible] Chicago, Ill.
2,924,506	Solvent Extraction Process for Plutonium	H. H. Anderson, Newton, Mass.; L. B. [illegible] Richmond, Calif.
2,924,877	Method of Jacketing a Fissionable Body	E. C. Creutz, Santa Fe, N. Mex.
2,925,322	Method of Separating Plutonium	H. G. Heal, Montreal, Canada
2,925,323	Method for the Recovery of Cesium Values	S. J. Rimshaw, London, Tenn.
2,925,327	Continuous Gas Analyzer	S. Katz and C. W. Weber, Oak Ridge, [illegible]
2,925,431	Cationic Exchange Process for the Separation of Rare Earths.	G. R. Choppin, Berkeley; S. G. [illegible] Pleasant Hill, and B. G. Harvey, [illegible] Calif.
2,925,509	Low Energy Counting Chambers	P. M. Hayes, Lafayette, Calif.
2,925,512	High Energy Gaseous Discharge Device	V. Josephson, Palos Verdes Estates, [illegible]
2,926,067	Concentration of Pu Using an Iodate Precipitate.	B. A. Fries, Richland, Wash.
2,926,068	Method for the Preparation of Plutonium Halides and Oxyhalides.	N. R. Davidson, Sierre Madre, [illegible]; Katz, Chicago, Ill.
2,926,083	Ternary Alloy-Containing Plutonium	J. T. Waber, Los Alamos, N. Mex

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TITLE	PATENTEE
Method of Forming a Protective Coating on Ferrous Metal Surfaces.	D. G. Schweitzer, East Islip, and J. R. Weeks, Port Jefferson, N.Y.; O. F. Kammerer, St. James, and D. H. Gurinsky, Center Moriches, N.Y.
Heat Treated U-Mo Alloy	R. K. McGeary, Pittsburgh, Pa.; W. M. Justusson, Dearborn, Mich.
Neutronic Reactor with Accessible Thimble and Emergency Cooling Features.	W. H. McCorkle, Hinsdale, Ill.
Ion Acceleration System	J. S. Luce and J. A. Martin, Oak Ridge, Tenn.
Ultrasonic Neutron Dosimeter	R. Truell and J. De Klerk, Providence, R.I.; P. W. Levy, Sayville, N.Y.
Control Limiter Device	J. A. DeShong, Jr., Elmhurst, Ill.
Jacketed Uranium Nuclear Reactor Fuel Element.	W. E. Huey, Swarthmore, Pa.
Non-Blocking Stabilized Feed Back Amplifier.	E. Fairstein, Oak Ridge, Tenn.
Intense Energetic Gas Discharge	J. S. Luce, Oak Ridge, Tenn.
Iron Coated Uranium and Its Production	A. G. Gray, Rocky River, Ohio.
Method for Producing Thorium Tetrachloride.	E. A. Mason, Lexington, and C. M. Cobb, Lynn, Mass.
Neutronic Reactor Construction and Operation.	J. T. Weills, and J. M. West, Downers Grove, Ill.
Source of Products of Nuclear Fission	P. Harteck and S. Dondes, Troy, N.Y.
Cooled Neutronic Reactor	E. P. Wigner, Princeton, N.J., E. C. Creutz, Pittsburgh, Pa.
Rotary Switch	J. P. E. Watterberg, Albuquerque, N. Mex.
Arc Discharge and Method of Producing the Same.	R. V. Neidigh, Knoxville, Tenn.
Delta Phase Plutonium Alloys	E. M. Cramer, Espanola, N. Mex.; F. H. Ellinger and C. C. Land, Los Alamos, N. Mex.
Method of Fabricating a Uranium Zirconium Hydride Reactor Core.	I. F. Weeks, Long Beach, and R. V. Goeddel, Riviera, Calif.
Method for Coating Graphite with Metallic Carbides.	M. A. Steinberg, University Heights, Ohio.
Convection Reactor	R. P. Hammond and L. D. P. King, Los Alamos, N. Mex.
Nuclear Reactor Core Design	J. E. Mahlmeister, Van Nuys, Calif., W. S. Peck, Pacoima, Calif., W. V. Haberer, Burbank, Calif., and A.C. Williams, Canoga Park, Calif.
Radiation Measuring Devices	G. M. B. Bouricius, Green-Hills, and G. K. Rusch, Dillonvale, Ohio.
Ion-Stabilized Electron	D. Finkelstein, Hoboken, N.J.
Regeneration of Reactor Fuel Elements	W. E. Roake and W. L. Lyon, Benton County Wash.
N¹ Scaler	C. W. Johnstone, Houston, Tex.
Process for Separating Plutonium by Repeated Precipitation with Amphoteric Hydroxide Carriers	B. F. Faris, Oak Ridge, Tenn.
Metathesis of Plutonium Carrier Lanthanum Fluoride Precipitate with an Alkali	R. B. Duffield, Champaign, Ill.
Preparation of Dibasic Aluminum Nitrate	A. T. Gresky, E. O. Nurmi, R. P. Wischow, and J. E. Savolainen, Oak Ridge, Tenn.; D. L. Foster, Knoxville, Tenn.
Regeneration of Reactor Fuel Elements	W. L. Lyon, Richland, Wash.
Neutronic Reactor Control	H. Hurwitz, Jr., Schenectady, N.Y.
Neutronic Reactor	E. Fermi (deceased).
Apparatus for Arc Welding	J. W. Lingafelter, Richland, Wash.
Electron gun	N. C. Christofilos, Berkeley, and K. W. Ehlers, Lafayette, Calif.
Method and Alloy for Bonding to Zirconium	F. D. McCuaig, LaGrange, Ill., R. D. Misch, Whiting, Ind.
Concentration of Pu Using Oxalate Type Carrier	D. M. Ritter and R. P. S. Black, Oak Ridge, Tenn.
Dissolution Method of Removing Bonding Agents	H. H. Hyman, Chicago, Ill.
Electronuclear Reactor	E. O. Lawrence (deceased), E. M. McMillan and L. W. Alvarez, Berkeley, Calif.
Neutron Source	J. S. Foster, Jr., Livermore, Calif.
High Voltage Ion Source	J. S. Luce, Oak Ridge, Tenn.
Precipitation Method for the Separation of Plutonium and Rare Earths	S. G. Thompson, Richmond, Calif.
Recovery of Americium	M. Ader and H. H. Hyman, Chicago, Ill.
Scavenger and Process of Scavenging	C. M. Olson, Newark, N.J.
Method for Purifying Uranium	J. B. Knighton, Brookfield, and H. M. Feder Park Forest, Ill.
Process of Electroplating Metals with Aluminum.	W. C. Schickner, Columbus, Ohio
Nuclear Reactor Fuel Element and Method of Manufacture.	H. Brooks, Cambridge, Mass.

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PATENT NO.	TITLE	PATENTEE
2,934,483	Process of Making Fuel Elements for Neutronic Reactors and Articles Produced Thereby.	W. A. Bostrom, Bridgeville, Pa.; R. B. [illegible] Jr., Los Alamos, N. Mex.
2,935,401	Control Rod Alloy Containing Noble Metal Additions.	W. K. Anderson and W. E. Ray, Schenectady, N.Y.
2,935,456	Variable Area Control Rod for Nuclear Reactor.	N. E. Huston, Woodland Hills, Calif.
2,935,686	Frequency Stabilizing System	Q. A. Kerns, Orinda, and O. A. Anderson, Oakland, Calif.
2,936,110	Method of Centrifuge Operation	K. Cohen, New York, N.Y.
2,936,119	Simultaneous Differential Equation Computer.	D. M. Collier and L. A. Meeks, Oak Ridge, Tenn.; J. P. Palmer, Stonybrook, N.Y.
2,936,213	Process of Reducing Plutonium to Tetravalent State.	D. F. Mastick, Napa, Calif.
2,936,231	Separation of Rare Earth Metal Fission Products from Liquid U-Bi.	R. H. Wiswall, Brookhaven, N.Y.
2,936,273	Steam Forming Neutronic Reactor and Method of Operating It.	S. Untermyer, Scotia, N.Y.
2,936,274	Determination of Specific Neutronic Reactivity.	C. G. Dessauer, Aiken, S.C.
2,936,277	Reactor Control System	J. H. MacNeill, Melbourne, Fla.; J. Y. [illegible] brook, Oak Ridge, Tenn.
2,936,318	Fission Product Removal from Organic Solutions.	R. H. Moore, Richland, Wash.
2,936,363	Apparatus and Method for Arc Welding	R. A. Noland, Chicago, and C. C. Stone, [illegible] dale, Ill.
2,936,372	Radiation Dosimeter	W. R. Balkwell, Jr., San Francisco, and G. [illegible] Adams, Jr., Larkspur, Calif.
2,936,401	Radiation Detector	H. N. Wilson, Oak Ridge, and F. M. [illegible] Morris, Tenn.
2,937,438	Method for Joining Aluminum to Stainless Steel.	L. C. Lemon, Richland, Wash.
2,937,654	Tube Shearing Valve	L. B. Wilner, Los Alamos, N. Mex.
2,937,924	Separation of Plutonium from Fission Products by a Colloid Removal Process.	J. Schubert, Chicago, Ill.
2,937,925	Solvent Extraction Process for Uranium from Chloride Solutions.	C. A. Blake, Jr. and K. B. Brown, Oak Ridge, Tenn.; D. E. Horner, Clinton, Tenn.
2,937,939	Method of Producing Niobium Metal	H. A. Wilhelm and E. R. Stevens, Ames, Iowa
2,937,981	Suppression of Water Decomposition	A. O. Allen, Shoreham, N.Y.; C. J. [illegible] anadel, Oak Ridge, Tenn.
2,937,982	Method of Making UO_2-Bi Slurries	H. T. Hahn, Richland, Wash.
2,937,984	Control Rod Drive	R. A. Chapellier, Whitestone, N.Y.
2,938,121	Personnel Neutron Dosimeter	J. J. Fitzgerald, Latham, and C. G. Dewar, Jr., Scotia, N.Y.
2,938,768	Method of Separating Pu from Metathesizing $BiPO_4$ Carrier.	W. J. Know, New Haven, Conn.; S. G. Thompson, Richmond, Calif.
2,938,769	Separation of Hafnium from Zirconium	L. G. Overholser, C. J. Barton, Sr. and I. E. Ramsey, Oak Ridge, Tenn.
2,938,784	Nuclear Fuel Composition	F. H. Spedding and H. A. Wilhelm, Ames, Iowa
2,938,791	Method of Producing Shaped Bodies from Powdered Metals.	A. Blainey, London, England.
2,938,807	Method of Making Refractory Bodies	J. C. Anderson, Niagara Falls, N.Y.
2,938,844	Neutronic Reactor Counter Method and System.	C. B. Graham and I. Spiewak, Oak Ridge, Tenn.
2,938,845	Superheating in a Boiling Water Reactor	M. Treshow, Hinsdale, Ill.
2,938,846	Fuel Element Fabrication Method	J. N. Hix, Kingston, and J. E. Cunningham, Oak Ridge, Tenn.; G. E. Cooley, Melrose ville, Tenn.
2,938,998	High Pressure Dies	W. B. Wilson, Columbus, Ohio.
2,939,633	Automatic Counter	H. P. Robinson, Lafayette, Calif.
2,939,803	Method of Impregnating a Porous Material	G. N. Steele, El Segundo, Calif.
2,940,819	Concentration Process for Plutonium Ions, in an Oxidation State not Greater than +4, in Aqueous Acid Solution.	G. T. Seaborg, Lafayette, and S. G. Thompson, Richmond, Calif.
2,940,915	High Temperature, High Power Heterogeneous Nuclear Reactor.	R. P. Hammond, H. M. Busey and W. [illegible] Wykoff, Los Alamos, N. Mex.
2,941,933	Fuel Element for Nuclear Reactor	W. E. Roake, E. A. Evans and D. W. [illegible] Richland, Wash.
2,942,109	Scintillation Spectrometer	P. R. Bell and J. E. Francis, Oak Ridge, Tenn.
2,942,116	Neutron Absorption and Shielding Device	I. R. Axelrad, Pittsburgh, Pa.
2,942,736	Crane Positioning Apparatus	W. Landsiedel, Glen Head, H. Wolff, Merrick, N.Y.
2,942,937	Adsorption-Bismuth Phosphate Method for Separating Phosphate.	E. R. Russell, Columbia, S.C.; A. W. Adamson, Inglewood, Calif., G. E. Boyd, Oak Ridge, Tenn.
2,942,938	Method of Dissolving Massive Plutonium	J. F. Facer and W. L. Lyon, Richland, Wash.
2,942,939	Separation of Plutonium Values from Other Metal Values in Aqueous Solutions by Selective Complexing and Adsorption.	R. H. Beaton, Richland, Wash.

PATENT NO.	T
[illegible] 943	Process for Separating Products.
[illegible] 944	Process of Preparing Z
[illegible] 968	Method of Separating
[illegible] 195	Heating and Cooling
[illegible] 275	Transformer for Joini
[illegible] 921	anced Transmission
[illegible] 258	Catalytic Recombine
[illegible] 873	Dual-Ridge Antenna.
[illegible] 293	Single-Step Conversio
[illegible] 740	Process for Jacketing
[illegible] 793	Ruthenium Decontan
[illegible] 794	Process for Coloring U
[illegible] 972	Neutronic Reactor O
[illegible] 699	Core System.
[illegible] 914	Ion Source
[illegible] 080	Process of Impregna
[illegible] 465	Uranium Compoun
[illegible] 471	Apparatus for Produc
[illegible] 472	Plasmas.
[illegible] 001	Method of Making Fu
[illegible] 521	Means and Method fo
[illegible] 676	Centrifuge End Cap
[illegible] 774	Centrifuge Apparatus.
[illegible] 967	Complex Fluorides o
[illegible] 902	Alkali Metal.
[illegible] 572	Ternary Alloys of U
[illegible] 586	and Zirconium.
[illegible] 045	Method of Making Wi
[illegible] 302	Preparation of Alkyl I
[illegible] 300	tants.
[illegible] 414	Control for Isotope Se
[illegible] 416	Magnetic Grid
[illegible] 166	Centrifuges
[illegible] 167	Fused Salt Process fo
[illegible] 168	from Used Nuclear F
[illegible] 188	Housings and Mountir
[illegible] 368	Loading and Unloadin
[illegible] 804	Method of Protecting
[illegible] 962	against Reaction wit
[illegible] 967	Self-Regulating Boilin
[illegible] 018	actors.
[illegible] 020	Concentric Tubular Fu
[illegible] 023	Method for Separatio
[illegible] 158	Uranium and Fissio
[illegible] 181	Extraction.
[illegible] 301	Method of Inhibiting
	Sulfate Solutions.
	Concentration and De
	tions Containing P
	Bismuth Phosphate
	Methods.
	Method of Suppressin
	U-Al Alloys.
	Mass Spectrometer
	Heat Transfer Method
	Reduction of Fluoride
	Plutonium-Zirconium
	Electrodeposition of Nc
	Method for Electrodep
	Method of Producing U
	Radiation Wave Detec
	Sampling Oscilloscope
	Zero-Time Indicator

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Serial No.	Title	Patentee
[illegible]	Process for Separating Iodine 132 from Fission Products.	M.W. Green, Bellport, N.Y., G. Samos, Lutherville, Md.; W. D. Tucker Sayville, N.Y.
[illegible]	Process of Preparing Zirconium Oxychloride	H. A. Wilhelm and M. L. Andrews, Ames, Iowa.
[illegible]	Method of Separating Uranium from Alloys	P. Chiotti and H. E. Shoemaker, Ames, Iowa.
[illegible]	Heating and Cooling System for Calutron	A. M. Starr, Piedmont, Calif.
[illegible]	Transformer for Joining Unbalanced to Balanced Transmission Means.	B. J. Bittner and R. H. Opperman, Albuquerque, N. Mex.
[illegible]	Catalytic Recombiner for a Nuclear Reactor	L. D. P. King, Los Alamos, N. Mex.
[illegible]	Dual-Ridge Antenna	D. K. Yearout, Sandia Park, and H. L. Jergins, Albuquerque, N. Mex.
[illegible]	Single-Step Conversion UO_3 to UF_4	J. E. Moore, Pittsburgh, Pa.
[illegible]	Process for Jacketing a Core	G. A. Last, Bountiful, Utah.
[illegible]	Ruthenium Decontamination Method	A. T. Gresky, Oak Ridge, Tenn.
[illegible]	Process for Coloring Diamonds	R. A. Dugdale, Harwell, England.
[illegible]	Neutronic Reactor Operational Method and Core System.	C. E. Winters, C. B. Graham, J. S. Culver and R. H. Wilson, Oak Ridge, Tenn.
[illegible]	Ion Source	C. W. Blue, Knoxville, and J. S. Luce, Oak Ridge, Tenn.
[illegible]	Process of Impregnating Graphite with a Uranium Compound.	M. C. Sanz, Los Angeles, R. R. Randolph, Bellflower, and C. Starr, Pacific Palisades, Calif.
[illegible]	Apparatus for Producing and Manipulating Plasmas.	S. A. Colgate, Livermore, J. P. Ferguson, Los Altos, H. P. Furth, Berkeley, and R. E. Wright, Hayward, Calif.
[illegible]	Method of Making Fuel Elements	L. W. Kates, Hempstead, and R. W. Campbell, Malverne, N.Y.; R. H. W. Heartel, Cranford, N.J.
[illegible]	Means and Method for Producing a Vacuum	M. A. Otavka, Chicago, Ill.
[illegible]	Centrifuge End Cap	J. W. Beams, Charlottesville, Va.; L. B. Snoddy (deceased).
[illegible]	Centrifuge Apparatus	C. Skarstrom, Pearl River, and K. Cohen, New York, N.Y.; and H. C. Urey, Leonia, N.J.
[illegible]	Complex Fluorides of Plutonium and an Alkali Metal.	G. T. Seaborg, Lafayette, Calif.
[illegible]	Ternary Alloys of Uranium, Columbium, and Zirconium.	F. G. Foote, Chicago, Ill.
[illegible]	Method of Making Wire Fuel Elements	J. L. Zambrow, Bayside, N.Y.
[illegible]	Preparation of Alkyl Pyrophosphate Extractants.	C. A. Levine, Concord, Calif., W. E. Skiens, Seattle, Wash. and G. R. Moore, Oakland, Calif.
[illegible]	Control for Isotope Separating Apparatus	H. W. Brackney, Bronxville, N.Y.
[illegible]	Magnetic Grid	R. F. Post, Walnut Creek, Calif.
[illegible]	Centrifuges	J. W. Beams, Charlottesville, Va. and L. B. Snoddy (deceased).
[illegible]	Fused Salt Process for Recovery of Values from Used Nuclear Reactor Fuels.	R. H. Moore, Richland, Wash.
[illegible]	Housings and Mountings for Centrifuges	F. C. Rushing, Pittsburgh, Pa.
[illegible]	Loading and Unloading Device	M. Treshow, Hinsdale, Ill.
[illegible]	Method of Protecting Tantalum Crucibles against Reaction with Molten Uranium.	H. M. Feder, Park Forest, and N. R. Chellew, Joliet, Ill.
[illegible]	Self-Regulating Boiling-Water Nuclear Reactors.	J. A. Ransohoff, Wash., D.C.; J. D. Plawchan, San Rafael, Calif.
[illegible]	Concentric Tubular Fuel Element	C. W. Wheelock, Canoga Park, Calif.
[illegible]	Method for Separation of Plutonium from Uranium and Fission Products by Solvent Extraction.	G. T. Seaborg, Lafayette, Calif.; W. J. Blaedel, Madison, Wis.; M. T. Walling, Jr., Richland, Wash.
[illegible]	Method of Inhibiting Corrosion in Uranyl Sulfate Solutions.	E. G. Bohlmann, Concord, and J. C. Griess, Jr., Oak Ridge, Tenn.
[illegible]	Concentration and Decontamination of Solutions Containing Plutonium Values by Bismuth Phosphate Carrier Precipitation Methods.	G. T. Seaborg, Lafayette, and S. G. Thompson, Richmond, Calif.
[illegible]	Method of Suppressing UAl_4 Formation in U-Al Alloys.	M. L. Picklesimer, Knoxville, and W. C. Thurber, Oak Ridge, Tenn.
[illegible]	Mass Spectrometer	F. A. White, Madison, Wis.
[illegible]	Heat Transfer Method	W. R. Gambill, Oak Ridge, and N. D. Greene, La Jolla, Calif.
[illegible]	Reduction of Fluoride to Metal	O. N. Carlson, F. A. Schmidt and F. H. Spedding, Ames, Iowa.
[illegible]	Plutonium-Zirconium Alloys	F. W. Schonfeld and J. T. Waber, Los Almos, N. Mex.
[illegible]	Electrodeposition of Neptunium	G. T. Seaborg, Lafayette, Calif.; A. C. Wahl, Sante Fe, N. Mex.
[illegible]	Method for Electrodepositing Polonium	R. F. Wehrmann, Waukegan, Ill.
[illegible]	Method of Producing U^{233}	G. T. Seaborg, Lafayette, Calif.; R. W. Stoughton, Oak Ridge, Tenn.
[illegible]	Radiation Wave Detection	L. F. Wouters, Hayward, Calif.
[illegible]	Sampling Oscilloscope	R. M. Sugarman, E. Patchogue, N.Y.
[illegible]	Zero-Time Indicator	H. H. Sander, Albuquerque, N. Mex.

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PATENT No.	TITLE	PATENTEE
2,951,448	Centrifugal Pump and Shaft Sealing Means	F. C. Rushing, Pittsburgh, Pa.
2,951,729	Gas Bearing	C. W. Skarstrom, Pearl River, N.Y.
2,951,730	Cushioned Bearing	F. C. Rushing, Pittsburgh, Pa.
2,951,731	Centrifuges	F. C. Rushing, Pittsburgh, Pa.
2,951,740	Processing of Neutron-Irradiated Uranium	H. H. Hopkins, Jr., Richland, Wash.
2,951,793	Electrolysis of Thorium and Uranium	W. N. Hansen, Reseda, Calif.
2,952,012	Analog-to-Digital Data Converter	G. W. Rodgers, D. P. Anderson, G. R. [illegible] and L. H. Minnear, Albuquerque, N. [illegible]; J. E. Althouse, San Diego, Calif.
2,952,056	Apparatus and Method for Injection Casting	A. B. Shuck, Wheaton, Ill.
2,952,139	Refrigeration System Especially for Very Low Temperature.	P. B. Kennedy, Berkeley, and H. R. [illegible], Oakland, Calif.
2,952,511	Separation of Plutonium Values from Uranium and Fission Product Values.	A. G. Maddock, Montreal, Canada; A. [illegible] Booth, Chalk River, Canada.
2,952,535	Sintering Metal Oxides	W. E. Roake, Richland, Wash.
2,952,600	Neutronic Reactor Control Element	H. W. Newson, Durham, N.C.
2,952,601	Nuclear Conversion Apparatus	G. T. Seaborg, Lafayette, Calif.
2,952,603	Jacketed Fissionable Member	E. R. Boller, Marion, Ind.; J. W. [illegible], Pasadena, Tex.
2,952,640	Cesium Recovery from Aqueous Solutions	C. A. Goodall, Torrance, Calif.
2,952,641	Strontium Precipitation	T. R. McKenzie, Richland, Wash.
2,952,802	Electromagnetic Release Mechanism	C. Michelson, Oak Ridge, Tenn.
2,953,510	Neutronic Reactor	H. L. Anderson, Chicago, Ill.
2,953,918	Range Increaser for Pneumatic Gauges	A. H. Fowler and G. B. Seaboru, Jr., [illegible] Ridge, Tenn.
2,953,993	Pump Construction	G. Strickland, Blue Point, N.Y.; F. L. [illegible], Sayville, N.Y. and H. T. White, [illegible] Park, Pa.
2,954,273	Process of Eliminating Hydrogen Peroxide in Solutions Containing Plutonium Values.	J. G. Barrick, Oak Ridge, Tenn.; B. A. [illegible], El Cerrito, Calif.
2,954,335	Neutronic Reactor	E. P. Wigner, Princeton, N.J.
2,954,421	Low-Loss Cable and Method of Fabrication	R. L. McCarthy, Westtown, Pa.; J. M. [illegible], Newark, Del.
2,955,913	Separation of Rare Earths by Solvent Extraction.	D. F. Peppard, Oak Park, and G. W. [illegible], Chicago, Ill.
2,955,937	Oxidation Resistant Chromium Alloy	J. A. McGurty, Cincinnati; J. F. [illegible], Hamilton, and V. P. Calkins, [illegible], Ohio.
2,955,997	Irradiation Method of Converting Organic Compounds.	A. O. Allen, Shoreham, and J. M. [illegible], Beacon, N.Y.
2,956,169	Ion Pulse Generation	R. F. King, Knoxville, and C. D. [illegible] Ridge, Tenn.; V. E. Parker, Baker, [illegible], La.
2,956,195	Hollow Carbon Arc Discharge	J. S. Luce, Oak Ridge, Tenn.
2,956,201	Particle Accelerator and Method of Controlling the Temperature Thereof.	R. B. Neal and W. J. Gallagher, Menlo [illegible], Calif.
2,956,771	Mass Spectrometer Leak	W. R. Shields, Washington, D.C.
2,956,858	Method of Separting Rare Earths by Ion Exchange.	F. H. Spedding and J. E. Powell, Ames, [illegible]
2,957,080	Method and Means for Radiation Dosimetry	J. W. Schulte and J. F. Suttle, Los [illegible], N. Mex.
2,957,096	Neutron Source	N. K. Bernander and R. J. Jones, Oak [illegible], Tenn.
2,957,210	Cave Window	M. Levenson, Downers Grove, Ill.
2,957,709	Sealing Means for Relatively Rotatable Members.	C. W. Skarstrom, Pearl River, N.Y.
2,958,779	Scintillation Exposure Rate Detector	Ward G. Spears, Richland, Wash.
2,959,326	Fluid Controlling Means	H. N. Pouliot, Rochester, Minn.
2,960,398	Direct Ingot Process for Producing Uranium	W. M. Leaders, Webster Groves, and [illegible] Knecht, Kirkwood, Mo.
2,960,653	Pulsed Indicator Circuit	W. I. Linlor, Livermore, and Q. A. [illegible], Berkeley, Calif.
2,960,687	Coincidence Occurrence Indicator	G. H. Robison, N. Merrick, N.Y.; [illegible] son, Neptune, N.J.
2,961,159	Multi-Channel Electric Pulse Height Analyser with Binary Coded Decimal Display.	J. D. Gallagher and J. L. McKi[illegible], Los Alamos, N. Mex.
2,961,390	Method of Preparing Uranium, Thorium, or Plutonium Oxides in Liquid Bismuth.	J. K. Davidson and W. L. Robb, [illegible], N.Y.; O. N. Salmon, Oneida, N.Y.
2,961,391	Water Boiler Reactor	L. D. P. King, Los Alamos, N. Mex.
2,961,392	Neutronic Reactors	E. P. Wigner, Chicago, Ill.
2,961,393	Power Breeder Reactor	H. O. Monson, Elmhurst, Ill.
2,961,415	Settable Neutron Radiation Shielding Material.	I. R. Axelrad, Pittsburgh, Pa.
2,961,558	Co-axial Discharges	J. S. Luce, Oak Ridge, Tenn.; L. F. [illegible], N. Andover, Mass.
2,961,559	Methods and Means for Obtaining Hydromagnetically accelerated Plasma Jet.	J. Marshall, Jr., Los Alamos, N. Mex.
2,961,652	Radio Altimeters	R. W. Bogle, Silver Spring, Md.
2,961,653	Radio Ranging Devices	R. W. Bogle, Silver Spring, Md.
2,962,351	Treatment for Improving the Operation of Strong Base Anion Exchange Resins.	P. C. Stevenson, Livermore, Calif.

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APPENDIX 6

Publications of the U.S. Atomic Energy Commission

The Atomic Energy Commission sponsors the publication of books, abstract journals, reviews, and research and development reports. In addition, the Commission encourages the publication of research results in the established scientific and technical journals. AEC research and development reports, not published elsewhere, are sold by the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Price lists of these reports are available from the Office of Technical Services. Collections of unclassified AEC publications are deposited in 85 libraries in the United States and 83 libraries abroad. *Nuclear Science Abstracts*, the Commission's abstract journal, announces and indexes newly released AEC reports, in the course of covering world-wide atomic energy literature.

SELECTED RECENT PUBLICATIONS

Advanced Pressurized Water Reactor Study (TID–8502, Parts 1, 2 & 3). U.S. Atomic Energy Commission, 1959. Total pages 1075. Total price $10.75. (Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) Another of the four advanced design studies initiated in 1958 to assess the feasibility of power generation through the use of certain types of nuclear reactors. This study deals with the advanced pressurized water reactor. Part 1 "Phase I Report"; Part 2 "Appendixes Phase I Report"; and Part 3 "235 mw Coal-fired Generating Plant".

AEC and Contractor SS Materials Management Meeting, May 25–28, 1959 (TID–7581) U.S. Atomic Energy Commission, 1959. 228 pages. $2.25. (Available from the Office of Technical Services, Department of Commerce, Washington 25, D.C.) This meeting covered a broad range of problems encountered in the AEC and SS Materials Management work. The papers delivered and presented by the Atomic Energy Commission and contractor personnel covered such topics as recovery of source and special nuclear materials; determination of a factor assay for uranium reguli; limits of error in weighing; and isotopic analyses by use of transistorized scintillation spectrometer.

Summary and Evaluation Report of Four Power Reactor Design Studies (TID–8704). U.S. Atomic Energy Commission, 1959. 60 pages. 60 cents. (Available from Office of Technical Services, U.S. Department of Commerce Washington 25, D.C.) This report summarizes and evaluates the four power reactor design and engineering studies completed for the AEC under Public Law 85–590. The report gives economic and technical conclusions, comparative cost analysis, technical analysis of reference designs, assumptions and criteria.

Water Reactors.[1] Andrew W. Kramer, Editor. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1958. 563 pages. $8.50. This reference

[1] U.S. Government presentation volume for the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958.

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work on the history and technology of boiling water reactors was prepared under the auspices of the Argonne National Laboratory, with the cooperation of the many scientists and engineers there who conceived and developed this type of reactor. It presents a brief history of the boiling water concept and of the early experiments of the Argonne Laboratory, including the development and operation of the Experimental Boiling Water Reactor. The various BORAX experiments are described in detail. A thorough explanation is given of the physics underlying the design of the reactor, and a lengthy description of the General Electric Co.'s Vallecitos plant is included. The book concludes with a discussion of present and future research and development programs for boiling reactors.

Boiling Water Reactor Study (TID–8500, Parts 1, 2 & 3). U.S. Atomic Energy Commission, 1959. Total pages 522. Total price $5.25. (Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This is one of four advanced design studies initiated in 1958 to assess the feasibility of power generation through the use of certain type of nuclear reactors. This study deals with the boiling water reactor. Part 1 (Volumes 1 and 2) is entitled "306 mw Power Reactor Conceptual Design"; Part 2 is entitled "Separate Studies"; and Part 3 is entitled "326 mw Case-first Installation".

Civilian Power Reactor Program. U.S. Atomic Energy Commission. Washington, U.S. Government Printing Office, 1960. (Parts separately numbered and priced).

Part I. Summary of Technical and Economic Status as of 1959. (TID–8516). $1.00.

Part II. Economic Potential and Development Program as of 1959. (TID–8517). 70 cents.

Part III, Book 1. Status Report on Fast Reactors as of 1959. (TID–8518(1)). $1.00.

Part III, Book 2. Status Report on Pressurized Water Reactors as of 1959. (TID–8518(2)). $1.25.

Part III, Book 3. Status Report on Aqueous Homogeneous Reactors as of 1959. (TID–8518(3)). $1.25.

Part III, Book 4. Status Report on Heavy Water Moderated Reactors as of 1959. (TID–8518(4)). $2.25.

Part III, Book 5. Status Report on Boiling Water Reactor Technology as of 1959. (TID–8518(5)). 60 cents.

Part III, Book 6. Status Report on Sodium Graphite Reactors as of 1959. (TID–8518(6)). $1.00.

Part III, Book 7. Status Report on Organic-Cooled Power Reactors as of 1959. (TID–8518(7)). $2.25.

Part III. Book 8. Status Report on Gas-Cooled Reactors as of 1959. (TID–8518(8)). 55 cents.

Part IV. Plans for Development as of February 1960. (TID–8519). 55 cents.

These reports survey the current status of the AEC's program for the use of reactors to produce power for civilian purposes. All major reactor concepts that are currently being developed under this program are included.

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Community Impact of Peaceful Applications of Atomic Energy. (TID-[illegible]) Harold Sandbank. U.S. Atomic Energy Commission, 1960. 80 pages. [illegible] (Available from the Office of Technical Services, U.S. Department of [illegible]ommerce, Washington 25, D.C.). This report deals with the impact on cities [illegible]al towns resulting from the peaceful applications of atomic energy. It is based on a study made by the American Municipal Association under a contract with the Atomic Energy Commission, and it is concerned with such areas as: the extent of peaceful uses of nuclear materials; effects on localities and local government functions; programs of federal and state agencies and other groups active in this field; standards and requirements controlling the use of nuclear materials; and sources of information and assistance available to communities and local officials.

Compendium of Information for Use in Controlling Radiation Emergencies. TID-8206 (Rev.) Compiled and Edited by Allen Brodsky and G. Victor Beard. U.S. Atomic Energy Commission, 1960. 100 pages. $1.00. Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.). This compilation summarizes information which may be needed by trained personnel in exercising rapid and professional judgment during the period immediately following an unexpected radiological incident. Such topics as past experiences in radiation accidents, the shipment of of radioactive materials, the control of fires during radiation emergencies, the results of fuel element burn tests, and monitoring activities are reviewed and discussed.

Conference on the Status of Radiation Effects Research on Structural Materials and the Implications to Reactor Design. (TID-7588) U.S. Atomic Energy Commission, 1959. 306 pages. $4.00. (Available from the Office of Technical Services, Department of Commerce, Washington 25, D.C.) This is the published proceedings of the October 1959 meeting of the AEC Welding Program held at Chicago, Ill. The discussion was confined almost exclusively to two aspects of the problem: (1) the significance and value of accumulated data and (2) the development of a research program which would be productive of information useful for design purposes. Some of the topics discussed are: techniques for measuring reactor neutron spectra; radiation effects in ferritic steels; practical aspects of reactor pressure vessel design; and the code aspects.

Controlled Thermonuclear Reactions. Edited by Samuel Glasstone and Ralph H. Lovberg. New York, D. Van Nostrand Co., Inc., 1960. 523 pages. $5.60. The principles of controlled thermonuclear reactions are presented. Thermonuclear processes are introduced so as to be understandable by physicists and engineers who have no background in this field. Fundamentals and techniques of thermonuclear research are explained completely enough to supply the foundation needed by one setting out in a research program. The book describes the conditions that are required for controlled thermonuclear reactions and the possible routes by which these conditions may be achieved. Plasma theory is discussed employing mathematics of adequate level. Equipment such as pinch and mirror devices is described, together with stellarator and other methods of creating and heating plasma. Experimental techniques employed in controlled thermonuclear research also receive attention.

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Costs of Nuclear Power (TID–8506). U.S. Atomic Energy Commission, [illegible] 29 pages. 50 cents. (Available from Office of Technical Services, U.S. [illegible] partment of Commerce, Washington 25, D.C.) This report is concerned [illegible] with stationary nuclear plants that are designed primarily for the [illegible] of electricity. It considers data on the cost of electricity from those [illegible] that are presently in operation, being built, or planned for early [illegible] Major topics covered are capital costs, annual fixed charges, fuel-cycle [illegible] inventory charges, cost of operation and maintenance and total cost of [illegible] power.

Cryogenic Engineering. Russell B. Scott. Princeton, N.J., D. Van Nostrand Co., 1959. 368 pages. $5.60. The book covers the entire range of cryogenic engineering and is intended primarily for students, engineers, and scientists who are unfamiliar with low-temperature techniques. It outlines the basic physical aspects of cryogenic processes and equipment, at the same time providing a careful discussion of the underlying theory. The book describes, in easily understood form, the development and improvement of low-temperature processes and equipment; the determination of the physical properties of materials used to produce, maintain, and utilize low temperatures; and the practical application of low-temperature techniques and processes.

3 *Design Studies for Selecting a Prototype Reactor for a Nuclear Tanker* (TID–8528). U.S. Atomic Energy Commission, 1960. 67 pages. $1.25 [illegible] able from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This study reports on the findings of an evaluation group convened to consider three nuclear-powered tanker design and engineering studies carried out in accordance with Public Law 86–50. This study was conducted to review water-reactor technology in order to determine the relative merit of the various water-reactor propulsion concepts which could be applied to a tanker and their potential to achieve economic operation in the relatively near future. A summary and a comparative tabulation of the cost estimates for the different systems are presented.

The Effects of Nuclear Weapons. Edited by Samuel Glasstone. Washington, U.S. Government Printing Office, 1957. 579 pages. $2.00. A publication prepared by the Armed Forces Special Weapons Project of the Department of Defense at the request of the Atomic Energy Commission. It updates information appearing in *The Effects of Atomic Weapons*, 1950, and provides the [illegible] knowledge of weapons effects obtained by observation and experiment in laboratory work and nuclear test detonations since 1950. It also includes data on radiological, blast and heat effects of nuclear detonations. Requirements of the Federal Civil Defense Administration for information necessary for civil defense planning are taken into account.

Fluid Fuel Reactor.[1] Edited by J. A. Lane, H. G. MacPherson, and F. Maslan. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1958. [illegible] pages. $11.50. Comprehensive discussion of three basic types of fluid fuel reactors which summarizes results of research carried on in the United States for almost 10 years. A unique feature of this work is its approach to [illegible]

[1] A U.S. Government presentation volume for the International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958.

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subject from the chemical standpoint rather than from the point of view of mechanical engineering.

Fossil Fuels in the Future (TID–8209). Milton F. Sear. U.S. Atomic Energy Commission, 1960. 63 pages. 75 cents. (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.). This report reviews the extent of fossil-fuel resources and forecasts the rate at which they will be depleted in the absence of new sources of energy, in order to estimate the earliest time when large amounts of nuclear power will be needed. Energy projections are included for the United States, other areas, and the world as a whole.

Heavy Water Moderated Power Reactor Plant (TID–8503, Parts 1 and 2). U.S. Atomic Energy Commission, 1959. Total pages 1136. Total price $11.25. (Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) Another of the four advanced design studies initiated in 1958 to assess the feasibility of power generation through the use of certain types of nuclear reactors. This study deals with the heavy water moderated power reactor. Part 1 "Design Study"; Part 2 "Preliminary Design of the Prototype Plant".

International Conference on the Preservation of Foods by Ionizing Radiations (TID–7585). U.S. Atomic Energy Commission. 1959. 294 pages. $4.00. (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This is the published proceedings of a conference sponsored by Massachusetts Institute of Technology, the U.S. Atomic Energy Commission, and the International Atomic Energy Agency held at Cambridge, Massachusetts, July 1959. Some of the topics covered are: reactors as radiation sources; problems of underdeveloped countries; direct and indirect effects of radiations; radiological safety; and electron beam sterilization.

Fighting With Radiation; the Problems of the Nuclear Age for the Layman. Part I. Fundamentals. Part II. Fire Service Problems. Prepared by Francis L. Brannigan. U.S. Atomic Energy Commission, Washington, U.S. Government Printing Office, 1960. Part I, 65 pages. 45 cents. Part II, 199 pages, $1.00.

These publications present what has been found by field experience to be a general approach to the understanding of the industrial radiation hazard. They are intended for the layman who requires a basic understanding of the radiation problem to his field. Part II is of interest not only to professional firemen but also to those charged with the control of radiation hazards.

Los Alamos Handbook of Radiation Monitoring. (LA–1835, 3d Ed.). Compiled and edited by Jerome E. Dummer, Jr., U.S. Atomic Energy Commission. Washington, U.S. Government Printing Office, 1959. 180 pages. 60 cents. An entirely rewritten and updated version of the "General Handbook for Radiation Monitoring" which was prepared by Los Alamos Scientific Laboratory to provide the Monitoring Group at Los Alamos with the basic data which should be available to them at all times. The book is pocket size and is designed to serve the purposes of the Los Alamos Scientific Laboratory. Some of the topics covered are monitor's check list, emergency monitoring, LASL

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radiation safety policies, decontamination, table of isotopes, monitoring ins... ments, alpha, beta-gamma neutron and tritium monitoring and air sampling...

Management of Nuclear Materials. Edited by Ralph F. Lumb. New Yo... D. Van Nostrand Co., Inc., 1960. 516 pages. $16.50. This book pre... techniques used in the management and control of special nuclear materi... i.e., (1) obtaining data by sampling, weighing, and analyzing analytica... (2) taking, verifying, and maintaining inventory; (3) recording data ... individual forms and periodic reports; and (4) controlling data flow and ... utilization. A brief description of the processes from ore buying thro... scrap recovery from reactor operations is given as background. The bo... will be of interest to companies presently processing nuclear materials ... companies interested in entering the field and wanting to determine wh... is involved in accounting for nuclear materials. The book includes a ... cussion of the philosophy of nuclear materials and management, a gen... description of records and statistical techniques, and detailed nuclear mate... ment considerations of each process.

Metallurgy and Fabrication of Fuel Elements. A. R. Kaufman and others ... Nuclear Metals, Inc. New York, Interscience Publishers, Inc. (In Pres... Metallurgists and fabrication specialists interested in the production ... nuclear reactor fuel elements will find this volume indispensable. Rea... engineers will obtain from it much useful information for conceptual de... purposes. The book describes all aspects of fuel element fabrication: ma... rials, production, assembly, and inspection. The nature of nuclear reac... the conditions which fuel elements will encounter in reactors, the import... physics and engineering design factors, the metallurgy of uranium, thor... plutonium, and their alloys plus ceramics and cermets, the choice of cladd... material, the manufacturing procedures for producing fuel elements from ... various components and for assembling them into clusters, and useful in... spection methods are discussed. A brief discussion of fuel element econo... and reprocessing problems is included. A short chapter on fluid fuels pr... vides perspective on homogeneous reactors. Also included are a glos... of terms and phase diagrams of uranium, thorium, plutonium, and ... alloys.

The Metallurgy of Hafnium. Edited by D. E. Thomas and E. T. Hayes. ... Atomic Energy Commission. Washington, U.S. Government Printing Off... 1960. 384 pages. $1.50. A reference work dealing with the science a... technology of the extraction, fabrication, properties, and uses of the m... hafnium. Individual chapters present information generally unavail... previously. The book, illustrated by 85 line drawings and photogra... follows the natural sequence of functions involved in processing the ... through to a finished product.

Midwestern Conference on the Industrial Uses of Isotopes (TID-7571). ... Atomic Energy Commission, 1959. 270 pages. $2.75. (Available from ... Office of Technical Services, Department of Commerce, Washington 25, D.... A conference on industrial uses of isotopes was held at Manhattan, Kans... February 25 and 26, 1959. Some representative papers covered indus... application of Cobalt 60; radioisotopes as sources of electrical power; ... isotopes in the petroleum industry; radioisotopes for radiography of ...

...ments; and castings ... applications.

...eutron Cross Sections ... and Robert B. Schwar... Government Printing ... rised and updated edi... sections. It is intend... book contains tables ... plots of curves of tota... data has been careful... oratories throughout t...

... Nuclear Data Table ... Washington, U.S. Gov... 1959 Nuclear Data Ta... tions which were publ... of presenting and cur... made it possible to or... nucleus and to devot... systematized accordin... book presents 10 con... nuclear physics appea...

...clear Reactor Experi ... Nostrand Co., Inc., 19... of experiments inv... measurements.

...clear Reactor Metall ... Murphy, Princeton, N... A volume of course n... International School o... Laboratory.

...homa Conference— ... Energy Commission, ... ndent of Documents ... Comprises a collectio... Radioisotopes in Agri... ...ch major topics as ... ...dy of genetic mat...

...mic Cooled Power ... Atomic Energy Com... Available from Offic... Washington 25, D.C.) ... ...tiated in 1958 to as... ...certain types of ... ...ded Power Reacto... ...actor Concept E... ...sign"; Part 5 "300 ...

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ments; and castings and radioactivity oil well logging and oil field tracer applications.

Neutron Cross Sections (BNL–325, Second Edition). Edited by Donald J. Hughes and Robert B. Schwartz, Brookhaven National Laboratory. Washington, U.S. Government Printing Office, 1958. 373 pages. $4.50. This is a completely revised and updated edition of experimentally determined values of neutron cross sections. It is intended for physicists, chemists, and reactor engineers. The book contains tables of thermal cross sections and resonance parameters and plots of curves of total and partial cross sections as functions of energy. The data has been carefully evaluated and the most recent results from many laboratories throughout the world are included.

New Nuclear Data Tables. Edited by K. Way. U.S. Atomic Energy Commission. Washington, U.S. Government Printing Office, 1959. 151 pages. $1.00. The New Nuclear Data Tables is the successor to the New Nuclear Data Cumulations which were published from 1952 through 1957. A change in the method of presenting and cumulating experimental results for individual nuclei has made it possible to omit from an annual volume data organized according to nucleus and to devote the yearbook instead to information which has been systematized according to some nuclear property or some specific topic. The book presents 10 compilations containing new data in fields of low-energy nuclear physics appearing in the literature during the periods indicated.

Power Reactor Experiments. Edited by J. B. Hoag. Princeton, N.J., D. Van Nostrand Co., Inc., 1958. 480 pages. $6.75. A laboratory manual detailing experiments involving the theory and practice of fission reactor measurements.

Power Reactor Metallurgy. Edited by Walter D. Wilkinson and William F. Murphy, Princeton, N.J., D. Van Nostrand Co., Inc., 1958. 382 pages. $5.60. A volume of course material in applied reactor metallurgy developed at the International School of Nuclear Science and Engineering of Argonne National Laboratory.

Oklahoma Conference—Radioisotopes In Agriculture (TID–7578). U.S. Atomic Energy Commission, 1959. 292 pages. $2.00. (Available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.) Comprises a collection of papers presented at the April 1959 Conference on Radioisotopes in Agriculture held at Oklahoma State University and treats such major topics as radioiodine and thyroid functions; radioisotpes in the study of genetic materials; ruminology and medical applications.

Organic Cooled Power Reactor Study (TID–8501, Parts 1, 2, 3, 4 & 5). U.S. Atomic Energy Commission, 1959. Total pages 1500. Total price $15.00. Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This is another of the four advanced design studies initiated in 1958 to assess the feasibility of power generation through the use of certain types of nuclear reactors. This study deals with the Organic-Cooled Power Reactor. Part 1 is entitled "Summary of Study"; Part 3 "Reactor Concept Evaluation"; Part 4 "75 mw Power Plant Conceptual Design"; Part 5 "300 mw Coal-fired Power Plant Comparison Study".

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Physical Metallurgy of Uranium.[1] A. N. Holden. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1958. 272 pages. $5.75. A comprehensive, unified treatment of the physical metallurgy of uranium, which summarizes, correlates, and critically evaluates the wealth of information that has become available in the field during the past several years. Although important experimental techniques and results are thoroughly described, emphasis has been placed upon interpretation in terms of fundamental properties and mechanisms.

The Physics of Intermediate Spectrum Reactors. Edited by J. R. Stehn, U.S. Atomic Energy Commission, Washington, 1959. 487 pages. $3.00 (paper bound). U.S. Government Printing Office. This handbook is the third volume of the Naval Reactors Physics Handbook, written for persons having basic knowledge of the physics of nuclear reactors. It is an accumulation of physics information obtained from the work on intermediate-spectrum reactors at Knolls Atomic Power Laboratory. Material covers the importance of the properties of critical assemblies and of techniques for obtaining related experimental information; the uses of critical assemblies and reactor theory in making and testing predictions of reactivity variation during operation; the spread of heat generation in space and time; nuclear effects resulting from the presence of beryllium or sodium in the reactor; the transient or near transient behavior of intermediate reactors.

Potential Nonnuclear Uses for Depleted Uranium (TID–8203). Harlan H. Nelson and Roland L. Carmichael. U.S. Atomic Energy Commission. 1958. 58 pages. 75 cents. (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This report presents potential uses of depleted uranium in the fields of semiconductors, cathodic protection, ion exchange, heavy-density media for mineral concentration, and metallurgy. The sections involving metallurgical applications, radiation shielding, and ceramic uses are presented in detail. Also included are sections devoted to the past industrial uses for uranium and to the health and safety aspects of handling depleted uranium in the industrial shop.

Principles of Nuclear Reactor Engineering. Samuel Glasstone. New York, D. Van Nostrand Co., 1955. 861 pages. $7.95. A text written for the student and the practicing engineer. An overall review of the fundamental scientific principles upon which reactor engineering is based.

Proceedings of the AEC Symposium for Chemical Processing of Irradiated Fuels From Power, Test, and Research Reactors (TID–7583). U.S. Atomic Energy Commission, 1959. 458 pages. $4.50. (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) A review is presented in this symposium of the technology currently available from processing spent fuels from research, test, and power reactors. The twenty-one papers included reports from the General Electric Co., Hanford Atomic Products Operation, the Phillips Petroleum Co. Atomic Energy Division, the E. I. du Pont de Nemours and Co., and the Oak Ridge National Laboratory.

[1] A U.S. Government presentation volume for the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958.

Proceedings of a Confe
Research (TID–7582).
$3.00. (Available from
merce, Washington 25,
Gatlinburg Conference
Unlike the previous me
wood, this meeting was
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and shock waves.

Proceedings of the 1959
Heat (TID–7580). U.S
(Available from the Of
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Project Sherwood—The I
Reading, Mass., Addison
Account of the extensiv
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Prospecting for Uranium.
Survey. Revised Janua
ber, 1957. 217 pages. 75
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Radiation: A Tool for In
1959. Washington, U.S
(Available from the Of
of industrial application
B. Little, Inc., is based o
of selected literature. T
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...ings of a Conference on the Theoretical Aspects of Controlled Fusion ...search (TID–7582). U.S. Atomic Energy Commission, 1959. 232 pages. ... (Available from the Office of Technical Services, Department of Com... Washington 25, D.C.) Comprises a compilation of papers given at the ...linburg Conference on theoretical aspects of controlled fusion research. ...like the previous meeting at Gatlinburg, which covered all aspects of Sher... this meeting was limited to theoretical papers, and covered such topics ... transport phenomena; waves in plasmas; stability; adiabatic invariants; ... shock waves.

...dings of the 1959 Symposium on Low-Temperature Nuclear Process ... (TID–7580). U.S. Atomic Energy Commission, 1959. 76 pages. $0.75. ...Available from the Office of Technical Services, Department of Commerce, ...Washington 25, D.C.) These are papers given at a symposium conducted by ... Atomic Energy Commission on the development and potential industrial ... of reactors for the production of low-temperature process heat. During ... symposium attendees were asked to complete a questionnaire designed to ...ert industry's interest in process heat reactors and the extent to which ...dustry would participate in their development. A tabulation of the answers ... included.

...ect Sherwood—The U.S. Program in Controlled Fusion.[1] Amasa Bishop. ...ading, Mass., Addison-Wesley Publishing Co., Inc., 1958. 228 pages. $5.75. ...count of the extensive research and development undertaken by the U.S. ...omic Energy Commission for harnessing the energy of thermonuclear re... ...ions. It presents a factual and readable account of Project Sherwood, ...cluding its origin, its development, its problems, and the outlook for its ...ntual success. The book describes the basic principles involved in a fusion ...action, and the various methods now being studied to control thermonuclear ...ergy, with the hope of eventually producing net power.

...specting for Uranium. U.S. Atomic Energy Commission and U.S. Geological ...rvey. Revised January 1957. Washington, U.S. Government Printing Of... ..., 1957. 217 pages. 75 cents. A nontechnical booklet describing the uranium-...aring minerals, where to look for them, and instruments to use in prospect-...g and in laboratory testing and analysis of ores. It contains six color plates ... principal minerals. Laws, regulations, and price schedules for uranium-...aring ores are included.

...ation: A Tool for Industry (ALI–52). U.S. Atomic Energy Commission, ... Washington, U.S. Government Printing Office. 414 pages. $2.50. ...ailable from the Office of Technical Services.) This one year survey ... industrial applications of ionizing radiation, undertaken in 1958 by Arthur ... Little, Inc., is based on interviews with workers in the field and on analysis ... selected literature. The survey revealed that ionizing radiation is not yet ...processing tool of major importance to industry generally, however, because ...has not yet demonstrated sufficient advantages over established methods of ...ieving a similar result. Skillfully oriented research and development will ...prove the likelihood of radiation becoming a tool of major importance for ... industry.

[1] U.S. Government presentation volume for the International Conference on the ... Uses of Atomic Energy, Geneva, 1958.

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Radiation Biology and Medicine: Selected Reviews in the Life Sciences. Edited by W. D. Claus. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1958. 968 pages. $11.50. A review of advances in thought and research in the uses and effects of nuclear radiation in the life sciences in the United States. Chapters are included on basic mechanisms of biological reaction to radiation, mutational effects of radiation, mathematical biology, maintaining response to radiation, radiation safety, medical uses of atomic radiation, agricultural uses of radiation, tracer applications, instrumentation and dosimetry.

Radiations From Radioactive Atoms in Frequent Use. L. Slack and Kathryn Way. U.S. Atomic Energy Commission. Washington, U.S. Government Printing Office, 1959. 75 pages. 55 cents. This book is designed especially for scientists and technicians in the biological and medical sciences who are concerned with estimations and calculations of dose. Tables and graphs for each radioactive atom show explicitly the energies and intensities of the particle and electromagnetic radiations emitted both by the decay in nuclear and also by the orbital electrons in the rearrangements which follow the nuclear transformation. Auxiliary graphs are given on gamma ray dose rates, half-thickness values for gamma rays, electron ranges, average beta energies, fluorescence yields, L-shell vacancies per K-shell vacancy, etc.

Radiochemistry of the Elements. Subcommittee on Radiochemistry of the Committee on Nuclear Science of the National Academy of Sciences—National Research Council. U.S. Atomic Energy Commission. (A series of monographs, separately priced, available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.)

Each monograph in the series is an up-to-date compilation of the latest available radiochemical information and procedures written by an expert on the chemistry and is intended as a primary source of radiochemical information. Intended for the working scientist, each monograph collects the pertinent information required for radiochemical work with an individual element or a group of related elements.

The monographs are of interest not only to the radiochemist but also to geochemists, nuclear physicists, biochemists, nuclear engineers and workers in medicine, environmental health, fall-out analysis, activation analysis and others having occasion to use radiochemical techniques.

Monographs on the following elements have been issued: Chromium; Rhodium; Molybdenum; Barium, Calcium, and Strontium; Zirconium and Hafnium; Astatine; Indium; Cadmium; Arsenic; Francium; Thorium; Fluorine, Chlorine, Bromine, and Iodine; Americium and Curium.

Radioisotopes at Work for Agriculture (SRIA–9). A. Gerlof Homan and Richard R. Tarrice. U.S. Atomic Energy Commission, 1959. 200 pages. [illegible] (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This report has as its objectives to estimate probable economic benefits from the use of radioisotopes in agriculture at present and in the future, and to present a detailed analysis of the current and probable future use for radioisotopes in agriculture. The investi-

[1] A U.S. Government presentation volume for the International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958.

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Reactor Handbook (Secon
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Each volume priced se
Volume I. *Materials.*
Volume II. *Fuel Rep*
(In press.)
Volume III. *Physics*
(In press.)
Volume IV. *Engineer*

Published in four volu
the accounts of nuclear
atomic energy programs.
and contributors the Ha
people engaged in researc
ing, evaluating, digestin
four volumes was under
W. H. Brooks, P. F. Gast,
Dean, Chairman.

Report on Civilian Reacto
Commission, 1959. 191
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published by the divisio
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policy. The report con

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covered the use of radioisotopes in research in the fields of farm animal sciences and veterinary medicine, agricultural entomology, plant genetics, plant physiology, and soil sciences and water.

Radioisotopes in Industry (NYO–2977). John J. McMahon and Arnold Berman. U.S. Atomic Energy Commission, 1959. 136 pages. $2.75. (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This report, prepared by the National Industrial Conference Board for the Commission, is based on the experiences of 523 companies that have realized savings through the use of radioisotopes. Twenty types of industries.

Radioisotopes in Medicine (SRIA–13). Richard R. Tarrice and Mark S. Blumberg. U.S. Atomic Energy Commission, 1959. 180 pages. $3.00. (Available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) This study, conducted by the Stanford Research Institute for the Atomic Energy Commission Office of Isotopes Development, had as its purpose a better understanding of the current position of radioisotope use in the field of medicine. Specific data is given on the medical research, diagnostic and therapeutic uses of radioisotopes.

Radioisotopes in Science and Industry. U.S. Atomic Energy Commission. Washington, U.S. Government Printing Office, 1960. 176 pages. $1.25. A detailed account of isotope utilization since the inception of the Commission's distribution program. Agriculture, medicine, and industry have benefited from the use of radioisotopes, and new applications are being developed.

Reactor Handbook (Second Edition). Prepared under contract with the United States Atomic Energy Commission. New York, Interscience Publishers, Inc. (Each volume priced separately.)

Volume I. *Materials.* Edited by C. R. Tipton, Jr., 1960. $36.50.

Volume II. *Fuel Reprocessing.* Edited by S. M. Stoller and R. B. Richards. (In press.)

Volume III. *Physics and Shielding.* Edited by H. Soodak and E. P. Blizard. (In press.)

Volume IV. *Engineering.* Edited by Stuart McLain. (In press.)

Published in four volumes, the Reactor Handbook will provide authoritative accounts of nuclear theory, data, hardware, and processes developed in atomic energy programs. Representing the efforts of several hundred authors and contributors the Handbook is intended as a desk reference for technical men engaged in research, development, and design. The process of gathering, evaluating, digesting, and organizing the information included in the five volumes was under the guidance of an Editorial Review Board composed of S. Brooks, P. F. Gast, J. P. Howe, S. Lawroski, M. C. Leverett, and W. H. Zinn, Chairman.

Report on Civilian Reactor Fuel Elements (TID–8503). U.S. Atomic Energy Commission, 1959. 191 pages. $1.75. (Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.) A report prepared by the Civilian Reactor Fuel Element Review Group which was established by the division of Reactor Development to assist the AEC in the formulation of long range plans for the development of fuel element technology. The report contains the following sections: Major conclusions;

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fuel problems of major reactor types; materials problems; supporting
nology; and summary of conclusions.

Report of the Fluid Fuel Reactor Task Force (TID–8507). U.S. Atomic
Commission, 1959. 188 pages. $1.75. (Available from Office of
Services, U.S. Department of Commerce, Washington 25, D.C.) This
was prepared by a task force composed of fifteen highly qualified
and scientists from the Atomic Energy Commission, its national
and contractor organizations, and representatives of the architect-
and utility industry. The task force was organized and commenced
form a critical evaluation of the three fluid fuel reactor concepts
homogeneous—AHR, molten salt—MSR, and liquid metal fuel—LMFR
development by the Commission. The report represents the group
and judgment of the three fluid fuel reactor concepts.

The Shippingport Pressurized Water Reactor.[1] By personnel of the
Reactors Branch, Division of Reactor Development, U.S. Atomic
Commission; Bettis Plant Westinghouse Electric Corp.; and Duquesne
Co. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1958. 600
$9.50. An account of the research and development for and construction
the first large-scale central station nuclear powerplant to be built and
in the U.S. This is the basic sourcebook for this plant and its
For those who want more detailed information, selected references are
at the end of each chapter.

Sodium Graphite Reactors.[1] Chauncey Starr and R. W. Dickinson.
Mass., Addison-Wesley Publishing Co., Inc., 1958. 304 pages. $6.50.
and coherent presentation of sodium graphite reactor technology.
has been placed on the design and development of the Sodium Reactor
ment (SRE); however, information applicable to sodium graphite
in many cases, to reactor design in general is included. The Hallam
Power Facility, a full-scale sodium graphite plant on which construction
started, is described.

Solid Fuel Reactors.[1] By J. R. Dietrich and W. H. Zinn. Reading, Mass.,
son-Wesley Publishing Co., Inc., 1958. 864 pages. $10.75. Reviews
concepts, present status of development in the United States, and
and economic outlooks in this country for five projected solid fuel
power reactor types. Chapters are included on the fast-neutron
tor; the experimental breeder reactor; the Enrico Fermi Atomic Power
heavy-water power reactors; gas-cooled reactors, organic-cooled and
reactors; and plutonium recycling in thermal reactors.

Sourcebook on Atomic Energy, Second Edition (revised and updated).
Glasstone. New York, D. Van Nostrand Co., 1958. 641 pages. $4.40.
is considered the standard sourcebook on atomic and nuclear science
It presents a comprehensive technical description of the theory, history,
velopment, and uses of atomic and nuclear energy. Chapters are included
the structure of the atom, radioactivity, isotopes, nuclear reactors,
research, acceleration of charged particles, new elements, radiation
tion and health physics, and other phases of nuclear science.

[1] A U.S. Government presentation volume for the International Conference
Peaceful Uses of Atomic Energy, Geneva, 1958.

Symposium on High Fl
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cal Services, U.S. Dep
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The papers cover the
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Thorium Production Te
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testing procedures.

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...posium on High Flux Materials Testing Reactors (TID–7584). U.S. Atomic ...nergy Commission, 1959. 447 pages. $4.50. (Available from Office of Techni... ...l services, U.S. Department of Commerce, Washington 25, D.C.) This is the ...blished proceedings of the September 1959 meeting held in Brussels, Belgium. ...e papers cover the AEC test reactor program; the design and uses of high ... research and test reactors; design of loops for high flux reactors; safety ...ciples in the instrumentation of reactors; and fast neutron dosimetry in ...search reactors.

...ting With Radioisotopes. U.S. Atomic Energy Commission, Washington, ...S. Government Printing Office, 1959. 60 pages. 40 cents. Based on mate... ...s submitted by teachers in many schools and colleges, this manual of ...periments with radioisotopes was prepared to supplement and extend the ...itial publication, *Laboratory Experiments With Radioisotopes—For High ...hool Demonstrations.* As an aid to teachers using the publication, Part I ... an extensive introductory section that contains definitions and notes on ...uipment and techniques and gives special attention to proper procedures ...d safety. Part II gives 16 suggested experiments. Each experiment ...gins with pertinent questions and answers and each is written in an "open-...ded" manner with the hope that variations will occur to teachers and ...dents. Five appendixes are: Some References on Radioactivity; Licens... ...g of Byproduct Material; Radioactive Isotopes for Sale Under a General ...ic License; Some Suppliers of Radioisotopes; Radioactive Decontamination ...ocedures.

...rium Production Technology.[1] F. L. Cuthbert. Reading, Mass., Addison-...sley Publishing Co., Inc., 1958. 320 pages. $6.50. This book contains ...actically all the information currently available on thorium production tech... ...gy. Chapters are included on thorium history, sources, and uses; prop... ...ies of thorium; thorium-bearing ores; their deposits and methods of ...centration; extraction of thorium from ores; purification of thorium con... ...trates; preparation of thorium metal by reduction; melting of thorium; ...rication of thorium; health and safety aspects of thorium production; ...ing procedures.

...Transuranium Elements.[1] Glenn T. Seaborg. Reading, Mass., Addison-...sley Publishing Co., 1958. 354 pages. $7.00. This book provides a com... ...summary of the chemical and nuclear properties of the known synthetic ...nsuranium elements, as well as the prospects for future transuranium ...ments. It is divided into four parts, the first of which begins with the ...overy of plutonium in 1940 as the result of the bombardment of natural ...nium with deuterons in the University of California's 60-inch cyclotron. ... next discusses the chemical properties of the actinide elements, ranging ... one of the heaviest elements, thorium, to Mendelevium. The third part ...evoted to the nuclear properties of the transuranium elements, and the ...rth to the as yet undiscovered elements.

...m Ore Processing.[1] Edited by J. W. Clegg and D. D. Foley. Reading, ..., Addison-Wesley Publishing Co., Inc., 1958. 448 pages. $7.50. Here, ...the first time in book form, is a condensed but essentially complete descrip... ...of practices and in winning uranium from its ores. While the emphasis

[1] U.S. Government presentation volume for the International Conference on the ...ceful Uses of Atomic Energy, Geneva, 1958.

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is on a well-rounded presentation of current practices in the United S... techniques in other countries are also described. Because of its comprehens... and authoritative nature, the volume should be a valuable reference for ... workers in the field. Various processes are described in full, and there ... many helpful comments and observations. Each chapter is accompanied ... an extensive reference list.

Uranium Production Technology. Edited by Charles D. Harrington and Ar... E. Ruehle. Princeton, N.J., D. Van Nostrand Co., Inc., 1959. 579 pa... $17.50. Presents the entire field of technology in the United States of uraniu... metal production from uranium concentrates or high-grade uranium ore. ... includes a description of the diethyl ether and tributyl phosphate solv... extraction, deoxidation, hydrofluorination, reduction and casting proc... Rolling, forging, extrusion, and machining fabrication techniques are ... discussed along with the chemistry and physical metallurgy of uran... Chapters on uranium alloys, producing uranium hexafluoride, producing ... riched uranium, new technology, and health hazard control complete the b... Limited amounts of history, pertinent production details, and developm... work are included. This comprehensive book, the first in its field, inclu... work done at many AEC installations throughout this country. It is writ... for the student of metallurgy both in an academic institution and in indus...

U.S. Research Reactor Operation and Use.[1] Edited by J. W. Chastain, ... Reading, Mass., Addison-Wesley Publishing Co., Inc., 1958. 384 pages. ... This book is intended primarily for scientists, engineers, and administrato... owning or using a reactor. It also may serve as a text or reference ... introductory courses in reactor engineering. It sets forth information ... only about technical aspects, characteristics, and operating problems but ... on administrative, legal and cost problems.

PERIODICAL PUBLICATIONS

Nuclear Science Abstracts. U.S. Atomic Energy Commission. Washing... U.S. Government Printing Office. Available postpaid on subscription ... in single copy at the following prices: Semimonthly issues: Annual ... scription rate, $18.00, domestic; $22.50, foreign; price per single copy, ... domestic; 25 percent extra for foreign mailing. Cumulated—index ... Annual subscription rate, $15.00, domestic; $17.50, foreign; price per ... copy varies according to the number of pages. Published bimonthly. ... bimonthly publication contains abstracts of all current Commission dec... fied and unclassified reports, of non-Commission reports related to a... energy, and of articles appearing in both foreign and domestic peri... literature.

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[1] A U.S. Government presentation volume for the International Conference ... Peaceful Uses of Atomic Energy, Geneva, 1958.

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APPENDIX 8

Regulations of the U.S. Atomic Energy Commission[1]

Part 4—Criteria and Procedures for Determining Eligibility for Security Clearance

APPLICATION TO GOVERNMENT EMPLOYMENT

The current title of 10 CFR Part 4 is changed from "Criteria and Procedures for Determining Eligibility for Security Clearance" to "Criteria and Procedures for Determining Eligibility for Security Clearance for AEC employment."

The three amendments to the present 10 CFR Part 4, "Criteria and Procedures for Determining Eligibility for Security Clearance" are as follows:

Section 4.2 is amended to read as follows:

§ 4.2 Scope.

The criteria and procedures outlined in this part shall be used in those cases in which there are questions of eligibility for AEC security clearance for employment, involving:

(a) Employees (including consultants) of, and applicants for employment with, the Atomic Energy Commission;

(b) Those other persons designated by the General Manager of the Atomic Energy Commission.

B. Paragraph (c) of § 4.25(c) is amended to read:

§ 4.25 Appointment of Personnel Security Boards.

* * * * *

(c) The personnel of the Board shall be selected from a panel of individuals possessing the highest degree of integrity, ability and good judgment. Such panels may not include an employee of the AEC as a voting member of a Personnel Security Board;

C. Paragraph (b) of § 4.32 is amended to read:

§ 4.32 Action by the General Manager.

* * * * *

(b) In making his determination, the mature viewpoint and responsible judgment of Commission staff members are available for consideration by the General Manager;

(Sec. 161, 68 Stat. 948, as amended; 42 U.S.C. 2201)

Dated at Washington, D.C., this 1st day of July 1960.

A. R. Luedecke,
General Manager.

Part 8—Interpretations

PRICE-ANDERSON ACT

An interpretation of section 170 is hereby added to the regulations in Title 10, Chapter 1, CFR Part 8, which contains interpretations of the Atomic Energy Act of 1954 (68 Stat. 919) and of regulations of the Atomic Energy Commission issued thereunder.

§ 8.2 Interpretation of Price-Anderson Act, section 170 of the Atomic Energy Act of 1954.

(a) It is my opinion that an indemnity agreement entered into by the Atomic Energy Commission under the authority of the Atomic Energy Act of 1954 (42 U.S.C. § 2011, et seq.), hereafter cited as "the Act," as amended by Public Law 85–256 (the "Price-Anderson Act") (42 U.S.C. § 2210) indemnifies persons indemnified against public liability for bodily injury, sickness, disease or

loss of or damage to
of use of property
United States by a
occurring within the U
(b) Section 170 auth
mission to indemnify
bility" as defined in s
the Act.[1] Coverage unde
is predicated upon
and requires (1)
(2) a "nuclear incid
tion of the Act's cove
necessitates a finding
ments are present.
(c) In the case of dam
the United States cause
bility based in the Unit
would be a "nuclear incid
section 11(o) since the
occurrence within the
causing * * * damage."
state" would be "with
States" since "occurrenc
the Act to be "that eve
licensed activity * *
cause damage rather tha
damage may perha
Rep. 296, 85th Cong.,
1957) (hereafter cited a
section 11(o) an "occur
which causes damage.

[1] Policies and regulations of the U.S. Atomic Energy Commission announced prior to this Annual Report can be found in the *Federal Register* and in the following semiannual reports to Congress: Fifth, Sixth, Ninth through the Seventeenth and Nineteenth through the Twenty-fifth; also in the Annual Report for 1959.

[1] Sec. 11u. "The term
means any legal liability a
resulting from a nuclear
arises under State or Fed
Compensation Acts of empl
indemnified who are employ
and in connection with the
the nuclear incident occurs,
claims arising out of an act
liability' also includes dam
persons indemnified: *Pro*
property is covered under t
financial protection required,
which is located at the site
connection with the activity
the incident occurs."
Sec. 11o. "The term 'n
means any occurrence wit
loss causing bodily injur
illness, or death, or loss of or
damage to or for loss of use of p
property or resulting from the ra
explosive, or other hazardou
source, special nuclear, or
material * * *."

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of or damage to property, or for
of use of property caused outside
United States by a nuclear incident
within the United States.

Section 170 authorizes the Com-
to indemnify against "public
" as defined in section 11(u) of
Coverage under the Act there-
is predicated upon "public liabil-
and requires (1) "legal liability"
2) a "nuclear incident." Determi-
of the Act's coverage, therefore,
necessitates a finding that these two
ents are present.

In the case of damage outside of
United States caused by a nuclear
based in the United States there
be a "nuclear incident" as defined
section 11(o) since there would be an
currence within the United States
* * * damage."[2] The "occur-
" would be "within the United
" since "occurrence" is intended
Act to be "that event at the site of
censed activity * * * which may
damage rather than the site where
damage may perhaps be caused."
296, 85th Cong., 1st Sess., p. 16
(hereafter cited as Report). In
11(o) an "occurrence" is that
causes damage. It would be, therefore, an event taking place at the site. This definition of "occurrence" is referred to in the Report at page 22 and is crucial to the Act's placing of venue under section 170(e).[3] In its definition of "nuclear incident," the Act makes no limitation upon the place where the damage is received but states only that the "occurrence" must be within the United States.

(d) Similarly, the requirement of "legal liability" would be met. The words of the Act impose no limitation that the liability be one for damage caused in the United States but, on the contrary, are exceedingly broad permitting indemnification for "any legal liability." In the most exhaustive study of the subject, it is stated that the phrase "any legal liability" indicates that liability for damage outside the United States is covered by the Act. Atomic Industrial Forum, Financial Protection Against Atomic Hazards 61 n. 355 (1957).

(e) Thus the precise language of the Act provides coverage for damage ensuing both within and without the United States arising out of an occurrence within the United States. There would be no occasion for doubt were it not for a single statement contained in the Report of the Joint Committee on Atomic Energy on the Price-Anderson Act. The Report states, at p. 16 that "if there is anything from a nuclear incident at the licensed activity which causes injury abroad, or if there is any activity abroad which causes further injury in the United States the situation will require further investigation at that time." This sentence follows an explicit and

---

11u. "The term 'public liability' any legal liability arising out of or from a nuclear incident, except under State or Federal Workmen's sation Acts of employees of persons fied who are employed at the site of connection with the activity where clear incident occurs, and except for arising out of an act of war. 'Public' also includes damage to property s indemnified: *Provided*, That such is covered under the terms of the protection required, except property located at the site of and used in ion with the activity where the nu- cident occurs."

11o. "The term 'nuclear incident' any occurrence within the United causing bodily injury, sickness, dis- death, or loss of or damage to prop- for loss of use of property, arising resulting from the radioactive, toxic, or other hazardous properties of special nuclear, or byproduct ma- * * *"

[3] In order to provide a framework for establishing the limitation of liability, the Commission or any person indemnified is permitted to apply to the appropriate district court of the United States which has venue in bankruptcy matters over the site of the nuclear incident. Again it should be pointed out that the site is where the occurrence takes place which gives rise to the liability, not the place where the damage may be caused * * *." Report, p. 22.

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lengthy statement that the "occurrence" is an event at the site of the activity:

> * * * The occurrence which is the subject of this definition is that event at the site of the licensed activity, or activity for which the Commission has entered into a contract, which may cause damage, rather than the site where the damage may perhaps be caused. This site must be within the United States. The suggested exclusion of facilities under license for export was not accepted. This is because the definition of "nuclear incident" limits the occurrence causing damage to one within the United States. It does not matter what license may be applicable if the occurrence is within the United States. If there is anything from a nuclear incident at the licensed activity which causes injury abroad or if there is any activity abroad which causes further injury in the United States the situation will require further investigation by the Congress at that time * * *

Read literally, the last sentence would seem inconsistent with the preceding statement. It is, however, possible to read the sentence as consistent with the preceding statement if it is taken as indicating a recognition by Congress of the fact that the statutory limitation of liability to $500,000,000 would probably not limit claims by foreign residents to that amount in foreign courts and that therefore the persons indemnified were not fully protected against bankrupting claims, one of the primary purposes of the bill.[4]

(f) The point in question received scant consideration during the hearings preceding adoption of the bill held by the Joint Committee on Atomic Energy. A summary of the study of the Atomic Industrial Forum, cited above, was introduced into the record of the hearing and included a conclusion that the provisions of the bill seemed to cover the situation.[5] That conclusion would seem entitled to more than ordinary weight since the Forum study received [illegible] careful consideration of the Joint Committee,[6] and the study referenced [illegible] statement from the 1956 Report [illegible] similar to the confusing statement [illegible] the 1957 Report noted above.[7]

(g) There was also a rather ambiguous colloquy in the hearings between Representative Cole and Mr. Charles Haugh in which Representative Cole indicated that the Joint Committee "* * * will do pretty well if we successfully protect the American people and property owners in this country without worrying about those that [illegible] abroad."[8]

(h) Congress, in enacting the Price-Anderson Indemnity Act added to section 2 of the Atomic Energy Act of 1954 a new subsection which stated, inter alia:

> In order * * * to encourage the development of the atomic energy industry, * * * the United States may make funds available for a portion of the damages suffered by the public from nuclear incidents, and may limit the liability of those persons liable for such losses.

This statutory purpose is frustrated if the atomic energy industry is not protected from bankrupting liabilities for damages caused abroad by an accident occurring in the United States.[9] In [illegible]

[4] Atomic Industrial Forum, Financial Protection Against Atomic Hazards, The International Aspects, p. 52 (1959).

[5] Hearings before the Joint Committee on Atomic Energy, Governmental Indemnity and Reactor Safety, 85th Cong., 1st Sess., p. 181 (1957) (hereinafter referred to as "Hearings.")

[6] Hearings, p. 168.

[7] Hearings, p. 182.

[8] Hearings, p. 97. It is significant to [illegible] that Mr. Haugh stated at that point [illegible] problem of the reactor operator who is [illegible] cerned with any type of liability. He [illegible] that the insurance contracts would [illegible] "* * * the instance where * * * [illegible] happen[ed] out of the country and a [illegible] brought in the United States on that."

[9] The Atomic Industrial Forum study [illegible] that "[T]o be adequate, the government indemnity must cover industry's liability [illegible] residents of the countries who suffer [illegible] result of an accident at an installation [illegible] in the United States," p. 61. This is [illegible] tainly the case and one of the major [illegible] gressional purposes is frustrated [illegible] Act be said to be unclear on this point. [illegible] principal reason for the conclusion that [illegible] is coverage reached in the Forum study [illegible] the fact that Price-Anderson provides [illegible] demnity for "any legal liability." [illegible] Murphy, Director of the study, in a [illegible]

Report, the Joint Com
Energy made explicit
fact that the private
provided for reactor o
coverage for damage
Mexico and, at another
Committee's hope tha
contract in its final f
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[9] Report, p. 11.

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report, the Joint Committee on Atomic
Energy made explicit mention of the
fact that the private insurance to be
provided for reactor operators included
coverage for damage in Canada and
Mexico and, at another point, noted the
Committee's hope that the insurance
contract in its final form would cover
the same scope as the bill.[10]

It is my opinion that since the
language of the Act draws no distinc-
tion between damage received in the
United States and that received abroad,
none can properly be drawn. To read
the Act as imposing such a limitation
in the absence of statutory direction
and in the light of an avowed Con-
gressional intention to encourage the
development of the atomic energy in-
dustry would be unwarranted. The
confusing sentence cited in the Report
should, therefore, be read consistently
with the language of the Act in the man-
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with the flat coverage of any legal liability
by the indemnity." Murphy, Liability for
Atomic Accidents and Insurance, in Law and
Administration in Nuclear Energy 75 (1959).
The testimony before the Joint Committee
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the authors of the comprehensive study of
Atoms and the Law apparently relying upon
legislative history, stated that the prob-
able cost of a reactor accident in the United
States causing damage in a foreign country
is unclear, presumably since he considered
the phrase "and legal liability" directed at
the settlement problem. Hearings before the
Joint Committee on Atomic Energy, Indem-
nity and Reactor Safety, 86th Cong., 1st
Sess., p. 77 (1959); Stason Estep, and Pierce,
Atoms and the Law, 577 (1959). Professor
Estep stated that there "surely ought to be"
coverage and suggested a clarifying amend-
ment. His statement that the phrase "any
legal liability" covers only the question of
the restrictions for claims seems to me
unsound since the language used, "any legal
liability," seems intentionally broad. Addi-
tionally, should this very narrow reading be
given to admittedly broad statutory lan-
guage, the Congressional purpose would be
defeated.

[illegible] Report, p. 11.

inconsistent with the broad coverage of the statutory language.

L. K. Olson,
General Counsel.

April 26, 1960.

Part 10—Criteria and Procedures for Determining Eligibility for Access to Restricted Data or Defense Information Within Industry

The following regulations of the Commission establishing the criteria and procedures for resolving questions concerning the eligibility of an individual who is not an AEC employee or applicant for AEC employment for access to Restricted Data pursuant to the Atomic Energy Act of 1954, as amended, or for access to defense information, are published to implement Executive Order 10865, 25 F.R. 1583 (February 24, 1960). It should be noted that these rules relate to personnel employed by or applicants for employment with AEC contractors, agents, access permittees, and licensees of the AEC, while the rules contained in Part 4 of the Atomic Energy Commission's rules and regulations relate to criteria and procedures for resolving questions concerning the eligibility of an individual for security clearance for AEC employment under the Atomic Energy Act of 1954, as amended.

Because these regulations relate to the performance of AEC functions as described in section 4(2) of the Administrative Procedure Act of 1946, 5 U.S.C. section 1003(2), the Commission has found that general notice of proposed rulemaking and public procedure thereon are not required and that good cause exists why these rules should be made effective immediately without the customary period of prior notice.

Because of the important nature of the regulations contained herein, the Commission invites written comments from interested members of the public. These comments should be mailed to the General Counsel, U.S. Atomic Energy Commission, Washington 25, D.C.

Pursuant to the Administrative Procedure Act, the following rules are published as a document subject to codification, to be effective immediately upon publication in the FEDERAL REGISTER.

GENERAL PROVISIONS

Sec.
10.1 Purpose.
10.2 Scope.
10.3 Reference.
10.4 Policy.
10.5 Definitions.

CRITERIA FOR DETERMINING ELIGIBILITY FOR ACCESS TO RESTRICTED DATA OR DEFENSE INFORMATION WITHIN INDUSTRY

10.10 Application of the criteria.
10.11 Derogatory information.

PROCEDURES

10.20 Purpose of the procedures.
10.21 Suspension of access.
10.22 Notice to individual.
10.23 Additional information.
10.24 Failure of individual to request a hearing.
10.25 Selection of Hearing Counsel.
10.26 Appointment of Personnel Security Boards.
10.27 Conduct of proceedings.
10.28 Recommendation of the Board.
10.29 New evidence.
10.30 Actions on the recommendations.
10.31 Recommendations of the AEC Personnel Security Review Board.
10.32 Action by the General Manager.
10.33 Action by the Commission.
10.34 Reconsideration of cases.

MISCELLANEOUS

10.35 Terminations.
10.36 Attorney Representation.
10.37 Certifications.
10.38 Washington area cases.

AUTHORITY: §§10.1 to 10.38 issued under sec. 161, 68 Stat. 948, as amended; 42 U.S.C. 2201.

GENERAL PROVISIONS

§ 10.1 Purpose.

This part establishes the criteria, procedures, and methods for resolving questions concerning the eligibility of an individual for access to Restricted Data pursuant to the Atomic Energy Act of 1954, as amended. The appropriate provisions of this part are also to be used to the extent the Commission has responsibilities under Executive Order 10865, 25 F.R. 1583 (February 24, 1960).

§ 10.2 Scope.

The criteria and procedures outlined in this part shall be used in those cases in which there are questions of eligibility for AEC access authorization involving:

(a) Those employees (including consultants) of, and those applicants for employment with, contractors and agents of the Atomic Energy Commission;

(b) Access permittees and licensees of the AEC and their employees (including consultants) and applicants for employment; and

(c) Those other persons designated by the General Manager of the Atomic Energy Commission.

§ 10.3 Reference.

The pertinent sections of the Atomic Energy Act of 1954 are as follows:

SEC. 141. *Policy.* It shall be the policy of the Commission to control the dissemination and disclosure of Restricted Data in such manner as to assure the common defense and security * * *

SEC. 145. *Restriction.* (a) No arrangement shall be made under section 31, no contract shall be made or continued in effect under section 41, and no license shall be issued under section 103 or 104, unless the person with whom such arrangement is made, the contractor or prospective contractor, or the prospective licensee agrees in writing not to permit any individual to have access to Restricted Data until the Civil Service Commission shall have made an investigation and report to the Commission on the character, associations, and loyalty of such individual, and the Commission shall have determined that permitting such person to have access to Restricted Data will not endanger the common defense and security.

(b) Except as authorized by the Commission or the General Manager upon a determination by the Commission or General Manager that such action is clearly consistent with the national interest, no individual shall be employed by the Commission nor shall the Commission permit any individual to have access to Restricted Data until the Civil Service Commission shall have made an investigation and report to the Commission on the character, associations, and

...security of such individual ...ion shall have determine ...uch person to have access ...will not endanger the co... ...security.

(c) In the event an i... pursuant to subsections (a ...section develops any data ...individual who is the subj... ...ation is of questionable ...Service Commission shall r... the Federal Bureau of Inv... conduct of a full field inv... ...sults of which shall be furn... Service Commission for its ...appropriate action.

(d) If the President dee... national interest, he may f... ...pense investigations of an ...which are required by sub... ...of this section to be ma... Bureau of Investigation i... Civil Service Commission.

(e) Notwithstanding th... subsections (a) and (b) o... majority of the members of ...shall certify those specific ...es of a high degree of imp... ...rity and upon such cert... ...stigation and reports r... ...visions shall be made ...Bureau of Investigation in... Civil Service Commission.

(f) The Commission shall ...es and specifications in w... ...pe and extent of investiga... by the Civil Service Comm... ...subsections (a) and (b) ...such standards and specifi... ...ased on the location and ...ork to be done, and shall, a... ...derations, take into accou... ...importance to the commo... ...security of the Restricted ...access will be permitted.

(g) Whenever the Congre... ...state of war exists, or in th... ...tional disaster due to ene... ...Commission is authorized dur... ...ay or period of national ... ...any attack to employ ind... ...permit individuals access to ... ...ending the investigation re... ...stigation required by sectio... ...ment that and so long as t... ...finds that such action is requ... ...ainment of its activities ...the common defense and s...

SEC. 161. *General provisions.* ...mance of its functions the ...horized to:

(a) Establish advisory bo... ...and make recommend... ...mission on the legislatio... ...tegration, research and o...

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Provided, That the Commission issues regulations setting forth the scope, procedure, and limitations of the authority of each such board.

* * * * *

(c) Make such studies and investigations, obtain such information, and hold such meetings or hearings as the Commission may deem necessary or proper to assist it in the administration or enforcement of this act, or any regulations or orders issued thereunder. For such purposes the Commission is authorized to administer oaths and affirmations, and by subpoena to require any person to appear and testify, or to appear and produce documents, or both, at any designated place. No person shall be excused from complying with any requirements under this paragraph because of his privilege against self-incrimination, but the immunity provisions of the Compulsory Testimony Act of February 11, 1893, shall apply with respect to any individual who specifically claims such privilege. Witnesses subpoenaed under this subsection, shall be paid the same fees and mileage as are paid witnesses in the district courts of the United States.

* * * * *

(n) Delegate to the General Manager or other officers of the Commission any of those functions assigned to it under this Act except those specified in sections 51, 57a(3), 61, 102 (with respect to the finding of a practical value), 108, 123, 145b (with respect to the determination of those persons to whom the Commission may reveal Restricted Data in the national interest), 145e, and 161a.

§ 10.4 Policy.

It is the policy of the Atomic Energy Commission to carry out its responsibility for the security of the atomic energy program in a manner consistent with traditional American concepts of justice. To this end, the Commission has established criteria for determining eligibility for access authorization and will afford those individuals described in § 10.2 the opportunity for administrative review of questions concerning their elibilibity for access authorization.

§ 10.5 Definitions.

As used in this part:

(a) "Access authorization" means an administrative determination that an individual is eligible for access to Restricted Data or defense information;

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(b) "Personnel Security Board" means an advisory board appointed by the Manager of Operations and consisting of three members, one of whom shall be designated as Chairman;

(c) "Hearing Counsel" means an AEC attorney assigned to prepare and conduct Personnel Security Board hearings;

(d) "AEC Personnel Security Review Board" means an advisory appeal board located in Washington, D.C., consisting of three members, one of whom shall be designated as Chairman;

(e) "Commission" means the commission of five members or a quorum thereof sitting as a body, as provided by section 21 of the Atomic Energy Act of 1954, as amended.

CRITERIA FOR DETERMINING ELIGIBILITY FOR ACCESS TO RESTRICTED DATA OR DEFENSE INFORMATION

§ 10.10 Application of the criteria.

(a) The decision as to access authorization is a comprehensive, commonsense judgment, made after consideration of all the relevant information, favorable or unfavorable, as to whether the granting of access authorization would endanger the common defense and security and would be clearly consistent with the national interest.

(b) To assist in making these determinations, on the basis of all the information in a particular case, there are set forth in this part a number of specific types of derogatory information. These criteria are not exhaustive but contain the principal types of derogatory information which create a question as to the individual's eligibility for access authorization. While there must necessarily be adherence to such criteria, the Commission is not limited thereto, nor precluded from exercising its judgment that information or facts in a case under its cognizance are derogatory although at variance with, or outside the scope of, the stated categories. These criteria are subject to continuing review and may be revised from time to time as experience and circumstances may make desirable.

(c) When the reports of investigation of an individual contain information reasonably tending to establish the truth of one or more of the items in the criteria, such information shall be regarded as substantially derogatory and shall create a question as to his eligibility for access authorization. Managers of Operations shall refer cases involving substantially derogatory information to the Director, Division of Security, AEC. The Director, Division of Security, AEC, may authorize the granting of access authorization on the basis of the information in the case or may authorize the conduct of an interview with the individual and, on the basis of such interview and such other investigation as he deems appropriate, may authorize the granting of access authorization. Otherwise, a question concerning the eligibility of an individual for access authorization shall be resolved in accordance with the procedures set forth in § 10.20 et seq.

(d) In resolving a question concerning the eligibility or continued eligibility of an individual for access authorization, the following principles shall be applied by the Board:

(1) Where there are grounds sufficient to establish a reasonable belief as to the truth of one or more of the items in Category "A", this shall be the basis for a recommendation for denying or revoking access authorization unless satisfactorily rebutted by the individual.

(2) Where there are grounds sufficient to establish a reasonable belief as to the truth of one or more of the items in Category "B", the extent of activities, the period in which such activities occurred, the length of time which has since elapsed, and the attitudes and convictions of the individual shall be considered in determining whether the recommendation will be adverse or favorable.

§ 10.11 Derogatory i

(a) *Category "A"* ...ation. Category "A ...es in which the i ...ouse has:

(1) Committed or a ...t, or aided, or abet ...mitted or attempte ...e of sabotage, espio ...ition;

(2) Knowingly esta ...ation with espiona ...ents of a foreign na ...iduals reliably repor ...f espionage or sabot ...entatives of foreign n ...ents may be inimical ...f the United States, wi ...ists, anarchists, or

(3) Held membership ...n or group designat ...y General pursuant ...der 10450, as amend ...ividual did not with ...embership when the o ...identified, or did not ... his rejection of its s ...e prior to the declara ...ary General, partic ...ivities of such an or ...acity where he sho ...e had knowledge as ...e aims of the organi ...e establish his reject ...spire aims. (If an or ...en removed from the ...'s list, membership i ...after such removal s ...ered as Category "A" ...ation but may be ...gory "B" derogatory

(4) Publicly or priva ...ation by force or vi ...the Government ...s or the alteration ...ernment of the Unite ...utional means;

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(5) Deliberately omitt ...ation from or fals ...Security Question

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...il Derogatory information.
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...) Committed or attempted to com... ...r aided, or abetted another who ...itted or attempted to commit, any ... of sabotage, espionage, treason or ...ion;
...) Knowingly established an asso... with espionage or sabotage ... of a foreign nation; with indi... reliably reported as suspected ...ionage or sabotage; with repre... ...tives of foreign nations whose in... may be inimical to the interests ... United States, with traitors, sedi... anarchists, or revolutionists;
...3) Held membership in any organiza... or group designated by the Attor... General pursuant to Executive ... 10450, as amended, provided the ...idual did not withdraw from such ...ership when the organization was ...ntified, or did not otherwise estab... ...s rejection of its subversive aims;
...ior to the declaration by the At... General, participated in the ...ities of such an organization in a ...ity where he should reasonably ... had knowledge as to the subver... aims of the organization and did ...stablish his rejection of its sub... aims. (If an organization has ... removed from the Attorney Gen... list, membership in the organiza... ...ter such removal shall not be con... as Category "A" derogatory in... but may be considered as ... "B" derogatory information.)
... Publicly or privately advocated ...ion by force or violence to over... the Government of the United ... or the alteration of the form of ...ment of the United States by un... ...utional means;
...ory "A" also includes those cases ...h the individual has:
... Deliberately omitted significant ...ion from or falsified his Per... Security Questionnaire or Personal History Statement concerning a significant matter;

(6) Wilfully violated or disregarded security regulations to a degree which would endanger the common defense and security; or intentionally disclosed classified information to any person not authorized to receive it;

(7) Any mental illness of a nature which in the opinion of competent medical authority may cause significant defect in the judgment or reliability of the individual;

(8) Been convicted of crimes indicating habitual criminal tendencies;

(9) Been, or is, a user of drugs habitually, without adequate evidence of rehabilitation.

(b) *Category "B" derogatory information.* In evaluating items under this category, the extent of the activities, the period in which such activities occurred, the length of time which has since elapsed, and the attitudes and convictions of the individual shall be considered. Category "B" includes those cases in which the individual or his spouse has:

(1) Advocated totalitarian, fascist, communist or other subversive political ideologies and has not subsequently established his rejection of them.

(2) Associated with persons falling within the provisions of Category "B", subparagraph (1) of this paragraph, when the individual himself did not establish his rejection of such ideologies. (Ordinarily this will not include chance or casual meetings nor contacts limited to normal business or official relations.)

(3) Affiliated with any organization or group designated in Category "A", paragraph (a)(3), of this section, provided the individual did not discontinue such affiliation when the organization was so identified or did not otherwise establish his rejection of its subversive aims;

(4) Associated with any person falling within the provisions of Category "A", paragraph (a)(3), of this section, provided the individual did not discon-

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tinue such association when the organization was so identified or did not otherwise establish his rejection of its subversive aims. (Ordinarily this will not include chance or casual meetings nor contacts limited to normal business or official relations.)

(5) Parent(s), brother(s), sister(s), spouse, or offspring residing in a nation whose interests may be inimical to the interests of the United States, or in satellites or occupied areas thereof (to be evaluated in the light of the risk that pressure applied through such close relatives could force the individual to reveal sensitive information or perform an act of sabotage); Category "B" also includes those cases in which the individual:

(6) Refuses to serve in the Armed Forces when such refusal cannot be clearly shown to be due to religious convictions;

(7) Has been grossly careless in failing to protect or safeguard any Restricted Data or defense information;

(8) Has abused trust, has been dishonest, or has engaged in infamous, immoral or notoriously disgraceful conduct without adequate evidence of reformation;

(9) Is a sexual pervert or homosexual;

(10) Is a user of alcohol habitually and to excess, or has been such without adequate evidence of rehabilitation;

(11) Refuses, upon the ground of constitutional privilege against self-incrimination, to testify before a Congressional Committee regarding charges of his alleged disloyalty or other misconduct.

PROCEDURES

§ 10.20 Purpose of the procedures.

These procedures establish methods for the conduct of personnel security board hearings and administrative review of questions concerning an individual's eligibility for access authorization pursuant to the Atomic Energy Act of 1954, as amended, and Executive Order 10865, when it has been determined that such questions cannot be favorably resolved by interview or other investigation.

§ 10.21 Suspension of access authorization.

In those cases where information is received which raises a question concerning the continued eligibility of an individual for AEC access authorization, the Manager of the office concerned shall forward to the General Manager, via the Director, Division of Security, AEC, his recommendation as to whether the individual's access authorization should be suspended pending the final determination resulting from the consideration of the procedures provided in this part. In making this recommendation the Manager shall consider such factors as the seriousness of the derogatory information developed, the possibility access of the individual to classified information, and the individual's opportunity by reason of his position to commit acts adversely affecting the national security. The access authorization of an individual shall not be suspended except by direction of the General Manager.

§ 10.22 Notice to individual.

A notification letter, prepared by the Division of Security, AEC, approved by the Office of the General Counsel, and signed by the Manager of Operations, shall be presented to each individual whose eligibility for access authorization is in question. Where practicable such letter shall be presented to the individual in person. The letter shall state:

(a) That reliable information in possession of the Commission has created substantial doubt concerning the individual's eligibility for access authorization;

(b) The information which creates substantial doubt regarding the individual's eligibility for access authorization shall be as comprehensive and detailed as the national security permits;

(c) In the event the [illegible] a Board hearing [illegible] days of the date [illegible] letter indicating [illegible] Manager from which [illegible] letter that he wishes [illegible] Personnel Security [illegible]

(d) That within twenty [illegible] of receipt of the notification letter the individual shall file with [illegible] from whom he received the letter a written answer under oath or affirmation, to each item of information which raises the question of eligibility for access authorization;

(e) That, if the individual requests, a hearing will be afforded before a Personnel Security Board. With due regard for the convenience and necessity of the parties or their representatives for the purpose of affording the individual an opportunity of supporting his eligibility and clearance;

(f) That, if the individual requests a hearing, he will be notified of the membership of a Personnel Security Board when it is appointed by the Manager;

(g) That the individual has the right to appear personally before the Personnel Security Board, to present evidence in his own behalf, through witnesses, or by documents, or both, subject to the limitations of § 10.27(f), be present during the hearing and be accompanied and advised by counsel or a representative of his choosing;

(h) That the individual may make a written request for a hearing before a Personnel Security Board in accordance with paragraph (e) of this section, will be deemed a relinquishment by him of his opportunity of availing himself of the right to a hearing and review procedure provided in this part, and that in such event a recommendation as to the action to be taken will be made by the Director of Operations and submitted to the General Manager for his

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letter that he wishes a hearing be-
a Personnel Security Board;

) That within twenty days of the
of receipt of the notification letter,
individual shall file with the Man-
from whom he received such letter
written answer under oath or affir-
, to each item of reported infor-
which raises the question of his
ility for access authorization;

) That, if the individual so re-
, a hearing will be scheduled be-
a Personnel Security Board with
regard for the convenience and
ity of the parties or their repre-
atives for the purpose of affording
individual an opportunity of sup-
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ation;

) That, if the individual requests a
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) That the individual will have the
to appear personally before a Per-
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ed and advised by counsel of his own
sing;

) That the individual's failure to
a written request for a hearing be-
a Personnel Security Board, in ac-
dance with paragraphs (c) and (d)
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part, and that in such event a
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be taken will be made by the Man-
Operations and submitted to the
Manager for his decision on the basis of the information in the case without reference to a Personnel Security Board;

(i) His access authorization status until further notice;

(j) The name of the designated AEC official to contact for any further information desired.

§ 10.23 Additional information.

A copy of this part shall be given to the individual with the notification letter.

§ 10.24 Failure of individual to request a hearing.

(a) In the event the individual fails, within the prescribed time, to file a written request for a hearing before a Personnel Security Board, pursuant to § 10.22, a recommendation as to the final action to be taken shall be made by the Manager of Operations to the General Manager on the basis of the information in the case;

(b) The Manager of Operations may for good cause shown, at the request of the individual, extend the time for filing a written request for a hearing or for filing a written answer to the matters contained in the notification letter.

§ 10.25 Selection of AEC Hearing Counsel.

(a) Upon receipt from the individual of his written answer to the notification letter, signifying his desire to appear before a Personnel Security Board and answering under oath or affirmation the allegations contained in the notification letter, an AEC attorney shall forthwith be assigned to act as Hearing Counsel;

(b) Hearing Counsel shall, prior to the scheduling of the Board hearing, review the information in the case and shall request the presence of witnesses and the production of physical evidence in accordance with the provisions of paragraphs (m), (n), (o), and (p) of § 10.27. When the presence of a witness is deemed by the Hearing Counsel to be necessary or desirable to a proper determination of the issues before the

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Board, the Manager shall make arrangement by subpoena or otherwise for such witnesses to appear, be confronted by the individual, and be subject to examination and cross-examination;

(c) Hearing Counsel is authorized to consult directly with the individual if he is not represented by counsel, or if so represented with his counsel or representative, for purposes of reaching mutual agreement upon arrangements for an expeditious hearing of the case. Such arrangements may include clarification of issues, and stipulations with respect to testimony and the contents of documents and other physical evidence. Such stipulations when entered into shall be binding upon the individual and the Atomic Energy Commission for the purposes of this part. Prior to such consultation the Hearing Counsel shall advise the individual of his right to Counsel or other representation and of the possibility that any statements made by the individual to the Hearing Counsel may be used in subsequent proceedings;

(d) The individual is responsible for producing witnesses in his own behalf or presenting other proof before the board to support his answer and defense to the allegations contained in the notification letter. When requested, however, Hearing Counsel shall assist him to the extent practicable and necessary. In the Hearing Counsel's sound discretion he may request the Manager of Operations to arrange for the issuance of subpoenas for witnesses to attend the hearing in the individual's behalf, or for the production of specific documents or other physical evidence, provided a showing of the necessity for such assistance has been made.

§ 10.26 Appointment of Personnel Security Boards.

(a) Upon receipt of advice from the Hearing Counsel that all arrangements for an expeditious hearing have been completed, the Manager shall forthwith appoint a Personnel Security Board consisting of three members, one of whom shall be designated as the Chairman of the Personnel Security Board;

(b) The personnel of the Board, as practicable as determined by the Manager, shall consist of at least one member who is an attorney and one member who is familiar with the general field of work of the individual;

(c) The personnel of the Board shall be selected from a panel of individuals possessing the highest degree of integrity, ability, and good judgment. Such panels may include employees of the AEC or its contractors but no employee of an AEC contractor shall serve as a member of a Personnel Security Board hearing the case of an employee of or an applicant for employment with the contractor;

(d) All persons serving as members of Personnel Security Boards shall have an AEC "Q" clearance;

(e) No person shall serve as a member of a Personnel Security Board who has prejudged the case to be heard who possesses information that would make it embarrassing to render impartial recommendations or advice; or who for bias or prejudice generated for any reason would be unable to render fair and impartial recommendations or advice;

(f) Immediately upon the appointment of a Personnel Security Board the Manager will notify the individual of the identity of the members of the Personnel Security Board and of his right to challenge any member for cause, such challenge or challenges, accompanied by the reasons therefor, to be submitted to the Manager within seventy-two hours of the receipt of the notice;

(g) In the event that the individual challenges a member or members of the Personnel Security Board, the justification of the action of the individual shall be determined by the Manager. Where the challenge of the individual is sustained, the Manager shall forthwith appoint such new members as required

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Board and notify the i
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(h) The Manager of
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one week in advance, of
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will convene. In the
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place specified, a recomm
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by the Manager of Ope
General Manager on the
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Manager of Operations
cause shown, at the requ
vidual, permit the indivi
before a Personnel Secur
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§ 10.27 Conduct of proce

(a) The proceedings
started by the Chairman
of Security Board in a
impartial, and decorous man
effort made to protect t
the Government and of
and to arrive at the truth
that undue delay be tole
the individual be hamper
restricting the time necess
preparation and presenta
forming their duties, the
the Board shall always bea
make clear to all concerned
hearing is an administra
and not a trial;

(b) The proceedings s
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mission, the individual, his
such persons as may be offi
ed by the Board. Witnes

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challenge shall be dealt with in the
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Manager shall also notify the indi-
of his rejection of any challenge.
Personnel Security Board shall con-
as soon as is reasonably practi-

The Manager of Operations shall
the individual in writing, at least
week in advance, of the date, hour,
place the Personnel Security Board
convene. In the event the indi-
fails to appear at the time and
specified, a recommendation as to
al action to be taken shall be made
the Manager of Operations to the
eral Manager on the basis of the in-
ation in the case. However, the
ager of Operations may for good
shown, at the request of the indi-
, permit the individual to appear
a Personnel Security Board at a
scheduled date, hour, and place.

Conduct of proceedings.

The proceedings shall be con-
ed by the Chairman of the Person-
curity Board in an orderly, im-
, and decorous manner with every
made to protect the interests of
overnment and of the individual
arrive at the truth. In no case
undue delay be tolerated nor will
ividual be hampered by unduly
ting the time necessary for proper
ation and presentation. In per-
their duties, the members of
rd shall always bear in mind and
ear to all concerned that the pro-
is an administrative hearing
a trial;

The proceedings shall be open
duly authorized representatives
staff of the Atomic Energy Com-
, the individual, his counsel, and
ons as may be officially author-
the Board. Witnesses shall not
testify in the presence of other witnesses;

(c) 1. Hearing Counsel shall examine and cross-examine witnesses and otherwise assist the Board in such a manner as to bring out a full and true disclosure of all facts, both favorable and unfavorable, having a bearing on the issues before the Board. In performing his duties, he shall avoid the attitude of a prosecutor and shall always bear in mind that the proceeding is an administrative hearing and not a trial;

2. Hearing Counsel shall not participate in the deliberations of the Board, and shall express no opinion to the Board concerning the merits of the case. He shall also advise the individual of his rights under these procedures when the individual is not represented by counsel of his own choosing;

(d) The Board may ask the individual AEC representatives, and other witnesses any supplemental questions which the Board deems appropriate to assure the fullest possible disclosure of relevant and material facts. The proponent of a witness shall conduct the direct examination of that witness;

(e) During the course of the proceedings the Chairman shall rule in open session on all questions presented to the Board for its determination, subject to the objection of any member of the Board. In the event of an objection by any member of the Board, a majority vote of the Board shall be determinative and constitute the ruling of the Chairman. Voting may be either in open or closed session on all questions except recommendations to grant or deny access authorization, which shall be in closed session;

(f) In the event it appears in the course of the hearing that Restricted Data or defense information may be disclosed, it shall be the duty of the Chairman to assure that disclosure is not made to persons who are not authorized to receive it;

(g) The Board shall admit in evidence any matters either oral or written

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which are material, relevant and competent in determining the issues involved, including the testimony of responsible persons concerning the integrity of the individual. The utmost latitude shall be permitted with respect to relevancy, materiality, and competency. Every reasonable effort shall be made to obtain the best evidence available. Hearsay evidence may for good cause shown be admitted without regard to technical rules of admissibility and accorded such weight as the circumstances warrant;

(h) Testimony of the individual and witnesses shall be given under oath or affirmation, and the individual and witnesses shall be subject to cross-examination. Attention of the individual and the witness shall be invited to 18 U.S.C. 1001 and 18 U.S.C. 1621;

(i) The individual shall be afforded the opportunity of testifying in his own behalf;

(j) The Board shall endeavor to obtain all the facts that are reasonably available in order for it to arrive at its recommendations. If, prior to or during the proceeding, in the opinion of the Board the allegations in the notification letter are not sufficient to cover all matters into which inquiry should be directed, the Board shall recommend to the Manager concerned that, in order to give more adequate notice to the individual, the notification letter should be amended. Any amendment shall be made with the concurrence of the Director, Division of Security, AEC, and the Office of the General Counsel. If, in the opinion of the Board, the circumstances of such an amendment may involve an undue hardship to the individual, because of limited time to answer the new allegations in the notification letter, an appropriate adjournment shall be granted upon the request of the individual;

(k) Unless permitted by paragraphs (*l*), (m), (n), (*o*), and (p) of this section, the record may contain no information adverse to the individual on any controverted issue unless (1) the information or its substance has been made available to the individual and he offers no objection to its presentation; or (2) the information or its substance is made available to him and the individual is afforded an opportunity to cross-examine the person providing the information. Information whose admission is not prohibited by this paragraph or by any other provision of this part, may be received and made a part of the record and may be considered by the Board or officials charged with making determinations under this part;

(l) A written or oral statement of a person relating to the characterization in the notification letter of any organization or person other than the individual may be received and considered by the Board without affording the individual an opportunity to cross-examine the person making the statement on matters relating to the characterization of the organization or person, provided the individual is given notice that it has been received and may be considered by the Board, and is informed of its contents provided such is not prohibited by § 10.27(f);

(m) The individual shall be afforded an opportunity to cross-examine persons who have made oral or written statements adverse to the individual relating to a controverted issue except that any such statement may be received and considered by the Board without affording such opportunity in either of the following circumstances:

(1) The head of the department supplying the statement certifies that the person who furnished the information is a confidential informant who has been engaged in obtaining intelligence information for the Government and that disclosure of his identity would be substantially harmful to the national interest, or

(2) The Commission or its special designee for that particular purpose has preliminarily determined, after considering information furnished by the investigative agency as to the reli-

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its presentation; or (2)
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opportunity to exam
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person and the accuracy of the
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and the Commission or such spe-
ee has determined that failure
Board to receive and consider
statement would, in view of the
to Restricted Data or defense in-
ion sought, be substantially
ful to the national security and
the person who furnished the infor-
cannot appear to testify (i) due
death, severe illness, or similar cause,
which case the identity of the per-
and the information to be considered
be made available to the individ-
or (ii) due to some other cause de-
ed by the Commission to be good
sufficient.

Whenever procedures under para-
(m) (1) or (2) of this section are
(i) the individual shall be given
mary of the information which
be as comprehensive and detailed
national security permits, and
appropriate consideration shall be
to the fact that the individual
have an opportunity to cross-
such person or persons;

Records compiled in the regular
of business, or other physical evi-
ther than investigative reports,
received and considered subject
ntal without authenticating wit-
provided that such information
en furnished to the AEC by an
ative agency pursuant to its re-
ilities in connection with assist-
Commission to safeguard Re-
Data or defense information;

Records compiled in the regular
of business, or other physical evi-
ther than investigative reports,
to a controverted issue which,
they are classified, may not be
ed by the individual, may be re-
and considered provided that;

The Commission or its special
for that purpose has made a
ry determination that such
evidence appears to be mate-

(2) The Commission or such designee has made a determination that failure to receive and consider such physical evidence would, in view of the access to Restricted Data or defense information sought, be substantially harmful to the national security; and

(3) To the extent that national security permits, a summary or description of such physical evidence shall be made available to the individual. In every such case, information as to the authenticity and accuracy of such physical evidence furnished by the investigative agency shall be considered.

(q) The Board may request the Manager to arrange for additional investigation on any points which are material to the deliberations of the Board and which the Board believes need extension or clarification. In this event, the Board shall set forth in writing those issues upon which more evidence is requested, identifying where possible persons or sources from which evidence should be sought. The Manager shall make every effort through appropriate sources to obtain additional information upon the matters indicated by the Board;

(r) A written transcript of the entire proceedings shall be made by a person possessing appropriate AEC clearance and, except for portions containing Restricted Data or defense information, a copy of such transcript shall be furnished the individual without cost.

§ 10.28 Recommendation of the Board.

(a) The Board shall carefully consider the record and the standards set forth herein. In reaching its determination the Board shall consider the demeanor of the witnesses who have testified before the Board, the probability or likelihood of the truth of their testimony, their credibility, the authenticity and accuracy of documentary evidence, or the lack of evidence upon some material points in issue. If the individual is, or may be, handicapped by the non-disclosure to him of confiden-

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tial information or by lack of opportunity to cross-examine confidential informants, the Board shall take that fact into consideration. The Board may also consider as part of the record the individual's past employment in the atomic energy program, and the nature and sensitivity of the job he is or may be expected to perform. Possible impact of the loss of the individual's services upon the AEC program shall not be considered by the Board;

(b) The Board shall make specific findings based upon the record as to whether each of the allegations contained in the notification letter is true or false and the significance which the Board attaches to such allegations. These findings shall be supported fully by a statement of reasons which constitute the basis for such findings;

(c) The recommendation of the Board shall be predicated upon its findings. If, after considering all the factors in the light of the criteria set forth in this part, the Board is of the opinion that it will not endanger the common defense and security and will be clearly consistent with the national interest to grant access authorization to the individual, it shall make a favorable recommendation; otherwise, it shall make an adverse recommendation;

(d) The recommendation of the Board shall be determined by a majority vote. In the event of a dissent from the majority, the recommendation of the minority member shall be made a matter of record together with a statement of the reasons leading to his conclusions. The recommendation of the Board shall be submitted to the Manager accompanied by a statement of the reasons leading to the Board's conclusions.

§ 1029 New evidence.

(a) In the event of the discovery of new evidence by the individual prior to final determination of the individual's eligibility for access authorization, such evidence shall be submitted by the individual or his representative [illegible] Manager of Operations from [illegible] received his notification letter;

(b) The Manager of Operations [illegible] the advice of Hearing Counsel [illegible] view the application for the [illegible] tion of new evidence to ascertain [illegible] teriality and relevancy and further [illegible] the individual or his representative [illegible] without fault in failing to present [illegible] evidence before. In the event it is [illegible] termined that the new evidence [illegible] be received, the Manager of Operations [illegible] shall:

(1) Refer the matter to the Personnel Security Board which had [illegible] appointed in the individual's case [illegible] the Manager of Operations has not [illegible] transmitted the record to the General Manager. The Board receiving the application for the presentation of evidence shall determine the form in which it shall be received, whether by testimony before the Board, by deposition, or by affidavit.

(2) In those cases where the Manager of Operations has forwarded the record to the General Manager, the application for presentation of new evidence shall be referred to the General Manager with appropriate comments and recommendations. In the event the General Manager determines that new evidence should be received, he shall determine the form in which it shall be received, whether by testimony before a Personnel Security Board, deposition, or by affidavit.

§ 10.30 Actions on the recommendations.

(a) The recommendations of the Board and any dissent therefrom shall be signed by the members of the Board as appropriate, and together with the record of the case, shall be transmitted with the least practicable delay to the Manager of Operations concerned.

(b) Upon receipt of the findings and recommendation of the Board, and the record, the Manager shall forthwith transmit it to the General Manager [illegible] through the Director [illegible] AEC. In those [illegible] access authorizations [illegible] the Board, the Manager [illegible] shall forward [illegible] the effect which [illegible] authorization would [illegible] atomic energy program.

(c) The General Manager [illegible] the record to the Manager [illegible] proceedings by the Board [illegible] with respect thereto [illegible] by the General Manager.

(d) (1) In the event [illegible] by the Board [illegible] authorization [illegible] shall be immediately [illegible] that fact by the General Manager [illegible] designee, and shall [illegible] Board's findings [illegible] each allegation contained [illegible] tion letter. The individual [illegible] notified of his right [illegible] of his case by the Personnel Security Review Board [illegible] submit a brief to support [illegible] The request for [illegible] mitted to the General Manager [illegible] five days after the [illegible] The brief shall [illegible] General Manager [illegible], Division of Security [illegible] later than 10 days after [illegible] notice, unless such time [illegible] General Manager [illegible]:

(2) Where the individual [illegible] view of the adverse [illegible] General Manager [illegible] the record, with [illegible] recommendations, to the Review Board;

(3) In the event the individual [illegible] request a review by the Personnel Security Review Board [illegible] recommendation with respect to the final determination [illegible] on the basis of the findings and recommendations [illegible]

(4) Where the Board's recommendation favors [illegible] and the General Manager [illegible]

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30 Actions on the recommendations.

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shall forward a statement concerning
the effect which denial of access
ation would have upon the
energy program;

The General Manager may return
ord to the Manager for further
dings by the Personnel Security
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ed by the General Manager;

) In the event of a recommendation
by the Board for a denial of
authorization, the individual
be immediately notified in writing
fact by the General Manager, or
signee, and shall be informed of
Board's findings with respect to
fication contained in the notification
letter. The individual shall also
ised of his right to request a review
of his case by the AEC Personnel
ity Review Board and of his right
mit a brief to support his contention.
The request for a review shall be
ted to the General Manager within
days after the receipt of the notification.
The brief shall be forwarded to
General Manager through the Director,
Division of Security, AEC, not
than 10 days after receipt of such
unless such time is extended by
General Manager for good cause

Where the individual requests a
of the adverse recommendation,
General Manager shall forthwith
the record, with all findings and
mendations, to the Personnel Security
Review Board;

In the event the individual fails
est a review by the AEC Personnel
rity Review Board of an adverse
mendation within the prescribed
the final determination shall be
the basis of the record with all
and recommendations;

Where the Board has made a
mendation favorable to the individual
and the General Manager proposes to transmit the record to the Personnel Security Review Board for its recommendation, the General Manager shall immediately cause the individual to be notified of that fact and of those matters contained in the notification letter concerning which he desires the advice of the Personnel Security Review Board. He shall further inform the individual that he may submit a brief concerning such matters for the consideration of the Personnel Security Review Board. Such brief shall be filed not later than 10 days from the receipt of the notice by the individual, unless extended for good cause shown. The brief shall be forwarded to the General Manager for transmission to the Personnel Security Review Board.

§ 10.31 Recommendations of the AEC Personnel Security Review Board.

(a) The AEC Personnel Security Review Board shall make its deliberations based upon the record, supplemented by such brief as the individual submits. The Personnel Security Review Board may request such additional briefs as it deems appropriate. In any case where the AEC Personnel Security Review Board determines that additional evidence or further proceedings are necessary, it may return the record to the General Manager with a recommendation that the case be remanded to the Manager of Operations for appropriate action;

(b) In its deliberations, the AEC Personnel Security Review Board shall make its findings and recommendations as to the eligibility of an individual for access authorization on the record supplemented by additional testimony or briefs, as determined by the Board. When additional testimony is taken by the Personnel Security Review Board a verbatim transcript of such testimony shall be made part of the record;

(c) The Personnel Security Review Board shall not concern itself with the possible impact of the loss of the indi-

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vidual's services upon the AEC program;

(d) After its deliberations, the AEC Personnel Security Review Board shall make its findings and recommendations on the record in writing to the General Manager.

§ 10.32 Action by the General Manager.

(a) The General Manager, on the basis of the record accompanied by all recommendations, shall then make a final determination whether access authorization shall be granted or denied, unless the provisions of § 10.27 (m), (n), (o), or (p) have been used, in which case the decision to deny or revoke access authorization may be made only by the Commission;

(b) In making the determination as to whether access authorization shall be granted or denied, the General Manager or Commission shall give due recognition to the favorable as well as the unfavorable information concerning the individual and shall take into account the value of the individual's services to the atomic energy program and the operational consequences of denial of access authorization;

(c) In the event of an adverse determination the General Manager shall notify the individual through the Manager of Operations of his decision that access authorization is being denied or revoked and of his findings with respect to each allegation contained in the notification letter for transmittal to the individual.

§ 10.33 Action by the Commission.

(a) Whenever an individual has not been afforded an opportunity to confront and cross-examine witnesses who have furnished information adverse to the individual under the provisions of § 10.27 (m), (n), (o), or (p) and an adverse recommendation has been made by the General Manager, the Commissioners shall personally review the record and determine whether access authorization shall be granted, de... revoked, based upon the record;

(b) When the Commission det... to deny or revoke access author... the individual will be notified th... the Manager of Operations of its ... cision that access authorization is ... denied or revoked and of its ... with respect to each allegation ... tained in the notification lette... transmittal to the individual;

(c) Nothing contained in the... cedures shall be deemed to lim... affect the responsibility and pow... the Commission to deny or revo... cess to Restricted Data or defe... formation if the security of the ... so requires. Such authority may ... delegated and may be exercised ... when the Commission determi... the procedures prescribed in ... (m), (n), (o), or (p) cannot be ... voked consistently with the ... security and such determinatio... be conclusive.

§ 10.34 Reconsideration of case.

(a) Where, pursuant to the ... dures set forth in §§ 10.20 to 10... General Manager or the Commis... made a determination granting ... authorization to an individual, the ... vidual's eligibility for access author... tion shall be reconsidered only ... subsequent to the time of the prior ... ing, there is new substantially de... tory information or a significa... crease in the scope or sensitivity ... Restricted Data or defense infor... to which the individual has or will ... access;

(b) Where, pursuant to these ... dures, the Commission or General ... ager has made a determination ... access authorization to an indivi... the individual's eligibility for ac... thorization may be reconsidered ... there is a bona fide offer of em... requiring access to Restricted Da... defense information and either ... and relevant new evidence, which ... individual and his representative ...

...out fault in failing ... or convincing eviden... or rehabilitation. R... sideration shall be ... to the General Ma... Manager of Operations ... over the position ... authorization is re... is shall be accompa... setting forth in de... referred to above. ... shall cause the ... ified as to whether ... access authorization ... and, if so, the mei... reconsideration wi...

... Where access auth... granted to an individ... of Operations witho... procedures set forth ... the individual's elig... authorization shall be ... in a case where subs... ...ing of the access ... substantially deroga... has been received ... ...ificant increase in the ...ity of the Restricted ... information to whic... has or will have acce... case only with spe... ...al of the Director, ...urity, AEC.

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fault in failing to present be-
convincing evidence of reforma-
rehabilitation. Requests for re-
ration shall be submitted in
to the General Manager through
Manager of Operations having juris-
over the position for which ac-
authorization is required. Such
shall be accompanied by an affi-
setting forth in detail the infor-
referred to above. The General
shall cause the individual to
ined as to whether his eligibility
access authorization will be recon-
and, if so, the method by which
reconsideration will be accom-
ed.

Where access authorization has
granted to an individual by a Man-
of Operations without recourse to
procedures set forth in §§ 10.20 to
the individual's eligibility for ac-
authorization shall be reconsidered
a case where subsequent to the
of the access authorization,
stantially derogatory informa-
has been received or there is a
ant increase in the scope or sen-
of the Restricted Data or de-
formation to which the individ-
has or will have access, and in any
only with specific prior ap-
of the Director, Division of
, AEC.

MISCELLANEOUS

Terminations.

the event the individual is no
an applicant for access authori-
or no longer requires access au-
tion the procedures of this part
terminated without a final de-
tion as to his eligibility for
uthorization.

Attorney Representation.

the event the individual is repre-
by an attorney or other such
ntative, the individual shall file
AEC a document designating
rney or representative and au-
such attorney or representa-
tive to receive all correspondance, transcripts and other documents pertaining to the proceeding under this part.

§ 10.37 Certifications.

Whenever information is made a part of the record under the exceptions authorized by § 10.27 (m), (n), (o), and (p), the record shall contain certificates evidencing that the determinations required therein have been made.

§ 10.38 Washington Area cases.

In those cases which may arise involving individuals within the Washington Area of AEC operations, an Assistant General Manager designated by the General Manager shall discharge the functions and responsibilities assigned to Managers of Operations in these procedures.

Dated at Washington, D.C., this 1st day of July 1960.

A. R. LUEDECKE,
General Manager.

PART 25—PERMITS FOR ACCESS TO RESTRICTED DATA

Part 25 is amended in its entirety to revise the procedures and categories of information under the Access Permit Program. Because interested persons will not be adversely affected and because the action liberalizes the conditions under which information may be obtained, the Commission has found that good cause exists why the regulations in this part should be made effective immediately.

Pursuant to the Administrative Procedure Act, Public Law 404, 79th Cong., 2d sess., the following rules are published as a document subject to codification, to be effective upon publication in the FEDERAL REGISTER.

GENERAL PROVISIONS

Sec.
25.1 Purpose.
25.2 Applicability.
25.3 Definitions.
25.4 Interpretations.
25.5 Communications.
25.6 Categories of available information.
25.7 Specific waivers.

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APPLICATIONS

Sec.
25.11 Applications.
25.12 Non-eligibility.
25.13 Additional information.
25.14 Public inspection of applications.
25.15 Requirements for approval of applications.

PERMITS

25.21 Issuance.
25.22 Scope of permit.
25.23 Terms and conditions of access.
25.24 Administration.
25.25 Term and renewal.
25.26 Assignment.
25.27 Amendment.
25.28 Commission action on application to renew or amend.
25.29 Suspension, revocation and termination of permits.
25.30 Exceptions and additional requirements.
25.31 Violations.

GENERAL PROVISIONS

§ 25.1 Purpose.

This part establishes procedures and standards for the issuance of an Access Permit to any person subject to this part who requires access to Restricted Data relating to the civil uses of atomic energy for use in his business, trade or profession; provides for the amendment, renewal, suspension, termination and revocation of an Access Permit; and specifies the terms and conditions under which the Commission will issue the Permit.

§ 25.2 Applicability.

The regulations in this part apply to any person within or under the jurisdiction of the United States who desires access to Restricted Data for use in his business, profession or trade.

§ 25.3 Definitions.

As used in this part:

(a) "Access Permit" means a permit, issued by the Atomic Energy Commission, authorizing access by the named permittee to Restricted Data relating to the civil uses of atomic energy in accordance with the terms and conditions stated on the permit.

(b) "Act" means the Atomic [illegible] Act of 1954 (68 Stat. 919), including amendments thereto.

(c) "Category" means a category of Restricted Data designated in Appendix "A" to the regulations in this [illegible]

(d) "Commission" means the Atomic Energy Commission or its duly authorized representatives.

(e) "Permittee" means the holder of a permit issued pursuant to the regulations in this part.

(f) "Person" means (1) any individual, corporation, partnership, association, trust, estate, public or private institution, group, Government agency other than the Commission, any state or any political subdivision of any political entity within a state, any other entity; and (2) any legal successor, representative, agent, or agency of the foregoing.

(g) "Restricted Data" means all data concerning (1) design, manufacture or utilization of atomic weapons, (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy, but shall not include data declassified or removed from the Restricted Data category pursuant to section 142 of the Act.

§ 25.4 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

§ 25.5 Communications.

All communications concerning the regulations in this part, and applications filed under them, should be addressed to the Commission Operations Office listed in Appendix "B" of this part responsible for the geographical area in which (a) the applicant's principal place of business is located, or (b) the principal place where the

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...political subdivision of, ...
...entity within a State, ...
...and (2) any legal ...
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...the Act.

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...has categorized Restricted Data ...
...will be made available to permit...
...the two categories as set forth in ...
...dix "A" to this part. Top Secret ...
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...of atomic weapons are not included ...
...categories and will not be ...
...available under this part.

...Specific waivers.

...Commission may, upon applica...
...any interested party, grant such ...
...from the requirements of this ...
...as it determines are authorized by ...
...and will not constitute an undue ...
...to the common defense and ...
...ity.

APPLICATIONS

...Applications.

...Any person desiring access to Re...
...Data pursuant to this part ...
...submit an application (Form ...
...), in triplicate, for an access ...
...to the Commission's Operations ...
...listed in Appendix "B" to this ...
...esponsible for the area in which ...
...applicant's principal place of ...
...is located, or (2) the princi...
...ce where the applicant will use ...
...stricted Data is located.

...Where an individual desires ac...
...Restricted Data for use in the ...
...rance of his duties as an em...
...the application for an access ...
...must be filed in the name of his ...
...er.

...Self-employed private consult...
...ering access to Restricted Data, ...
...the application in their own ...
...an individual access permit. ...
...Each application should contain ...
...wing information:

...Name of applicant (unincorpo...
...subsidiaries or divisions of a ...
corporation must apply in the name of the corporation);

(2) Address of applicant;

(3) Description of business or occupation of applicant;

(4) (i) If applicant is an individual, state citizenship.

(ii) If applicant is a partnership, state name, citizenship and address of each partner and the principal location where the partnership does business.

(iii) If applicant is a corporation or an unincorporated association, state:

(*a*) The state where it is incorporated or organized and the principal location where it does business;

(*b*) The names, addresses and citizenship of its directors and of its principal officers;

(*c*) Whether it is owned, controlled or dominated by an alien, a foreign corporation, or foreign government, and if so, give details.

(iv) If the applicant is acting as agent or representative of another person in filing the application, identify the principal and furnish information required under this subparagraph with respect to such principal;

(5) Total number of full-time employees;

(6) Classification of Restricted Data (Confidential or Secret) to which access is requested;

(7) Potential use of the Restricted Data in the applicant's business, profession or trade. If access to Secret Restricted Data is requested, list the specific categories by number and furnish detailed reasons why such access within the specified categories is needed by the applicant. The need for Secret information should be stated by describing its proposed use in specific research, design, planning, construction, manufacturing, or operating projects; in activities under licenses issued by the Commission; in studies or evaluations planned or underway; or in work or services to be performed for other organizations.

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In addition, if access to Secret Restricted Data in category C–65 Plutonium Production is requested, the application should also include sufficient information to satisfy the requirements of § 25.15(b)(2).

(8) Principal Location(s) at which Restricted Data will be used.

(e) Applications should be signed by a person authorized to sign for the applicant.

(f) Each application shall contain complete and accurate disclosure with respect to the real party or parties in interest and as to all other matters and things required to be disclosed.

§ 25.12 Non-eligibility.

The following persons are not eligible to apply for an access permit:

(a) Corporations not organized under the laws of the United States or a political subdivision thereof.

(b) Any individual who is not a citizen of the United States.

(c) Any partnership not including among the partners one or more citizens of the United States; or any other unincorporated association not including one or more citizens of the United States among its principal officers.

(d) Any organization which is owned, controlled or dominated by the Government of, a citizen of, or an organization organized under the laws of a country or area listed as a Subgroup A country or destination in § 371.3 (15 CFR 371.3) of the Comprehensive Export Schedule of the United States Department of Commerce.

(e) Persons subject to the jurisdiction of the United States who are not doing business within the United States.

§ 25.13 Additional information.

The Commission may, at any time after the filing of the original application and before the termination of the permit, require additional information in order to enable the Commission to determine whether the permit should be granted or denied or whether it should be modified or revoked.

§ 25.14 Public inspection of applications.

Applications and documents submitted to the Commission in connection with applications may be made available for public inspection in accordance with the regulations contained in Part [illegible] of this chapter.

§ 25.15 Requirements for approval of applications.

(a) An application for an access permit authorizing access to Confidential Restricted Data in the categories set forth in Appendix "A" will be approved only if the application demonstrates that the applicant has a potential need or application for such data in his business, trade or profession and has filed a complete application form.

(b)(1) An application for an access permit authorizing access to Secret Restricted Data will be approved only if the application demonstrates that the applicant has a need for such data in his business, trade or profession and has filed a complete application form.

(2) An application for an access permit authorizing access to Secret Restricted Data in category C–65 Plutonium Production will be approved only if the application demonstrates to that the applicant:

(i) Is directly engaged in a substantial effort to develop, design, build or operate a chemical processing plant or other facility related to his participation in the peaceful uses of atomic energy for which such production and cost data are needed; or

(ii) Is furnishing to a person having access to C–65 under subdivision (i) of this subparagraph, substantial scientific, engineering or other professional services to be used by such permittee in carrying out the activities for which said permittee received access to category C–65.

PERMI

§ 25.21 Issuance.

(a) Upon a determ application meets the this regulation, the issue to the applicant Form AEC 379.

(b) An Access Perm rity clearance. It do any individual not hav AEC security clea Restricted Data. See of this chapter.

§ 25.22 Scope of permi

(a) All access permi authorize access terms and conditions o to Confidential Re categories C–44 and C–

(b) In addition, acc authorize access, subje and conditions of the a Secret Restricted cluded within the partic categories specified in

§ 25.23 Terms and cond

(a) Neither the Uni Commission, nor an behalf of the Com warranty or other expressed or implied, (1) accuracy, complete of any information pursuant to an access the use of any su not infringe pri rights.

(b) The Commission rights with respect or discovery as it m to section 152 of the such invention or dis made or conceived in connection with, or to Restricted Data terms of an access per

(c) Each permittee sh (1) Comply with all a of the Atomic Ener with Part 95 of thi

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ices to be used by said
arrying out the activities
permittee received acces
–65.

PERMITS

Issuance.

Upon a determination that an
cation meets the requirements of
regulation, the Commission will
to the applicant an access permit
m AEC 379.

An Access Permit is not a secu-
clearance. It does not authorize
individual not having an appropri-
AEC security clearance to receive
ricted Data. See § 25.24 and Part
this chapter.

Scope of permit.

All access permits will as a mini-
authorize access, subject to the
and conditions of the access per-
to Confidential Restricted Data in
ories C–44 and C–65.

In addition, access permits may
horize access, subject to the terms
conditions of the access permit, to
Secret Restricted Data as is in-
within the particular category or
ories specified in the permit.

Terms and conditions of access.

Neither the United States, nor
mmission, nor any person acting
half of the Commission makes
warranty or other representation,
or implied, (1) with respect to
curacy, completeness or useful-
any information made available
nt to an access permit, or (2)
use of any such information
not infringe privately owned

The Commission hereby waives
ghts with respect to any inven-
discovery as it may have pursu-
section 152 of the Act by reason
invention or discovery having
made or conceived in the course of,
nection with, or resulting from
Restricted Data received under
of an access permit.

Each permittee shall:

Comply with all applicable pro-
of the Atomic Energy Act of 1954
h Part 95 of this chapter and with all other applicable rules, regulations and orders of the Commission;

(2) Be deemed to have waived all claims for damages under section 193 of title 35 U.S. Code by reason of the imposition of any secrecy order on any patent application and all claims for just compensation under section 173 of the Atomic Energy Act of 1954, with respect to any invention or discovery made or conceived in the course of, in connection with or as a result of access to Restricted Data received under the terms of the access permit;

(3) Be deemed to have waived any and all claims against the United States, the Commission and all persons acting on behalf of the Commission that might arise in connection with the use, by the applicant, of any and all information supplied by them pursuant to the access permit;

(4) Obtain and preserve in his files written agreements from all individuals who will have access to Restricted Data under his access permit. The agreement shall be as follows:

In consideration for receiving access to Restricted Data under the access permit issued by the AEC, I hereby agree to:

(a) Waive all claims for damages under section 183 of Title 35 U.S. Code by reason of the imposition of any secrecy order on any patent application, and all claims for just compensation under section 173 of the Atomic Energy Act of 1954, with respect to any invention or discovery made or conceived in the course of, in connection with or resulting from access to Restricted Data received under the terms of the access permit issued to (insert the name of the holder of the access permit),

(b) Waive any and all claims against the United States, the Commission and all persons acting on behalf of the Commission that might arise in connection with the use, by me, of any and all information supplied by them pursuant to the access permit issued to (insert the name of the holder of the access permit).

(5) Pay all established charges for personnel security clearances, AEC consulting services, publication and reproduction of documents, and such other services as the Commission may furnish in connection with the access permit.

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§ 25.25 Administration.

With respect to each permit issued pursuant to the regulations in this part, the cognizant Operations Office, will:

(a) Process all personnel security clearances requested in connection with the permit;

(b) Review the procedures submitted by the Applicant, in accordance with Part 95 of this chapter, for the safeguarding of Restricted Data; and

(c) Provided information to the permittee with respect to the sources and locations of Restricted Data available under this permit and to assist the permittee in other matters pertaining to the administration of his permit.

§ 25.25 Term and renewal.

(a) Each access permit will be issued for a two year term, unless otherwise stated in the permit.

(b) Applications for renewal shall be filed in accordance with § 25.11. Each renewal application must be complete, without reference to previous applications. In any case in which a permittee has filed a properly completed application for renewal more than thirty (30) days prior to the expiration of his existing permit, such existing permit shall not expire until the application for a renewal has been finally acted upon by the Commission.

§ 25.26 Assignment.

An access permit is nontransferable and nonassignable.

§ 25.27 Admendment.

An access permit may be amended from time to time upon application by the permittee. An application for amendment may be filed, in triplicate, in letter form and shall be signed by an individual authorized to sign on behalf of the applicant. The term of an access permit shall not be altered by an amendment thereto.

§ 25.28 Commission action on application to renew or amend.

In considering an application by a permittee to renew or amend his permit, the Commission will apply the criteria set forth in § 25.15. Failure of an applicant to reply to a Commission request for additional information concerning an application for renewal or amendment within 60 days shall result in a rejection of the application without prejudice to resubmit a properly completed application at a later date.

§ 25.29 Suspension, revocation and termination of permits.

The Commission may revoke or suspend any access permit for any material false statement in the application or in any report submitted to the Commission pursuant to the regulations in this part or because of conditions or facts which would have warranted a refusal to grant the permit in the first instance, or for violation of any of the terms and conditions of the Atomic Energy Act of 1954 or Commission rules, regulations or orders issued pursuant thereto. A permittee should request termination of his permit when he no longer requires Restricted Data for use in his business, trade or profession.

§ 25.30 Exceptions and additional requirements.

Notwithstanding any other provision in the regulations in this part, the Commission may deny an application for an access permit or suspend or revoke an access permit, or incorporate additional conditions or requirements in any access permit, upon finding that such denial, revocation or the incorporation of such conditions and limitations is necessary or appropriate in the interest of the common defense and security or is otherwise in the public interest.

§ 25.31 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or any regulation or order issued thereunder. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be

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Dated at Germantow
day of April 1960.

For the Atomic Ene

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APPENDIX

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including Scope Notes f

Nuclear Technol
includes classified technic
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information on the follow

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sion studies.

Chemistry, chemical
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compounds. Included ar
processes of chemical s
active waste handling a
processing.

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studies and operation of
sources and reactor compo
This category does not i

Information which
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be distinguished from d
production rates and unit
nuclear production program

Information on an a
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86 and 86.

Top Secret informati
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or of isotope separation.

Plutonium Produc
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Technology which does
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Exceptions and additional
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conditions and limitations
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he common defense and
herwise in the public

Violations.

junction or other court
obtained prohibiting any
any provision of the Act or
on or order issued thereunder
son who willfully violates
n of the Act or any
issued thereunder may be

a crime and, upon conviction, may be
ished by fine or imprisonment or
as provided by law.

ted at Germantown, Md., this 11th
of April 1960.

For the Atomic Energy Commission.

A. R. LUEDECKE,
General Manager.

APPENDIX A

ories of Restricted Data Available
ding Scope Notes for Each Category)

(a) *Nuclear Technology.* This category
classified technical information con-
nuclear technology. It may contain
mation on the following:

1. Materials, including metals, ceramics,
and inorganic compounds. In-
are such technical areas as the tech-
and fabrication of fuel elements, cor-
studies, cladding techniques and radi-
studies.

2. Chemistry, chemical engineering and
chemistry of all the elements and their
pounds. Included are techniques and
of chemical separations, radio-
waste handling and feed material
ing.

3. Reactor physics, engineering and tech-
including theory, design, criticality
and operation of reactors, reactor
and reactor components.

This category does not include:

a. Information which reveals or from
can be calculated actual or planned
distinguished from design) capacities,
uction rates and unit costs for the plu-
production program; or

b. Information on an actual or planned
system which falls within the scope
military reactor categories—C–82, 83,
and 86.

c. Top Secret information and informa-
concerning weapons or classified meth-
isotope separation.

(b) *Plutonium Production.* This cate-
includes information on reactor, fuel
and separations technology which
or from which can be calculated ac-
planned (as distinguished from de-
capacities, production rates and unit
for the Hanford and Savannah River
ion facilities.

nology which does not reveal or en-
culation of production rates and unit
Hanford or Savannah River produc-
facilities is categorized in C–44—Nu-
Technology.

APPENDIX B

Commission's Operations Offices

Albuquerque Operations Office, U.S. Atomic Energy Commission, P.O. Box 5400, Albuquerque, N. Mex.

Chicago Operations Office, U.S. Atomic Energy Commission, 9800 South Cass Avenue, Argonne, Ill.

Hanford Operations Office, U.S. Atomic Energy Commission, P.O. Box 550, Richland, Wash.

Idaho Operations Office, U.S. Atomic Energy Commission, P.O. Box 2108, Idaho Falls, Idaho.

New York Operations Office, U.S. Atomic Energy Commission, 376 Hudson Street, New York 14, N.Y.

Oak Ridge Operations Office, U.S. Atomic Energy Commission, P.O. Box E, Oak Ridge, Tenn.

San Francisco Operations Office, U.S. Atomic Energy Commission, 518 17th Street, Oakland 12, Calif.

Savannah River Operations Office, U.S. Atomic Energy Commission, P.O. Box A, Aiken, S.C.

Geographical areas of responsibility

Arizona, Kansas, New Mexico, Oklahoma, and Texas.

Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

Alaska, Oregon, and Washington.

Colorado, Idaho, Montana, Utah, and Wyoming.

Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Arkansas, Kentucky, Louisiana, Mississippi, Missouri, Panama Canal Zone, Puerto Rico, Tennessee, Virginia, Virgin Islands, and West Virginia.

California, Hawaii, Nevada, and U.S. Pacific Territories.

Alabama, Florida, Georgia, North Carolina, and South Carolina.

PART 30—LICENSING OF BY PRODUCT MATERIAL

EXEMPT CONCENTRATIONS

On October 31, 1958, the Commission issued for public comment a proposed amendment to "Licensing of Byproduct Material," 10 CFR Part 30, which would exempt byproduct material from licensing requirements when contained in products in specified low concentrations. The amendment published below

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retains the substantive provisions set forth in the proposed rule although changes have been made in the text and concentration values to reflect recent information from the National Committee on Radiation Protection and is consonant with the Radiation Protection Guide approved by the President on May 13, 1960.

The exemption is intended to facilitate the distribution of products subjected to control procedures involving the use of byproduct material. With the exception of the person who introduces the byproduct material into a product, a license will not be required in order to receive, use, transfer, or dispose of such products. The licensee who introduces byproduct material into a product may transfer the byproduct material only if the transfer is made in accordance with a license issued pursuant to § 30.24(h) of the amendment. This limitation, however, would not restrict the transfer to a duly licensed person of byproduct material intended for analytical or laboratory purposes or for waste disposal.

The license-exempt concentrations in § 30.73 *Schedule C*, of the following amendment are equal to the lowest value for each byproduct material given in Table I of National Bureau of Standards Handbook 69 for continuous occupational exposure (168-hour week). The values selected are those for soluble forms which in general are lower than for insoluble forms. The products in which license-exempt concentrations would be permitted are items such as oil, gasoline, plastics, and similar commercial or industrial items where inhalation or ingestion is unlikely. In addition, while the concentration values in NBS 69 are based on continuous exposure for a whole lifetime, such exposure from the products involved here is highly unlikely. It is highly improbable, therefore, that any member of the public will receive an organ dose in excess of a small fraction of 0.5 rem, the Radiation Protection Guide for members of the general population recommended by the President in his memorandum dated May 13, 1960. The proposed exempt concentrations are high enough to make quality control applications feasible from the licensing standpoint and low enough to assure safety of the public.

The values set forth in the following amendment are established as concentrations which the Commission considers may be exempted from licensing requirements to the extent provided in this amendment. However, applications for licenses pursuant to § 30.24(h) of the amendment will be required to show that, for their particular purpose, lower concentrations than those specified in § 30.73 are not feasible. The Commission does not propose to license the distribution of products containing byproduct material under this amendment if it is likely that such products will be ingested or inhaled.

Persons licensed under this amendment to distribute products containing byproduct material would be required to file an annual report describing the products transferred and the type and amount of each byproduct material in such products transferred during the year. This will keep the Commission informed of the total amount of material transferred in such concentrations and provide a basis for a continuing evaluation of the addition of radioactivity to the environment.

The scheduled concentrations refer to the parent activity in those cases where a radioisotope disintegrates into other radioactive isotopes or daughter products. The proposed exemptions do not extend to imports of byproduct material. Requirements for the issuance of a license authorizing the transfer of products or materials containing byproduct material are separately established in § 30.24(h) of the amendment published below.

The Commission has found that the exemption set forth in this amendment will not constitute an unreasonable risk to the common defense and security

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Section 274 of the
of 1954, as amended
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Commission's regul
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assumption thereof
withstanding, any
the Commission and
assumption of regu
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under subsection 2
rule or order, "that
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by the Commission."
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Part 30, "Licensing
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FEDERAL REGISTER:
1. Add a new § 30.9
§ 30.9 Exempt conc
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(b) This section s
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30.24(h) of the amendment
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the health and safety of the public. Section 274 of the Atomic Energy Act 1954, as amended, establishes, among things, procedures and criteria the discontinuance of certain of the Commission's regulatory responsibilities with respect to byproduct, source, special nuclear materials, and the exemption thereof by the states. Notwithstanding, any agreement between the Commission and any state for the exemption of regulatory responsibilities previously exercised by the Commission, the Commission is authorized under subsection 274c, to require, by rule or order, "that the manufacturer, processor, or producer of any equipment, device, commodity, or other product containing source, byproduct, or special nuclear material shall not transfer possession or control of such product except pursuant to a license issued by the Commission."

Prior to executing any agreement providing for assumption of regulatory responsibilities by a state, the Commission will consider exercising the authority conferred on it by subsection 274c with respect to distribution of products covered by the following amendments.

Pursuant to the Administrative Procedure Act, Public Law 404, 79th Congress, 2d session, Title 10, Chapter I, Part 30, "Licensing of Byproduct Material," is amended as follows, effective ... days after publication in the FEDERAL REGISTER:

1. Add a new § 30.9 to read as follows:

§ 30.9 Exempt concentrations.

(a) Except as provided in § 30.32(f), any person is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations of this part to the extent that such person receives, possesses, uses, transfers, or delivers or acquires products or materials containing byproduct material in concentrations not in excess of those listed in § 30.73.

(b) This section shall not be deemed to authorize the import of byproduct material or products containing byproduct material.

§ 30.24 [Amendment]

2. Add a new § 30.24(h) to read as follows:

(h) *Licensing the transfer of products containing exempt concentrations of byproduct material.* (1) An application for a specific license to transfer possession or control of products or materials containing exempt concentrations of byproduct material which the transferor has introduced into the product or material will be approved if the applicant:

(i) Satisfies the general requirements specified in § 30.23;

(ii) Submits a description of the product or material into which the byproduct material will be introduced, intended use of the byproduct material and the product into which it is introduced, method of introduction, initial concentration of the byproduct material in the product or material, control methods to assure that no more than the specified concentration is introduced into the product or material, estimated time interval between introduction and transfer of the product or material, and estimated concentration of the radioisotope in the product or material at the time of transfer by the licensee; and

(iii) Provides reasonable assurance that the concentrations of the byproduct material at the time of transfer will not exceed the concentrations in § 30.73, that reconcentration of the byproduct material in concentrations exceeding those in § 30.73 is not likely, that the product or material is not likely to be inhaled or ingested, and that use of lower concentrations is not feasible.

(2) Each person licensed under this paragraph shall file an annual report with the Director, Division of Licensing and Regulation, describing the kinds and quantities of products transferred, the concentration of byproduct material contained and the quantity of byproduct

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material transferred during the reporting period. Each report shall be filed as of June 30 and shall be filed within 30 days thereafter.

§ 30.32 [Amendment]

3. Add a new § 30.32(f) to read as follows:

(f) Notwithstanding the provisions of §§ 30.9 and 30.32(c) of this part, no person licensed by the Commission pursuant to the regulations in this part shall transfer possession or control of any product or material containing concentrations of byproduct material not exceeding those specified in § 30.73 which he has introduced into the product or material unless the transferor has received a license from the Commission pursuant to § 30.24(h) authorizing such transfer. The provisions of this paragraph (f) shall not apply to transfers to duly licensed persons of products or materials containing byproduct material for analytical, laboratory, or waste disposal purposes. This paragraph shall not be deemed to modify any authority granted to any person in a specific license issued by the Commission prior to the effective date of this paragraph.

4. Add a new § 30.73 to read as follows:

§ 30.73 Schedule C.

Element (atomic number)	Isotope	Column I Gas concentration uc/ml [1]	Column II Liquid and solid concentration uc/ml [2]
Antimony (51)	Sb 122	----------	3×10^{-4}
	Sb 124	----------	2×10^{-4}
	Sb 125	----------	1×10^{-3}
Argon (18)	A 37	1×10^{-3}	----------
	A 41	4×10^{-7}	----------
Arsenic (33)	As 73	----------	5×10^{-3}
	As 74	----------	5×10^{-4}
	As 76	----------	2×10^{-4}
	As 77	----------	8×10^{-4}
Barium (56)	Ba 131	----------	2×10^{-3}
	Ba 140	----------	3×10^{-4}
Beryllium (4)	Be 7	----------	2×10^{-2}
Bismuth (83)	Bi 206	----------	4×10^{-4}
Bromine (35)	Br 82	4×10^{-6}	----------
Cadmium (48)	Cd 109	----------	2×10^{-3}
	Cd 115m	----------	3×10^{-4}
	Cd 115	----------	3×10^{-4}
Calcium (20)	Ca 45	----------	1×10^{-4}
	Ca 47	----------	1×10^{-4}
Carbon (6)	C 14	1×10^{-6}	----------
Cerium (58)	Ce 141	----------	9×10^{-4}
	Ce 143	----------	4×10^{-4}
	Ce 144	----------	1×10^{-4}
Cesium (55)	Cs 131	----------	2×10^{-3}
	Cs 134m	----------	4×10^{-3}
	Cs 134	----------	9×10^{-5}
Chlorine (17)	Cl 38	9×10^{-5}	----------
Chromium (24)	Cr 51	----------	2×10^{-3}
Cobalt (27)	Co 57	----------	1×10^{-3}
	Co 58	----------	1×10^{-4}
	Co 60	----------	1×10^{-4}
Copper (29)	Cu 64	----------	3×10^{-3}
Dysprosium (66)	Dy 165	----------	1×10^{-3}
	Dy 166	----------	4×10^{-4}
Erbium (68)	Er 169	----------	9×10^{-4}
	Er 171	----------	1×10^{-3}
Europium (63)	Eu 152 (T/2N9.2 Hrs)	----------	6×10^{-4}
	Eu 155	----------	7×10^{-3}
Fluorine (9)	F 18	2×10^{-4}	----------
Gadolinium (64)	Gd 153	----------	2×10^{-3}
	Gd 159	----------	1×10^{-3}
Gallium (31)	Ga 72	----------	6×10^{-4}
Germanium (32)	Ge 71	----------	2×10^{-2}
Gold (79)	Au 196	----------	2×10^{-3}
	Au 198	----------	5×10^{-4}
	Au 199	----------	7×10^{-4}
Hafnium (72)	Hf 181	----------	7×10^{-4}
Hydrogen (1)	H 3	5×10^{-6}	----------
Indium (49)	In 113m	----------	9×10^{-4}
	In 114m	----------	2×10^{-4}
Iodine (53)	I 126	3×10^{-8}	2×10^{-4}
	I 131	3×10^{-8}	5×10^{-5}
	I 132	8×10^{-6}	6×10^{-4}
	I 133	1×10^{-6}	2×10^{-4}
	I 134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir 190	----------	2×10^{-4}
	Ir 192	----------	1×10^{-4}
	Ir 194	----------	1×10^{-3}
Iron (26)	Fe 55	----------	4×10^{-3}
	Fe 59	----------	1×10^{-4}
Krypton (36)	Kr 85m	1×10^{-6}	----------
	Kr 85	3×10^{-6}	----------
Lanthanum (57)	La 140	----------	2×10^{-4}
Lead (82)	Pb 203	----------	4×10^{-3}
Lutetium (71)	Lu 177	----------	2×10^{-3}
Manganese (25)	Mn 52	----------	3×10^{-4}
	Mn 54	----------	4×10^{-4}
	Mn 56	----------	1×10^{-3}
Mercury (80)	Hg 197m	----------	2×10^{-3}
	Hg 197	----------	3×10^{-3}
	Hg 203	----------	2×10^{-4}
Molybdenum	Mo 99	----------	4×10^{-4}
Neodymium	Nd 147	----------	6×10^{-4}
	Nd 149	----------	4×10^{-4}
Nickel (28)	Ni 65	----------	1×10^{-3}
Niobium (Columbium) (41)	Nb 95	----------	2×10^{-4}
	Nb 97	----------	6×10^{-4}
Osmium (76)	Os 185	----------	7×10^{-4}
	Os 191m	----------	3×10^{-3}
	Os 191	----------	2×10^{-4}
	Os 193	----------	1×10^{-4}
Palladium (46)	Pd 103	----------	1×10^{-3}
	Pd 109	----------	1×10^{-3}
Phosphorus (15)	P 32	----------	3×10^{-4}
Platinum (78)	Pt 191	----------	1×10^{-3}
	Pt 193m	----------	4×10^{-3}
	Pt 197m	----------	1×10^{-3}
	Pt 197	----------	1×10^{-3}
Potassium (19)	K 42	----------	6×10^{-4}
Praseodymium	Pr 142	----------	2×10^{-4}
	Pr 143	----------	3×10^{-4}
Promethium	Pm 147	----------	2×10^{-3}
	Pm 149	----------	1×10^{-3}
Rhenium (75)	Re 183	----------	6×10^{-3}
	Re 186	----------	1×10^{-3}
	Re 188	----------	6×10^{-4}
Rhodium (45)	Rh 103m	----------	2×10^{-2}
	Rh 105	----------	9×10^{-4}
Rubidium (37)	Rb 86	----------	7×10^{-4}
Ruthenium (44)	Ru 97	----------	7×10^{-4}
	Ru 103	----------	3×10^{-4}
	Ru 105	----------	9×10^{-4}
	Ru 106	----------	2×10^{-4}
Samarium (62)	Sm 153	----------	2×10^{-3}
Scandium (21)	Sc 46	----------	5×10^{-4}
	Sc 47	----------	1×10^{-3}
	Sc 48	----------	2×10^{-4}
Selenium (34)	Se 75	----------	1×10^{-3}
Silicon (14)	Si 31	----------	1×10^{-3}
Silver (47)	Ag 105	----------	1×10^{-3}
	Ag 110m	----------	1×10^{-4}
	Ag 111	----------	4×10^{-4}
Sodium (11)	Na 24	1×10^{-6}	----------
Strontium (38)	Sr 89	3×10^{-6}	----------
	Sr 91	----------	3×10^{-4}
	Sr 92	----------	6×10^{-4}
Sulfur (16)	S 35	----------	6×10^{-4}
Tantalum (73)	Ta 182	----------	1×10^{-4}
Technetium (43)	Tc 96m	----------	1×10^{-2}
	Tc 96	----------	1×10^{-3}

See footnotes at end of table.

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Isotope	Column I Gas concentration uc/ml [1]	Column II Liquid and solid concentration uc/ml [2]
Mn 52	----------	3×10^{-4}
Mn 54	----------	1×10^{-3}
Mn 56	----------	1×10^{-3}
Hg 197m	----------	2×10^{-3}
Hg 197	----------	3×10^{-3}
Hg 203	----------	2×10^{-4}
Mo 99	----------	2×10^{-3}
Nd 147	----------	6×10^{-4}
Nd 149	----------	3×10^{-3}
Ni 65	----------	1×10^{-3}
Nb 95	----------	1×10^{-3}
Nb 97	----------	9×10^{-3}
Os 185	----------	7×10^{-4}
Os 191m	----------	3×10^{-2}
Os 191	----------	2×10^{-3}
Os 193	----------	6×10^{-4}
Pd 103	----------	3×10^{-3}
Pd 109	----------	9×10^{-4}
P 32	----------	2×10^{-4}
Pt 191	----------	1×10^{-3}
Pt 193m	----------	1×10^{-2}
Pt 197m	----------	1×10^{-2}
Pt 197	----------	1×10^{-3}
K 42	----------	3×10^{-3}
Pr 142	----------	3×10^{-4}
Pr 143	----------	5×10^{-4}
Pm 147	----------	2×10^{-3}
Pm 149	----------	4×10^{-4}
Re 183	----------	6×10^{-3}
Re 186	----------	9×10^{-4}
Re 188	----------	6×10^{-4}
Rh 103m	----------	1×10^{-1}
Rh 105	----------	1×10^{-3}
Rb 86	----------	7×10^{-4}
Ru 97	----------	4×10^{-3}
Ru 103	----------	8×10^{-4}
Ru 105	----------	1×10^{-3}
Ru 106	----------	1×10^{-4}
Sm 153	----------	8×10^{-4}
Sc 46	----------	4×10^{-4}
Sc 47	----------	9×10^{-4}
Sc 48	----------	3×10^{-4}
Se 75	----------	3×10^{-3}
Si 31	----------	9×10^{-3}
Ag 105	----------	1×10^{-3}
Ag 110m	----------	3×10^{-4}
Ag 111	----------	4×10^{-4}
Na 24	----------	2×10^{-3}
Sr 89	----------	1×10^{-4}
Sr 91	----------	7×10^{-4}
Sr 92	----------	7×10^{-4}
S 35	9×10^{-8}	6×10^{-4}
Ta 182	----------	4×10^{-4}
Te 96m	----------	1×10^{-1}
Te 96	----------	1×10^{-3}
Te 125m	----------	2×10^{-3}
Te 127m	----------	6×10^{-4}
Te 127	----------	3×10^{-3}
Te 129m	----------	3×10^{-4}
Te 131m	----------	6×10^{-4}
Te 132	----------	3×10^{-4}
Tb 160	----------	4×10^{-4}
Tl 200	----------	4×10^{-3}
Tl 201	----------	3×10^{-3}
Tl 202	----------	1×10^{-3}
Tl 204	----------	1×10^{-3}
Tm 170	----------	5×10^{-4}
Tm 171	----------	5×10^{-3}
Sn 113	----------	9×10^{-4}
Sn 125	----------	2×10^{-4}
W 181	----------	4×10^{-3}
W 187	----------	7×10^{-4}
V 48	----------	3×10^{-4}
Xe 131m	4×10^{-6}	--------
Xe 133	3×10^{-6}	--------
Xe 135	1×10^{-6}	--------
Yb 175	----------	1×10^{-3}
Y 90	----------	2×10^{-4}
Y 91m	----------	3×10^{-2}
Y 91	----------	3×10^{-4}
Y 92	----------	6×10^{-4}
Y 93	----------	3×10^{-4}
Zn 65	----------	1×10^{-3}
Zn 69m	----------	7×10^{-4}
Zn 69	----------	2×10^{-2}
Zr 95	----------	6×10^{-4}
Zr 97	----------	2×10^{-4}
Beta and/or gamma emitting byproduct material not listed above with half-life less than 3 years.	1×10^{-10}	1×10^{-6}

NOTE 1: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the concentrations in Schedule C, the activity stated is that of the parent isotope and takes into account the daughters.

NOTE 2: For purposes of § 30.9 where there is involved a combination of isotopes, the limit for the combination should be derived as follows:

Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in Schedule C for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (i.e., unity). (Footnote Continued on following page.)

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Dated at Germantown, Md., this 8th day of August 1960.

For the Atomic Energy Commission.

R. E. HOLLINGSWORTH,
Acting General Manager.

PART 30—LICENSING OF BYPRODUCT MATERIAL

LICENSING CRITERIA FOR RADIOGRAPHY

On March 15, 1960, the Commission issued for public comment a proposed amendment to 10 CFR Part 30 which would establish special requirements for the issuance of specific licenses for the use of sealed sources of byproduct material in radiography. Comments filed by interested persons have been given careful consideration.

The following rules are published as a document subject to codification, effective 30 days after publication in the FEDERAL REGISTER. The requirements of this regulation are in addition to, and not in substitution for, other requirements of the Atomic Energy Commission.

1. Add the following definitions to § 30.4:

(r) "Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of the regulations of this part and the conditions of the license.

(s) "Radiographer's assistant" means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or survey instruments in radiography.

(t) "Radiography" means the examination of the structure of materials by nondestructive methods, utilizing sealed sources of byproduct materials.

2. Revise § 30.4(1) to read as follows:

(l) "Sealed source" means any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material.

3. Add the following paragraph to § 30.24:

(g) *Use of sealed sources in radiography.* An application for a specific license for use of sealed sources in radiography will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.32; and

(2) The applicant will have an adequate program for training radiographers and radiographers' assistants and submits to the Commission a schedule or description of such program which specifies the:

(i) Initial training;

(ii) Periodic training;

(iii) On-the-job training;

(iv) Means to be used by the licensee to determine the radiographer's knowledge and understanding of and ability to comply with Commission regulations and licensing requirements, and the operating and emergency procedures of the applicant;

(v) Means to be used by the licensee to determine the radiographer's assistant's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant; and

(3) The applicant has established and submits to the Commission satisfactory written operating and emergency procedures as described in § 31.302 of this chapter; and

(4) The applicant will have an adequate internal inspection system or other management control to assure that Commission license provisions, Commission regulations, and the applicant's operating and emergency pro-

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PART 31—RADIATION
MENTS FOR RADIOGR

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Example:

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt concentration of Isotope B}} \leq 1$$

[1] Values are given only for those materials normally used as gases.

[2] uc/gm for solids.

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ures are followed by radiographers and
diographer's assistants; and
(5) The applicant submits a descrip-
n of its overall organizational struc-
re pertaining to the radiography pro-
am, including specified delegations of
thority and responsibility for opera-
e of the program; and
(6) The applicant who desires to con-
ct his own leak tests has established
equate procedures to be followed in
g testing sealed sources, for possible
akage and contamination and submits
the Commission a description of such
ocedures including:
(i) Instrumentation to be used,
(ii) Method of performing test, e.g.,
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ethod of taking smear, and
(iii) Pertinent experience of the per-
n who will perform the test.

(Sec. 161, 68 Stat. 948; 42 U.S.C. 2201)

Dated at Germantown, Md., this 18th
y of November 1960.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

Part 31—Radiation Safety Requirements for Radiographic Operations

On March 15, 1960, the Commission
ued for public comment a new pro-
sed regulation, 10 CFR Part 31, to
tablish radiation safety requirements
r persons utilizing sealed sources of
product material for radiography.
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ve been given careful consideration.
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th experience and applied in the
se of licensing radiography opera-
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e inclusion in licenses of special
ditions applicable to radiography
d provides guidance as to information
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e following rules are published as
cument subject to codification, effec-
ve 30 days after publication in the
Federal Register. The requirements
of this regulation are in addition to,
and not in substitution for, other re-
quirements of the Atomic Energy Com-
mission.

General Provisions

Sec.
31.1 Purpose.
31.2 Scope.
31.3 Definitions.
31.4 Interpretations.

Equipment Control

31.101 Limits on levels of radiation for radiographic exposure devices and storage containers.
31.102 Locking of radiographic exposure devices and storage containers.
31.103 Storage precautions.
31.104 Radiation survey instruments.
31.105 Leak testing, repair, tagging, opening, modification and replacement of sealed sources.
31.106 Quarterly inventory.
31.107 Utilization logs.

Personal Radiation Safety Requirements for Radiographers and Radiographers' Assistants

31.201 Limitations.
31.202 Operating and emergency procedures.
31.203 Personal monitoring control.

Precautionary Procedures in Radiographic Operations

31.301 Security.
31.302 Posting.
31.303 Radiation surveys and survey records.

Exemptions and Additional Requirements

31.401 Applications for exemptions.
31.402 Additional requirements.

Enforcement

31.501 Violations.

Authority: §§ 31.1 to 31.501 issued under sec. 161, 68 Stat. 948; 42 U.S.C. 2201.

General Provisions

§ 31.1 Purpose.

The regulations in this part establish radiation safety requirements for persons utilizing sealed sources of byproduct material for radiography. The requirements of this part are in addition to, and not in substitution for, other requirements of this chapter.

§ 31.2 Scope.

The regulations in this part apply to all licensees who use byproduct material for radiography under a license issued by the Commission pursuant to the regulations in Part 30 of this chapter: *Provided, however,* That nothing in this part shall apply to uses of byproduct material for medical diagnosis or therapy.

§ 31.3 Definitions.

As used in this part:

(a) "Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of these regulations and the conditions of the license.

(b) "Radiographer's assistant" means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or survey instruments in radiography.

(c) "Radiographic Exposure Device" means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.

(d) "Radiography" means the examination of the structure of materials by nondestructive methods utilizing sealed sources of byproduct material.

(e) "Sealed source" means any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material.

(f) "Storage Container" means a device in which sealed sources are transported or stored.

(g) Other terms defined in section 11 of the Atomic Energy Act, as amended, shall have the same meaning when used in this part.

§ 31.4 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

EQUIPMENT CONTROL

§ 31.101 Limits on levels of radiation for radiographic exposure devices and storage containers.

Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device and all storage containers for sealed sources or for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. The radiation levels specified are with the sealed source in the shielded (i.e., "off") position.

§ 31.102 Locking of radiographic exposure devices and storage containers.

Each radiographic exposure device shall be provided with a lock or other locked container designed to prevent unauthorized or accidental removal of exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a radiographer or radiographer's assistant or as may be otherwise authorized pursuant to § 31.301. Each storage container likewise shall be provided with a lock and kept locked when containing sealed sources except when the

ainer is under the
of a radiographer
assistant.

§ 31.103 Storage pr

Locked radiographi
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§ 31.104 Radiation s

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§ 31.105 Leak testing
opening, modificati
ment of sealed sou

(a) The replacemen
source fastened to or c
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testing, repair, tagging
other modification of a
shall be performed
specifically authorized
sion to do so.

(b) Each sealed sou
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ed at the nearest acc
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...iner is under the direct surveillance ... a radiographer or radiographer's ...sistant.

§ 31.103 Storage precautions.

Locked radiographic exposure devices ...d storage containers shall be physi... secured to prevent tampering or ...moval by unauthorized personnel.

§ 31.104 Radiation survey instruments.

The licensee shall maintain sufficient ...alibrated and operable radiation sur... instruments to make physical ra... surveys as required by this part ... Part 20 of this chapter. Each ra... survey instrument shall be cali... at intervals not to exceed three ... months and after each instrument ...iring and a record maintained of ... latest date of calibration. Instru... required by this section shall ... a range such that two milliroent... per hour through one roentgen per ... can be measured.

§ 31.105 Leak testing, repair, tagging, ...ening, modification and replace... of sealed sources.

(a) The replacement of any sealed ... fastened to or contained in a ra... exposure device and leak ...ing, repair, tagging, opening or any ... modification of any sealed source ... be performed only by persons ...ically authorized by the Commis... to do so.

(b) Each sealed source shall be test... for leakage at intervals not to ex... 6 months. In the absence of a cer... from a transferor that a test ... been made within the 6 months ... to the transfer, the sealed source ... not be put into use until tested.

(c) The leak test shall be capable of ...ting the presence of 0.005 micro... of removable contamination on ... sealed source. An acceptable leak ... for sealed sources in the possession ... radiography licensee would be to ... the nearest accessible point to ... sealed source storage position, or other appropriate measuring point, by a procedure to be approved pursuant to § 30.24(g)(6) of this chapter. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this section which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with Commission regulations. A report shall be filed, within 5 days of the test, with the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall be sent to the Manager of the nearest Atomic Energy Commission Operations Office listed in Appendix D of Part 20 of this chapter "Standards For Protection Against Radiation."

(e) A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one (1) inch square bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger—Radioactive Material—Do Not Handle—Notify Civil Authorities if Found."

§ 31.106 Quarterly inventory.

Each licensee shall conduct a quarterly physical inventory to account for all sealed sources received and possessed under his license. The records of the inventories shall be maintained for inspection by the Commission, and shall include the quantities and kinds of byproduct material, location of sealed sources, and the date of the inventory.

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§ 31.107 Utilization logs.

Each licensee shall maintain current logs, which shall be kept available for inspection by the Commission at the address specified in the license, showing for each sealed source the following information:

(a) A description (or make and model number) of the radiographic exposure device or storage container in which the sealed source is located;

(b) The identity of the radiographer to whom assigned; and

(c) The plant or site where used and dates of use.

PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS

§ 31.201 Limitations.

(a) The licensee shall not permit any person to act as a radiographer as defined in this part until such person:

(1) Has been instructed in the subjects outlined in Appendix A of this part and shall have demonstrated understanding thereof;

(2) Has received copies of and instruction in the regulations contained in this part and the applicable sections of Part 20 of this chapter, AEC license(s), and the licensee's operating emergency procedures, and shall have demonstrated understanding thereof; and

(3) Has demonstrated competence to use the radiographic exposure devices, sealed sources, related handling tools and survey instruments which will be employed in his assignment.

(b) The licensee shall not permit any person to act as a radiographer's assistant as defined in this part until such person:

(1) Has received copies of and instructions in the licensee's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(2) Has demonstrated competence to use under the personal supervision of the radiographer the radiographic exposure devices, sealed sources, related handling tools and radiation survey instruments which will be employed in his assignment.

§ 31.202 Operating and emergency procedures.

The licensee's operating and emergency procedures shall include instructions in at least the following:

(a) The handling and use of licensed sealed sources and radiographic exposure devices to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Part 20 of this chapter "Standards For Protection Against Radiation";

(b) Methods and occasions for conducting radiation surveys;

(c) Methods for controlling access to radiographic areas;

(d) Methods and occasions for locking and securing radiographic exposure devices, storage containers and sealed sources;

(e) Personnel monitoring and the use of personnel monitoring equipment;

(f) Transporting sealed sources to field locations, including packing of radiographic exposure devices and storage containers in the vehicles, posting of vehicles and control of the sealed sources during transportation;

(g) Minimizing exposure of persons in the event of an accident;

(h) The procedure for notifying proper persons in the event of an accident; and

(i) Maintenance of records.

§ 31.203 Personnel monitoring equipment.

(a) The licensee shall not permit any person to act as a radiographer or as a radiographer's assistant unless, at all times during radiographic operations each such person shall wear a film badge and either a pocket dosimeter or pocket chamber. Pocket dosimeters and pocket chambers shall be capable of measuring doses from zero to at least 200 milliroentgens. A film badge shall be assigned to only one person.

(b) Pocket dosimeters and pocket chambers shall be read and recorded daily. A film badge shall be immediately processed if the pocket chamber or pocket dosimeter is discharged beyond its range. Film badge reports received from the film badge processor and records of pocket dosimeter and pocket chamber readings shall be maintained for inspection by the Commission.

PRECAUTIONARY PROCEDURES FOR RADIOGRAPHIC OPERATIONS

§ 31.301 Security.

During each radiographic operation the radiographer or radiographer's assistant shall maintain adequate surveillance of the operation to protect against unauthorized entry into a radiation area, as defined in Part 20, except (a) where the radiation area is equipped with a functioning alarm system as described in § 20.203(c)(2), or (b) where the radiation area is locked sufficiently against unauthorized entry.

§ 31.302 Posting.

Notwithstanding any provision of § 20.204(c) of this chapter, each area in which radiography is being performed shall be conspicuously posted as required by § 20.203 (b) of this chapter.

§ 31.303 Radiation surveys; records.

(a) No radiographic operation shall be conducted unless adequate radiation survey instruments as described in § 31.104 is present at each site where radiation exposures are made.

(b) A physical radiation survey shall be made after each radiographic exposure during a radiographic operation to determine that the sealed source has been returned to its shielded

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...ge shall be assigned to and worn by ...y one person.

(b) Pocket dosimeters and pocket ...mbers shall be read and doses re...rded daily. A film badge shall be ...mediately processed if a pocket ...mber or pocket dosimeter is dis...rged beyond its range. The film ...ure reports received from the film ...ge processor and records of pocket ...simeter and pocket chamber readings ...all be maintained for inspection by ...e Commission.

PRECAUTIONARY PROCEDURES IN RADIOGRAPHIC OPERATIONS

§ 31.301 Security.

During each radiographic operation ...e radiographer or radiographer's as...stant shall maintain a direct surveil...nce of the operation to protect against ...unauthorized entry into a high radiation ...a, as defined in Part 20 of this chap...r, except (a) where the high radiation ...a is equipped with a control device ...r an alarm system as described in ...0.203(c)(2), or (b) where the high ...diation area is locked to protect ...ainst unauthorized or accidental ...try.

§ 31.302 Posting.

Notwithstanding any provisions in ...0.204(c) of this chapter, areas in ...ich radiography is being performed ...all be conspicuously posted as re...uired by § 20.203 (b) and (c)(1) of ...is chapter.

§ 31.303 Radiation surveys and survey records.

(a) No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in § 31.104 is available and used at each site where radiographic exposures are made.

(b) A physical radiation survey shall be made after each radiographic exposure during a radiographic operation to determine that the sealed source has been returned to its shielded condition.

(c) A physical radiation survey shall be made to determine that each sealed source is in its shielded condition prior to securing the radiographic exposure device and storage container as specified in § 31.102.

(d) Records shall be kept of the surveys required by paragraph (c) of this section and maintained for inspection by the Commission.

EXEMPTIONS AND ADDITIONAL REQUIREMENTS

§ 31.401 Applications for exemptions.

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

§ 31.402 Additional requirements.

The Commission may, by rule, regulation, or order, impose upon any licensee such requirements in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

ENFORCEMENT

§ 31.501 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provisions of the Act or any regulation or order issued thereunder. Any person who wilfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment, or both, as provided by law.

APPENDIX A

I. Fundamentals of radiation safety.

A. Characteristics of gamma radiation.

B. Units of radiation dose (mrem) and quantity of radioactivity (curie).

C. Hazards of excessive exposure of radiation.

D. Levels of radiation from licensed material.

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E. Methods of controlling radiation dose.
1. Working time.
2. Working distances.
3. Shielding.
II. Radiation detection instrumentation to be used.
A. Use of radiation survey instruments.
1. Operation.
2. Calibration.
3. Limitations.
B. Survey techniques.
C. Use of personnel monitoring equipment.
1. Film badges.
2. Pocket dosimeters.
3. Pocket chambers.
III. Radiographic equipment to be used.
A. Remote handling equipment.
B. Radiographic exposure devices.
C. Storage containers.
IV. The requirements of pertinent Federal Regulations.
V. The licensee's written operating and emergency procedures.

Dated at Germantown, Maryland this 18th day of November 1960.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

PART 40—CONTROL OF SOURCE MATERIAL

EXEMPTED PRODUCTS; URANIUM

The following amendment is designed to relieve persons receiving or possessing uranium contained in aircraft counterweights installed in aircraft from the necessity of obtaining a specific license from the Atomic Energy Commission authorizing such receipt or possession. Under the amendment to § 40.60, the uranium in such counterweights is exempted from the specific licensing requirement of § 40.10 relating to transfers, deliveries and receipt of possession or title. The Commission has found that the transfer, delivery and receipt of possession or title to uranium in such products involve unimportant quantities of source material within the meaning of section 62 of the Atomic Energy Act of 1954, as amended, which are not of significance to the common defense and security, and that such activities can be conducted without adversely affecting public health and safety.

Inasmuch as this amendment is intended to relieve from rather than impose restrictions under regulations currently in effect and will not adversely affect the public health and safety, the Commission has found that general notice of proposed rule making and public procedure thereon are unnecessary and good cause exists why this amendment should be made effective without the customary period of notice and prior publication in the FEDERAL REGISTER.

Effective upon publication in the FEDERAL REGISTER, Part 40, Title 10, Code of Federal Regulations, "Control of Source Material," is hereby amended as follows:

Section 40.60 *Schedule I: Exempted products* is amended to include an additional exempted product by the addition of the following new paragraph (i):

(i) Uranium contained in aircraft counterweights installed in aircraft, provided that any such counterweight has been impressed with a statement, clearly legible after plating, which states "Caution—Radioactive Material—Uranium"; and provided further that the exemption contained in this paragraph shall not be deemed to authorize the chemical, physical, metallurgical or other treatment or processing of any such counterweight or the installation in, or removal from, an aircraft of any such counterweight, without a specific license from the Commission.

Dated at Germantown, Md., this 28th day of June 1960.

For the Atomic Energy Commission.

A. R. LUEDECKE,
General Manager.

PART 50—LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

DEFINITION OF "TESTING FACILITY" HEARING AND REPORTS

The following amendments implement subsection 182b and 189a of the Atomic Energy Act of 1954, as amended, by incorporating in 10 CFR Part 50 a definition of "testing facility" and the statutory requirement of r
Advisory Committee on
guards and formal hear
applications for power an
Notice of proposed iss
amendments was publish
FEDERAL REGISTER on Marc
F.R. 2449).

Effective 30 days after
the FEDERAL REGISTER, 1(
is hereby amended as fo
1. Paragraph (r) of § 2
nated paragraph (s).
new paragraph (r) is ad

§ 50.2 Definitions.

* * *

(r) "Testing facility" clear reactor which is scribed in § 50.21(c) and application has been filed authorizing operation at:

(1) A thermal power l of 10 megawatts; or

(2) A thermal power l of 1 megawatt, if the rea tain:

(i) A circulating loop core in which the applican conduct fuel experiments;

(ii) A liquid fuel loadin

(iii) An experimental f core in excess of 16 squa cross-section.

2. The following new added:

§ 50.57 Hearing and repor visory Committee on R guards.

(a) Each application for a production or utilizat which is of a type describe 50.21 or 50.22 and each appli license for a testing facilit any application for a pr utilization facility which i scribed in § 50.21 (a) or ferred to the Advisory C reactor Safeguards for rev port thereon. Such repo made part of the record of

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...requirement of review by the ...Advisory Committee on Reactor Safeguards and formal hearings on license applications for power and test reactors. Notice of proposed issuance of these amendments was published in the FEDERAL REGISTER on March 28, 1959 (24 F.R. 2449).

Effective 30 days after publication in the FEDERAL REGISTER, 10 CFR Part 50 is hereby amended as follows:

1. Paragraph (r) of § 50.2 is redesignated paragraph (s). The following new paragraph (r) is added to § 50.2:

§ 50.2 Definitions.

* * * * *

(r) "Testing facility" means a nuclear reactor which is of a type described in § 50.21(c) and for which an application has been filed for a license authorizing operation at:

(1) A thermal power level in excess of 10 megawatts; or

(2) A thermal power level in excess of 1 megawatt, if the reactor is to contain:

(i) A circulating loop through the core in which the applicant proposes to conduct fuel experiments; or

(ii) A liquid fuel loading; or

(iii) An experimental facility in the core in excess of 16 square inches in cross-section.

2. The following new section is added:

§ 50.57 Hearing and reports of the Advisory Committee on Reactor Safeguards.

(a) Each application for a license for a production or utilization facility which is of a type described in §§ 50.21 or 50.22 and each application for a license for a testing facility shall, and each application for a production or utilization facility which is of a type described in § 50.21 (a) or (c) may, be referred to the Advisory Committee on Reactor Safeguards for review and report thereon. Such report shall be made a part of the record of the application and available to the public, except to the extent that security classification prevents disclosure.

(b) The Commission will hold a hearing after 30 days' notice and publication once in the FEDERAL REGISTER on each application for a license for a production or utilization facility which is of a type described in §§ 50.21(b) or 50.22, and on each application for a license for a testing facility.

(Sec. 161, 60 Stat. 948; 42 U.S.C. 2201)

Dated at Germantown, Md., this 29th day of January, 1960.

For the Atomic Energy Commission.

A. R. LUEDECKE,
General Manager.

PART 70—SPECIAL NUCLEAR MATERIAL

MISCELLANEOUS AMENDMENTS

On August 6, 1959, the Atomic Energy Commission issued for public comment a proposed amendment to Part 70 requiring that persons holding special nuclear material licenses furnish the Commission semi-annual reports as of June 30 and December 31 concerning special nuclear material distributed by the Commission pursuant to section 53 of the Atomic Energy Act of 1954, as amended. These reports, to be submitted on Form AEC–578, would provide the Commission with information concerning special nuclear material received, transferred or possessed by the licensee or for which the licensee is financially responsible to the Commission. In addition to providing information semi-annually as to the location of material, the report would include information needed in computing use, loss of material and related charges for special nuclear material.

Based on comments received from interested persons, certain revisions have been made in the proposed reporting form and in the accompanying instructions. On the form itself Item 1d has been added to identify the ending date of the period for which the report is

prepared. In the accompanying instructions;

(1) Licensees are instructed to send the original and one copy to the Commission's Oak Ridge Operations Office and one to the Commission's Washington Headquarters.

(2) Concerning Items 6 and 10, the language is modified to make it clear that the report should list each receipt or shipment, rather than provide only the total quantities received from or shipped to others during the period. The instructions also now require that an asterisk be used to identify material for which the licensee was charged or relieved, during the reporting period, with respect to financial responsibility to the Commission.

(3) Concerning Items 12, 13 and 17, the instructions are modified to require identification of the licensee having financial responsibility with respect to losses and burn-up.

Copies of Form AEC–578 may be obtained from the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C.

The proposed amendment as published on August 6, 1959, would have required that all special nuclear material licensees furnish a report semi-annually to the Commission. The amendment has been changed so that the June 30 report will not be required from licensees who during the six months preceding June 30 had losses or burn-up of less than ten grams of special nuclear material, and who did not receive or transfer any special nuclear material, or financial responsibility therefor.

Effective upon publication in the FEDERAL REGISTER, 10 CFR Part 70, "Special Nuclear Material", is amended in the following respects:

(1) Redesignate §§ 70.53 and 70.54 as 70.54 and 70.55, respectively.

(2) Add the following new § 70.53:

§ 70.53 Material Status Reports.

Each licensee shall submit to the Commission on Form AEC–578 reports concerning special nuclear material [illegible] uted by the Commission pursuant [illegible] section 53 of the Act and received [illegible] ferred or possessed by the licensee [illegible] which the licensee is financially [illegible] sible. Such reports shall be made [illegible] December 31 and June 30 of each [illegible] and shall be filed with the Commission [illegible] within 30 days after the end of the period covered by the report, except that any licensee who during the six months preceding June 30 had losses or burn-up of less than ten grams of special nuclear material and did not receive or transfer any special nuclear material or financial responsibility therefor is required to file only an annual report as of December 31. The Commission may permit a licensee to submit Material Status Reports at other times where good cause is shown.

Dated at Germantown, Md., this [illegible] day of February 1960.

For the Atomic Energy Commission,

A. R. LUEDECKE,
General Manager.

PART 80—GENERAL RULES OF PROCEDURE ON APPLICATIONS FOR THE DETERMINATION OF REASONABLE ROYALTY FOR JUST COMPENSATION OR GRANT OF AN AWARD FOR PATENTS, INVENTIONS OR DISCOVERIES

MISCELLANEOUS AMENDMENTS

In order to permit the Patent Compensation Board to conduct its proceedings by panel pursuant to section [illegible] of the Atomic Energy Act of 1954, as amended, two changes to the rules with respect thereto, 10 CFR Part 80, are promulgated by this notice. New [illegible] is added to permit the Commission to designate a chairman of the Board and to provide for the designation by the chairman of panels to hear cases consisting of three members of the Board. The definition of "Board" contained in § 80.2(b) of the regulations has been revised to include a panel of three members of the Board.

Because these amendments deal with matters relating to agency organization, [illegible] and procedure and effective upon [illegible] will not adversely affect [illegible] Commission has found [illegible] exists why such amendments should be made effective 30 days after publication in the FEDERAL REGISTER. However, interested persons who desire to submit written comments and suggestions with respect to these rules should send them to the United States Atomic Energy Commission, Washington 25, D.C. Attention: General Counsel.

Pursuant to the Administrative Procedure Act, Public Law 404, 79th Cong., 2d Sess., Title 10, Code of Federal Regulations, Part 80, is amended as set forth below, effective 30 days after publication in the FEDERAL REGISTER:

1. Section 80.2(b) is amended as follows:

§ 80.2 Definitions.

* * *

(b) "Board" means the Patent Compensation Board designated by the Commission pursuant to section 153 of the Atomic Energy Act of 1954, as amended, or any three or more members thereof acting as a panel pursuant to § 80.8.

2. Section 80.8 is added as follows:

§ 80.8 Chairman; designation; quorum.

(a) The Chairman shall be designated by the Commission. The Commission may, from time to time, with the concurrence of a majority of the members of the Board, divide the Board into two or more panels, each consisting of not less than three members. A majority of the number of members assigned to constitute the Board or a panel thereof shall constitute a quorum of the Board or panel, as the case may be.

(b) Panels shall sit at the times and hear the cases assigned as the Board directs and may not hear or render any decision which would have been empowered to hear or render if the matter had been assigned to the panel. Every

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and procedure and effectiveness thereof will not adversely affect any person, the Commission has found that good cause exists why such amendments should be made effective 30 days after publication in the FEDERAL REGISTER. However, all interested persons who desire to submit written comments and suggestions with respect to these rules should send them to the United States Atomic Energy Commission, Washington 25, D.C., Attention: General Counsel.

Pursuant to the Administrative Procedure Act, Public Law 404, 79th Cong., 2d Sess., Title 10, Code of Federal Regulations, Part 80, is amended as follows, effective 30 days after publication in the FEDERAL REGISTER:

1. Section 80.2(b) is amended to read as follows:

(b) Definitions.

* * * * *

(i) "Board" means the Patent Compensation Board designated by the Commission pursuant to section 157a. of the Atomic Energy Act of 1954, as amended, or any three or more members thereof designated as a panel pursuant to § 80.8.

2. Section 80.8 is added to read as follows:

§ 80.8 Chairman; designation of panels; quorum.

(a) The Chairman shall be designated by the Commission. The Chairman may from time to time, with the concurrence of a majority of the members of the Board, divide the Board into two or more panels, each consisting of not less than three members. A majority of the number of members authorized to constitute the Board or a panel thereof shall constitute a quorum of the Board or panel, as the case may be. Panels shall sit at the times and places and hear the cases assigned as the Chairman directs and may make any findings or render any decision which the Board could have been empowered to render if the matter had not been assigned to the panel. Every such order made or decision rendered by a panel shall be made as the order, or rendered as the decision, of the Board.

(Sec. 161, 68 Stat. 948, 42 U.S.C. 2201)

Dated at Germantown, Md., this 3d day of August 1960.

For the Atomic Energy Commission.

R. E. HOLLINGSWORTH,
Acting General Manager.

PART 95—SAFEGUARDING OF RESTRICTED DATA

EXTERNAL TRANSMISSION OF DOCUMENTS AND MATERIAL

Notice is hereby given of amendment of the Commission's regulations relating to the transmission of Restricted Data under this Part. The amendment is designed to permit the transmission of Confidential material by first class mail or certified mail. In addition, the types of express services that may be used for transmitting either Secret or Confidential material are specified. Because the Atomic Energy Commission has issued a substantial number of access permits, and because interested persons will not be adversely affected, the Commission has found that good cause exists why the regulations in this part should be made effective without the customary 30 day period of notice. Effective upon publication in the FEDERAL REGISTER, § 95.33(d) is amended to read:

(d) *Methods of transportation.* (1) Secret documents and material shall be transported only by one of the following methods:

(i) Registered mail.

(ii) Railway or air express in "Armed Guard Service" or "Armed Surveillance Service".

(iii) Individuals possessing appropriate AEC security clearance who have been given written authority by their employers.

(2) Confidential documents and material shall be transported by one of the methods set forth in subparagraph (1) of this paragraph or by one of the following methods:

(i) Certified or first-class mail, if approved by the Manager of Operations administering the permit. Certified or first-class mail may not be used in any transmission of Confidential documents to Alaska, Hawaii, the Canal Zone, Puerto Rico, or any United States territory or possession.

(ii) Railway or air express "Protective Signature Service;" railway express "Recorded Tally Service;" airlines "Protective Signature Service;" when available; rail or motor vehicles in sealed car or sealed van service: or services providing equivalent protection.

(iii) Material in less than carload, truckload, or planeload lots, by regular commercial carrier when the container and its contents weigh more than 500 pounds and such container is locked and sealed.

Dated at Germantown, Md., this 11th day of April 1960.

For the Atomic Energy Commission.

A. R. LUEDECKE,
General Manager.

PART 140—FINANCIAL PROTECTION REQUIREMENTS AND INDEMNITY AGREEMENTS

The following amendments to Part 140 constitute a comprehensive revision to this part.

Notice of proposed issuance of the following rules was published in the FEDERAL REGISTER on May 1, 1959 (24 F.R. 3508). A detailed statement of considerations explaining the provisions of the following amendments was published with the notice of proposed rule making at 24 F.R. 3508. Comments filed by interested persons have been given careful consideration.

Except for §§ 140.3, 140.6, 140.12, 140.15 and 140.17, the provisions of the following amendments are the same as those incorporated in the notice of proposed rule making. Section 140.6 (concerning reports) has been rewritten to clarify the obligations of an indemnified licensee following a nuclear incident and to eliminate the filing of extensive reports by a licensee until the extent of the incident and the need for such reports and records have been determined by the Commission. Minor changes, mainly of a drafting nature, have been made in §§ 140.3(j), 140.12(b)(4), 140.15(a) and 140.17(b).

Sections 140.11 and 140.12 establish the amount of financial protection to be maintained by reactor licensees. These are substantially similar to the corresponding provisions in the proposed rule published on May 1, 1959. Representatives of the Nuclear Energy Liability Insurance syndicates ("NELIA" and "MAELU") have urged that the Commission require, in some cases, the maintenance of higher levels of financial protection than are required under the following rules. Their recommendations are set forth particularly in a letter dated January 22, 1960, and the attachments thereto, from Charles J. Haugh, Vice President, The Travelers Insurance Company. This letter and the attachments are available for public inspection in the Commission's Public Document Room, 1717 H Street NW., Washington 25, D.C. Copies of the aforesaid letter may be obtained upon request to the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C.

The Commission plans to re-evaluate the provisions of §§ 140.11 and 140.12 in the light of comments received from the Nuclear Energy Liability Insurance syndicate, and comments received from interested members of the public, not later than December 31, 1960.

All interested persons who desire to submit comments for the consideration of the Commission on the proposals filed by the nuclear energy insurance syndicates and their member companies should send them to the U.S. Atomic Energy Commission, Washington 25, D.C., Attention: Director, Division of Licensing and Regulation within [illegible] after publication of this notice in the FEDERAL REGISTER.

Effective 30 days af
the FEDERAL REGISTER,
-Financial Protectio
and Indemnity Agreer
ed to read as follows:

SUBPART A—GENER

Sec.
140.1 Purpose.
140.2 Scope.
140.3 Definitions.
140.3 Interpretations.
140.4 Communications.
140.5 Reports.
140.6 Fees.
140.7 Specific exemptio
140.8

SUBPART B—PROVISIONS
PLICANTS AND LICENSE
FEDERAL AGENCIES AN
CATIONAL INSTITUTIONS

140.10 Scope.
140.11 Amounts of financ
certain reactors
140.12 Amount of financ
quired for other
140.13 Amount of financ
quired of certai
struction permit
140.14 Types of financial
140.15 Proof of financial
140.16 Commission review
cial protection.
140.17 Special provisions
censees furnishi
tection in whole
form of liability
140.18 Special provisions
censees furnishi
tection in whole
form of adequate
140.19 Failure by license
financial protecti
140.20 Indemnity agreemen

SUBPART C—PROVISIONS AI
TO FEDERAL AGE

140.31 Scope.
140.32 Indemnity agreemen

SUBPART D—PROVISIONS AP
TO NONPROFIT EDUCATIONAL

140.71 Scope.
140.72 Indemnity agreemen

AUTHORITY: §§ 140.1 to
sec. 161, 68 Stat. 948;
interpret or apply sec. 4, Publ
Public Law 85-744.

SUBPART A—GENERAL P

§ 140.1 Purpose.

The regulations in this p
provide appropriate pro

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Effective 30 days after publication in the FEDERAL REGISTER. 10 CFR Part 140, "Financial Protection Requirements and Indemnity Agreements," is amended to read as follows:

SUBPART A—GENERAL PROVISIONS

Sec.
140.1 Purpose.
140.2 Scope.
140.3 Definitions.
140.4 Interpretations.
140.5 Communications.
140.6 Reports.
140.7 Fees.
140.8 Specific exemptions.

SUBPART B—PROVISIONS APPLICABLE TO APPLICANTS AND LICENSEES OTHER THAN FEDERAL AGENCIES AND NONPROFIT EDUCATIONAL INSTITUTIONS

140.10 Scope.
140.11 Amounts of financial protection for certain reactors.
140.12 Amount of financial protection required for other reactors.
140.13 Amount of financial protection required of certain holders of construction permits.
140.14 Types of financial protection.
140.15 Proof of financial protection.
140.16 Commission review of proof of financial protection.
140.17 Special provisions applicable to licensees furnishing financial protection in whole or in part in the form of liability insurance.
140.18 Special provisions applicable to licensees furnishing financial protection in whole or in part in the form of adequate resources.
140.19 Failure by licensees to maintain financial protection.
140.20 Indemnity agreements.

SUBPART C—PROVISIONS APPLICABLE ONLY TO FEDERAL AGENCIES

140.21 Scope.
140.22 Indemnity agreements.

SUBPART D—PROVISIONS APPLICABLE ONLY TO NONPROFIT EDUCATIONAL INSTITUTIONS

140.71 Scope.
140.72 Indemnity agreements.

AUTHORITY: §§ 140.1 to 140.72 issued under sec. 161, 68 Stat. 948; 42 U.S.C. 2201, interpret or apply sec. 4, Public Law 85-256; Public Law 85-744.

SUBPART A—GENERAL PROVISIONS

§ 140.1 Purpose.

The regulations in this part are issued to provide appropriate procedures and requirements for determining the financial protection required of licensees and for the indemnification and limitation of liability of certain licensees and other persons pursuant to section 170 of the Atomic Energy Act of 1954 (68 Stat. 919), as amended.

§ 140.2 Scope.

(a) The regulations in this part apply to each person who is an applicant for or holder of a license issued pursuant to Part 50 of this chapter to operate a nuclear reactor.

(b) (1) Subpart B of this part does not apply to any person subject to Subpart C of this part or D. Subpart C of this part applies only to persons found by the Commission to be Federal agencies. Subpart D of this part applies only to persons found by the Commission to be nonprofit educational institutions with respect to licenses and applications for licenses for the conduct of educational activities.

(2) Any applicant or licensee subject to this part may apply for a finding that such applicant or licensee is subject to the provisions of Subpart C or D of this part. The application should state the grounds for the requested finding. Any application for a finding pursuant to this paragraph may be included in an application for license.

§ 140.3 Definitions.

As used in this part,

(a) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto.

(b) "Commission" means the Atomic Energy Commission or its duly authorized representatives.

(c) "Federal agency" means a Government agency such that any liability in tort based on the activities of such agency would be satisfied by funds appropriated by the Congress and paid out of the United States Treasury.

(d) "Financial protection" means the ability to respond in damages for public liability and to meet the costs of inves-

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tigating and defending claims and settling suits for such damages.

(e) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government.

(f) "Nuclear reactor" means any apparatus, other than an atomic weapon, designed or used to sustain nuclear fission in a self-supporting chain reaction.

(g) "Person" means (1) any individual, corporation, partnership, firm, association, trust, estate, public, or private institution, group, Government agency other than the Commission, any State or any political subdivision thereof, or any political entity within a State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (2) any legal successor, representative, agent, or agency of the foregoing.

(h) "Source material" means source material as defined in the regulations contained in Part 40 of this chapter.

(i) "Special nuclear material" means (1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material.

(j) "Testing reactor" means a nuclear reactor which is of a type described in § 50.21(c) of this chapter and for which an application has been filed for a license authorizing operation at:

(1) A thermal power level in excess of 10 megawatts; or

(2) A thermal power level in excess of 1 megawatt, if the reactor is to contain:

(i) A circulating loop through the core in which the applicant proposes to conduct fuel experiments; or

(ii) A liquid fuel loading; or

(iii) An experimental facility in the core in excess of 16 square inches in cross-section.

§ 140.4 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretations of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

§ 140.5 Communications.

All communications concerning the regulations in this part should be addressed to the Atomic Energy Commission, Washington 25, D.C., Attention: Division of Licensing and Regulation.

§ 140.6 Reports.

(a) In the event of bodily injury or property damage arising out of or in connection with the possession or use of the radioactive material at the location or in the course of transportation or in the event any claim is made therefor, written notice containing particulars sufficient to identify the licensee and reasonably obtainable information with respect to the time, place, and circumstances thereof, or the nature of the claim shall be furnished by or for the licensee to the Commission as promptly as practicable. The terms "the radioactive material", "the location", and "the course of transportation" as used in this section shall have the meanings defined in the applicable indemnity agreement between the licensee and the Commission.[1]

[1] A proposed form of indemnity agreement was published in the FEDERAL REGISTER of August 28, 1958 (23 F.R. 6651), for public comment. It is expected that a final form of indemnity agreement will be published at an early date as Appendix B to this part.

(b) The Commission ... person subject to this ... records and furnish su... Commission as the C... necessary for the adm... regulations in this par...

§ 140.7 Fees.

(a) Each licensee s... the Commission at th... year per thousand kilo... capacity authorized in ... vided, That no fee sh... $100 per annum for any ... Such fee shall be due ... ginning with the date ... plicable indemnity ag... ive and shall be pai... with billing instructio... the Commission.

(b) Where a licensee ... number of nuclear reac... power level not exce... watts, for sale to oth... them at the licensee's ... rarily prior to delive... shall report to the ... maximum number of ... be operated at that loc... time. In such cases, th... fee multiplied by the ... tors reported by the ... event the number of r... at any one time exceed ... reported, the licensee ... additional number of ... Commission and additio... made. If experience ... the estimated num... have been operated, app... ment in subsequent bills ... the Commission.

§ 140.8 Specific exempt... The Commission may ... by any interested ... exemptions from th... this part as it determ... by law and are o... the interest.

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(b) The Commission may require any person subject to this part to keep such records and furnish such reports to the Commission as the Commission deems necessary for the administration of the regulations in this part.

(c) Fees.

(1) Each licensee shall pay a fee to the Commission at the rate of $30 per year per thousand kilowatts of thermal capacity authorized in its license: *Provided*, That no fee shall be less than $100 per annum for any nuclear reactor. Such fee shall be due for the period beginning with the date on which the applicable indemnity agreement is effective and shall be paid in accordance with billing instructions received from the Commission.

(2) Where a licensee manufactures a number of nuclear reactors each having a power level not exceeding 3½ megawatts for sale to others and operates them at the licensee's location temporarily prior to delivery, the licensee shall report to the Commission the maximum number of such reactors to be operated at that location at any one time. In such cases, the fee shall equal $30 multiplied by the number of reactors reported by the licensee. In the event the number of reactors operated at any one time exceed the estimate so reported, the licensee shall report the additional number of reactors to the Commission and additional charges will be made. If experience shows that less than the estimated number of reactors have been operated, appropriate adjustments in subsequent bills will be made by the Commission.

(d) Specific exemptions.

The Commission may, upon application by any interested person, grant such exemptions from the requirements of this part as it determines are authorized by law and are otherwise in the public interest.

SUBPART B—PROVISIONS APPLICABLE ONLY TO APPLICANTS AND LICENSEES OTHER THAN FEDERAL AGENCIES AND NONPROFIT EDUCATIONAL INSTITUTIONS

§ 140.10 Scope.

This subpart applies to applicants for and holders of licenses issued pursuant to Part 50 of this chapter authorizing operation of nuclear reactors, except licenses for the conduct of educational activities issued to, or applied for by, persons found by the Commission to be nonprofit educational institutions and except persons found by the Commission to be Federal agencies.

§ 140.11 Amounts of financial protection for certain reactors.

(a) Each licensee is required to have and maintain financial protection—

(1) In the amount of $1,000,000 for each nuclear reactor he is authorized to operate at a thermal power level not exceeding ten kilowatts;

(2) In the amount of $1,500,000 for each nuclear reactor he is authorized to operate at a thermal power level in excess of ten kilowatts but not in excess of one megawatt;

(3) In the amount of $2,500,000 for each nuclear reactor other than a testing reactor or a reactor licensed under section 104b of the Act which he is authorized to operate at a thermal power level exceeding one megawatt but not in excess of ten megawatts; and

(4) In the amount of $60,000,000 for each nuclear reactor he is authorized to operate and which is designed for the production of electrical energy and has a rated capacity of 100,000 electrical kilowatts or more.

(b) In any case where a person is authorized pursuant to Part 50 of this chapter to operate two or more nuclear reactors at the same location, the total financial protection required of the licensee for all such reactors is the highest amount which would otherwise be required for any one of those reactors: *Provided*, That such financial protection covers all reactors at the location.

§ 140.12 Amount of financial protection required for other reactors.

(a) Each licensee is required to have and maintain financial protection for each nuclear reactor for which the amount of financial protection is not determined in § 140.11, in an amount determined pursuant to the formula and other provisions of this section: *Provided*, That in no event shall the amount of financial protection required for any nuclear reactor under this section be less than $3,500,000 or more than $60,000,000.

(b) (1) The formula is:

$x = B$ times P.

(2) In the formula:

x = Amount of financial protection in dollars.
B = Base amount of financial protection.
P = Population factor.

(3) The base amount of financial protection is equal to $150 times the maximum power level, expressed in thermal kilowatts, as authorized by the applicable license.

(4) The population factor (P) shall be determined as follows:

(i) *Step 1.* The area to be considered includes all minor civil divisions (as shown in the 1950 Census of Population, Bureau of the Census, or later data available from the Bureau) which are wholly or partly within a circle with the facility at its center and having a radius in miles equal to the square root of the maximum authorized power level in thermal megawatts.

(ii) *Step 2.* Identify all minor civil divisions according to the same census which are in whole or in part within the circle determined in Step 1. Determine the population of each such minor civil division (according to the same census or later data available from the Bureau of the Census). For each minor civil division, divide its population by the square of the estimated distance to the nearest mile from the reactor to the geographic center of the minor civil division: *Provided*, That no such distance shall be deemed to be less than one mile. If the sum of the quotients thus obtained for all minor civil divisions wholly or partly within the circle is 1000 or less, the population factor is 1. If the sum of these quotients is more than 1000 but not more than 3000, the population factor is 1.1. If the sum of these quotients is more than 3000 but not more than 5000, the population factor is 1.2. If the sum of these quotients is more than 5000 but not more than 7000, the population factor is 1.3. If the sum of these quotients is more than 7000 but not more than 9000, the population factor is 1.4. If the sum of these quotients is more than 9000, the population factor is 1.5.

(c) In any case where a person is authorized pursuant to Part 50 of this chapter to operate two or more nuclear reactors at the same location, the total financial protection required of the licensee for all such reactors is the highest amount which would otherwise be required for any one of those reactors: *Provided*, That such financial protection covers all reactors at the location.

(d) Except in cases where the amount of financial protection calculated under this section is a multiple of $100,000, amounts determined pursuant to this section shall be adjusted to the next highest multiple of $100,000.

§ 140.13 Amount of financial protection required of certain holders of construction permits.

Each holder of a construction permit under Part 50 of this chapter authorizing construction of a nuclear reactor who is also the holder of a license under Part 70 of this chapter authorizing possession and storage only of special nuclear material at the site of the nuclear reactor for use as fuel in operation of the nuclear reactor after issuance of an operating license under Part 50 of this chapter, shall (during the period prior to issuance of the license authorizing operation of the reactor) have and maintain financial protection in the

amount of $1,000,000
cial protection shall
Commission in the
§ 140.15 prior to issu
under Part 70 of thi

§ 140.14 Types of f

(a) The amounts
tion required under
furnished and main
of:

(1) An effective p
surance from privat

(2) Adequate reso
financial protection r
of § 140.12; or

(3) Such other ty
tection as the Commis
of

(4) Any combinat
going.

(b) In any case w
sion has approved
protection filed by a li
shall not substitute o
protection for another
obtaining the writte
Commission.

§ 140.15 Proof of fin

(a) (1) Proof of fi
in the case of license
financial protection in
in the form of liabilit
with respect to such
ist of a copy of the li
policies) together wit
the insurers issuing s
that said copy is a tr
ently effective policy
ance. The licensee
ancial protection in
clear energy liability
forth in § 140.75.

(2) Such proof m
ist of a copy of
e of a nuclear energ
the form set forth
ed to the licensee:
policy form has
surers with the Co
arations page shall
certificate by the

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emed to be less than one mile
n of the quotients thus ob-
r all minor civil divisions
partly within the circle is
ss, the population factor is 1.
u of these quotients is more
but not more than 3000, the
factor is 1.1. If the sum of
ients is more than 3000 but
than 5000, the population fac-
If the sum of these quotients
han 5000 but not more than
opulation factor is 1.3. If the
ese quotients is more than 7000
ore than 9000, the population
1.4. If the sum of these quo-
nore than 9000, the population
1.5.

any case where a person is au-
pursuant to Part 50 of this
o operate two or more nuclear
at the same location, the total
protection required of the li-
r all such reactors is the high-
nt which would otherwise be
for any one of those reactors.
. That such financial protection
l reactors at the location.

cept in cases where the amount
ial protection calculated under
ion is a multiple of $100,000
determined pursuant to this
shall be adjusted to the next
multiple of $100,000.

Amount of financial protec-
required of certain holders of
struction permits.

holder of a construction permit
Part 50 of this chapter author-
nstruction of a nuclear reactor
lso the holder of a license under
of this chapter authorizing pos-
and storage only of special nu-
aterial at the site of the nuclear
for use as fuel in operation of
clear reactor after issuance of
ating license under Part 50 of
apter, shall (during the period
issuance of the license and
peration of the reactor) have
in financial protection in the

amount of $1,000,000. Proof of financial protection shall be filed with the Commission in the manner specified in § 140.15 prior to issuance of the license under Part 70 of this chapter.

§ 140.14 Types of financial protection.

(a) The amounts of financial protection required under this part may be furnished and maintained in the form of:

(1) An effective policy of liability insurance from private sources; or

(2) Adequate resources to provide the financial protection required by § 140.11 or § 140.12; or

(3) Such other type of financial protection as the Commission may approve; or

(4) Any combination of the foregoing.

(b) In any case where the Commission has approved proof of financial protection filed by a licensee the licensee shall not substitute one type of financial protection for another type without first obtaining the written approval of the Commission.

§ 140.15 Proof of financial protection.

(a)(1) Proof of financial protection (in the case of licensees who maintain financial protection in whole or in part in the form of liability insurance shall with respect to such insurance) consist of a copy of the liability policy (or policies) together with a certificate by the insurers issuing such policy stating that said copy is a true copy of a currently effective policy issued to the licensee. The licensee may furnish such financial protection in the form of the nuclear energy liability insurance policy set forth in § 140.75.

(2) Such proof may alternatively consist of a copy of the declarations page of a nuclear energy liability policy in the form set forth in § 140.75 and issued to the licensee: *Provided*, That a policy form has been filed by the insurers with the Commission. The declarations page shall be accompanied by a certificate by the insurers stating that said copy is a true copy of the declarations page of a currently effective policy and identifying the policy (including endorsements) by reference to the policy form which has been filed by them with the Commission.

(3) The Commission will accept any other form of nuclear energy liability insurance as proof of financial protection, if it determines that the provisions of such insurance provide financial protection under the requirements of the Commission's regulations and the Act.

(b) Proof of financial protection in the case of licensees who maintain financial protection in whole or in part in the form specified in § 140.14(a)(2) shall consist of a showing that the licensee clearly has adequate resources to provide the financial protection required under this part. For this purpose the applicant or licensee shall file with the Commission:

(1) Annual financial statements for the three complete calendar or fiscal years preceding the date of filing, together with an opinion thereon by a certified public accountant. The financial statements shall include balance sheets, operating statements and such supporting schedules as may be needed for interpretation of the balance sheets and operating statements.

(2) If the most recent statements required under subparagraph (1) have been prepared as of a date more than 90 days prior to the date of filing, similar financial statements, prepared as of a date not more than 90 days prior to the date of filing, should be included. These statements need not be reviewed by a certified public accountant.

(c) The Commission may require any licensee to file with the Commission such additional proof of financial protection or other financial information as the Commission determines to be appropriate for the purpose of determining whether the licensee is maintaining financial protection as required under this part.

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(d) Proof of financial protection shall be subject to the approval of the Commission.

(e) The licensee shall promptly notify the Commission of any material change in proof of financial protection or in other financial information filed with the Commission under this part.

§ 140.16 Commission review of proof of financial protection.

The Commission will review proof of financial protection filed by any licensee or applicant for license. If the Commission finds that the licensee or applicant for license is maintaining financial protection in accordance with the requirements of this part, approval of the financial protection will be evidenced by incorporation of appropriate provision in the license.

§ 140.17 Special provisions applicable to licensees furnishing financial protection in whole or in part in the form of liability insurance.

In any case where a licensee undertakes to maintain financial protection in the form of liability insurance for all or part of the financial protection required by this part,

(a) The Commission may require proof that the organization or organizations which have issued such policies are legally authorized to issue them and do business in the United States and have clear ability to meet their obligations; and

(b) At least 30 days prior to the termination of any such policy, the licensee shall notify the Commission of the renewal of such policy or shall file other proof of financial protection.

§ 140.18 Special provisions applicable to licensees furnishing financial protection in whole or in part in the form of adequate resources.

In any case where a licensee undertakes to maintain financial protection in the form specified in § 140.14(a)(2) for all or part of the financial protection required by this part,

(a) The licensee shall file with the Commission at least annually, before such dates as are specified in the applicable written approval issued by the Commission pursuant to § 140.16, balance sheet and operating statement prepared and certified by a certified public accountant in accordance with conventional accounting practices.

(b) The Commission may require such licensee to file with the Commission such additional financial information as the Commission determines to be appropriate for the purpose of determining whether the licensee is maintaining financial protection as required by this part.

§ 140.19 Failure by licensees to maintain financial protection.

In any case where the Commission finds that the financial protection maintained by a licensee is not adequate to meet the requirements of this part, the Commission may suspend or revoke the license or may issue such order with respect to licensed activities as the Commission determines to be appropriate or necessary in order to carry out the provisions of this part and of section 170 of the Act.

§ 140.20 Indemnity agreements

(a) The Commission will execute and issue agreements of indemnity pursuant to the regulations in this part or such other regulations as may be issued by the Commission. Such agreements shall, as to any licensee, shall be effective as of

(1) The effective date of the license (issued pursuant to Part 50 of this chapter) authorizing the licensee to operate the nuclear reactor involved; or

(2) The effective date of the license (issued pursuant to Part 70 of this chapter) authorizing the licensee to possess and store special nuclear material at the site of the nuclear reactor for use as fuel in operation of the nuclear reactor after issuance of an operating license for the reactor,

whichever is earlier. No agreement, however, shall be executed after September 26, 1957.

(b)(1) The general form of indemnity agreement to be entered into by the Commission with licensees under this subpart is set forth in this part. The form of indemnity agreement to be entered into by the Commission with any particular licensee under this part shall contain such modifications of the form in Appendix B as may be provided for in applicable regulations or orders of the Commission.

(2) Each licensee who executes an indemnity agreement under this part shall enter into such agreements of such indemnity agreements as may be required by applicable licensing regulations or orders of the Commission.

SUBPART C—PROVISIONS RELATING ONLY TO FEDERAL AGENCIES

§ 140.51 Scope.

This subpart applies only to agreements entered into by the Commission with Federal agencies, which have applications for orders of licenses issued under Part 50 of this chapter authorizing operation of nuclear reactors.

NOTE: Federal agencies are not required to furnish financial protection.

§ 140.52 Indemnity agreements.

(a) The Commission will execute indemnity agreements of indemnity with any Federal agency subject to this subpart pursuant to the regulations in this part or such other regulations as may be issued by the Commission. Each agreement shall contain such provisions as required by law and such other provisions as may be included by the Commission in its discretion. Such agreements shall be effective as of

[1] A proposed form of indemnity agreement was published in the FEDERAL REGISTER of September 28, 1958 (23 F.R. 6681) for public comment. It is expected that the final indemnity agreement will be substantially the same as Appendix B to

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...ever is earlier. No such agree-
...however, shall be effective prior
...tember 26, 1957.

...(1) The general form of indem-
...agreement to be entered into by the
...ission with licensees subject to
...ubpart is set forth in Appendix
... The form of indemnity agree-
...to be entered into by the Commis-
...with any particular licensee under
...part shall contain such modifica-
...of the form in Appendix "B" as are
...ed for in applicable licenses,
...tions or orders of the Commis-

... Each licensee who has executed
...emnity agreement under this part
...ter into such agreements amend-
...such indemnity agreement as are
...d by applicable licenses, regula-
...or orders of the Commission.

...PART C—PROVISIONS APPLICABLE ONLY TO FEDERAL AGENCIES

...3 Scope.

...subpart applies only to persons
...d by the Commission to be Federal
...which have applied for or are
...of licenses issued pursuant to
...50 of this chapter authorizing op-
...of nuclear reactors.

... Federal agencies are not required
...h financial protection.

...2 Indemnity agreements.

... The Commission will execute
...ents of indemnity with each Fed-
...ency subject to this subpart pur-
...to the regulations in this part or
...her regulations as may be issued
...Commission. Each such agree-
...all contain such provisions as
...ired by law and such additional
...as may be incorporated
...by the Commission pursuant to
...on. Such agreements, as to any
... shall be effective on:

...posed form of indemnity agreement
...shed in the FEDERAL REGISTER on
...1958 (23 F.R. 6681), for public
... It is expected that a final form
...ity agreement will be published at
...date as Appendix B to this part.

...(1) The effective date of the license (issued pursuant to Part 50 of this chapter) authorizing the licensee to operate the nuclear reactor involved; or

(2) The effective date of the license (issued pursuant to Part 70 of this chapter) authorizing the licensee to possess and store special nuclear material at the site of the nuclear reactor for use as fuel in operation of the nuclear reactor after issuance of an operating license for the reactor,

whichever is earlier. No such agreement, however, shall be effective prior to September 26, 1957.

SUBPART D—PROVISIONS APPLICABLE ONLY TO NONPROFIT EDUCATIONAL INSTITUTIONS

§ 140.71 Scope.

This subpart applies only to applicants for and holders of licenses issued for the conduct of educational activities to persons found by the Commission to be nonprofit educational institutions, except that this subpart does not apply to Federal agencies.

NOTE: Financial protection is not required with respect to licenses issued for the conduct of educational activities to persons found by the Commission to be non-profit educational institutions.

§ 140.72 Indemnity agreements.

(a) The Commission will execute agreements of indemnity with each person subject to this subpart in accordance with this part or such other regulations as may be issued by the Commission. Each such agreement shall contain such provisions as are required by law and such additional provisions as may be incorporated therein by the Commission pursuant to regulation. Such agreements, as to any licensee, shall be effective on:

(1) The effective date of the license (issued pursuant to Part 50 of this chapter) authorizing the licensee to operate the nuclear reactor involved; or

(2) The effective date of the license (issued pursuant to Part 70 of this chapter) authorizing the licensee to

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possess and store special nuclear material at the site of the nuclear reactor for use as fuel in operation of the nuclear reactor after issuance of an operating license, whichever is earlier. No such agreement shall be effective as of a date earlier than August 23, 1958, except that the Commission may upon good cause found, make such agreement effective as of a date prior to August 23, 1958. In no event may the agreement be effective as of a date prior to September 26, 1957.

Appendix "A"—Form of Indem... Policy (see F.R. Doc. 60-3080 ...

Appendix "B"—Form of Inde... Agreement (to be added later).

NOTE: The reporting requirements ... tained herein have been approved by ... reau of the Budget in accordance ... Federal Reports Act of 1942.

Dated at Germantown, Md., this ... day of March 1960.

For the Atomic Energy Commis...

A. R. LUEDECKE,
General Manager.

...ENSES AND ACCESS I...

SUMMAR...

FACILITIES [a]	
...r Reactors:	
...nstruction permits	
...nstruction permit amendments	
...nse to operate	
...nse amendments & authorizations	
...r Reactors:	
...nstruction permits	
...nstruction permit amendments	
...nse to operate	
...nse amendments & authorizations	
...rch Reactors:	
...nstruction permits	
...nstruction permit amendments	
...nse to operate (including acquire ...	
...nse amendments	
...r Exports:	
...rch Reactor Licenses	
...r Reactor Licenses	
...r Reactor Licenses	
...nse amendments	
...s Experiment Facilities:	
...nstruction permits	
...nstruction permit amendments	
...nses to operate	
...nse amendments	
...nse Facilities:	
...nstruction permits	
...nses to operate	
...rt licenses	
...r licenses	
...r license amendments & renewals	
...r Nuclear Material licenses	
...r License amendments & renewals	
...r Material licenses issued or renewed	
...r Material export licenses	

...orizations to construct and operate a ...
...nses to operate are made upon satisfa...
...nses authorize construction of 36 rea...
...nses authorize construction of 38 rea...
...nses authorize construction of 13 rea...
...nses authorize construction of 24 rea...
...r licenses terminate upon complet...
...nses authorize possession only.

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: "A"—Form of Ina...
: F.R. Doc. 60-30... ...
: "B"—Form of Inde...
(to be added later).

...e reporting requirements ...
...n have been approved by th... ...
Budget in accordance ...
...orts Act of 1942.

Germantown, Md., thi... ...
...rch 1960.

Atomic Energy Commis...
A. R. LUEDECKE,
General Manager.

APPENDIX 9

...SES AND ACCESS PERMITS APPLICATIONS FILED AND ACTIONS TAKEN

SUMMARY OF LICENSING ACTIONS

FACILITIES [a]	PERMITS AND LICENSES ISSUED				PERMITS AND LICENSES IN EFFECT AS OF NOV. 30, 1960
	SEPT. 1, 1954 TO DEC. 31, 1957	JAN. 1, 1958 TO DEC. 31, 1958	JAN. 1, 1959 TO DEC. 31, 1959	JAN. 1, 1960 TO NOV. 30, 1960	
...actors:					
...ction permits	5	0	0	5	7
...ction permit amendments	1	4	5	1	
...to operate	1	0	1	1	3
...amendments & authorizations	1	7	7	7	
...ctors:					
...ction permits	1	2	0	0	1
...ction permit amendments	1	0	1	0	
...to operate	0	0	2	0	2
...amendments & authorizations	0	0	3	6	
...Reactors:					
...ction permits	[b] 20	[c] 11	[d] 15	14	[e] 19
...ction permit amendments	5	9	15	10	
...to operate (including acquire & operate)	28	19	9	10	45
...amendments	16	17	34	21	
...ports:					
...Reactor Licenses	16	5	11	3	(f)
...actor Licenses	0	2	0	0	(f)
...actor Licenses	0	1	1	0	(f)
...endments	6	14	10	13	
...periment Facilities:					
...ction permits	10	4	1	2	1
...ction permit amendments	2	2	1	2	
...to operate	6	[g] 5	3	2	14
...amendments	1	10	16	14	
...Facilities:					
...ction permits	0	0	0	0	0
...to operate	0	0	0	0	0
...enses	0	0	0	1	
...enses	148	215	176	190	538
...ense amendments & renewals	21	67	81	127	
...ear Material licenses	151	115	73	78	356
...ense amendments & renewals	92	156	194	232	
...eral licenses issued or renewed	4,541	1,303	1,168	1,009	1,175
...eral export licenses	2,456	676	721	644	(f)

...ses to construct and operate are filed simultaneously; conversions from construction permits ...e to operate are made upon satisfactory completion of construction.
...authorize construction of 36 reactors and modification of 2 reactors.
...authorize construction of 38 reactors.
...authorize construction of 13 reactors and modification of 2 reactors.
...authorize construction of 24 reactors and modification of 1 reactor.
...enses terminate upon completion of shipment.
...ses authorize possession only.

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FACILITY LICENSE APPLICATIONS

Applicant and Location of Facility	Description of Facility	Date Filed	Status
POWER REACTORS			
Carolinas Virginia Nuclear Power Associates, Inc. Parr, S.C.	17,000-kilowatt, vertical pressure tube, heavy water moderated and cooled reactor.	July 9, 1959	Construction permit: May 4, 1960.
Commonwealth Edison Co., Dresden Station, Grundy County, Ill.	180,000-kilowatt, dual cycle, boiling water reactor.	Apr. 1, 1955	Construction permit: May 4, 1956; 45-day license for 1-megawatt (thermal) operation issued Aug. 28, 1959; amended Nov. 1959 to expire Dec. amended Nov. 16, 315-megawatt (thermal) operation after Dec. amended June 2, operation at power to, but not in excess steady state power 630 megawatts amended Oct. 14, steady state operation megawatts (thermal).
Consolidated Edison Co., Westchester County, N.Y.	163,000-kilowatt, pressurized water (plus 112,000 kw of conventional superheater capacity).	Mar. 22, 1955 (date of application)	Construction permit: May 4, 1956.
Consumers Power Co., Big Rock Point, Charlevoix County, Mich.	75,000-kilowatt, high power density, single cycle, boiling water reactor.	Jan. 18, 1960	Construction permit: May 31, 1960.
Florida West Coast Nuclear Group, Inc., Polk County, Fla.	50,000-kilowatt, high temperature, gas-cooled, heavy water moderated, pressure tube type reactor.	Dec. 10, 1959	Pending.[a]
General Electric Co., Alameda County, Calif.	3,000 to 5,000-kilowatt developmental boiling water reactor.	Jan. 10, 1956 (date of application)	Construction permit: May 14, 1956; license for criticality test; 1957; for power Aug. 31, 1957; license ment authorizing at power levels to (thermal) issued; 1959; amended July 1, to authorize operation certain internal tions and with rangements amended 5, 1960 to authorize make changes with cal specifications license amendment no unreviewed tion is involved.
Northern States Power Co., Sioux Falls, S. Dak.	66,000-kilowatt, controlled recirculation boiling water reactor.	Apr. 1, 1959	Construction permit: May 12, 1960.
Pacific Gas and Electric Co., Humboldt Bay Power Plant, Eureka, Calif.	50,000-kilowatt, single cycle boiling water reactor.	Apr. 30, 1959	Construction permit: Nov. 9, 1960.
Philadelphia Electric Co., Peach Bottom, York County, Pa.	40,000-kilowatt, helium-cooled, graphite moderated, developmental reactor.	July 25, 1960	Pending.
Power Reactor Development Co., Lagoona Beach, Mich.	100,000-kilowatt, fast breeder reactor.	Jan. 7, 1956	Construction permit: Aug. 4, 1956.[b]
Saxton Nuclear Experimental Corp., Saxton, Pa.	20,000-kilowatt (thermal) pressurized light water reactor.	July 24, 1959	Construction permit: Feb. 11, 1960.
Yankee Atomic Electric Co., Rowe, Mass.	134,000-kilowatt pressurized light water reactor.	July 9, 1956	Construction permit: Nov. 4, 1957; for 5-megawatt eration issued amended July operation at power in excess of (thermal).

[a] Action on application withheld at applicant's request pending submission of new
[b] Circuit Court Order dated June 10, 1960 vacated construction permit; Circuit Court decision Aug. 8, 1960, pending appeal by the parties.

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ICATIONS

ILED	STATUS
1959	Construction permit May 4, 1960.
, 1955	Construction permit May 4, 1956; 45-day license for 1-megawatt (thermal) operation issued 28, 1959; amended 1959 to expire Dec. amended Nov. 16, 315-megawatt (ther eration after Dec. amended June 2, operation at power to, but not in excess steady state power 630 megawatts amended Oct. 14, steady state operation megawatts (thermal).
22, 1955 f appli- on)	Construction permit May 4, 1956.
18, 1960	Construction permit May 31, 1960.
10, 1959	Pending.*
10, 1956 of appli- tion)	Construction permit May 14, 1956; license for criticality tests 1957; for power Aug. 31, 1957; license ment authorizing at power levels to (thermal) issued Jan. 1959; amended July 1 to authorize operation certain interim tions and with rangements amended 5, 1960 to authorize make changes within cal specifications license amendment no unreviewed safety tion is involved.
. 1, 1959	Construction permit May 12, 1960.
. 30, 1959	Construction permit Nov. 9, 1960.
y 25, 1960	Pending.
l. 7, 1956	Construction permit Aug. 4, 1956.*
ly 24, 1959	Construction permit Feb. 11, 1960.
ly 9, 1956	Construction permit Nov. 4, 1957, issued for 5-megawatt (thermal) operation issued June 28, amended July 28, operation at power in excess of 100 (thermal).

ıding submission of new technical
ıction permit; Circuit Court granted

FACILITY LICENSE APPLICATIONS—Continued

NAME AND LOCATION OF FACILITY	DESCRIPTION OF FACILITY	DATE FILED	STATUS
TEST REACTORS			
General Nucleonic, San Ramon, Calif. Wilcox Babcock & Wilcox Lynchburg, Va.	10,000-kilowatt, light water moderated, pool.	Oct. 22, 1958	Application withdrawn by letter dated Sept. 21, 1959.
	55,000-kilowatt, light water and beryllium moderated reactor.	May 31, 1960	Application withdrawn by letter dated July 11, 1960.
Electric Co., Alameda County, Calif.	33,000-kilowatt, pressurized water reactor.	June 14, 1957	Construction permit issued Mar. 11, 1958; licenses issued, for criticality tests Dec. 22, 1958, for test reactor operation Jan. 7, 1959; amended Mar. 11, 1960 to authorize changes in boiling water loop and operation of the loop.
Aeronautics and Space Administration, Cleveland, Ohio.	60,000-kilowatt, pressurized water reactor.	Aug. 20, 1956	Construction permit issued July 21, 1958.
Electric Power Electric Company, Waltz Mill, Pa.	60,000-kilowatt, pressurized water reactor (MTR type).	Mar. 12, 1956	Construction permit issued July 3, 1957; license for 20,000 kw (thermal) operation issued June 19, 1959; amended for 60,000 kw (thermal) operation Jan. 8, 1960; operation suspended by Commission Order June 30, 1960, resumption of operation authorized Sept. 7, 1960.
RESEARCH REACTORS			
General Nucleonic, San Ramon, Calif. (ESNPS).	100-milliwatt Model AGN-201 reactor, serial 100.	May 28, 1956	Construction permit issued Aug. 16, 1956; license issued Oct. 19, 1956.
General Nucleonic, San Ramon, Calif. and 102 sold nsees).	Two 100-milliwatt and one 5-watt (later amended to 20-watt) Model AGN-201 and AGN-201M reactors, serials 101, 102 and 103.	Sept. 11, 1956	Construction permit issued Feb. 22, 1957; licenses issued Feb. 23, 1957, Mar. 14, 1957 and Mar. 29, 1957 (amended for 20-watt operation Aug. 22, 1958 (ser. 103).
General Nucleonic, San Ramon, Calif. other licensees).	Four 100-milliwatt and one 5-watt Model AGN-201 and AGN-201M reactors, serials 104 through 108.	Nov. 28, 1956	Construction permit issued July 8, 1957; two licenses issuod July 10, 1957; licenses also issued, July 31, 1957, Aug. 23, 1957 and Sept. 20. 1957.
General Nucleonic, San Ramon, Calif. licensees).	Twelve 100-milliwatt Model AGN-201 reactors, serials 109 through 120.	Feb. 12, 1957	Construction permit issued July 8, 1957; six licenses issued Aug. 23, 1957, Oct. 28, 1957, Jan. 22, 1958, May 16, 1958, June 3, 1958 and June 30, 1958. Application covering construction of remaining six reactors withdrawn by letter Sept. 16, 1960.
Nucleonic, Calif. reported).	One 1-watt pool-type Model AGN-211 reactor, serial 100.	Nov. 12, 1957	Construction permit issued Jan. 24, 1958; license issued Feb. 12, 1958.
Nucleonic, Calif. nsees).	Fifteen 100-milliwatt Model AGN-201 reactors, serials 126 through 140.	Dec. 2, 1957	Construction permit Feb. 20, 1958. Ten reactors (serials 131 through 140) withdrawn from application by letter Sept. 16, 1960.
----------	Five 5-watt (later amended to 20-watt) Model AGN-201 reactors, serials 121 through 125.	Dec. 3, 1957	Construction permit issued Feb. 20, 1958; amendment issued increasing operating level to 20 watts issued Nov. 14, 1958. Application withdrawn by letter Sept. 16, 1960.
----------	Ten 15-watt (later amended to 100-watt for 3 reactors) Model AGN-211 reactors, serials 101 through 110.	Apr. 14, 1958	Construction permit issued Aug. 6, 1958; amended Mar. 4, 1959 to increase operating level to 100 watts for serials 103, 104 and 105. Two reactors (serials 104 and 105) withdrawn from application by letter Sept. 16, 1960.

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FACILITY LICENSE APPLICATIONS—Continued

Applicant and Location of Facility	Description of Facility	Date Filed	Status
RESEARCH REACTORS—Continued			
American Radiator & Standard Sanitary Corp., Mountain View, Calif.	1-watt (UTR-1) graphite moderated reactor (Argonaut type).	July 12, 1957	Construction permit Oct. 31, 1957; license May 21, 1958. Remantled and exported for exhibition in Japan; license terminated [illegible] 1960.
Do	1-watt Exhibition UTR-Model II reactor.	Feb. 2, 1960	Construction permit Feb. 29, 1960; license Mar. 1, 1960. Remantled and exported for exhibition in Egypt and Pakistan; facility license terminated Aug. 4, 1960.
Armour Research Foundation, Chicago, Ill.	100-kilowatt water boiler type reactor.	Jan. 7, 1955	Construction permit Mar. 28, 1958; license June 12, 1956 for operation; amended Jan. [illegible] for 100 kw. operation.
The Babcock & Wilcox Co. Lynchburg, Va.	10-kilowatt pool-type reactor.	Mar. 28, 1958	Construction permit Sept. 4, 1958; license Sept. 5, 1958.
Battelle Memorial Institute, West Jefferson, Ohio.	1,000-kilowatt pool-type reactor (later amended for 2,000 kw. steady state and 3,000 kw. intermittent operation).	May 10, 1955	Construction permit Aug. 5, 1955; license Aug. 10, 1956 for [illegible] operation; amended [illegible] 1959 for continuous [illegible] at 2,000 kw. and [illegible] operation at 3,000 kw.
Catholic University of America, Washington, D.C.	AGN-201 100-milliwatt reactor, serial 101 (purchased from AGN).	July 10, 1957	License issued Nov. [illegible]
Colorado State University, Fort Collins, Colo.	AGN-201 100-milliwatt reactor, serial 109 (purchased from AGN).	July 22, 1957	License issued Sept. [illegible]
Cornell University, Ithaca, N.Y.	10-kilowatt dual core, pool-type reactor (application resubmitted to cover 10-watt pool-type reactor designated the Zero Power Reactor).	Feb. 21, 1958 Jan. 4, 1960	Construction permit Nov. 21, 1958; amended 15, 1960 to authorize [illegible] tion of Zero Power [illegible]
Do	10-kilowatt TRIGA reactor.	Jan 4, 1960	Construction permit June 29, 1960.
Curtiss-Wright Corp. Quehanna, Pa.	1,000-kilowatt pool-type reactor.	Oct. 29, 1956	Construction permit June 20, 1957; license Apr. 29, 1958 for [illegible] ation; amended for [illegible] operation at power [illegible] 1,000 kw. June [illegible] amended Oct. 16, [illegible] thorizing shutdown [illegible] for 1-year period. [illegible] minated on transfer [illegible] to Penn State [illegible] effective Dec. 12, 1960.
Daystrom, Inc., West Caldwell, N.J.	10-kilowatt Argonaut-type reactor.	Dec. 11, 1956	Construction permit Oct. 11, 1957.[a]
The Dow Chemical Co., Midland, Mich.	1,000 to 10,000-kilowatt liquid metal fuel reactor.	Jan. 31, 1956	Application withdrawn letter Oct. 30, 1957.
Ford Motor Co., Dearborn, Mich.	10 to 100-kilowatt pool-type reactor.	Jan. 17, 1956	Application withdrawn letter Oct. 16, 1957.
General Dynamics Corp., San Diego, Calif.	TRIGA reactor, 250-kilowatt steady state, multi-megawatt pulses.	Nov. 19, 1957	Construction permit May 2, 1958; [illegible] May 3, 1958.
Do	1,000-kilowatt FLAIR reactor (redesignated TRIGA Mark F by applicant).	Mar. 9, 1960	Construction permit July 1, 1960; [illegible] July 1, 1960.
General Electric Co., Alameda County, Calif.	30-kilowatt, light water cooled and moderated, graphite reflected reactor.	July 1, 1957	Construction permit Oct. 24, 1957; [illegible] Oct. 31, 1957 [illegible] pended from Aug. [illegible] Aug. 18, 1959.
Georgia Institute of Technology, Atlanta, Ga.	1,000-kilowattt, tank type, heavy water moderated and cooled reactor.	Feb. 3, 1960	Construction permit June 13, 1960.

[a] At applicant's request the construction permit was revoked Feb. 14, 1958, without prejudice [illegible] of new application at later date.

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FACILITY LICENSE APPLICATIONS—Continued

...ANT AND LOCATION ...OF FACILITY	DESCRIPTION OF FACILITY	DATE FILED	STATUS
	RESEARCH REACTORS—Continued		
...Reactor Laboratory, Inc., Plainsboro ...ship, N.J.	5,000-kilowatt pool-type reactor, light water cooled and moderated.	Jan. 12, 1956	Construction permit issued Jan. 22, 1957; license for 100 kw. operation issued Oct. 10, 1958; amended for 5,000 kw. operation June 1, 1959; amended to authorize Columbia Univ. to operate the reactor Oct. 24, 1960.
...tate University, ...Iowa.	10-kilowatt Argonaut-type reactor (AR&SSC Model UTR-10).	Sept. 8, 1958	Construction permit issued Oct. 12, 1959; license issued Oct. 16, 1959.
...Aircraft Corp., ...ersville, Ga.	10-watt pool-type training reactor.	Apr. 18, 1960	Construction permit issued June 13, 1960; license issued July 22, 1960, expired Sept. 1, 1960.[d]
	10-megawatt Radiation Effects Reactor.	Oct. 3, 1960	Pending.
...setts Institute of ...ology, Cambridge,	1,000-kilowatt heavy water moderated reactor.	Feb. 20, 1956	Construction permit issued May 7, 1956; license issued June 9, 1958.
...Naval Medical ..., Bethesda, Md.	TRIGA reactor, 100-kilowatt steady state, multi-megawatt pulses.	July 21, 1960	Construction permit issued Nov. 8, 1960.
...American Aviation, ...Atomics International Division, Canoga ...Calif.	5-watt solution-type laboratory reactor (Model L-47).	Jan. 24, 1957	Construction permit issued Aug. 2, 1957; license issued Aug. 5, 1957.[e]
	10-watt solution-type laboratory reactor (Model L-77).	Jan. 20, 1958	Construction permit issued May 17, 1958; license issued May 17, 1958.
...State College, Raleigh, N.C.	100-kilowatt water boiler type reactor.	June 1, 1955	License issued Oct. 1, 1955.
	Modification for 500-watt operation.	Dec. 13, 1956	Construction permit issued Mar. 6, 1957; amended license for 500-watt operation issued May 1, 1957.
	Relocation and modification for 100-watt operation.	Nov. 19, 1958	Construction permit issued Mar. 18, 1959; amended license for 100-watt operation issued July 13, 1959.
...State College, Raleigh, N.C.	10-kilowatt, graphite reflected, heterogeneous, water moderated.	July 21, 1958	Construction permit issued Nov. 26, 1958; license issued March 16, 1960.
...Development ...America, Pawling, N.Y.	5-watt heavy water moderated and reflected reactor.	Apr. 7, 1958	Construction permit issued Oct. 7, 1958; license issued Oct. 22, 1958.
...State University, ...bus, Ohio.	10-kilowatt pool-type, light water moderated, graphite reflected reactor.	Nov. 2, 1959	Construction permit Feb. 3, 1960.
...State Univ., ...ater, Okla.	AGN-201 100-milliwatt reactor, serial 102 (purchased from AGN).	Mar. 20, 1957	License issued Aug. 26, 1957.
...Materials Reserve Office, Waterto... ...Mass.	1,000-kilowatt pool-type reactor.	Jan. 15, 1957	Construction permit issued Oct. 2, 1957; license issued June 14, 1960.
...State College, ...Oreg.	AGN-201 100-milliwatt reactor, serial 114 (purchased from AGN).	May 5, 1958	License issued Nov. 13, 1958.
...State University Park,	100-kilowatt pool-type reactor.	May 9, 1955	License issued July 8, 1955; amended for 200-kw-operation May 13, 1960.
...ania State University, ...Quehanna, Pa.	Curtiss-Wright 4,000-kilowatt pool-type reactor.	Oct. 4, 1960	Pending.[f]
...A&M College University, ...Tex.	AGN-211 15-watt, pool-type reactor, serial 101 (purchased from AGN).	Aug. 4, 1958	License issued Jan. 8, 1959.
...University, ...Calif.	10-kilowatt pool-type, light water moderated and reflected reactor.	June 15, 1959	Construction permit Nov. 20, 1959; license issued Dec. 4, 1959.

...l reactor was dismantled and exported to South America for exhibition purposes.
...del L-47 was dismantled by owner, North American Aviation, Inc., and license was terminated ...request on June 30, 1958.
...Curtiss-Wright reactor (built and previously operated by Curtiss-Wright Corporation) is a gift ...Wright to Pennsylvania State University. Penn State requests a license for possession only ...time. License for possession only, issued effective Dec. 12, 1960.

...ONS—Continued

...ED	STATUS
...ued	
...957	Construction permit ... Oct. 31, 1957; license ... May 21, 1958. Reactor ... mantled and exported ... hibition in Japan; ... license terminated ... 1960.
...960	Construction permit ... Feb. 29, 1960; license ... Mar. 1, 1960. Reactor ... mantled and exported ... hibition in Egypt and ... stan; facility license ... nated Aug. 4, 1960.
...1955	Construction permit ... Mar. 28, 1955; license ... June 12, 1956 for 10 kw ... tion; amended Jun. 14, ... for 100 kw. operation.
...1958	Construction permit ... Sept. 4, 1958; license ... Sept. 5, 1958.
...1955	Construction permit ... Aug. 5, 1955; license ... Aug. 10, 1956 for ... operation; amended ... 1959 for continuous ... at 2,000 kw. and ... operation at 3,000 kw.
1957	License issued Nov. 15, ...
1957	License issued Sept. 12, ...
1958 1960	Construction permit ... Nov. 21, 1958; amended ... 15, 1960 to authorize ... tion of Zero Power ...
1960	Construction permit ... June 29, 1960.
1956	Construction permit ... June 20, 1957; license ... Apr. 29, 1958 for 100 kw ... ation; amended for ... operation at power ... 1,000 kw. June 12, ... amended Oct. 10, ... thorizing shutdown of ... for 1-year period. License ... minated on transfer of ... to Penn State ... effective Dec. 12, 1960.
...1956	Construction permit ... Oct. 11, 1957.[c]
...1956	Application withdrawn ... letter Oct. 30, 1957.
...1956	Application withdrawn ... letter Oct. 10, 1957.
...1957	Construction permit ... May 2, 1958; license ... May 3, 1958.
...1960	Construction permit ... July 1, 1960; license ... July 1, 1960.
...1957	Construction permit ... Oct. 24, 1957; license ... Oct. 31, 1957 (operation ... pended from Aug. 14, ... Aug. 18, 1959).
...1960	Construction permit ... June 13, 1960.

...eb. 14, 1958, without prejudice ...

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FACILITY LICENSE APPLICATIONS—Continued

Applicant and Location of Facility	Description of Facility	Date Filed	Status
RESEARCH REACTORS—Continued			
Texas A&M College System, College Station, Tex.	AGN-201 100-milliwatt reactor, serial 106 (purchased from AGN).	Mar. 25, 1957	License issued Aug. 26, [illegible]
Do.	100-kilowatt pool-type, light water moderated and cooled reactor.	Mar. 17, 1959	Construction Permit Aug. 4, 1959.
Texas Technological College, Lubbock, Tex.	10-kilowatt pool-type, water moderated and cooled reactor.	Feb. 1, 1960	Construction permit Aug. 1960.
The Prosperity Co., Inc., Coral Gables, Fla.	Pool-type reactor	Mar. 6, 1956	Incomplete application Dec. 20, 1957, without prejudice to filing of new application at later date.
Union Carbide Corp., Sterling Forest Orange County, N.Y.	5,000-kilowatt pool-type reactor.	Feb. 15, 1957	Construction permit Oct. 31, 1957.
U.S. Air Force Dawsonville, Ga.	10-Megawatt Radiation Effects Reactor.	Oct. 17, 1960	Pending.[a]
U.S. Naval Hospital, Bethesda, Md.	AGN-201M 5-watt reactor, serial 105 (purchased from AGN).	Mar. 27, 1957	License issued Sept. 11, [illegible]
U.S. Naval Postgraduate School, Monterey, Calif.	AGN-201 100-milliwatt reactor, serial 100 (purchased from AGN).	Nov. 28, 1956	License issued Apr. 22, [illegible]
U.S. Naval Research Laboratory, Washington, D.C.	100-kilowatt pool-type reactor.	Apr. 5, 1955	Construction permit Apr. 29, 1955; license Sept. 14, 1956.
Do.	Modification for 1,000-kilowatt operation with forced convection cooling.	July 2, 1959	Construction Permit Nov. 20, 1959.
University of Akron, Akron, Ohio.	AGN-201 100-milliwatt reactor, serial 104 (purchased from AGN).	Apr. 5, 1957	License issued Sept. 5, [illegible]
University of Arizona, Tucson, Ariz.	10-kilowatt tank-type reactor (General Atomic TRIGA).	July 16, 1958	Construction permit [illegible] 1958; license issued [illegible] 1958.
University of Buffalo, Buffalo, N.Y.	1,000-kilowatt pool-type reactor.	Mar. 11, 1957	Construction permit [illegible] 1959.
University of California, Los Angeles, Calif.	50-kilowatt water boiler type reactor.	June 2, 1955 (date of application)	Application withdrawn by letter June 11, 1958.
Do.	10-kilowatt Argonaut-type reactor.	July 2, 1959	Construction permit Nov. 16, 1959; license Oct. 3, 1960, for 10-kw operation.
University of California, Berkeley, Calif.	AGN-201 100-milliwatt reactor, serial 112 (purchased from AGN).	Aug. 26, 1957	License issued Nov. [illegible]
University of Delaware, Newark, Delaware.	AGN-201 100-milliwatt reactor, serial 113.	Mar. 21, 1958	License issued July 2, [illegible]
University of Florida, Gainesville, Fla.	10-kilowatt Argonaut-type reactor.	Aug. 23, 1957	Construction permit Dec. 23, 1957; license May 21, 1959.
University of Illinois, Urbana, Ill.	100-kilowatt tank-type reactor (General Atomic TRIGA Mark II).	Nov. 16, 1959	Construction permit Apr. 5, 1960; license Aug. 16, 1960.
University of Kansas, Lawrence, Kans.	10-kilowatt tank-type, light water moderated and cooled reactor.	Aug. 24, 1959	Construction permit Apr. 7, 1960.
University of Maine, Orono, Maine.	AGN-201 100-milliwatt reactor, serial 132 (to be purchased from AGN).	Sept. 16, 1958	Pending—application incomplete.
University of Maryland, College Park, Md.	10-kilowatt pool-type, light water moderated, graphite reflected reactor.	Apr. 11, 1960	Construction permit June 29, 1960; license Oct. 14, 1960.
University of Michigan, Ann Arbor, Mich.	1,000-kilowatt pool-type reactor.	Jan. 12, 1955	Construction permit Feb. 17, 1955; license for 100 kw. operation Dec. 1957; amended for 1 [illegible] operation Aug. 11, [illegible]
University of Missouri, Rolla, Mo.	10-kilowatt pool-type, light water moderated reactor.	Jan. 29, 1959	Construction permit Nov. 20, 1959.

[a] The Radiation Effects Nuclear Reactor was constructed and operated by Lockheed Aircraft Corporation for the Air Force pursuant to the provisions of Section 91 b. of the Atomic Energy Act of 1954. The lease arrangement with the Air Force Lockheed proposes to operate the reactor for other government [illegible] and has requested a Class 104c license. The Air Force has requested a 5-year license for possession of the facility.

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FACILITY LICENSE APPLICATIONS—Continued

...NT AND LOCATION OF FACILITY	DESCRIPTION OF FACILITY	DATE FILED	STATUS
RESEARCH REACTORS—Continued			
...ity of Oklahoma, ...man, Okla.	5-watt laboratory reactor (Atomics International.)	Aug. 30, 1957	Application withdrawn by letter Aug. 22, 1958.
do	AGN-211 15-watt, pool-type reactor, serial 102 (purchased from AGN).	July 25, 1958	License issued Dec. 29, 1958.
...ity of Tennessee ...ville, Tenn.	10-kilowatt heavy water moderated reactor.	Sept. 5, 1958	Application withdrawn by letter May 2, 1960.
...ity of Utah, Salt ...e City, Utah.	AGN-201 100-milliwatt reactor, serial 107 (purchased from AGN).	June 24, 1957	License issued Sept. 12, 1957.
...ity of Virginia, ...ttesville, Va.	1,000-kilowatt pool-type reactor.	Mar. 29, 1957	Construction permit issued Sept. 13, 1957; license issued June 24, 1960.
...ity of Washington, ...tle, Wash.	10-kilowatt Argonaut-type reactor.	June 15, 1959	Construction permit Oct. 13, 1959.
...ity of Wisconsin, ...ison, Wis.	10-kilowatt pool-type, light water moderated reactor.	Jan. 27, 1960	Construction permit issued June 7, 1960; license issued Nov. 23, 1960.
...ity of Wyoming, ...mie, Wyo.	AGN-201 100-milliwatt reactor, serial 111.	Aug. 21, 1957	Application withdrawn by letter Nov. 3, 1958.
do	10-watt laboratory reactor (Atomics International Model L-77).	Nov. 14, 1958	Construction permit issued Feb. 24, 1959; license issued Feb. 25, 1959.
...erbilt University ...ville, Tenn.	AGN-201 100-milliwatt reactor, serial 116.	Jan. 30, 1958	Application withdrawn by letter Sept. 28, 1959.
...Administration ...tial, Omaha, Nebr.	10-kilowatt tank-type reactor.	Apr. 10, 1959	Construction permit issued June 24, 1959; license issued June 26, 1959.
...Polytechnic In... ...e, Blacksburg, Va.	10-kilowatt Argonaut-type reactor (AR&SSC Model UTR-10).	Feb. 9, 1959	Construction permit issued Nov. 16, 1959; license issued Dec. 18, 1959.
...Reed Army Insti... ...of Research Wash... ...n, D.C.	50-kilowatt homogeneous solution-type reactor (Atomics International Model L-54).	May 20, 1959	Construction permit issued Jan. 6, 1960.
...ton State Univ. ...y State College ...Washington) Pull... ...Wash.	100-kilowatt pool-type reactor.	June 22, 1956	Construction permit issued July 8, 1959.
...Virginia University ...gantown, W. Va.	AGN-211 75-watt, pool-type reactor, srial 103.	Mar. 30, 1959	Construction permit issued June 19, 1959; license issued July 28, 1959.
...Polytechnic In... ...Worcester, Mass.	1-kilowatt pool-type reactor.	May 1, 1959	Construction permit issued Nov. 23, 1959; license issued Dec. 16, 1959.
CRITICAL EXPERIMENT FACILITIES			
...ducts, Inc., Sche... ...dy, N.Y.	Various critical experiments.	Oct. 13, 1958	License issued March 25, 1959.[b]
...almers Mfg. Co., ...ukee, Wis.	Northern States Power Co. critical experiments.	June 16, 1958	Construction permit issued Nov. 13, 1958; license issued Nov. 3, 1959.
...abcock & Wilcox ...Lynchburg, Va.	Consolidated Edison Co. critical experiments and NMSR critical experiments.	Oct. 27, 1955	Construction permit issued Dec. 9, 1955; license issued Mar. 20, 1957; amended to authorize additional experiments Jan. 24, 1958, May 28, 1958, Apr. 16, 1959, Oct. 12, 1959, Dec. 29, 1959, Oct. 25, 1960 and Nov. 28, 1960.
do	Critical experiments for Nuclear Merchant Ship Reactor (NMSR).	Feb. 1, 1957	Construction permit issued Oct. 2, 1957; license issued Jan. 22, 1958; amended to authorize additional experiments May 7, 1959 and June 25, 1959.
do	Critical experiments for Liquid Metal Fuel Reactor Experiment (LMFRE).	May 20, 1958	Construction permit issued Sept. 24, 1958; license issued Sept. 24, 1958.
...Memorial Insti... ...West Jefferson,		Oct. 28, 1955	Construction permit issued Dec. 28, 1955; license (to possess only) issued Jan. 16, 1958.

...ly constructed in 1956 under contract with and for the account of the Atomic Energy Commission ...thorizes conduct of private work.

—Continued

STATUS
...license issued Aug. 26, ...
...Construction permit Aug. 4, 1959.
...Construction permit Aug. ... 1960.
Incomplete application ... Dec. 20, 1957, without ... udice to filing of new ap... tion at later date.
Construction permit ... Oct. 31, 1957.
Pending.[a]
License issued Sept. 12, ...
License issued Apr. 29, ...
Construction permit Apr. 29, 1955; license ... Sept. 14, 1956.
Construction permit ... Nov. 20, 1959.
License issued Sept. 5, ...
Construction permit No... 1958; license issued ... 1958.
Construction permit Se... 1959.
Application withdrawn ... ter June 11, 1958.
Construction permit ... Nov. 16, 1959; license ... Oct. 3, 1960, for 10-watt ... tion.
License issued Nov. 12, ...
License issued July 3, ...
Construction permit ... Dec. 23, 1957; license ... May 21, 1959.
Construction permit ... Apr. 5, 1960; license ... Aug. 16, 1960.
Construction permit ... Apr. 7, 1960.
Pending—application ... plete.
Construction permit ... June 29, 1960; license ... Oct. 14, 1960.
Construction permit ... Feb. 17, 1955; license ... for 100 kw. operation ... 1957; amended for ... operation Aug. 11, ...
Construction permit ... Nov. 20, 1959.

...ed by Lockheed Aircraft Co... ...tomic Energy Act of 1954 ... ...actor for other government ... ...-year license for possession ...

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FACILITY LICENSE APPLICATIONS—Continued

Applicant and Location of Facility	Description of Facility	Date Filed	Status
CRITICAL EXPERIMENT FACILITIES—Continued			
General Dynamics Corp., San Diego, Calif.	Critical experiments for General Dynamics research reactors.	Oct. 25, 1956	Construction permit June 18, 1957; license Aug. 13, 1957; amendment additional experiments 26, 1957, Feb. 5, 1958 and July 18, 1958.
General Electric Co., Alameda County, Calif.	Critical experiments for Commonwealth Edison reactor.	Mar. 27, 1956	Construction permit June 29, 1956; license Aug. 30, 1957; amendment broaden scope of May 29, 1959 and June amended for additional periments Oct. 4, 1
Do	Nuclear checkout tests for Spanish Research Reactor.	June 14, 1957	Construction permit Sept. 20, 1957; license Oct. 16, 1957 (tests and license expired 1958).
Lockheed Aircraft Corp., Palo Alto, Calif.		June 20, 1956	Construction permit Mar. 14, 1957 (expired 30, 1957).[j]
Lockheed Aircraft Corp., Dawsonville, Ga.	Various critical experiments.	Oct. 3, 1960	Pending.
The Martin Co., Middle River, Md.	Martin Power Reactor (MPR) and Engineering Research and Development Lab. (ERDL) critical experiments.	Oct. 26, 1956	Construction permit May 13, 1957; license Dec. 6, 1957 for MPR ments amended for E experiments June amended for additional iments Apr. 30, 1 27, 1959, Mar. 5, 1 1960 and June 7, 1
Do	Liquid Fluidized Bed Reactor (LFBR) critical experiments.	Jan. 4, 1960	Construction permit May 13, 1960.
National Aeronautics and Space Administration, Cleveland, Ohio.	Series of critical experiments.	July 8, 1957	Construction permit Jan. 22, 1958; license Jan. 5, 1959.
North American Aviation, Inc.	Critical experiments relating to Advanced Epithermal Thorium Reactor (AETR) program.	Aug. 20, 1959	Construction permit Dec. 24, 1959; license Oct. 3, 1960.
Nuclear Development Corp. of America, Pawling, N.Y.		Mar. 14, 1956	Construction permit June 11, 1956, license possess only) issued 1958.
U.S. Air Force, Dawsonville, Ga.		Oct. 17, 1960	Pending.[k]
Westinghouse Electric Corp., Waltz Mill, Pa.	CRX Facility—Yankee critical experiments.	Sept. 21, 1956	Construction permit Oct. 17, 1957; license for Yankee experiments 25, 1957, with amendments for additional experiments June 30, 1958 and Aug 1958; license amended BR-3 experiments on 1958, with amendments additional experiments 12, 1959 and Jan. 7, license amended to region experiments Jan 1958, with amendments additional experiments 3, 1959 which also RFMF experiments amended for "Loose Lattice" experiments July 8,
	Belgian Reactor-3 (BR-3)	Sept. 8, 1958	
	Two-region critical experiments.	Nov. 13, 1958	
	Reactor Fuel Measurement Facility (RFMF) experiments.	Apr. 30, 1959	
	Loose Lattice critical experiments.	May 25, 1959	
Do	CES Facility—Westinghouse Test Reactor critical experiments.	Oct. 24, 1957	Construction permit June 14, 1958; license June 17, 1958, amendments additional experiments 7, 1959 and Oct. 29,
Do	LRX Facility—Carolinas Virginia Tube Reactor critical experiments.	Dec. 23, 1959	Construction permit Apr. 26, 1960; license May 3, 1960.

[j] Facility dismantled and license terminated Mar. 15, 1960 at licensee's request.
[j] Plans to construct facility as originally designed abandoned, per Lockheed letter dated Feb. 1
[k] See footnote g. The same information applies to both the Radiation Effects Reactor and the experiment facility.

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FACILITY LICENSE APPLICATIONS—Continued

...NT AND LOCATION OF FACILITY	DESCRIPTION OF FACILITY	DATE FILED	STATUS
PRODUCTION FACILITIES			
...er Corporation, ...rmond, Pa. ...ntific Develop... Pittsburg, Inc.,	Gas Centrifuge Plant	Mar. 29, 1960	Pending—Application incomplete.
	Multi-stage gas centrifuge production facility for the separation of isotopes of uranium.	July 14, 1959	Pending—Application incomplete.[1]
EXPORT LICENSES			
...dustries, Inc., ...rk, N.Y.	1-watt pool-type, light water cooled and moderated research reactor for export to Tecnicas Hispano Americanas S.A., Madrid, Spain.	Feb. 4, 1958	Application withdrawn.
...General Nucleonics ...mo, Calif.	100-milliwatt AGN-201 reactor, serial 110, for export to Laboratoires R. Derveaux, Boulogne, France.	July 9, 1957	Application withdrawn.
	100-milliwatt AGN-201 reactor or AGN-211 pool-type reactor for export to Government of Belgium for exhibit at 1958 World's Fair, Brussels, Belgium.	Dec. 9, 1957	Application withdrawn.
	100-milliwatt AGN-201 reactor, serial 110, for export to Instituto di Fisica, Facolta D'Ingegneria, University of Palermo, Palermo, Sicily.	Apr. 21, 1958	License issued Jan. 7, 1959.
	100-milliwatt AGN-201 reactor, serial 111, for export to Universite de Geneve, Geneva, Switzerland.	Apr. 24, 1958	Application withdrawn.
	20-watt AGN-201P reactor, serial 121, for export to University of Zurich, Zurich, Switzerland.	Oct. 16, 1958	Application withdrawn.
...ers Mfg. Co., ...ee, Wis. (for... ...F Industries).	5,000-kilowatt tank-type heavy water moderated and cooled research reactor for export to Comitato Nazionale per le Ricerche Nucleari, Milan, Italy.	Dec. 12, 1956	License issued May 16, 1957.
	20,000-kilowatt tank-type materials testing reactor for export to Reactor Centrum Nederland, Pettin, The Netherlands.	Apr. 23, 1957	License issued Jan. 17, 1958.
	30,000-kilowatt tank-type materials testing reactor for export to Aktiebolaget Atomenergi of Sweden, Tystberga, Sweden.	June 18, 1957	License issued May 14, 1958.
...ntercontinental ... Service Co., ...rk, N.Y.	43,000-kilowatt pressurized light water power reactor for export to Centre d'Etudes de l'Energie Nucleaire, Brussels, Belgium.	July 8, 1958	License issued Nov. 6, 1958.
...ent Machine & ...ry Co., New ...N.Y.	10-kilowatt light water moderated research reactor for export to Ministry of Education, Kingdom of the Netherlands, Amsterdam, The Netherlands.	Sept. 27, 1956	License issued Feb. 1, 1957.
	1,000-kilowatt pool-type research reactor for export to Laboratorium fur Technische Physik der Technischen Hochschule, Munich, Germany.	July 2, 1956	License issued Mar. 15, 1957.
	1,000-kilowatt pool-type research reactor for export to Hamilton College, McMaster University, Hamilton, Canada.	May 17, 1957	License issued Aug. 27, 1957.

...NS—Continued

	STATUS
...ontinued	
...	Construction permit ... June 18, 1957; license ... Aug. 13, 1957; amended ... additional experiments ... 26, 1957, Feb. 3, 1958, ... 1958 and July 15, 1958.
...	Construction permit ... June 29, 1956; license ... Aug. 30, 1957; amended ... broaden scope of ... May 29, 1959 and June 1, 1959 ... amended for additional ... periments Oct. 4, 1959.
...	Construction permit ... Sept. 20, 1957; license ... Oct. 16, 1957 (tests ... and license expired May ... 1958).
6	Construction permit ... Mar. 14, 1957 (expired ... 30, 1957).[j]
0	Pending.
6	Construction permit ... May 13, 1957; license ... Dec. 6, 1957 for MPR ... ments amended for ... experiments June 12, 1959, ... amended for additional ... iments Apr. 30, 1959, ... 27, 1959, Mar. 8, 1960, ... 1960 and June 7, 1960.
60	Construction permit ... May 13, 1960.
957	Construction permit ... Jan. 22, 1958; license ... Jan. 5, 1959.
959	Construction permit ... Dec. 24, 1959; license ... Oct. 3, 1960.
956	Construction permit ... June 11, 1956; license ... possess only) issued Jan. ... 1958.
960	Pending.[k]
1956	Construction permit ... Oct. 17, 1957; license ... for Yankee experiments ...
1958 1958	... 25, 1957, with amendments ... for additional experiments ... June 30, 1958 and Aug. ... 1958; license amended for ... BR-3 experiments Oct. ... 1958, with amendments ... additional experiments ... 12, 1959 and Jan. 27, ... license amended for ... region experiments Dec. ... 1958, with amendments ... additional experiments ... 3, 1959 which also ... RFMF experiments, ... amended for "Loose Lattice" ... experiments July 10, 1959.
1959	
1959	
1957	Construction permit ... June 14, 1958; license ... June 17, 1958, amended ... additional experiments ... 7, 1959 and Oct. 29, 1959.
1959	Construction permit ... Apr. 26, 1960; license ... May 3, 1960.

...see's request.
... Lockheed letter dated Feb. 11, ...
...iation Effects Reactor and the ...

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FACILITY LICENSE APPLICATIONS—Continued

Applicant and Location of Facility	Description of Facility	Date Filed	Status
EXPORT LICENSES—Continued			
American Machine & Foundry Co., New York, N. Y.—Continued	1,000-kilowatt pool-type research reactor for export to Junta de Energia Nuclear, Lisbon, Portugal.	July 22, 1957	License issued Sept. 12, [illegible]
Do	1,000-kilowatt pool-type research reactor for export to Greek Atomic Energy Commission, Athens, Greece.	May 7, 1957	License issued Sept. [illegible], [illegible]
Do	1,000-kilowatt pool-type research reactor for export to Societa Ricerche Impianti Nucleari, Milan, Italy.	July 3, 1957	License issued Dec. 6, [illegible]
Do	1,000-kilowatt pool-type research reactor for export to Commissariat a L'Energie Atomique, Tel Aviv, Israel.	Apr. 11, 1958	License issued June 12, [illegible]
Do	5,000-kilowatt tank-type research reactor for export to Osterreichische Studiengesellschaft m.b.h., Seibersdorf, Austria.	June 19, 1958	License issued Sept. 3, [illegible]
Do	5,000-kilowatt pool-type research reactor for export University of Teheran, Teheran, Iran.	Apr. 20, 1959	License issued Aug. 5, [illegible]
Do	1,000-kilowatt pool-type research reactor for export to Turkish Atomic Energy Commission, Istanbul, Turkey.	June 10, 1959	License issued Sept. 4, [illegible]
American Radiator & Standard Sanitary Corp., Mountain View, Calif.	10-kilowatt Model UTR-10 research reactor for export to Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales, Australia.	June 6, 1960	License issued Sept. [illegible], [illegible]
Do	0.1 watt water-moderated, graphite-reflected research reactor for export to Kinki University, Fuse, Osaka, Japan.	Oct. 7, 1960	Pending.
The Babcock & Wilcox Co., New York, N.Y.	5,000-kilowatt pool-type research reactor for export to Conselho Nacional de Pesquisas do Brasil, for Comissao de Energia Atomica, Sao Paulo, Brazil.	Oct. 5, 1956	License issued Jan. 21, [illegible]
Do	5,000-kilowatt pool-type research reactor for export to Society for the Utilization of Nuclear Energy in Shipbuilding & Navigation, Inc., Hamburg, Germany.	Feb. 1, 1957	License issued June [illegible], [illegible]
Curtiss-Wright Corp., New York, N.Y.	1,000-kilowatt pool-type research reactor for export to Thai Atomic Energy Commission for Peace, Bangkok, Thailand.	June 12, 1959	License issued Nov. [illegible], [illegible]
Foster-Wheeler Corp., New York, N.Y.	5,000-kilowatt tank-type research reactor for export to Danish Atomic Energy Commission, Christiansborg, Copenhagen, Denmark.	Jan. 25, 1957	License issued Apr. [illegible], [illegible]
General Dynamics Corp., San Diego, Calif.	100-kilowatt tank-type research reactor (TRIGA Mark II) for export to Comitato Nazionale per le Ricerche Nucleari, Rome, Italy.	Nov. 7, 1958	License issued Jan. [illegible], [illegible]

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NS—Continued

	Status
7	License issued Sept. 12, 19[illegible]
7	License issued Sept. 25, 19[illegible]
57	License issued Dec. 6, 19[illegible]
58	License issued June 12, 19[illegible]
958	License issued Sept. 3, 19[illegible]
959	License issued Aug. 5, 19[illegible]
1959	License issued Sept. 4, 19[illegible]
1960	License issued Sept. 12, 19[illegible]
, 1960	Pending.
, 1956	License issued Jan. 22, 19[illegible]
1, 1957	License issued June 10, 19[illegible]
2, 1959	License issued Nov. 5, 19[illegible]
25, 1957	License issued Apr. 4, 19[illegible]
7, 1958	License issued Jan. 8, 19[illegible]

FACILITY LICENSE APPLICATIONS—Continued

Name and Location of Facility	Description of Facility	Date Filed	Status
	EXPORT LICENSES—Continued		
Dynamics Corp., [illegible], Calif.—Con.	100-kilowatt tank-type research reactor (TRIGA Mark II) for export to Government of the Republic of Korea, Seoul, Korea.	Mar. 4, 1959	License issued May 21, 1959.
"	30-kilowatt TRIGA research reactor for export to Escola de Engenharia da Universidade de Minas Ferais, Belo Horizonte, Brazil.	Mar. 4, 1959	License issued Aug. 3, 1959.
"	100-kilowatt tank-type research reactor (TRIGA Mark II) for export to Republic of Austria, Federal Ministry of Education, Vienna, Austria.	Mar. 4, 1959	License issued Nov. 24, 1959.
"	100-kilowatt tank-type research reactor (TRIGA Mark II) for export to Office of Atomic Energy of the Republic of Viet Nam, Dalat, Viet Nam.	June 16, 1959	License issued Oct. 20, 1959.
"	100-kilowatt tank-type research reactor (TRIGA Mark II) for export to Musashi College of Technology, Tokyo, Japan.	Feb. 19, 1960	License issued July 8, 1960.
"	100-kilowatt tank-type research reactor (TRIGA Mark II) for export to Rikkyo University, Tokyo, Japan.	Feb. 19, 1960	License issued July 8, 1960.
Electric Co., New [illegible], N.Y.	3,000-kilowatt pool-type research reactor for export to Junta de Energia Nuclear, Madrid, Spain.	May 22, 1957	License issued July 29, 1957.
"	3,000-kilowatt pool-type research reactor for export to Instituto Venezolano de Investigaciones Cientificas, Caracas, Venezuela.	Oct. 3, 1957	License issued Jan. 16, 1958.
"	1,000-kilowatt pool-type research reactor for export to National Tsing-Hua University, Taipei, Taiwan, Republic of China.	Apr. 4, 1958	License issued June 5, 1958.
"	15,000-kilowatt (electrical) boiling water type power reactor for export to Allgemeine Elektricitata-Gesellschaft AG, Frankfurt, Germany.	June 9, 1959	License issued Sept. 30, 1959.
"	1,000-kilowatt pool-type research reactor for export to the Philippine Atomic Energy Commission, Manila, Republic of the Philippines.	July 7, 1959	License issued Nov. 16, 1959.
Electric Co. [illegible], N.Y.	150,000-kilowatt (electrical) boiling water type power reactor for export to Societa Elettronucleare Nazionale (SENN), Rome, Italy.	Apr. 5, 1960	Pending.
ental Chemical [illegible] York, N.Y.	50-kilowatt solution-type research reactor (Atomics Int'l. Model L–54) for export to Farbwerke Hoechst AG, Frankfurt, Germany.	Apr. 1, 1957	License issued June 11, 1957.
Company, Los [illegible], Calif.	500-watt solution-type research reactor (Atomics Int'l. Model L–55) for export to the Danish Atomic Energy Commission, Christiansborg, Copenhagen, Denmark.	Jan. 17, 1957	License issued Apr. 4, 1957.

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FACILITY LICENSE APPLICATIONS—Continued

Applicant and Location of Facility	Description of Facility	Date Filed	Status
EXPORT LICENSES—Continued			
James Loudon & Co., Inc., Los Angeles, Calif.	50-kilowatt solution-type research reactor (Atomics Int'l. Model L–54) for export to the Senate of the Land Berlin, Berlin, Germany.	Mar. 28, 1957	License issued Sept.
Luigi Serra, Inc., New York, N.Y.	5,000-kilowatt pool-type research reactor for export to Centro Autonomo Militare Energia Nucleare (C.A.M.E.N.), Accademia Navale, Livorno, Italy.	Sept. 3, 1959	License issued Dec. 1
Marubeni-Iida Co. (N.Y.), Inc., New York, N.Y.	50-kilowatt solution-type research reactor (Atomics Int'l. Model L–54) for export to The Japan Atomic Energy Research Institute, Tokyo, Japan.	Sept. 13, 1956	License issued Nov.
Mitsubishi International Corporation, New York, N.Y.	10,000-kilowatt tank-type research reactor for export to The Japan Atomic Energy Research Institute, Tokyo, Japan.	Aug. 12, 1957	License issued Oct. 1
S. A. Innocente Mangili Adriatica, Inc., New York, N.Y.	50-kilowatt solution-type research reactor (Atomics Int'l. Model L–54) for export to Politecnico Di Milano, Milan, Italy.	June 2, 1958	License issued Aug.

Business or Occupation of Access Permit Holders

	Dec. 31, 1959	Nov. 30, 1960
Aircraft and/or Components	32	30
Beverage Industry	1	1
Chemical-General	70	56
Chemical-Pharmaceutical	4	3
Chemical-Processing Equipment	11	12
Coal Industry	3	2
Communications	1	1
Consultants	77	66
Educational Institutions	25	27
Electronic Industry	36	19
Engineering-Construction	40	32
Engineering-Consulting	86	48
Engineering-Design	38	54
Federal, State, and City Governments or Departments	45	32
Financial Organizations	11	8
Food Companies	1	1
Information Services	15	14
Instrument Manufacturer	56	47
Insurance Companies	82	70
Lawyers and Public Accountants	31	26
Machinery-General	33	27
Machinery-Special	26	21
Metal Products Manufacture	122	101
Mining and Refining		
Motor Vehicles and/or Components		
Paper and Pulp Companies		
Petroleum and Petroleum Products		
Printing and Publishing		
Professors, Teachers, and Scientists		
Railroads and Railway Equipment		
Research-General		
Research-Medical		
Rubber and Rubber Products		
Scrap and Waste Disposal		
Shipbuilding and/or Components		
Special Carriers and Warehousing		
Stone, Clay, and Glass Products		
Tobacco and Tobacco Products		
Unions, Trade Associations, Chambers of Commerce, and Manufacturers' Representatives		
Utilities		
Weapons, Explosives, and Propellants		
Others (not elsewhere classifiable)		
Total [1]		

[1] Some Permittees have been classified in more than one category.

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NS—Continued

	STATE
License issued Sept.	
License issued Dec.	
License issued Nov.	
License issued Oct.	
License issued Aug.	

ermit Holders

- fining
- and/or Components
- p Companies
- Petroleum Products
- ublishing
- chers, and Scientists
- Railway Equipment
- ral
- ical
- ubber Products
- ste Disposal
- nd/or Components
- s and Warehousing
- nd Glass Products
- Tobacco Products
- e Associations, Chamb
- nerce, and Manufactur
- atatives
- plosives, and Prop
- sewhere classifiable

Access Permit Holders by Principal Fields of Interest

	Dec. 31, 1959	Nov. 30, 1960		Dec. 31, 1959	Nov. 30, 1960
Nuclear)	0	0	Ore Refining and Production of Feed Materials	63	43
Processing and Equipment	46	41	Radiation Hazards and Effects	47	35
except Reactor Compo-	65	49	Radioactive Waste	41	29
	186	145	Reactor-Central Station	190	146
Thermonuclear Field	24	22	Reactor-Components	40	31
Construction of Atomic	78	67	Reactor-Heating	4	4
Facilities	10	9	Reactor-Other	22	20
Systems	24	21	Reactor-Propulsion	41	35
Fabrication	60	53	Reactor-Research	16	14
Research and Devel-	29	25	Shield Materials	17	13
Services	78	61	Special Materials	89	11
	85	73	Surveys for Potential Use or Need	21	16
Evaluation	12	8	Training and Education	14	12
and Banking	70	52	Transportation and Storage	6	6
Production and Utilization	30	25	Weapons and Components	0	1
and Accounting	12	11	Others (Not Elsewhere Classifiable)	9	7
			Total	1,429	1,145

These figures include permit holders with more than one field of interest, resulting in a total greater number of permittees.

Access Permit Holders by Geographic Areas

	Dec. 31, 1959	Nov. 30, 1960		Dec. 31, 1959	Nov. 30, 1960
	118	109	West South Central	54	41
	432	357	Mountain	37	31
Central	256	192	Pacific	138	121
Central	68	50	Hawaii, Alaska, and Puerto Rico	5	4
	132	104	Total	1,268	1,032
Central	28	23			

Standard Department of Commerce Areas.

Number of Permittees Having Access to Secret Restricted Data by Categories

	Dec. 31, 1959	Nov. 30, 1960		Dec. 31, 1959	Nov. 30, 1960
General	466		Particle Accelerators and High Voltage Machines	187	
Irradiation and Radio-	515		Physics and Mathematics	503	
Separation Processes for			Plutonium Production		12
Uranium	379		Radiation Effects on Reactor Materials	546	
Transuranic Elements	249		Radioactive Waste	548	
Thermonuclear Processes	102		Reactors-Power	592	
Fuels	406		Reactors-Production	322	
Element Technology	3		Reactors-Research and Testing	513	
Technology	1		Savannah River-Fuel Element Technology	2	
Process Techno-	5		Savannah River-Reactor Technology	1	
	577		Savannah River-Separations Process Technology	5	
	497		Technology-Feed Materials	279	
	98		Technology-Plutonium	267	
Ceramics	572		Technology-Tritium	60	
Materials	33	693			

On December 30, 1960, 540 permittees had 500 employees or less, while 492 had over 500 employees. On December 31, 1959, permittees with 500 or less employees numbered 583, while 685 had over 500 em-

5007005

Number of Access Authorizations Granted to Personnel or Permitt... for Access to Secret and Confidential Restricted Data

	Total as of Dec. 31, 1959	Total ... Nov. ...
Q(X) Access Authorizations:		
New authorizations granted	10,717	
Authorizations reinstated	2,477	
Authorizations extended	6,465	
Total	19,659	
Authorizations terminated	4,936	
Active Authorizations	14,723	

For Access to Confidential Restricted Data

L(X) Access Authorizations:		
New authorizations granted	9,906	
Authorizations reinstated	826	
Authorizations extended	1,737	
Total	12,469	
Authorizations terminated	3,020	
Active Authorizations	9,449	

S

...ance Industrial X-ra...

...after hearings in 195... ...Examiner on Januar... ...issued to Advance p... ...ifications of personn... ...order provided also ... ...a list of radiograp... ...intermediate decisio... ...was issued to Ad...

...olinas Virginia Nuclea...

...hearing was held in ...nstruction permit appl... ...Presiding Officer iss... ...visional construction ... ...South Carolina. Sinc... ...ate review of its own... ...mit was issued on May...

...y of Piqua, Piqua, Ohio

...January 7, 1960, t... ...ich authorized Atomic... ...proceed with construc... ...filed, the decision ... ...ter was held on Noven...

...ercise Marine Disposa...

...This is a proceeding to ...ng business as Coastw... ...ght pursuant to an o... ...the Presiding Office ...ng Beach, Calif., in w... ...framework of the i... ...on an investigatio... ...Commission on May ... ...authorized the rec... ...with regard to ma... ...licensee was require... ...erial except after ob... ...on or except in th... ...mission inspector. T... ...1960.

...May 23, 1960, the lic... ...ed by the order of M... ...denied by an order ... ...1960, the licensee file... ...king proof as to the...

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rsonnel or Permitt
estricted Data

Total as of Dec. 31, 1959	Total as of Nov. 30, 19
10,717	
2,477	
6,465	
19,659	
4,936	
14,723	

ed Data

9,906	
826	
1,737	
12,469	
3,020	
9,449	

APPENDIX 10

SUMMARY OF FORMAL HEARINGS

Industrial X-ray Laboratories, Inc., Los Angeles, Calif.

hearings in 1959, an intermediate decision was rendered by the Hear- Examiner on January 12, 1960, ordering that a byproduct material license issued to Advance provided that it furnish satisfactory information as to ifications of personnel, organization, and specified procedures and forms. order provided also that the license require Advance to submit on a monthly a list of radiographic jobs to be performed. In the absence of exceptions, intermediate decision became final on February 2, 1960. Subsequently, a was issued to Advance, with an expiration date of June 30, 1961.

Virginia Nuclear Power Associates, Inc., Parr, S.C.

hearing was held in Germantown, Md., on February 23 and 26, 1960, on a nction permit application filed by Carolinas Virginia. On April 12, 1960, Presiding Officer issued his Intermediate Decision approving issuance of a onal construction permit for the proposed nuclear steam generating plant uth Carolina. Since no exceptions were filed and the Commission did not ake review of its own motion, the decision became final and the construction mit was issued on May 4, 1960.

Piqua, Piqua, Ohio.

January 7, 1960, the Presiding Officer issued his Intermediate Decision authorized Atomics International Division, North American Aviation, Inc. ceed with construction of the reactor. In the absence of any exceptions filed, the decision became final on January 28, 1960 (the hearing in the was held on November 20, 1959).

Marine Disposal Company, Long Beach, Calif.

is a proceeding to revoke the waste disposal license of Robert Boswell, business as Coastwise Marine Disposal Company. The proceeding was pursuant to an order to show cause dated April 13, 1960. On April 29, the Presiding Officer issued an order granting the request of the city of Beach, Calif., in which Boswell's facility is located, to intervene within framework of the issues specified for consideration by the Commission. on an investigation which revealed certain additional alleged violations, Commission on May 5, 1960, ordered that the license be suspended insofar authorized the receipt of byproduct, source or special nuclear material with regard to material then in transit to the licensee. Under the order licensee was required to cease and desist from any further disposal of al except after obtaining specific written authorization from the Com- or except in the immediate presence and with the approval of a ssion inspector. The hearing was held in Long Beach on May 9, 10 and

May 23, 1960, the licensee filed a motion to relieve him from the suspension by the order of May 5, 1960. This motion was opposed by the staff and nied by an order of the Presiding Officer dated June 7, 1960. On June the licensee filed a motion to reopen the proceeding for the purpose proof as to the status of one of his customers with whom he alleged

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that certain drums having excessive radiation levels had originated. The motion was opposed by the staff and was denied by an order of the Presiding Officer dated July 19, 1960. However, the Presiding Officer requested further information concerning the relationship between certain customers and the Commission. On August 1, 1960, the staff filed its proposed findings and conclusions and brief.

On August 5, 1960, the licensee filed a document in support of its contention that the proceeding should be reopened and requested that the licensee be authorized to engage in controlled and limited operations of waste disposal until the final determination of this matter. On August 24, 1960, the staff filed a memorandum in opposition to the Licensee's Application of August 5, 1960. On August 30, 1960, the staff filed documents which constitute the present form of the contract between the Commission and the Regents of the University of California and asked that the documents be made a part of the record of the case. Subsequently, these documents were made a part of the record in the case.

On September 28, 1960, the Presiding Officer on the request of the licensee extended the time for the filing by the licensee of its finding and conclusions and brief until October 10, 1960. Time for the staff's reply was extended to October 25, 1960. On December 16, 1960, the Presiding Officer issued his Immediate Decision which ordered that the Coastline license be revoked and terminated and stated that exceptions must be filed by January 6, 1961.

Commonwealth Edison Co., Dresden, Ill.

On April 28, 1960, Commonwealth filed a report of test operations of its reactor as required by the Supplemental Intermediate Decision of November 25, 1959, which authorized test operations at limited power levels of up to 315 thermal megawatts (50% of design power). Following a hearing on the matter held May 4 and 6, 1960, at Germantown, Md., the Presiding Officer on May 16, 1960, issued his Second Supplemental Intermediate Decision authorizing operation of the Commonwealth Edison reactor at power levels of up to 630 mw (thermal) but not in excess of that level or at steady state operations at that power level. On August 2, 1960, the licensee filed Report No. 4, "Full Rated Power Test Operations of the Dresden Reactor," in accordance with license DPR-2, as amended, issued on June 2, 1960. On September 26 and 27, 1960, a hearing was held to consider the Report No. 4 and other relevant matters, including the question whether the Commission should consent to a lien on the company's facilities at the Dresden Nuclear Power Station. On October 11, 1960, the Hearing Examiner issued a Third Supplemental Intermediate Decision, which authorized power operations at the Dresden plant to power levels up to 630 MWT. This decision also gave the Commission's consent to the attachment of a lien on the facility. On October 14, 1960, the license was issued pursuant to the decision, for a full term of years to 1996.

By telegram dated November 16, 1960, Commonwealth reported a malfunction of the control rod drive mechanism. On November 17, 1960, the AEC Staff filed with the Commission a "Motion to Extend Period for Commission Review" until December 16, 1960, subject to such further extension as may be necessary in order to permit investigation and development of the facts disclosed in the Commonwealth telegram and permit determination of their relevance to issuance of the operating license to Commonwealth Edison. By memorandum dated November 22, 1960, Commonwealth amplified their telegram of November 16, and on November 23d the staff filed a memorandum supporting their motion to extend the period for Commission review. On November 23, 1960, following

...ipt of oral argumen...
...r extension of the ...
...when it became clea...
...the Commission staf...
...eriod until January ...
...the staff motion.

...umers Power Co.

On February 19, 19...
...pplication for a 75 ...
...actor proposed for ...
...f Michigan Departm...
...f Position regarding ...
...r limited appearanc...
...Resources Commissio...
...f Michigan filed a ...
...960, the Presiding O...
...ral, that the Petiti...
...Michigan Water Resc...
March 28, 1960, the I...
...d Limited Particip...
...ld, in Germantown, ...
...State Department of ...
...ficer issued his Int...
...onstruction permit f...
...kilowatts, and an ulti...
...ecision became final ...
...n May 31, 1960.

On October 17, 196...
...permit regarding the a...
...a hearing on the prop...
...the Hearing Examine...
...hearing be granted a ...
...time to be specified in ...

...neral Electric Co., P...

On February 24, 196...
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of oral argument, the Commission granted the AEC Staff's motion and order extension of the period for Commission review to and until December 16, 1960. it became clear that the investigation would extend beyond December 16, Commission staff moved that the Commission further extend the review until January 31, 1960. On December 14, 1960, the Commission granted staff motion.

Consumers Power Co., Big Rock Point, Mich.

February 19, 1960, Notice of Hearing was issued on the construction permit cation for a 75 megawatt (electrical) high power density, boiling water for proposed for construction by Consumers. On March 22, 1960, the State Michigan Department of Health filed with the Presiding Officer a Statement Position regarding the proposed project. A Statement of Position and request limited appearance was submitted on March 23, 1960, by the Michigan Water sources Commission. On March 24, 1960, the Attorney General of the State Michigan filed a Petition for Intervention. By telegram dated March 25, the Presiding Officer notified the State of Michigan, by its Attorney Gen- that the Petition for Intervention was granted, and that the State of Michigan Water Resources Commission could enter a limited appearance; on March 28, 1960, the Presiding Officer issued his formal Order for Intervention Limited Participation. The hearing in the matter took place March 29, in Germantown, Md., at which time the limited appearance of the Michigan Department of Health was permitted. On May 6, 1960, the Presiding issued his Intermediate Decision authorizing issuance of a provisional construction permit for a reactor with an initial capacity of 50,000 electrical watts, and an ultimate design capacity of 75,000 kilowatts (electrical). The sion became final on May 28, 1960, and the construction permit was issued May 31, 1960.

October 17, 1960, Consumers filed an application for amendment to their regarding the addition of technical specifications for reactor containment. hearing on the proposed amendment was held on December 13, at which time Hearing Examiner ordered that the applicant's motion for postponement of ing be granted and that the hearing in the proceeding be convened at a to be specified in a subsequent order.

General Electric Co., Pleasanton, Calif.

February 24, 1960, a Notice of Hearing on Application for Amendment to nation Facility License was issued. The hearing was commenced on April 5, and on April 6, 1960, was recessed to reconvene on May 2, 1960. At the re- of the licensee, the hearing was postponed until May 23, 1960. On June 14, the Presiding Officer issued his Intermediate Decision, authorizing the sion of the Vallecitos Boiling Water Reactor with certain internal modifica- with a new fuel arrangement including a new type of control rod and ed rod activators and with both turbine-and-electrical-driven coolant cir- pumps. In the absence of exceptions, or Commission review on its own the decision was to have become final on July 6, 1960. On June 30, 1960, Electric advised the Presiding Officer and the Commission that it would ceptions to the Intermediate Decision in regard to the issue of the pro- to be followed by the licensee before making changes in the reactor method of operation. The licensee also requested that the license amend- uthorized in the Intermediate Decision be made effective immediately, or July 6, 1960, notwithstanding the filing of exceptions. By order dated 1960, the Commission designated July 6, 1960, as the effective date of

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the Intermediate Decision and ordered that the amendment to the licens
issued as of that date. On July 2, 1960, General Electric filed its exception
the Presiding Officer's Intermediate Decision. On July 25, 1960, the staff
a brief with respect to the exceptions. On July 30, 1960, the licensee file
reply brief. On August 18, 1960, the Commission issued a Memorandum
Order which denied the licensee's exceptions to the Intermediate Decision
respect to the change procedures, and ordered that certain modifications be
to Amendment 14 to license DPR–1. On August 20, 1960, the licensee file
petition for reconsideration of the final decision stated in the Commissio
Memorandum and Order dated August 18, 1960. On September 7, 1960,
staff filed a memorandum in answer to the licensee's petition for reconsidera
By order issued September 27, 1960, the Commission agreed to consider
Memorandum and Order and set October 10, 1960, as the date and place for
arguments on the licensee's petition for reconsideration. On October 10,
the Commission heard oral argument on the petition for reconsideration.
October 7, the staff had filed a draft of a proposed license which was concur
in by the licensee. On November 2, the Commission issued a Memorandum
Order which directed the issuance of a license amendment incorporating
change procedure which had been jointly proposed by Commission staff and
licensee. Under the amended license, the licensee has freedom to make cha
within the limits of the technical specifications, provided no unreviewed
question is involved. Any change involving unreviewed safety questions
all changes in the technical specifications must be referred to the Commis
The Director, Division of Licensing and Regulation, may authorize such cha
if they present no significant new hazards considerations. Otherwise, refer
to the Advisory Committee on Reactor Safeguards and scheduling of a
hearing is required.

Houston Gamma Ray Company, Houston, Tex.

Houston Gamma Ray is the holder of a byproduct material license author
the use of byproduct material in radiography. The activities of the co
had been inspected on three previous occasions, after which alleged violation
the regulations and license conditions had been brought to the attention
licensee by notices issued pursuant to 10 CFR 2. The fourth inspection
company's activities was conducted in August and September, 1960, and
closed several alleged willful violations of the regulations and conditions
license. Accordingly, on September 19, 1960, AEC issued an order to show
why license should not be revoked at a hearing to be held in Houston, Tex.
October 11, 1960.

The licensee requested that the hearing date be postponed. By an order
October 4, 1960, the Hearing Examiner scheduled the hearing for Octob
1960. On October 6, 1960, the licensee's answer to the order to show
was filed.

On October 20, 1960, a stipulation was filed by counsel for the AEC staff
for the licensee reciting that the license would be revoked, the applicati
license renewal denied, and that a new application for a new license
be considered by the AEC after one year upon a showing that the licens
provided adequate safeguards to prevent the occurrence of any violation

The Presiding Officer entered an order pursuant to the stipulation of Oc
1960, together with a memorandum specifying that the stipulation
no way a limitation on the AEC in reviewing any applications filed by the
after one year.

Industrial Waste Disp

After the hearing w
Examiner issued
that a license be issu
disposal of low level,
Exceptions to the In
the State of Texas whi
on January 13, 1960, t
of Mexico to the Acti
Mexico expressed its
Gulf of Mexico. On J
matter submitted to the
County, Tex., resolutio
extensive oral argume
session on January 2
burn, Md.

The Commission issu
that the applicant was
receipt and storage of
waste at sea, the Comm
further proceedings to
after their disposal in
matters as the Examine
The intervenor, Harr
order in the Court of
petition for review con
mission's order which v
Disposal Corp., and wa
The Commission tran
record, filed on Septem
that motion to set proc
Commission transmitted
with

Base Development, Inc.

On November 13, 1959
AEC's November 2, 195
surveys to determine ai
directing the licensee t
mission regulations. A
for a hearing on Janu
changed, and the heari
filed by the staff on July
1960. The Staff's reply
that the Presiding Offi
advance to institute a p
their corrective action
were submitted by both p

National Aeronautics and

By notice dated Septe
date for consideration of

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...strial Waste Disposal Corporation, Houston, Tex.

...the hearing which was held on January 22 and 23, 1959, the AEC Hearing Examiner issued an Intermediate Decision on May 29, 1959, and directed ... a license be issued to the applicant for the storage, transportation, and ...sal of low level, radioactive waste material in the Gulf of Mexico. ...ceptions to the Intermediate Decision were filed by the intervenors, including ...State of Texas which had been permitted to intervene on September 3, 1959. ...January 13, 1960, the AEC staff filed a copy of a letter from the Ambassador ...Mexico to the Acting Secretary of State, dated December 16, 1959, by which ...ey expressed its opposition to the disposal of radioactive wastes in the ...of Mexico. On January 15, 1960, the United States Department of the In... ...submitted to the Presiding Officer a copy of its negative reply to the Harris ...y, Tex., resolution requesting intervention in the matter by the Department. ...sive oral arguments on the part of all of the parties were heard by the Com... ...on January 20, 1960, at the Commission's headquarters in German... ...Md.

...Commission issued its decision on June 22, 1960. The Commission found ...the applicant was entitled to receive a byproduct material license for the ...and storage of packaged low level waste material. As to the disposal of ...at sea, the Commission remanded the case to the Hearing Examiner for ...proceedings to take testimony concerning the integrity of containers ...their disposal in the Gulf of Mexico, and concerning such other material ...as the Examiner might permit.

...intervenor, Harris County, filed its petition for review of the Commission's ...in the Court of Appeals for the Fifth Circuit on August 19, 1960. The ...for review contained an application for interlocutory stay of the Com...'s order which was opposed by the Commission, and by Industrial Waste ...l Corp., and was denied by the Fifth Circuit on September 14, 1960. ...Commission transmitted to the Court a certified list of material in the ...filed on September 22, 1960, and proposed to the parties the filing of a ...motion to set procedures and time schedule. On the Clerk's request, the ...sion transmitted the entire certified record to the Court on November 2, ...

...Development, Inc., Edgemont, S. Dak.

...November 13, 1959, the licensee requested a formal hearing with respect to ...November 2, 1959 order, citing the licensee for alleged failure to make ...to determine airborne radioactivity and external radiation levels, and ...the licensee to bring the mill operation into compliance with Com... ...regulations. A notice of hearing, issued November 30, 1959, provided ...hearing on January 7, 1960. The date of hearing was subsequently ...and the hearing was held on May 17, 18, and 19, 1960. A brief was ...the staff on July 25, 1960. The licensee submitted its brief on August 29, ...The Staff's reply brief was filed on September 21, 1960. On November 25, ...Presiding Officer issued an Intermediate Decision which ordered the ...to institute a program to assure that adequate surveys are made and ...rrective action taken. Exceptions were filed in December and briefs ...mitted by both parties.

...Aeronautics and Space Administration, Sandusky, Ohio.

...ice dated September 13, 1960, October 18, 1960, was set as the hearing ...consideration of issuance of an operating license for the NASA 60 mega-

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watt (thermal) test reactor located at the NASA Plum Brook Facility, Sandusky, Ohio.

On October 4, 1960, the applicant filed an answer to the notice of hearing and motion for continuance on the ground that the applicant will not be able to complete construction by October 18, 1960. On October 7th, the staff informed the Examiner that it had no objection for continuance of the hearing scheduled for October 18, 1960. The hearing was held on October 18, 1960, and was recessed to reconvene on December 14, 1960. On October 19th, the Examiner issued an order postponing the hearing to December 14, 1960.

The hearing was convened on December 14 and recessed until December 15. On the later date, witnesses testified on behalf of the applicant and the AEC Staff. The applicant indicated that since construction of the facility was almost complete, only a provisional operating license authorizing initial loading of fuel and low power operation to 100 kilowatts (thermal) was being sought, pursuant to Section 50.57 of the Commission's regulations. The Examiner will issue an Intermediate Decision after filing of proposed findings and conclusions by the parties.

Northern States Power Co., Sioux Falls, S. Dak.

In accordance with the Notice of Hearing issued January 7, 1960, a hearing was held on February 15 and 16, 1960 to consider issuance of a provisional construction permit to Northern States. On April 21, 1960, the Presiding Officer issued his Intermediate Decision authorizing the issuance of a provisional construction permit for the 62 megawatt (electrical) "Pathfinder" reactor. The Decision became final and the construction permit was issued on May 12, 1960.

Nuclear Engineering Company, Inc., Pleasanton, Calif.

A hearing was held in San Francisco on November 16, 1960, to consider whether, in granting renewal of Nuclear Engineering's license, the Commission should prohibit the licensee from continuing the loading of packaged low-level radioactive waste at Fulton's Shipyard near Antioch, Calif., and require that another site be designated in the license. Officials of the State of California have objected to the conduct of further operations by the licensee at the site near Antioch. The decision of the Presiding Officer on the matter is pending.

Pacific Gas and Electric Company, Eureka, Calif.

A hearing was held on August 24–26, 1960, to consider a construction permit for the proposed nuclear reactor at the licensee's Humboldt Bay Power Plant. The hearing originally scheduled for April 14, 1960, was postponed at the request of the applicant to allow the applicant to conduct further tests regarding the proposed reactor. An intermediate decision issued on October 17, 1960, became final on November 8, 1960, and ordered that a construction permit substantially in the form attached thereto be issued. The construction permit was issued on November 9, 1960.

Power Reactor Development Company, Lagoona Beach, Mich.

A summary of the status of this case is set forth in the section on Licensing Regulations and Indemnification.

Puerto Rico Water Resources Authority, Rincon, Puerto Rico.

A hearing on the construction of a reactor to be constructed for the Puerto Rico Water Resources Authority at a site near Rincon, Puerto Rico was held at San Juan, Puerto Rico on April 27, 1960. On June 28, 1960, the Presiding Officer issued his Intermediate Decision which authorized construction of the

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Nuclear Super Heater (BONUS) Power Plant. The decision became
July 19, 1960.

operatives Power Association, Elk River, Minn.

Intermediate Decision of the Presiding Officer issued December 18, 1959,
final January 9, 1960. The decision authorized construction of the Elk
reactor, which was considered during the hearing held November 10, 1959.
notice dated November 17, a hearing on the operating authorization for
thousand ekw facility was scheduled for December 20. By order dated
ember 9, the Presiding Officer granted the applicants' request that the hearing
ferred until March 7, 1961.

Inspection Company, Sarnia, Ontario, Dominion of Canada.

rnia is the holder of a license permitting the use of byproduct material in
graphy. An inspection of the licensee's activities in the United States
ealed several alleged violations of the Commission's regulation and conditions
license dealing primarily with the alleged failure of the licensee to provide
ate supervision and inspection of the employees using byproduct material.
ordingly, the Commission issued an order to show cause dated June 21, 1960,
ding that the licensee conduct no further radiography operations unless
operations were conducted by or under the supervision of individuals
ically approved by the Commission, that 48-hour notice of the beginning
ch operation in the United States be given to the Commission, and the
show cause why these requirements should not be imposed.
June 28, 1960, the licensee filed an answer. On July 6, 1960, the staff
for a prehearing conference for the purpose of clarifying the licensee's
as stated in its answer. Subsequently, by a letter dated July 7, 1960, a
ance of the hearing was requested by counsel newly retained by the
. On July 20, 1960, an amendment to the answer was filed in which
ensee stated that it consents to the entry of an order by the Hearing
ner containing the restrictions set forth in the order of June 21, 1960.
an order dated July 22, 1960, the case was continued indefinitely. At the
of the Presiding Officer the parties prepared a final order dismissing
ceeding. This order was submitted to the Presiding Officer with a
ation by the parties on October 5, 1960. A final order dated October 11,
was entered by the Presiding Officer pursuant to the stipulation.

Nuclear Experimental Corporation, Saxton, Pa.

January 21, 1960, the Presiding Officer issued his Intermediate Decision
izing construction of Saxton Reactor. (A hearing had been held on
ber 15, 1959). The construction permit was issued on February 11, 1960.

Trucking Company, New Britain, Conn.

ring was held in New Britain, Conn., on June 3, 1959, to consider the
of a requested license amendment which would authorize the applicant
age and store byproduct and source material at a site in that city. In
eeding the Mayor of the city of New Britain was permitted to intervene
alf of himself and the city. Algert F. Politis was permitted to inter-
behalf of himself and others. This hearing was recessed to reconvene
24, 1959, to permit intervenors to obtain expert testimony and assistance
the application. Subsequent postponements of the hearing were made
request of the intervening objectors in order that they might complete
reparation. The hearing was scheduled to reconvene on February 9,

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1960, but was postponed at the request of staff because the staff had b
informed of certain changes in the licensee's organization. The hearing w
further postponed on the request of the intervening objectors. The hear
reconvened on June 14, and 15, 1960. After the filing of briefs and pro
findings and conclusions by the parties, the Presiding Officer requested that
staff file a supplemental brief since the intervenor's brief covered several matte
not previously considered in the staff's brief. This supplemental brief was
by the staff on September 28, 1960. On October 18, 1960, the Presiding O
asked the intervening objectors if they desired to file a reply brief to the
supplemental brief. A brief was filed by Mr. Politis on November 17, 19
Filings are now completed, and a decision by the Presiding Officer is pe

X-Ray Engineering Company, Burlingame, Calif.

A hearing in the matter had been held December 2–4, 1959, to consider
Order to Show Cause and Order Suspending Licensed Operations, issued
X-Ray by the Commission on October 19, 1959. On February 6, 1960, X-R
filed a motion with the Presiding Officer requesting amendment to its lic
regarding the type of equipment used in its operations. The AEC staff
objections to the licensee's request. On February 19, 1960, the Presiding O
issued an Order Granting Request for Amendment of License by Substitu
of Equipment, and Denying Request for Amendment of Order Which Susp
Certain Licensed Operations.

The Hearing Examiner delivered his intermediate decision on July 19, 19
in which a revocation of license was ordered. With one exception, he fo
that all violations alleged by the Staff were willful, and that the licens
its letter of September 11, 1959, falsified its report of compliance.

The licensee filed exceptions to the intermediate decision and a supp
brief on August 28, 1960. The staff filed its brief in opposition on Sept
12, 1960. By stipulation it was agreed between staff and licensee that
licensee should have until October 12, 1960, to file a reply brief.

On November 18, 1960, the Commission sustained the Intermediate Dec
and directed that the company could file a new license application which
receive timely consideration contingent upon a demonstration that ad
provision for the public health and safety will be provided and maintain
complete compliance with Commission regulations. The applicant sou
stay of the order of revocation until such an application for license could be
The Commission denied the motion for stay.

Yankee Atomic Electric Company, Rowe, Mass.

On March 3 and 4, 1960, a hearing was held in Germantown, Md., on
application for removal of the provisional terms in the construction p
issued to Yankee in connection with the 110 megawatt (electrical) power
under construction at Rowe, Massachusetts. On April 22, 1960, the Pre
Officer issued his Intermediate Decision granting conditional approv
certain technical specifications regarding the reactor; final approval to
presentations of further evidence. The decision became final on May 17, 19

On May 18, 1960, the Commission issued an Order, in response to the
cant's motion, permitting the Presiding Officer to provide that any interm
decision and order subsequently issued be made immediately effective.
hearing to consider issuance of the facility license was held on M
and 26, 1960. The hearing was successively adjourned to June 15, June
July 8, 1960. On July 9, 1960, the Presiding Officer issued the Second I

ate Decision which
on of the reactor
for the purpose of i
the Presiding Office
the issuance of a lic
nal) subject to a
power level. A lice
On August 8, 1960,
ion with respect to
specifications be sub
ion denied the exce
for further proceedi
the technical specifi
Yankee filed a moti
provisions of the li
Memorandum and Or
Electric-Vallecitos B
ember 12, 1960, conv
g was reconvened. I
and the Staff, and a d

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decision which ordered issuance of an interim license authorizing operation of the reactor at power levels not in excess of 5 MW (thermal) solely for the purpose of initial fuel loading and low-power testing. On July 19, 1960, the Presiding Officer issued the Third Intermediate Decision, which ordered issuance of a license authorizing power operations to 392 megawatts (thermal), subject to a further hearing to be held to review operations at such power level. A license in the form specified was issued on July 29, 1960.

On August 8, 1960, Yankee filed an exception to the Third Intermediate Decision with respect to the requirement that all proposed changes in the technical specifications be subject to a public hearing. On August 18, 1960, the Commission denied the exception and remanded the matter to the Hearing Examiner for further proceedings and appropriate decision with respect to the scope of the technical specifications, and other relevant matters. On November 15, 1960, Yankee filed a motion asking that the hearing be reconvened to conform the provisions of the license to the views expressed by the Commission in the Memorandum and Order dated November 2, 1960, in Docket No. 50-18 (General Electric-Vallecitos Boiling Water Reactor). A hearing was scheduled for December 12, 1960, convened on that date and recessed to December 13, 1960, when it was reconvened. Proposed findings and conclusions have been filed by Yankee and the Staff, and a decision by the Hearing Examiner is pending.

APPENDIX 11

MEMORANDUM TO PRESIDENT FROM FRC ON RADIATION PROTECTION GUIDANCE FOR FEDERAL AGENCIES

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Radiation Protection Guidance for Federal Agencies

Pursuant to Executive Order 10831 and P.L. 86-373 the Federal Radiation Council has made a study of the hazards and use of radiation. We hereby transmit our first report to you concerning our findings and our recommendations for the guidance of Federal agencies in the conduct of their radiation protection activities.

It is the statutory responsibility of the Council to ". . . advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all Federal agencies in the formulation of radiation standards and in the establishment and execution of programs of cooperation with States . . ."

Fundamentally, setting basic radiation protection standards involves passing judgment on the extent of the possible health hazard society is willing to accept in order to realize the known benefits of radiation. It involves inevitably a balancing between total health protection, which might require foregoing all activities increasing exposure to radiation, and the vigorous promotion of the use of radiation and atomic energy in order to achieve optimum benefits.

The Federal Radiation Council has reviewed available knowledge on radiation effects and consulted with scientists within and outside the Government. Each member has also examined the guidance recommended in this memorandum in light of his statutory responsibilities. Although the guidance does not cover all phases of radiation protection, such as internal emitters, we find that the guidance which we recommend that you provide for the use of Federal agencies gives appropriate consideration to the requirements of health protection and the beneficial uses of radiation and atomic energy. Our further findings and recommendations follow.

Discussion

The fundamental problem in establishing radiation protection guides is to allow as much of the beneficial uses of ionizing radiation as possible while assuring that man is not exposed to undue hazard. To get a true insight into the scope of the problem and the impact of the decisions involved, a review of the benefits and the hazards is necessary.

It is important in considering both the benefits and hazards of radiation to appreciate that man has existed throughout his history in a bath of natural radiation. This background radiation, which varies over the earth, provides a partial basis for understanding the effects of radiation on man and serves as an indicator of the ranges of radiation exposures within which the human population has developed and increased.

The Benefits of Ionizing Radiation

Radiation properly controlled is a boon to mankind. It has been of inestimable value in the diagnosis and treatment of diseases. It can provide sources of

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...greater than any the world has yet had available. In industry, it is used ... tool to measure thickness, quantity or quality, to discover hidden flaws, ... liquid flow, and for other purposes. So many research uses for ionizing ...ation have been found that scientists in many diverse fields now rank radia... with the microscope in value as a working tool.

... Hazards of Ionizing Radiation

...izing radiation involves health hazards just as do many other useful tools. ...ific findings concerning the biological effects of radiation of most immediate ...t to the establishment of radiation protection standards are the following:

- Acute doses of radiation may produce immediate or delayed effects, or both.
- As acute whole body doses increase above approximately 25 rems (units of radiation dose), immediately observable effects increase in severity with dose, beginning from barely detectable changes, to biological signs clearly indicating damage, to death at levels of a few hundred rems.
- Delayed effects produced either by acute irradiation or by chronic irradiation are similar in kind, but the ability of the body to repair radiation damage is usually more effective in the case of chronic than acute irradiation.
- The delayed effects from radiation are in general indistinguishable from familiar pathological conditions usually present in the population.
- Delayed effects include genetic effects (effects transmitted to succeeding generations), increased incidence of tumors, lifespan shortening, and growth and development changes.
- The child, the infant, and the unborn infant appear to be more sensitive to radiation than the adult.
- The various organs of the body differ in their sensitivity to radiation.
- Although ionizing radiation can induce genetic and somatic effects (effects on the individual during his lifetime other than genetic effects), the evidence at the present time is insufficient to justify precise conclusions on the nature of the dose-effect relationship at low doses and dose rates. Moreover, the evidence is insufficient to prove either the hypothesis of a "damage threshold" (a point below which no damage occurs) or the hypothesis of "no threshold" in man at low doses.
- If one assumes a direct linear relation between biological effect and the amount of dose, it then becomes possible to relate very low dose to an assumed biological effect even though it is not detectable. It is generally agreed that the effect that may actually occur will not exceed the amount predicted by this assumption.

... Biological Assumptions

...re are insufficient data to provide a firm basis for evaluating radiation ... for all types and levels of irradiation. There is particular uncertainty ...spect to the biological effects at very low doses and low-dose rates. It is ...dent therefore to assume that there is a level of radiation exposure ... which there is absolute certainty that no effect may occur. This con...tion, in addition to the adoption of the conservative hypothesis of a linear ... between biological effect and the amount of dose, determines our basic ...ch to the formulation of radiation protection guides.

...lack of adequate scientific information makes it urgent that additional ...ch be undertaken and new data developed to provide a firmer basis for ...ating biological risk. Appropriate member agencies of the Federal Radia... Council are sponsoring and encouraging research in these areas.

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Recommendations

In view of the findings summarized above the following recommendations are made:

It is recommended that:

1. There should not be any man-made radiation exposure without the expectation of benefit resulting from such exposure. Activities resulting in man-made radiation exposure should be authorized for useful applications provided the recommendations set forth herein are followed.

It is recommended that:

2. The term "Radiation Protection Guide" be adopted for Federal use. The term is defined as the radiation dose which should not be exceeded without careful consideration of the reasons for doing so; every effort should be made to encourage the maintenance of radiation doses as far below the guide as practicable.

It is recommended that:

3. The following Radiation Protection Guides be adopted for normal peacetime operations.

Type of Exposure	Condition	Dose (rem)
Radiation Worker:		
(a) Whole body, head and trunk, active blood forming organs, gonads, or lens of eye	Accumulated dose	5 times the number of years beyond age 18.
	13 weeks	3.
(b) Skin of whole body and thyroid	Year	30.
	13 weeks	10.
(c) Hands and forearms, feet and ankles	Year	75.
	13 weeks	25.
(d) Bone	Body burden	0.1 microgram of radium or its biological equivalent.
(e) Other organs	Year	15.
	13 weeks	5.
Population:		
(a) Individual	Year	0.5 (whole body).
(b) Average	30 year	5 (gonads).

The following points are made in relation to the Radiation Protection Guides herein provided:

(1) For the individual in the population, the basic Guide for external whole body dose is 0.5 rem. This Guide applies when the individual external body doses are known. As an operational technique, where the individual whole body doses are not known, a suitable sample of the exposed population should be developed whose protection guide for annual whole body dose will be 0.17 rem per capita per year. It is emphasized that this is an operational technique which should be modified to meet special circumstances.

(2) Considerations of population genetics impose a per capita dose limitation for the gonads of 5 rems in 30 years. The operational method described above for the annual individual whole body dose of 0.5 rem is likely in the immediate future to assure that the gonadal exposure guide (5 rem in 30 years) is not exceeded.

(3) These Guides do not differ substantially from certain other recommendations such as those made by the National Committee on Radiation Protection and Measurements, the National Academy of Sciences, and the International Commission on Radiological Protection.

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(4) The term "maximum permissible dose" is used by the National Committee on Radiation Protection (NCRP) and the International Commission on Radiological Protection (ICRP). However, this term is often misunderstood. The words "maximum" and "permissible" both have unfortunate connotations not intended by either the NCRP or the ICRP.

(5) There can be no single permissible or acceptable level of exposure without regard to the reason for permitting the exposure. It should be general practice to reduce exposure to radiation, and positive efforts should be carried out to fulfill the sense of these recommendations. It is basic that exposure to radiation should result from a real determination of its necessity.

(6) There can be different Radiation Protection Guides with different numerical values, depending upon the circumstances. The Guides herein recommended are appropriate for normal peacetime operations.

(7) These Guides are not intended to apply to radiation exposure resulting from natural background or the purposeful exposure of patients by practitioners of the healing arts.

(8) It is recognized that our present scientific knowledge does not provide a firm foundation within a factor of two or three for selection of any particular numerical value in preference to another value. It should be recognized that the Radiation Protection Guides recommended in this paper are well below the level where biological damage has been observed in humans.

It is recommended that:

The current protection guides used by the agencies be continued on an interim basis for organ doses to the population.

No recommendations are not made concerning the Radiation Protection Guides for individual organ doses to the population, other than the gonads. Unfortunately, the complexities of establishing guides applicable to radiation exposure of all body organs preclude the Council from making recommendations concerning them at this time. However, current protection guides used by agencies appear appropriate on an interim basis.

It is recommended that:

The term "Radioactivity Concentration Guide" be adopted for Federal use. This term is defined as the concentration of radioactivity in the environment which is determined to result in whole body or organ doses equal to the Radiation Protection Guide.

From this definition, Radioactivity Concentration Guides can be determined after the Radiation Protection Guides are decided upon. Any given Radioactivity Concentration Guide is applicable only for the circumstances for which the use of its corresponding Radiation Protection Guide is appropriate.

It is recommended that:

The Federal agencies, as an interim measure, use radioactivity concentration guides which are consistent with the recommended Radiation Protection Guides. Where no Radiation Protection Guides are provided, Federal agencies continue present practices.

No specific numerical recommendations for Radioactivity Concentration Guides are provided at this time. However, concentration guides now used by agencies appear appropriate on an interim basis. Where appropriate radio-

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activity concentration guides are not available, and where Radiation Protection Guides for specific organs are provided herein, the latter Guides can be used by the Federal agencies as a starting point for the derivation of radioactivity concentration guides applicable to their particular problems. The Federal Radiation Council has also initiated action directed towards the development of additional Guides for radiation protection.

It is recommended that:

7. The Federal agencies apply these Radiation Protection Guides with judgment and discretion, to assure that reasonable probability is achieved in the attainment of the desired goal of protecting man from the undesirable effects of radiation. The Guides may be exceeded only after the Federal agency having jurisdiction over the matter has carefully considered the reason for doing so in light of the recommendations in this paper.

The Radiation Protection Guides provide a general framework for the radiation protection requirements. It is expected that each Federal agency, by virtue of its immediate knowledge of its operating problems, will use these Guides as a basis upon which to develop detailed standards tailored to meet its particular requirements. The Council will follow the activities of the Federal agencies in this area and will promote the necessary coordination to achieve an effective Federal program.

If the foregoing recommendations are approved by you for the guidance of Federal agencies in the conduct of their radiation protection activities, it is further recommended that this memorandum be published in the Federal Register.

ARTHUR S. FLEMMING
Chairman, Federal Radiation Council

The recommendations numbered "1" through "7" contained in the above memorandum are approved for the guidance of Federal agencies, and the memorandum shall be published in the Federal Register.

DWIGHT D. EISENHOWER
May 13, 1960

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D. EISENHOWER
May 13, 1960

APPENDIX 12

NUCLEAR REACTORS BUILT, BUILDING, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 1, 1960

This compilation contains information about facilities built, building, or planned in the United States as of December 1, 1960, which are capable of sustaining a nuclear chain reaction. Certain projects relating to military systems are not listed in detail because of their classified nature.

The information is presented in five parts, each of which is categorized by primary function or purpose. The major parts—civilian, military, production, and export, as well as such categories as power, propulsion and process heat—are self-explanatory. The major parts of the tabulation are:

I. Civilian Reactors (Domestic).
II. Military Reactors.
III. Production Reactors.
IV. Reactors for Export.
V. Critical Assembly Facilities.

The various classes of reactors within the several parts are defined as follows:

Power Reactor Experiment. A reactor in the research and development program, usually producing less than 10 Mw(t), designed for the limited purpose of testing the technical feasibility of a reactor concept or some unique reactor feature or piece of equipment. (Part I, Section 2A.2)

Power Experimental Reactor. A relatively complete reactor plant designed, engineered, constructed, and operated to provide the technical basis for the design of a large-scale nuclear power plant. Design flexibility permits changes to test out different aspects of reactor technology. Electrical or power generation may or may not be included as part of the plant. (Part I, Section 2A.1)

Power Prototype Reactor Plant. A nuclear power plant of any size designed, constructed, and operated principally for the purpose of proving-out economical and technical aspects of a future commercial nuclear power plant of the same type. The generation of significant quantities of electricity, mechanical power, or process heat is usually a function of such a plant. Prototypes (40 to 50 Mw(e) and larger) for large central station plants are listed in Part I, Section 2A. Prototypes for small utility stations (smaller than 40 Mw(e)) are listed in Part I, Section 1A.2.

Power Commercial Reactor Plant. A nuclear facility constructed and operated under a license issued under Section 103 of the Atomic Energy Act of 1954 and capable of producing steam for the generation of electricity, propulsion, and heat or process heat applications at costs as low as a nonnuclear plant built on the same site. (No reactors presently in the category)

General Irradiation Test Reactor. The general-test-reactor category includes those reactors having (1) a thermal output of 10,000 kw or more; (2) test facilities or experimental facilities within, or in close proximity to, the core; and (3) use of nuclear radiation for testing the life or performance of reactor components as its major function. (Part I, Section 3A.1–2 and Part IV, Section A)

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Other Test Reactors. A reactor which is in general an integral part of [illegible] test performance which has kinetic or short-duration high power excursion [illegible] which is designed for special testing purposes. (Part I, Section 3B and [illegible] II, Section 3A)

Research Reactor. Any reactor whose nuclear radiations are used primarily as a research tool for basic or applied research regardless of operating power level. May include facilities for testing reactor materials. (Part I, Section 3C, Part II, Section 3B and Part IV, Section 2B)

Teaching Reactor. Any reactor operated for the primary purpose of training in the operation and utilization of reactors and for instruction in reactor theory and performance. Thermal power level is arbitrarily limited to [illegible] (Part I, Section 3D and Part IV, Section 2C)

Critical Facility. A reactor capable of sustaining a nuclear chain reaction and designed to test at extremely low power (a few watts) a critical [illegible] neutron flux distribution, and other characteristics of flexible arrangements of nuclear fuel, materials of construction, coolant, and other reactor components. Fluid critical facilities are used to explore the critical masses of various concentrations of solutions in differing geometries. Metal critical assemblies are used to investigate the variation in heterogeneous cores. The tabulation of these facilities in Part V excludes those that have been dismantled.

The abbreviated listings in the principal-contractor column refer to the [illegible] cal organization assigned primary responsibility for design and/or fabrication of the reactor system. The spelled-out forms for these abbreviations, as well as those for designers, shipbuilders, and facility operators, are given in the table on page 435.

Startup dates refer to the year of first criticality. Estimated dates for projects not yet in service, based on the best available information, are included. Such dates for non-Commission projects are estimates announced by the sponsoring organizations.

Reactors are listed as being *operable* under the following circumstances:

1. Federal Government reactors—when criticality is achieved.
2. Non-Federal Government reactors in the United States—when an operating license is issued by the Commission.
3. Reactors for foreign locations—when criticality is achieved.

Reactors are listed as *being built* under the following circumstances:

1. Federal Government reactors—when ground is broken, components ordered or construction contract awarded, whichever is first.
2. Non-Federal Government reactors in the United States—when a construction permit is issued by the Commission.
3. Reactors for foreign locations—when an application for an export license is received by the Commission or when reliable information is available relating to the fabrication of reactor components.

Reactors are listed in the *planned* category under the following circumstances:

1. Federal Government reactors—when publicly announced or development work is started.
2. Non-Federal Government reactors in the United States—when [illegible] plication is received by the Commission, or a public announcement which includes principal contractor and reactor type is made, whichever is

[illegible] Reactors for foreign [illegible] principal contractor [illegible] celves information [illegible] preconstruction des

[illegible] Statistical Summa [illegible] ories are summarize [illegible] such facilities hav

[illegible] OF CONTRACTORS, D [illegible] FOR WHIC

[illegible] ---------- Allis
[illegible] ---------- ACF
[illegible] ---------- Aero
[illegible] ---------- Aero
[illegible] Ge
[illegible] ---------- Atom
[illegible] Avi
[illegible] ---------- Alco
[illegible] ---------- AMF
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[illegible] ---------- Argon
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[illegible] GE -------- Aircra
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[illegible] ---------- Ameri
[illegible] ---------- The B
[illegible] ---------- Shipbu
[illegible] ---------- Blaw-K
[illegible] ---------- Brookh
[illegible] Univ
[illegible] ---------- The B
[illegible] ---------- Combu
[illegible] ---------- Clinton
[illegible] Distr
[illegible] ---------- Convair
[illegible] ---------- Nucledy
[illegible] Co.
[illegible] ---------- Curtiss-
[illegible] ---------- Daystro
[illegible] ---------- E. I. du
[illegible] ---------- Ebasco
[illegible] ---------- Electric
[illegible] ---------- The Flu
[illegible] ---------- Foster W
[illegible] ---------- General
[illegible] ---------- General

[illegible] 72—61——29

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Reactors for foreign locations—when public announcement that includes principal contractor and reactor type is made or when the Commission receives information that a U.S. reactor manufacturer is proceeding with construction design and development on the basis of a letter of intent.

Statistical Summary on page 437 excludes critical facilities. All other reactors are summarized. Dismantled reactors in these categories are included because such facilities have made significant contributions to reactor technology.

CONTRACTORS, DESIGNERS, SHIPBUILDERS, AND FACILITY OPERATORS FOR WHICH ABBREVIATIONS APPEAR IN TABLES

_____ Allis-Chalmers Mfg. Co.
_____ ACF Industries, Inc. (Absorbed by AC).
_____ Aerojet-General Corp.
_____ Aerojet-General Nucleonics, a Subsidiary of Aerojet-General Corp.
_____ Atomics International, a Division of North American Aviation, Inc.
_____ Alco Products, Inc.
_____ AMF Atomics, Inc., a Division of American Machine & Foundry Co.
_____ Argonne National Laboratory, operated by the University of Chicago.
_____ Aircraft Nuclear Propulsion Department, Generel Electric Co.
_____ American Radiator & Standard Sanitary Corp.
_____ The Bendix Corp.
_____ Shipbuilding Division, Bethlehem Steel Co.
_____ Blaw-Knox Co.
_____ Brookhaven National Laboratory, operated by Associated Universities, Inc.
_____ The Babcock and Wilcox Co.
_____ Combustion Engineering, Inc.
_____ Clinton Laboratory of the Manhattan Engineering District.
_____ Convair Division, General Dynamics Corp.
_____ Nucledyne Corp. of Chicago, a Division of Cook Electric Co.
_____ Curtiss-Wright Corp.
_____ Daystrom, Inc.
_____ E. I. du Pont de Nemours & Co.
_____ Ebasco Services Inc.
_____ Electric Boat Division, General Dynamics Corp.
_____ The Fluor Corporation, Ltd.
_____ Foster Wheeler Corp.
_____ General Atomic Division, General Dynamics Corp.
_____ General Electric Co.

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GNE	General Nuclear Engineering Corp., a Subsidiary Combustion Engineering, Inc.
HKF	H. K. Ferguson Co.
Ingalls	Ingalls Shipbuilding Corp.
KE	Kaiser Engineers, a Division of Henry J. Kaiser Co.
LASL	Los Alamos Scientific Laboratory, operated by the ... versity of California.
Lockheed	Lockheed Aircraft Corp.
Mare Island	Mare Island Naval Shipyard.
Martin	Martin Co.
Maxon	Maxon Construction Company, Inc.
Met. Lab	Metallurgical Laboratory of the Manhattan Engin... District.
NASA	National Aeronautics and Space Administration.
NDA	Nuclear Development Corp. of America.
Newport News	Newport News Shipbuilding & Dry Dock Co.
NRL	Naval Research Laboratory.
NYSC	New York Shipbuilding Corp.
ORNL	Oak Ridge National Laboratory, operated by ... Carbide Nuclear Co., a Division of Union Ca... Corp.
Portsmouth	Portsmouth Naval Shipyard.
PPC	Phillips Petroleum Co.
P&W	Pratt and Whitney Aircraft Division, United Air... Corp.
Sandia	Sandia Laboratory, operated by Sandia Corp., a ... sidiary of Western Electric Co.
SL	Sargent and Lundy.
UCLRL	University of California Lawrence Radiation Lab...
West	Westinghouse Electric Co.
Vitro	Vitro Engineering Division, Vitro Corp. of America

REA

CIVILIAN REACTORS:
1. Power Reactor Proto...
A.1 Prototypes, Larg...
A.2 Prototypes, Smal...
B.1 Prototypes, Mari...
2. Experimental Reactor...
A.1 Experimental P... tricity)
A.2 Power Reactor E... duction, if any)
B.1 Maritime Propul...
B.2 Space Propulsion
C. Process Heat Exp...
3. Test, Research and T...
A.1 General Irradiatio...
A.2 General Irradiatio...
B. Special Test
C. Research
D. Teaching

Total Civilian...

MILITARY REACTORS:
1. Defense Power React...
A. Electric Power Re...
B. Propulsion Reacto...
2. Developmental Powe...
A.1 Electric Power ... types
A.2 Systems for Nucl...
B.1 Naval Propulsion
B.2 Aircraft Propulsi...
B.3 Missile Propulsio...
3. Test and Research:
A. Testing Reactors...
B. Research Reactors

Total Military...

PRODUCTION REACTORS
1. Material Production...
2. Process Development

Total Production...

REACTORS FOR EXPORT:
1. Power Reactors:
A. Central Station El...
B. Propulsion
2. Test, Research and T...
A. General Irradiatio...
B. Research
C. Teaching

Total export...

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STATISTICAL SUMMARY

	Operated, later dismantled	Operable	Being built	Planned
CIVILIAN REACTORS:				
Power Reactor Prototypes:				
Prototypes, Large Central Station Plants		3	6	5
Prototypes, Small Central Station Plants			4	1
Prototypes, Maritime Propulsion (Seagoing)			1	
Experimental Reactors and Reactor Experiments:				
Experimental Power Reactors (Generate Electricity)		3	4	
Power Reactor Experiments (token electrical production, if any)	5	4	4	
Maritime Propulsion Experiments				
Space Propulsion Experiments (Rover)	3			1
Process Heat Experiments				1
Research and Teaching Reactors:				2
General Irradiation Test (Government Owned)		2	1	
General Irradiation Test (Privately Owned)		2		1
Special Test		9	3	
Research	4	26	9	2
Teaching	3	35	16	2
Total Civilian	15	84	48	14
MILITARY REACTORS:				
Nuclear Power Reactor Applications:				
Electric Power Reactors, Remote Installations		1	2	
Propulsion Reactors (Naval)	1	14	45	
Developmental Power Reactors:				
Electric Power Reactor Experiments and Prototypes		3	2	1
Systems for Nuclear Auxiliary Power (SNAP)		1	2	4
Naval Propulsion Reactor Prototypes	1	5	1	1
Aircraft Propulsion Reactor Experiments	2	2	1	1
Missile Propulsion Reactor Experiments			1	2
Test and Research:		5	3	
Testing Reactors	1	2	2	4
Research Reactors	5	33	59	13
Total Military				
PRODUCTION REACTORS:		13	1	
Material Production		5		
Process Development		18	1	
Total Production				
REACTORS FOR EXPORT:				
Power Reactors:		1	3	2
Central Station Electric Power			1	
Propulsion		2	1	
Research and Teaching Reactors:		13	8	2
General Irradiation Test		12	7	5
Research		28	20	9
Teaching				
Total export				

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PART I—CIVILIAN REACTORS (Domestic)

1. POWER

A. CENTRAL STATION ELECTRIC

A.1. Large Plant Prototypes

Name and/or owner	Location	Principal nuclear contractor	Type	Power [1]		Startup
				Net kw(e)	Kw(t)	
Operable:						
Shippingport Atomic Power Station (AEC and Duquesne Light Co.)[2]	Shippingport, Pa	West	Pressurized water	60,000	231,000	1957
Dresden Nuclear Power Station (Commonwealth Edison Co.).	Morris, Ill	GE	Boiling water	180,000	626,000	1959
Yankee Atomic Electric Co [3,4]	Rowe, Mass	West	Pressurized water	110,000	392,000	1960
Being built:						
Consolidated Edison Co. Thorium Reactor [5]	Indian Point, N.Y	B&W	Pressurized water	255,000	795,000	1961
Enrico Fermi Atomic Power Plant (Power Reactor Development Co.).[4,6]	Lagoona Beach, Mich	Owner	Fast breeder	94,000	300,000	1961
Hallam Nuclear Power Facility, Sheldon Station (AEC and Consumers Public Power District.)[3]	Hallam, Nebr	AI	Sodium graphite	75,000	254,000	1962
Northern States Power Co. Pathfinder Plant [3,7]	Sioux Falls, S. Dak	AC	Boiling water, nuclear superheat.	62,000	203,000	1962
Consumers Power Company [3]	Big Rock Point, Mich	GE	Boiling water	50,000	240,000	1962
Humboldt Bay Power Plant, Unit No. 3 (Pacific Gas and Electric Co.).	Humboldt Bay, Calif	GE	Boiling water	48,500	163,000	1962
Planned:						
High Temperature Gas Cooled Reactor [3] (Philadelphia Electric Co.).	Peach Bottom, Pa	GDC	Gas cooled, graphite moderated.	40,000	115,000	1963
Improved Cycle Boiling Water Reactor Prototype (AEC and Cities of Los Angeles and Pasadena Departments of Water and Power) [8]	Haskel Canyon, Los Angeles County, Calif.	AC	Boiling water	50,000	----------	1964
Organic Cooled Reactor Prototype (AEC)	----------	----------	Organic cooled	50,000	----------	1964
East Central and Florida West Coast Nuclear Groups [1]	Polk County, Fla	GNE	Gas cooled, heavy water moderated.	50,500	159,700	1965
Southern California Edison	Southern California	West	Pressurized water	360,000	----------	1965

Name and/or owner	Location	Principal nuclear contractor	Type	Power [1]		Startup
				Net kw(e)	Kw(t)	
Being built:						
Rural Cooperative Power Association and AEC [3,9]	Elk River, Minn	AC	Boiling water	22,000	73,000	1961
City of Piqua and AEC [3]	Piqua, Ohio	AI	Organic cooled and moderated.	11,400	45,500	1961
Carolinas-Virginia Tube Reactor (Carolinas-Virginia Nuclear Power Associates, Inc.)[3,10]	Parr, S.C	West	Pressure tube, heavy water	16,950	60,500	1963

Name and/or owner	Location	Principal reactor contractor	Type	Power		Start-up
				Net kw(e)	Kw(t)	
Electric Co.).						
Planned:						
High Temperature Gas Cooled Reactor [3] (Philadelphia Electric Co.).	Peach Bottom, Pa.	GDC	Gas cooled, graphite moderated.			
Improved Cycle Boiling Water Reactor Prototype (AEC and Cities of Los Angeles and Pasadena Departments of Water and Power) [3]	Haskel Canyon, Los Angeles County, Calif.	AC	Boiling water	50,000		1964
Organic Cooled Reactor Prototype (AEC)			Organic cooled	50,000		1964
East Central and Florida West Coast Nuclear Groups [3]	Polk County, Fla.	GNE	Gas cooled, heavy water moderated.	50,600	150,700	1965
Southern California Edison	Southern California	West	Pressurized water	360,000		1965

Name and/or owner	Location	Principal reactor contractor	Type	Power		Start-up
				Net kw(e)	Kw(t)	
Being built:						
Rural Cooperative Power Association and AEC [3,9]	Elk River, Minn.	AC	Boiling water	22,000	73,000	1961
City of Piqua and AEC [3]	Piqua, Ohio	AI	Organic cooled and moderated.	11,400	45,500	1961
Carolinas-Virginia Tube Reactor (Carolinas-Virginia Nuclear Power Associates, Inc.) [3,10]	Parr, S.C.	West	Pressure tube, heavy water	16,950	60,500	1962
Boiling Reactor Nuclear Superheat Project (AEC and Puerto Rico Water Resources Authority) [3]	Punta Higuera, P.R.	GNEC	Boiling water, internal nuclear superheat.	16,300	50,000	1962
Planned:						
Small Size Nuclear Power Plant (AEC and undetermined utility organization) [3,11]			Pressurized water	20,500	61,000	1962

B. Propulsion (Maritime)

B.1. Maritime Seagoing Prototypes

Name and/or owner	Nuclear designer	Shipbuilder	Type	Shaft maximum horsepower	Power kw(t)	Start-up
Being built:						
Nuclear Ship Savannah (AEC and Maritime Administration)	B&W	NYSC	Pressurized water	22,000	69,000	1961

See footnotes at end of table.

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2. Experimental Power Reactors and Reactor Experiments

A. Electric Power

A.1. Experimental Reactors

Name (all owned by AEC except as noted)	Designation	Location	Principal nuclear contractor	Type	Net kw(e)	Kw(t)	Start-up
Operable:							
Experimental Boiling Water Reactor [12]	EBWR	Argonne, Ill	ANL	Boiling water	4,500	100,000	1956
Vallecitos Boiling Water Reactor (General Electric Co. and Pacific Gas and Electric Co.).	VBWR	Pleasanton, Calif	GE	Boiling water	5,000	50,000	1957
Sodium Reactor Experiment (AEC and Southern California Edison Co.).	SRE	Santa Susana, Calif	AI	Sodium graphite	6,000	20,000	1957
Being built:							
Experimental Breeder Reactor No. 2	EBR-2	NRTS, Idaho	ANL	Fast breeder	16,500	62,500	1961
Boiling Reactor Experiment No. 5	BORAX-5	NRTS, Idaho	ANL	Boiling water	2,650	20,000	1961
Westinghouse Experimental Reactor Project (Pittsburgh Testing Laboratory).		Easton, Pa	West	Pressurized water	3,250		1961
Experimental Gas Cooled Reactor (4,000 kw) and Power Plant Testing Facility [3]		Oak Ridge, Tenn	AEC and [illegible]	Gas cooled, graphite moderated	23,000	84,000	1962

Name (all owned by AEC)	Designation	Location	Principal nuclear contractor	Type	Power		Start-up	Dismantled
					Net kw(e)	Kw(t)		
Operated, Later Dismantled:								
Boiling Reactor Experiment No. 1	BORAX-1	NRTS, Idaho	ANL	Boiling water	No electricity.	1,400	1953	1954
Homogeneous Reactor Experiment No. 1.	HRE-1	Oak Ridge, Tenn	ORNL	Aqueous homogeneous solution (UO_2SO_4).	140	1,000	1952	1954
Los Alamos Power Experiment No. 1 [4]	LAPRE-1	Los Alamos, N. Mex	LASL	Aqueous homogeneous (phosphoric acid)	No elec-	2,000	1956	1957
Boiling Reactor Experiments [5]	BORAX-2, -3, -4	NRTS, Idaho	ANL	Boiling water			1954	1956

Name (all owned by AEC except as noted)	Designation	Location	Principal nuclear contractor	Type	Power: Net kw(e)	Power: Kw(t)	Date start up	Date shut down
Operable:								
Experimental Boiling Water Reactor [12]	EBWR	Argonne, Ill.	ANL	Boiling water	4,500	100,000	1956	
Vallecitos Boiling Water Reactor (General Electric Co. and Pacific Gas and Electric Co.).	VBWR	Pleasanton, Calif.	GE	Boiling water	5,000	50,000	1957	
Sodium Reactor Experiment (AEC and Southern California Edison Co.).	SRE	Santa Susana, Calif.	AI	Sodium graphite	6,000	20,000	1957	
Being built:								
Experimental Breeder Reactor No. 2	EBR-2	NRTS, Idaho	ANL	Fast breeder	16,500	62,500	1961	
Boiling Reactor Experiment No. 5	BORAX-5	NRTS, Idaho	ANL	Boiling water	2,650	20,000	1961	
Saxton Nuclear Experimental Reactor Project (Pittsburgh Owned)		Saxton, Pa.	West	Pressurized water	3,250		1961	
Experimental Gas Cooled Reactor (AEC and Tennessee Valley Authority) [13]	EGCR	Oak Ridge, Tenn.	KE-ACF	Gas cooled, graphite moderated.	22,500	81,000	1962	
Operated, Later Dismantled:								
Boiling Reactor Experiment No. 1	BORAX-1	NRTS, Idaho	ANL	Boiling water	No electricity.	1,400	1953	1954
Homogeneous Reactor Experiment No. 1.	HRE-1	Oak Ridge, Tenn.	ORNL	Aqueous homogeneous solution (UO_2SO_4).	140	1,000	1952	1954
Los Alamos Power Experiment No. 1 [14]	LAPRE-1	Los Alamos, N. Mex.	LASL	Aqueous homogeneous (phosphoric acid).	No electricity.	2,000	1956	1957
Boiling Reactor Experiments [15]	BORAX-2, 3, 4.	NRTS, Idaho	ANL	Boiling water	2,400	15,500	1954	1958
Los Alamos Power Reactor Experiment No. 2.	LAPRE-2	Los Alamos, N. Mex.	LASL	Aqueous homogeneous (phosphoric acid).	No electricity.	1,000	1959	1959
Operable:								
Experimental Breeder Reactor No. 1 [16]	EBR-1	NRTS, Idaho	ANL	Fast breeder	150	1,400	1951	
Homogeneous Reactor Experiment No. 2.	HRE-2	Oak Ridge, Tenn.	ORNL	Aqueous homogeneous solution (UO_2SO_4).	300	5,220	1957	
Organic Moderated Reactor Experiment.	OMRE	NRTS, Idaho	AI	Organic cooled and moderated.	No electricity.	5,000 to 15,000	1957	
Plutonium Recycle Test Reactor	PRTR	Hanford, Wash.	GE	Heavy water moderated and cooled pressure tube.	No electricity.	70,000	1960	
Being built:								
Los Alamos Molten, Plutonium Reactor Experiment.	LAMPRE-1	Los Alamos, N. Mex.	LASL	Fast molten plutonium fueled, sodium cooled.	No electricity.	1,000	1961	
Heavy Water Components Test Reactor.	HWCTR	Savannah River, S.C. (TC-1 Area).	du Pont	Pressurized heavy water	No electricity.	61,000	1961	
Experimental Organic Cooled Reactor.	EOCR	NRTS, Idaho	AI-PPC	Organic cooled	No electricity.	40,000	1962	
Molten Salt Reactor Experiment	MSRE	Oak Ridge, Tenn.	ORNL	Single region graphite moderated.		5,000 to 10,000	1963	

See footnotes at end of table.

B. Propulsion

B.1. Maritime Experiments and Prototypes

Name and/or owner	Designation	Location	Contractor	Type	Power[1] Kw(t)	Startup
Planned:						
Beryllium Oxide Reactor Experiment	BORE			Gas cooled, BeO moderated	10,000	1962

B.2. Space Experiments and Prototypes (Rover)

Name (all owned by AEC)	Designation	Location	Principal nuclear contractor	Type	Startup	Dismantled
Operated, Later Dismantled:						
Low Power Nuclear Rocket Propulsion Experiment	KIWI-A	NTS, Nev	LASL	Open cycle hydrogen gas cooled.	1959	1959
Low Power Nuclear Rocket Propulsion Experiment	KIWI-A, prime	NTS, Nev	LASL	Open cycle, hydrogen gas cooled.	1960	1960
Low Power Nuclear Rocket Propulsion Experiment	KIWI-A3	NTS, Nev	LASL	Open cycle, liquid hydrogen gas cooled.	1960	1960
Planned:						
Intermediate Power Nuclear Rocket Propulsion Experiment	KIWI-B1	NTS, Nev	LASL	Open cycle, liquid hydrogen gas cooled.	1961	

C. Process Heat Experiments

Name (all owned by AEC except as noted)	Designation	Location	Principal nuclear contractor	Type	Power[1] Kw(t)	Startup
Planned:						
Experimental Low Temperature Process Heat Reactor With Intermediate Gas Cooled Reactor Experiment II	ELITR/ TURRET	Los Alamos, N. Mex.	AC/ LASL	Pressurized water/ Gas cooled	40,000/ 3,000	1962

A. Experimental Facilities

Name and/or owner	Designation	Location	Principal nuclear contractor	Operator	Type	Power[1] kw(t)	Startup
Operable:							
Materials Testing Reactor (AEC)	MTR	NRTS, Idaho	Blaw-Knox	PPC	Tank	40,000	1952
Engineering Test Reactor (AEC)	ETR	NRTS, Idaho	KE	PPC	Tank	175,000	1957
Being built:							
Plum Brook Reactor Facility (NASA)	NASA-TR	Sandusky, Ohio	NASA		Tank	60,000	1962
Planned:							
Advanced Test Reactor	ATR	NRTS, Idaho	Ebasco-B&W	PPC	Tank	250,000	1964

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Name (all owned by AEC except as noted)	Designation	Location	Principal nuclear contractor	Type	Power[1] Kw(t)	Startup
Planned:						
Experimental Low Temperature Process Heat Reactor	ELPHR	Los Alamos, N. Mex.	AC	Pressurized water	40,000	
High Temperature Gas Cooled Reactor Experiment. II	TURRET		LASL	Gas cooled	3,000	1962

Name and/or owner	Designation	Location	Principal nuclear contractor	Operator	Type	Power[1] kw(t)	Startup
Operable:							
Materials Testing Reactor (AEC)	MTR	NRTS, Idaho	Blaw-Knox	PPC	Tank	40,000	1952
Engineering Test Reactor (AEC)	ETR	NRTS, Idaho	KE	PPC	Tank	175,000	1957
Being built:							
Plum Brook Reactor Facility (NASA)	NASA-TR	Sandusky, Ohio	NASA		Tank	60,000	1962
Planned:							
Advanced Test Reactor	ATR	NRTS, Idaho	Ebasco-B&W	PPC	Tank	250,000	1964

A.2. Private Facilities

Operable:							
General Electric Company Materials Testing Reactor	GETR	Pleasanton, Calif.	Owner	Owner	Tank	30,000	1958
Westinghouse Testing Reactor	WTR	Waltz Mill, Pa.	Owner	Owner	Tank	60,000	1959

B. Other Testing (Special)

Name (all owned by AEC)	Designation	Location	Principal contractor	Type	Power kw(t)	Startup
Operable:						
Thermal Test Reactor	SP	Savannah River, S.C.	du Pont	Graphite	2 to 10	1953
Bulk Shielding Reactor No. 1	BSR-1	Oak Ridge, Tenn.	ORNL	Pool	1,000	1950
Bulk Shielding Reactor No. 2[18]	BSR-2	Oak Ridge, Tenn.	ORNL	Pool	1,000	1950
Special Power Excursion Reactor Test No. 1	SPERT-1	NRTS, Idaho	PPC	Open tank	Transient	1959
Special Power Excursion Reactor Test No. 2	SPERT-2	NRTS, Idaho	PPC	Pressurized water	Transient	1955
Special Power Excursion Reactor Test No. 3	SPERT-3	NRTS, Idaho	PPC	Pressurized water	Transient	1960
Kinetic Experiment on Water Boilers	KEWB	Santa Susana, Calif.	AI	Homogeneous	50	1958
Transient Test Reactor Facility	TREAT	NRTS, Idaho	ANL	Graphite	100	1956
Fast Source Reactor	AFSR	NRTS, Idaho	ANL	Fast	1	1959
Being built:						1959
Special Power Excursion Reactor Test No. 4	SPERT-4	NRTS, Idaho	PPC	Pool	Transient	1961
Biological Research Reactor	JANUS	Argonne, Ill.	ANL	Tank	200	1961
Fast Burst Reactor	FBR	Oak Ridge, Tenn.	ORNL	Fast		1962

See footnotes at end of table.

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C. Research

Name and/or owner	Designation	Location	Principal nuclear contractor	Type	Power [19] kw(t)	Start-up	Dismantled
Operated, later dismantled:							
Los Alamos Water Boiler	HYPO	Los Alamos, N. Mex.	LASL	Homogeneous	5.5	1944	1950
Chicago Pile 1, rebuilt as CP-2 (Manhattan Engineering District—AEC).[20]	CP-1	Chicago, Ill	Met. Lab.	Graphite	0.2	1942	1954
Argonne CP-3, rebuilt as CP-3, (Manhattan Engineering District–AEC).	CP-3,	Palos Park, Ill	Met. Lab.	Heavy water	300	1944	1955
Los Alamos Fast Reactor (AEC)	Clementine	Los Alamos, N. Mex.	LASL	Fast, plutonium fuel, mercury cooled.	25	1946	1953
Operable:							
Oak Ridge Graphite Reactor	X-10	Oak Ridge, Tenn.	CL	Graphite	3,800	1943	
Los Alamos Water Boiler (AEC)	SUPO	Los Alamos, N. Mex.	LASL	Homogeneous	25	1950	
Brookhaven Research Reactor (AEC)	BGRR	Upton, N.Y.	HKF	Graphite	20,000	1950	
Low Intensity Test Reactor (AEC)[21]	LITR	Oak Ridge, Tenn.	ORNL	Tank	3,000	1950	
North American Aviation Water Boiler Neutron Source (AEC).[22]	AE-6 (WBNS)	Santa Susana, Calif.	AI	Homogeneous	2	1952	
Livermore Water Boiler (AEC)	LIWB	Livermore, Calif.	AI	Homogeneous	0.5	1953	
Argonne Research Reactor (AEC)	CP-5	Argonne, Ill.	ANL	Heavy water	5,000	1954	
Pennsylvania State University		University Park, Pa.	Owner	Pool	200	1955	
Armour Research Foundation	ARR	Chicago, Ill.	AI	Homogeneous	50	1956	
Battelle Memorial Institute	BRR	West Jefferson, Ohio	AMF	Pool	2,000	1956	
Omega West Reactor (AEC)	OWR	Los Alamos, N. Mex.	LASL	Tank	5,000	1956	
General Electric Nuclear Test Reactor	NTR	Pleasanton, Calif.	GE	Light water	30	1957	
University of Michigan (Ford Nuclear Reactor).		Ann Arbor, Mich.	B&W	Pool	1,000	1957	
Livermore Pool Type Reactor (AEC)	LPTR	Livermore, Calif.	FW	Tank	2,000	1957	
Curtiss-Wright Corporation [23]		Quehanna, Pa.	Owner	Pool	4,000	1958	
General Dynamics Corp.	TRIGA	San Diego, Calif.	GDC	U-Zr hydride, tank	250	1958	
Brookhaven Neutron Source Reactor (AEC)		Upton, N.Y.	BNL	Tank	100	1958	
Massachusetts Institute of Technology	MITR	Cambridge, Mass.	ACF	Heavy water	1,000	1958	
Industrial Reactor Laboratories, Inc. (Operated by Columbia Univ.).		Plainsboro, N.J.	AMF	Pool	5,000	1958	
Babcock and Wilcox Lynchburg Pool Reactor.	LPR	Lynchburg, Va.	Owner	Pool	10	1958	
Oak Ridge Research Reactor (AEC)	ORR	Oak Ridge, Tenn.	ORNL	Tank	30,000	1958	
Brookhaven Medical Research Reactor (AEC).	MRR	Upton, N.Y.	Daystrom	Tank	3,000	1959	
Omaha Veterans Administration Hospital	TRIGA	Omaha, Nebr.	GDC	U-Zr hydride, tank	10	1959	
General Dynamics Corp. TRIGA Pulsing Reactor.	TRIGA Mk F	San Diego, Calif.	Owner	U-Zr hydride, tank	1,000	1959	
University of Virginia		Charlottesville, Va.	Owner–B&W	Pool	1,000	1960	
Puerto Rico Nuclear Center (AEC)		Mayaguez, P.R.	AMF	Pool	2,000	1961	
University of Illinois		Urbana, Ill.	AMF	Pool	1,000	1961	
Brookhaven High Flux Beam Research Reactor (AEC)	HFBR	Upton, N.Y.	BNL	Heavy water	40,000	Well. 1962	
Ames Laboratory Research Reactor (AEC)	ALRR	Ames, Iowa	AMF	Heavy water	5,000	1962	
Washington State University		Pullman, Wash.	GE	Pool	100	1961	
Georgia Institute of Technology	GTRR	Atlanta, Ga.	GNE	Heavy water, tank	1,000	1962	
Nuclear Science Center Reactor, Texas A&M	NSCR	College Station, Tex.	Convair	Pool	100	1961	
Biomedical Radiation Research Facility (DOD).	DASA-TRIGA	Bethesda, Md.	GDC	U-Zr, hydride	100	1961	
Planned:							
High Flux Isotope Reactor (AEC)	HFIR	Oak Ridge, Tenn.	ORNL	Pool, flux trap	100,000	1963	
University of Rhode Island		Saunderstown, R. I.	GE	Pool	1,000	1961	

D. Teaching

[illegible]	TRIGA	[illegible]	BNL	Tank	1,000	1958	
General Dynamics Corp.		Upton, N.Y.	ACF	Heavy water	5,000	1958	
Brookhaven Neutron Source Reactor (AEC)	MITR	Cambridge, Mass.	AMF	Pool			
Massachusetts Institute of Technology		Plainsboro, N.J.			10	1958	
Industrial Reactor Laboratories, Inc. (Operated by Columbia Univ.)	LPR	Lynchburg, Va.	Owner	Pool			
Babcock and Wilcox Lynchburg Pool Reactor					30,000	1958	
Oak Ridge Research Reactor (AEC)	ORR	Oak Ridge, Tenn.	ORNL	Tank	3,000	1959	
Brookhaven Medical Research Reactor (AEC)	MRR	Upton, N.Y.	Daystrom	Tank			
Omaha Veterans Administration Hospital	TRIGA	Omaha, Nebr.	GDC	U-Zr hydride, tank	10	1959	
General Dynamics Corp. TRIGA Pulsing Reactor	TRIGA Mk F	San Diego, Calif.	Owner	U-Zr hydride, tank	1,000	1960	
University of Virginia		Charlottesville, Va.	Owner-B&W	Pool	1,000	1960	
Puerto Rico Nuclear Center (AEC)		Mayaguez, P.R.	AMF	Pool	1,000	1960	

[illegible]	HFBR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Brookhaven High Flux Beam Research Reactor (AEC)		Upton, N.Y.	BNL	Heavy water	40,000	1962	
Ames Laboratory Research Reactor (AEC)	ALRR	Ames, Iowa	AMF	Heavy water	5,000	1962	
Washington State University		Pullman, Wash.	GE	Pool	100	1961	
Georgia Institute of Technology	GTRR	Atlanta, Ga.	GNE	Heavy water, tank	1,000	1962	
Nuclear Science Center Reactor, Texas A&M	NSCR	College Station, Tex.	Convair	Pool	100	1961	
Biomedical Radiation Research Facility (DOD)	DASA-TRIGA	Bethesda, Md.	GDC	U-Zr, hydride	100	1961	
Planned:							
High Flux Isotope Reactor (AEC)	HFIR	Oak Ridge, Tenn.	ORNL	Pool, flux trap	100,000	1963	
University of Rhode Island		Saunderstown, R. I.	GE	Pool	1,000	1961	

D. Teaching

Operated, later dismantled:							
Atomics International	L-47	Canoga Park, Calif.	AI	Homogeneous	Negligible	1957	1958
American Radiator & Standard Sanitary Corp.[24]	UTR-1	Mountain View, Calif.	ARRS	Graphite/water	Negligible	1958	1960
General Dynamics Corporation (World Agricultural Fair-U.S. Exhibit Reactor [25]		San Diego, Calif.	GDC	TRIGA-Mk II	50	1960	1960
Operable:							
North Carolina State College (Raleigh Research Reactor) [26]	RRR	Raleigh, N.C.	Owner	Homogeneous	0.5	1957	
Argonne Nuclear Assembly for University Training (AEC)	Argonaut (CP-11)	Lemont, Ill.	ANL	Graphite/water	10	1957	
U.S. Naval Post Graduate School (USN)	AGN-201-100	Monterey, Calif.	AGN	Homogeneous solid	Negligible	1956	
Catholic University of America	AGN-201-101	Washington, D.C.	AGN	Homogeneous solid	Negligible	1957	
Oklahoma State University of Agriculture and Applied Science	AGN-201-102	Stillwater, Okla.	AGN	Homogeneous solid	Negligible	1957	
Aerojet-General Nucleonics	AGN-201P-103	San Ramon, Calif.	AGN	Homogeneous solid	Negligible	1957	
University of Akron	AGN-201-104	Akron, Ohio	AGN	Homogeneous solid	Negligible	1957	
National Naval Medical Center (USN)	AGN-201M-105	Bethesda, Md.	AGN	Homogeneous solid	Negligible	1957	
Texas Agricultural and Mechanical College	AGN-201-106	College Station, Tex.	AGN	Homogeneous solid	Negligible	1957	
University of Utah	AGN-201-107	Salt Lake City, Utah	AGN	Homogeneous solid	Negligible	1957	
Argonne National Laboratory (AEC)	AGN-201-108	Lemont, Ill.	AGN	Homogeneous solid	Negligible	1957	
Colorado State University	AGN-201-109	Ft. Collins, Colo.	AGN	Homogeneous solid	Negligible	1957	
University of California	AGN-201-112	Berkeley, Calif.	AGN	Homogeneous solid	Negligible	1957	
University of Delaware	AGN-201-113	Newark, Del.	AGN	Homogeneous solid	Negligible	1957	
Oregon State College	AGN-201-114	Corvallis, Oreg.	AGN	Homogeneous solid	Negligible	1958	
Atomics International	L-77	Canoga Park, Calif.	AI	Homogeneous	Negligible	1958	
American Radiator and Standard Sanitary Corp. Exhibition, UTR Model 2.[24]	UTR Mod. 2	Mountain View, Calif.	Owner	Graphite/water	Negligible	1960	
Pawling Research Reactor	PRR	Pawling, N.Y.	NDA	Heavy water	Negligible	1958	
William Marsh Rice University	AGN-211-101	Houston, Tex.	AGN	Homogeneous solid, pool	Negligible	1959	
University of Oklahoma	AGN-211-102	Norman, Okla.	AGN	Homogeneous solid, pool	Negligible	1958	

See footnotes at end of table.

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D. Teaching—Continued

Name and/or owner	Designation	Location	Principal nuclear contractor	Type	Power [19] kw(t)	Start-up	Dismantled
Operable—Continued.							
West Virginia University College of Engineering.	AGN-211-103	Morgantown, W. Va.	AGN	Homogeneous solid, pool	Negligible	1959	
University of Arizona	TRIGA	Tucson, Ariz.	GDC	U-Zr hydride, tank	10	1958	
University of Wyoming	L-77	Laramie, Wyo.	AI	Homogeneous	Negligible	1959	
University of Florida	UFTR	Gainesville, Fla.	GNE	Graphite/water	10	1959	
Puerto Rico Nuclear Center (AEC)	L-77	Mayaguez, P.R.	AI	Homogeneous	Negligible	1959	
Iowa State University	UTR-10	Ames, Iowa	ARSS	Graphite/water	10	1959	
Leland Stanford University		Palo Alto, Calif.	GE	Pool	10	1959	
Worcester Polytechnic Institute		Worcester, Mass.	GE	Pool	Negligible	1959	
Virginia Polytechnic Institute	UTR-10	Blacksburg, Va.	ARSS	Graphite/water	10	1959	
North Carolina State College		Raleigh, N.C.	Cook	Graphite/water	10	1960	
University of Illinois	TRIGA-Mk II	Urbana-Champaign, Ill.	GDC	U-Zr hydride, tank	100	1960	
University of Maryland	UMNE-1	College Park, Md.	AC	Tank	10	1960	
University of California at Los Angeles (College of Engineering).	Educator	Los Angeles, Calif.	AMF	Graphite/water	10	1960	
University of Wisconsin		Madison, Wis.	GE	Pool	10	1960	
Lockheed Aircraft Corp.		USAEC South American Exhibit Program.	Owner	Pool	Negligible	1960	
University of Washington	Educator	Seattle, Wash.	AMF	Graphite/water	10	1960	
Being built:							
Aerojet-General Nucleonics (5 reactors)	AGN-201 (126-130)	San Ramon, Calif.	AGN	Homogeneous solid	Negligible	1961-62	
Aerojet-General Nucleonics (5 reactors)	AGN-211 (106-110)	San Ramon, Calif.	AGN	Homogeneous solid, pool	Negligible	1961-62	
Cornell University	TRIGA	Ithaca, N.Y.	GDC	U-Zr hydride, tank	10	1961	
University of Missouri, School of Mines and Metallurgy.		Rolla, Mo.	CW	Pool	10	1961	
Argonne National Laboratory (AEC) [37]	Juggernaut	Lemont, Ill.	ANL	Graphite/water	250	1961	
University of Kansas	Model 4180	Lawrence, Kans.	BAC	Pool	10	1961	
Ohio State University		Columbus, Ohio	Lockheed	Pool	10	1961	
Texas Technological College	CONVAIR	Lubbock, Tex.		Pool	10	1963	
Planned:							
University of Maine	AGN-201-132	Orno, Maine	AGN	Homogeneous solid	Negligible	1961	
Kansas State University	TRIGA-Mk II	Manhattan, Kans.	GDC	U-Zr hydride, tank	10	1961	

B. Dispersed Power Applications

A. Electrical Power Generation for Remote Installations

Name and/or owner	Designation [38]	Location	Principal nuclear contractor	Type	Power [1] net kw(e)	Start-up
Operable:						
Portable Medium Power Plant No. 2A (USA) [39]	PM-2A	Camp Century, Greenland	Alco	Pressurized water	1,500	1960
Being built:						
Stationary Medium Power Plant No. 1A (USA) [40]	SM-1A	Fort Greely, Alaska	Alco	Pressurized water	1,700	1960

Metallurgy.							
Argonne National Laboratory (AEC) [37]	Juggernaut	Lemont, Ill.	ANL	Pool	10	1961	
University of Kansas	Model 4180	Lawrence, Kans.	BAC	Pool	10	1961	
Ohio State University		Columbus, Ohio	Lockheed	Pool	10	1963	
Texas Technological College	CONVAIR	Lubbock, Tex.		Pool			
Planned:							
University of Maine	AGN-201-132	Orno, Maine	AGN	Homogeneous solid	Negligible	1961	
Kansas State University	TRIGA-Mk II	Manhattan, Kans.	GDC	U-Zr hydride, tank	10	1961	

A. Electrical Power Generation for Remote Installations

Name and/or owner	Designation [29]	Location	Principal nuclear contractor	Type	Power, net kw(e)	Start-up
Operable:						
Portable Medium Power Plant No. 2A (USA) [29]	PM-2A	Camp Century, Greenland	Alco	Pressurized water	1,500	1960
Being built:						
Stationary Medium Power Plant No. 1A (USA) [30]	SM-1A	Fort Greely, Alaska	Alco	Pressurized water	1,700	1960
Portable Medium Power Plant No. 3A	PM-3A	McMurdo Sound Antarctica	Martin	Pressurized water	1,500	1962

B. Propulsion (Naval)

Name (all owned by U.S. Navy)	Designation	Nuclear designer	Shipbuilder	Type [31]	Start-up	Dismantled
Operated, later dismantled:						
Seawolf S2G Sodium Reactor	S2G	GE		Sodium	1956	1959
Operable:						
USS Nautilus	SSN571	West	Electric Boat	S2W	1955	
USS Seawolf [32]	SSN575	West	Electric Boat	S2Wa	1960	
USS Skate	SSN578	West	Electric Boat	S3W	1957	
USS Swordfish	SSN579	West	Portsmouth	S4W	1958	
USS Sargo	SSN583	West	Mare Island	S3W	1958	
Operable:						
USS Seadragon	SSN584	West	Portsmouth	S4W	1959	
USS Skipjack	SSN585	West	Electric Boat	S5W	1958	
USS Triton (2 reactors)	SS(R)N586	GE	Electric Boat	S4G	1959	
USS Halibut	SS(G)N587	West	Mare Island	S3W	1959	
USS Scorpion	SSN589	West	Electric Boat	S5W	1960	
USS George Washington	SSB(N)598	West	Electric Boat	S5W	1959	
USS Patrick Henry	SSB(N)599	West	Electric Boat	S5W	1960	
USS Robert E. Lee	SSB(N)601	West	Newport News	S5W	1960	

See footnotes at end of table.

B. Propulsion (Naval)—Continued

Name (all owned by U.S. Navy)	Designation	Nuclear designer	Shipbuilder	Type [31]	Start-up	Dismantled
Being built:						
Submarine Scamp	SSN588	West	Mare Island	S5W		
Submarine Sculpin	SSN590	West	Ingalls	S5W		
Submarine Shark	SSN591	West	Newport News	S5W		
Submarine Snook	SSN592	West	Ingalls	S5W		
Submarine Thresher	SSN593	West	Portsmouth	S5W		
Submarine Permit	SSN594	West	Mare Island	S5W		
Submarine Plunger	SSN595	West	Mare Island	S5W		
Submarine Barb	SSN603	West	NYSC	S5W		
Submarine Tullibee	SSN597	GE	Electric Boat	S2C		
Submarine Theodore Roosevelt	SSB(N)600	West	Mare Island	S5W		
Submarine Abraham Lincoln	SSB(N)602	West	Portsmouth	S5W		
Submarine Pollack	SSN596	West	Ingalls	S5W		
Submarine Haddo	SSN604	West	NYSC	S5W		
Submarine Jack	SSN605	West	Portsmouth	S5W		
Submarine Tinosa	SSN606	West	Portsmouth	S5W		
Submarine Dace	SSN607	West	Ingalls	S5W		
Submarine Ethan Allen	SSB(N)608	West	Electric Boat	S5W		
Submarine Sam Houston	SSB(N)609	West	Newport News	S5W		
Submarine Thomas A. Edison	SSB(N)610	West	Electric Boat	S5W		
Submarine John Marshall	SSB(N)611	West	Newport News	S5W		
Submarine Guardfish	SSN612	West	NYSC	S5W		
Submarine Flasher	SSN613	West	Electric Boat	S5W		
Submarine Greenling	SSN614	West	Electric Boat	S5W		
Submarine Gato	SSN615	West	Electric Boat	S5W		
Submarine Lafayette	SSB(N)616	West	Electric Boat	S5W		
Submarine	SSB(N)617	West	Electric Boat	S5W		
Submarine	SSB(N)618	West	Newport News	S5W		
Submarine	SSB(N)619	West	Mare Island	S5W		
Submarine	SSB(N)620	West	Portsmouth	S5W		
Submarine	SSN621	West	Ingalls	S5W		
Submarine	SSN622	West		S5W		
Submarine	SSN623	West		S5W		
Submarine	SSN624	West		S5W		
Guided Missile Cruiser Long Beach (2 reactors)	CGN9	West	Bethlehem	C1W		
Aircraft Carrier Enterprise (8 reactors)	CVA(N)65	West	Newport News	A2W		
Guided Missile Destroyer Bainbridge (2 reactors)	DLG(N)25	GE	Bethlehem	D2G		

A. Electric Power Experiments and Prototypes

A.1. Power for Remote Installations

Name (all owned by AEC except as noted)	Designation [33]	Location	Principal nuclear contractor	Type	Power, net, kw(e), Kw(t)	Startup
Operable:						
Stationary Medium Power Plant No. 1 (formerly APPR-1) (USA).	SM-1	Ft. Belvoir, Va	Alco	Pressurized water	1,855	1957
Stationary Low Power Plant No. 1 (formerly ALPR) [83]	SL-1	NRTS, Idaho	ANL-CE	Boiling water	200	1958
Gas Cooled Reactor Experiment	GCRE-1	NRTS, Idaho	AG	Gas cooled	No electric	1960
Being built:						
Portable Medium Power [34] Plant No. 1 (USAF-AEC)	PM-1	Sundance, Wyo				
Mobile Low Power Plant No. 1						

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Submarine	SSN622	West		S5W		
Submarine	SSN623	West		S5W		
Submarine	SSN624	West		S5W		
Submarine	CG(N)9	West	Bethlehem	C1W		
Guided Missile Cruiser Long Beach (2 reactors)	CVA(N)65	West	Newport News	A2W		
Aircraft Carrier Enterprise (8 reactors)	DLG(N)25	GE	Bethlehem	D2G		
Guided Missile Destroyer Bainbridge (2 reactors)						

A. Electric Power Reactors and Prototypes

A.1. Power for Remote Installations

Name (all owned by AEC except as noted)	Designation [31]	Location	Principal nuclear contractor	Type	Power, net, kw(e), Kw(t)	Startup
Operable:						
Stationary Medium Power Plant No. 1 (formerly APPR-1) (USA).	SM-1	Ft. Belvoir, Va	Alco	Pressurized water	1,855	1957
Stationary Low Power Plant No. 1 (formerly ALPR) [33]	SL-1	NRTS, Idaho	ANL-CE	Boiling water	200	1958
Gas Cooled Reactor Experiment	GCRE-1	NRTS, Idaho	AG	Gas cooled	No electric	1960
Being built:						
Portable Medium Power [34] Plant No. 1 (USAF-AEC)	PM-1	Sundance, Wyo	Martin	Pressurized water	1,000	1961
Mobile Low Power Plant No. 1	ML-1	NRTS, Idaho	AG	Gas cooled	300 to 500	1961
Planned:						
Military Compact Reactor Pilot Plant	MCRPP	NRTS, Idaho	NDA		Up to 3,000	

A.2. Systems for Nuclear Auxiliary Power (SNAP)

Name (All owned by AEC)	Designation	Location	Principal nuclear contractor	Type	Power		Startup
					KWE	KWT	
Operable:							
SNAP 2 Experimental Reactor	SER	Santa Susana, Calif	AI	NaK cooled		50	1959
Being built:							
SNAP 2 Developmental System #1	S-2-DS-1	Santa Susana, Calif	AI	NaK cooled	3	50	1961
SNAP 10 Developmental System	S-10-DS	Santa Susana, Calif	AI	Fuel plates, static	.3	12	1961
Planned:							
SNAP 2 Developmental System #2	S-2-DS-2	Santa Susana, Calif	AI	NaK cooled	3	50	1962
SNAP 2 Package System	S-2-PS	Santa Susana, Calif	AI	NaK cooled	3	50	1962
SNAP 8 Experimental Reactor	S-8-ER	Santa Susana, Calif	AI	NaK cooled		600	1962
SNAP 10 Package System	S-10-PS	Santa Susana, Calif	AI	Fuel plates, static	.3	12	1962

See footnotes at end of table.

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B. Propulsion Experiments and Prototypes

B.1. Naval

Name (all owned by AEC)	Designation	Location	Principal nuclear contractor	Type	Start-up	Dismantled
Operated, later dismantled:						
Submarine Intermediate Reactor Mark A	S1G	West Milton, N.Y.	GE	Sodium	1955	1957
Operable:						
S1W Reactor Facility	S1W	NRTS, Idaho	West	Pressurized water	1953	
Large Ship Reactor Prototype (2 reactors)	A1W	NRTS, Idaho	West	Pressurized water	1958	
Submarine Advanced Reactor Prototype	S3G	West Milton, N.Y.	GE	Pressurized water	1958	
Small Submarine Reactor Prototype	S1C	Windsor, Conn.	CE	Pressurized water	1959	
Being built:						
Destroyer Reactor Prototype	D1G	West Milton, N.Y.	GE	Pressurized water		
Planned:						
Natural Circulation Test Plant	S5G	NRTS, Idaho	GE	Pressurized water	1963	

B.2. Aircraft

Name (all owned by AEC)	Designation	Location	Principal nuclear contractor	Type	Thermal power Kw(t)	Start-up	Dismantled
Operated, later dismantled:							
Aircraft Reactor Experiment	ARE	Oak Ridge, Tenn.	ORNL	Molten salt		1954	1954
Heat Transfer Reactor Experiment No. 1 [5]	HTRE-1	NRTS, Idaho	ANPD	Air cooled	20,000	1956	1957
Operable:							
Heat Transfer Reactor Experiment No. 2	HTRE-2	NRTS, Idaho	ANPD	Air cooled	14,000	1957	
Heat Transfer Reactor Experiment No. 3	HTRE-3	NRTS, Idaho	ANPD	Air cooled	32,000	1958	
Being built:							
Experimental Reactor	PWAC-IIC	NRTS, Idaho	P&W	Liquid metal cooled	10,000		
Planned:							
Advanced Core Test	ACT	NRTS, Idaho	ANPD	Air cooled			

Name (all owned by AEC)	Designation	Location	Principal nuclear contractor	Type	Start-up
Being built:					
Experimental Power Reactor Test	Tory-IIA-1	NTS, Nev.	UCLRL	Air cooled	
Experimental Power Reactor	Tory-IIA-2	NTS, Nev.	UCLRL	Air cooled	1960
Planned:					
Nuclear Ramjet Test Reactor	Tory-IIC	NTS, Nev.	UCLRL	Air cooled	

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3. Test and Research

Being built:							
Experimental Reactor	PWAC-IIC	NRTS, Idaho	P&W	Liquid metal cooled	10,000		
Planned:							
Advanced Core Test	ACT	NRTS, Idaho	ANPD	Air cooled			

Being built:						
Experimental Power Reactor Test	Tory-IIA-1	NTS, Nev.	UCLRL	Air cooled		
Experimental Power Reactor	Tory-IIA-2	NTS, Nev.	UCLRL	Air cooled		1960
Planned:						
Nuclear Ramjet Test Reactor	Tory-IIC	NTS, Nev.	UCLRL	Air cooled		

3. Test and Research

A. Test

Name (all owned by AEC except as noted)	Designation	Location	Principal nuclear contractor	Type	Power Kw(t)	Start-up	Dismantled
Operated, later dismantled:							
Tower Shielding Reactor No. 1	TSR-1	Oak Ridge, Tenn.	ORNL	Tank	500	1954	1958
Operable:							
Ground Test Reactor (USAF)	GTR	Ft. Worth, Tex.	Convair	Pool	3,000	1953	
Aircraft Shield Test Reactor	ASTR	Ft. Worth, Tex.	Convair	Light water	3,000	1954	
Radiation Effects Reactor (USAF)	RER	Dawsonville, Ga.	Lockheed	Tank	10,000	1958	
Shield Test Pool Facility	SUSIE	NRTS, Idaho	ANPD	Pool	10 to 100	1959	
Tower Shielding Reactor No. 2	TSR-2	Oak Ridge, Tenn.	ORNL	Light water	5,000	1960	
Being built:							
Nuclear Engineering Test Reactor (USAF)	NETR	Dayton, Ohio	Maxon-AC	Pool	10,000	1961	
Sandia Engineering Reactor Facility	SERF	Sandia Base, N. Mex.	Sandia	Tank	5,000	1961	
Sandia Pulsed Reactor Facility	SPRF	Sandia Base, N. Mex.	Sandia	Prompt burst		1961	

See footnotes at end of table.

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B. Research

Operable:							
Thermal Test Reactor No. 1	TTR-1	Schenectady, N.Y.	KAPL	Graphite	10	1951	
Naval Research Reactor (USN)	NRR	Washington, D.C.	NRL	Pool	100	1956	
Being built:							
Horace Hardy Lester Reactor for Materials Research (Watertown Arsenal, USA).		Watertown, Mass.	Owner	Pool	1,000	1961	
Diamond Ordnance Fuse Laboratory Radiation Facility (USA).	TRIGA (DORF)	Washington, D.C.	GDC	Zr hydride, tank	100	1961	
Planned:							
Ordnance Pulsed Experimental Research Assembly (USA).	OPERA	Aberdeen Proving Ground, Md.	AGN	Prompt burst	100	1962	
White Sands Missile Range Nuclear Effects Facility (USA).	WSMR	White Sands, N. Mex.		Prompt burst		1963	
Picatinny Arsenal (USA)		Dover, N.J.		Prompt burst	20,000		

Part III.—PRODUCTION REACTORS

1. Materials Production

Designation	Nuclear designer	Type	Location
Operable:			
B Reactor	du Pont	Graphite	Hanford, Wash.
D Reactor	du Pont	Graphite	Hanford, Wash.
F Reactor	du Pont	Graphite	Hanford, Wash.
C Reactor	GE	Graphite	Hanford, Wash.
DR Reactor	GE	Graphite	Hanford, Wash.
H Reactor	GE	Graphite	Hanford, Wash.
KE Reactor	GE	Graphite	Hanford, Wash.
KW Reactor	GE	Graphite	Hanford, Wash.
R Reactor	du Pont	Heavy water	Savannah River, S.C.
P Reactor	du Pont	Heavy water	Savannah River, S.C.
K Reactor	du Pont	Heavy water	Savannah River, S.C.
L Reactor	du Pont	Heavy water	Savannah River, S.C.
C Reactor	du Pont	Heavy water	Savannah River, S.C.
Being Built			
New Production Reactor [illegible]	GE	Graphite	Hanford, Wash.

[illegible]	Designation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Operable:						
Process Development Pile	PDP	Savannah River, S.C.	du Pont	Heavy water	1	1953
Hanford 305 Test Reactor	HEW-305	Hanford, Wash.	du Pont	Graphite	0.03	1944
Savannah River Test Pile 305	SR-305	Savannah River, S.C.	du Pont	Graphite	1	1953
Physical Constants Test Reactor	PCTR	Hanford, Wash.	GE	Graphite	0.1	1955
Thermal Test Reactor No. 2	TTR-2	Hanford, Wash.	GE	Graphite	0.1	1955

KE Reactor	GE	Graphite	Hanford, Wash.
KW Reactor	du Pont	Heavy water	Savannah River, S.C.
R Reactor	du Pont	Heavy water	Savannah River, S.C.
P Reactor	du Pont	Heavy water	Savannah River, S.C.
K Reactor	du Pont	Heavy water	Savannah River, S.C.
L Reactor	du Pont	Heavy water	Savannah River, S.C.
C Reactor			
Being Built			
New Production Reactor [36]	GE	Graphite	Hanford, Wash.

Operable:						
Process Development Pile	PDP	Savannah River, S.C.	du Pont	Heavy water	1	1953
Hanford 305 Test Reactor	HEW-305	Hanford, Wash.	du Pont	Graphite	0.03	1944
Savannah River Test Pile 305	SR-305	Savannah River, S.C.	du Pont	Graphite	1	1953
Physical Constants Test Reactor	PCTR	Hanford, Wash.	GE	Graphite	0.1	1955
Thermal Test Reactor No. 2	TTR-2	Hanford, Wash.	GE	Graphite	0.1	1955

Part IV.—Reactors for Export

1. Power Reactors

A. Central Station Electric Power

Name and/or owner	Location	Principal nuclear contractor	Type	Power [1]		Start-up
				Net kw(e)	Kw(t)	
Operable:						
Germany (Rhine-Westphalia Power Co., RWE)	Kahl-am-Main	GE	Boiling water	16,000	60,000	1960
Being built:						
Belgium (Center for the Study of Nuclear Energy CEN)	Mol	West	Pressurized water	11,500	43,000	1960
Italy (Project Enrico Fermi of SELNI, Edisonvolta)	Trino	West	Pressurized water	165,000	615,000	1964
Italy (Project ENSI of SENN)	Punta Fiume	GE	Boiling water	150,000	508,000	1963
Planned:						
Japan, Government of (JAERI)	Tokai-Mura	GE	Boiling water	10,000	40,000	1962
France (Franco-Belgium Society for Nuclear Energy of Ardennes—SENA).	Chooz	West	Pressurized water	150,000	----------	1964

See footnotes at end of table.

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B. PROPULSION

Name	Owner	Designation	Designer	Type	Start-up
Being built: S5W for HMS Dreadnaught	Great Britain		West	S5W	

2. TEST, RESEARCH, AND TEACHING

A. GENERAL IRRADIATION TEST

Owner	Location	Principal nuclear contractor	Type	Power,[18] Kw(t)	Start-up
Operable:					
Sweden, Gov't of (Atomic Energy Company)	Studsvik	AC	Tank (MTR)	30,000	1960
Japan, Gov't of (Atomic Energy Research Inst.)	Tokai-Mura	AMF	Heavy water	10,000	1960
Being built:					
Netherlands, Gov't of (Reactor Center)	Petten	AC	Tank (MTR)	20,000	1962

B. RESEARCH

Operable:					
Austria, Gov't of (Seibersdorf Research Center)	Seibersdorf	AMF	Pool	5,000	1960
Brazil, Gov't of (University of Sao Paulo)	Sao Paulo	B&W	Pool	5,000	1957
Canada (McMaster University)	Hamilton, Ont	AMF	Pool	1,000	1959
Denmark, Gov't of (Atomic Energy Commission)	Riso	FW	Tank	5,000	1959
Germany, Federal Republic of (Technical Univ. of Munich)	Munich	AMF	Pool	1,000	1957
Germany, Federal Republic of (Society for the Utilization of Nuclear Energy in Shipbuilding and Navigation, Inc.)	Geesthacht	B&W	Pool	5,000	1958
Israel, Gov't of (Atomic Energy Commission)	Nebi Rubin	AMF	Pool	1,000	1961
Italy, Gov't of (National Committee for Nuclear Research)	Ispra	AC	Heavy water, tank	5,000	1959
Italy (ECRIN Nuclear Center)	Saluggia	AMF	Pool	1,000	1959
Italy, Gov't of (National Committee for Nuclear Research)	Rome	GDC	TRIGA-MkII	100	1960
Spain, Government of (Nuclear Energy Board)	Moncloa	GE	Pool	3,000	1958
Switzerland, Gov't of (Reactor, Inc.)	Wuerenlingen	ORNL	Pool	1,000	1955
Venezuela, Gov't of (Institute of Neurology and Brain Research)	Caracas	GE	Pool	3,000	1960
Being built:					
Turkey, Republic of (Istanbul Technical University)	Istanbul	AMF	Pool	1,000	1961
Turkey, Gov't of (Atomic Energy Commission)	Ankara	AMF	Pool	1,000	1961
Planned:					
Pakistan, Gov't of (Atomic Energy Commission)	Taxila	AMF	Pool	1,000	
Union of South Africa (Atomic Energy Commission)		AC	Tank (OROO)	6,600	

C. TEACHING

Operable:					
Brazil (University of Minas Gerias)	Belo Horizonte	GDC	TRIGA	30	1960
Congo, Gov't of (University of Lovanium)[38]	Leopoldville	GDC	TRIGA		
Denmark, Gov't of (Atomic Energy Commission)					
Germany, Federal Republic of					

Denmark, Gov't of (Atomic Energy Commission)	Munich	AMF	Pool	5,000	1958
Germany, Federal Republic of (Technical Univ. of Munich)	Geesthacht	B&W	Pool	1,000	1961
Germany, Federal Republic of (Society for the Utilization of Nuclear Energy in Shipbuilding and Navigation, Inc.).	Nebl Rubin	AMF	Pool	5,000	1959
Israel, Gov't of (Atomic Energy Commission)	Ispra	AC	Heavy water, tank	1,000	1959
Italy, Gov't of (National Committee for Nuclear Research)	Saluggia	AMF	Pool	100	1960
Italy (SORIN Nuclear Center)	Rome	GDC	TRIGA-MkII	3,000	1958
Italy, Gov't of (National Committee for Nuclear Research)	Muncles	GE	Pool	1,000	1955
Spain, Government of (Nuclear Energy Board)	Warrenlingen	ORNL	Pool	3,000	1960
Switzerland, Gov't of (Reactor, Inc.)	Carnegie	GE	Pool		
Venezuela, Gov't of (Institute of Neurology and Brain Research)					
Being built:	Dalton	GE	Pool	1,000	1961
China, Republic of (National Tsing Hua University)	Ajaccio	AMF	Pool	1,000	1961
Greece, Gov't of (Atomic Energy Commission)					
Pakistan, Gov't of (Atomic Energy Commission)	Islamabad	[illegible]	[illegible]	[illegible]	[illegible]
Union of South Africa (Atomic Energy Commission)	Pretoria	AMF	Pool	1,000	1961
		AC	Tank (ORGO)	6,000	

C. Teaching

Operable:					
Brazil (University of Minas Gerias)	Belo Horizonte	GDC	TRIGA	30	1960
Congo, Gov't of (University of Lovanium) [39]	Leopoldville	GDC	TRIGA	10	1959
Denmark, Gov't of (Atomic Energy Commission)	Riso	AI	L-55	2	1957
Germany, Federal Republic of (Universities of Frankfurt and Darmstadt)	Frankfurt	AI	L-54	50	1958
Germany (Interatom, Inc.) [39]	Duisberg	AI	L-77	Neglig.	1958
Italy (University of Palermo)	Palermo	AGN	201-110	Neglig.	1960
Italy (University of Milan)	Milan	AI	L-54	50	1959
Japan, Gov't of (Atomic Energy Research Institute)	Mito	AI	L-54	50	1957
Netherlands, Gov't of (Delft Technical Univ.) [40]	Delft	AMF	Pool	100	1957
Switzerland (University of Geneva) [41]	Geneva	AGN	201-111	Neglig.	1958
Switzerland (University of Basel) [42]	Basel	AGN	211-100	Neglig.	1958
West Berlin, City of (Institute for Nuclear Research)	West Berlin	AI	L-54	50	1958
Being built:					
Australia (Atomic Energy Commission)	Lucas-Hights New South Wales.	ARSS	UTR-10	Neglig.	1961
Austria, Gov't of (Vienna Polytechnic Institute)	Vienna	GDC	TRIGA-Mk II	100	1961
Japan (Kinki University)	Osaka	ARSS	UTR-10	Neglig.	1961
Japan (Rikkyo University)	Yokosuka City	GDC	TRIGA-Mk II	100	1961
Japan (Musashi University)	Kawasaki City	GDC	TRIGA-Mk II	100	1961
Korea, Gov't of (Atomic Energy Commission)	Seoul	GDC	TRIGA-Mk II	100	1961
Vietnam, Government of	Dalat	GDC	TRIGA-Mk II	100	1961
Planned:					
Finland, Gov't of (Institute of Technology)	Helsinki	GDC	TRIGA-Mk II	100	1961
Germany (University of Mainz)	Mainz	GDC	TRIGA-Mk II	100	------
Indonesia (Institute of Technology)	Bandung	GDC	TRIGA-Mk II	100	------
Japan (Tokai University)		ARSS	UTR-10	Neglig.	------
Yugoslavia, Federal Peoples Gov't of (Josef Stefan Nuclear Institute)	Ljubljana	GDC	TRIGA-Mk II	100	1962

See footnotes at end of table.

PART V—CRITICAL ASSEMBLY FACILITIES

A. IDENTIFICATION OF FACILITIES

Abbreviation	Name and location of facility	Operator	Number of cells	Number of control panels
AC	Allis-Chalmers Critical Experiment Facility, Greendale, Wis	Owner	1	1
AI	Atomics International Critical Experiment Laboratory (AEC), Santa Susana, Calif	Owner	4	4
Alco	Alco Products, Inc., Schenectady, N.Y	Owner	1	1
ANL	Argonne National Laboratory (AEC), Lemont, Ill	ANL	3	3
ANL-ID	Argonne National Laboratory, Idaho Division (AEC), NRTS, Idaho	ANL	1	1
ARMF	Advanced Reactivity Measurement Facility (AEC), NRTS, Idaho	PPC	1	1
Bettis	Bettis Plant (AEC), Pittsburgh, Pa	West	9	9
BMI	Battelle Memorial Institute, West Jefferson, Ohio	Owner	1	1
BNL	Brookhaven National Laboratory (AEC), Upton, N.Y	BNL	2	2
B & W	The Babcock & Wilcox Co., Lynchburg, Va	Owner	3	3
CANEL	Connecticut Aircraft Nuclear Engine Laboratory (AEC), Middletown, Conn	P&W	2	2
CE	Nuclear Engine Laboratory of Combustion Engineering, Inc., Windsor, Conn	Owner	3	2
Cornell	Cornell University Zero Power Reactor, Ithaca, N.Y	Owner	1	1
ETRC	Engineering Test Reactor Critical Facility (AEC), NRTS, Idaho	PPC	1	1
GE	General Electric Company, Vallecitos Laboratory Experimental Physics Facility, Pleasanton, Calif	Owner	1	1
GEANP	Evendale Critical Experiment Facility (AEC), Evendale, Ohio	GE	2	2
GDC	General Dynamics Corp., San Diego, Calif	Owner	3	3
HAN	Hanford Critical Facilities (AEC Hanford, Wash.)	GE	2	2
KAPL	Knolls Atomic Power Laboratory (AEC), Schenectady, N.Y	GE	7	1
LAC	Lockheed Aircraft Corp., Dawsonville, Ga. (USAF)	Owner	1	1
LASL	Los Alamos Scientific Laboratory, Los Alamos, N. Mex	LASL		
Livermore	University of California Lawrence Radiation Laboratory Critical Assembly Area (AEC), SAGA Building, Livermore, Calif.	UCLRL	4	3
LPTF	Low Power Test Facility (AEC), NRTS, Idaho	GE	2	2
Martin	Martin Co., Middle River, Md	Owner	3	3
NASA	Lewis Flight Propulsion Laboratory, Sandusky, Ohio	Owner	1	1
NDA	Nuclear Development Corporation of America, Pawling, N.Y	Owner	1	1
ORNL-CF	Oak Ridge National Laboratory Critical Facility (AEC), Oak Ridge, Tenn	ORNL	3	5
ORNL-PCA	Pool Critical Assembly, BSF Pool (AEC), Oak Ridge, Tenn	ORNL	1	1
RMF	Reactivity Measurement Facility, MTR Canal (AEC), NRTS, Idaho	PPC	1	1
UCLRL-NTS	University of California Lawrence Radiation Laboratory (AEC), NTS, Nev	UCLRL	1	1
West	Westinghouse Reactor Evaluation Center Critical Experiment Station (CES), Yankee Critical Facility (YCF), and Large Reactor Critical Facility (LRX), Waltz Mill, Pa.	Owner	3	3

B. Operation

Operator and location within facility	Subject of current experiment or study	Designation	Start-up
Operable:			
AC	Northern States Power Reactor critical experiment	CRBR-CX	1959
AI, Bldg 9	Nuclear properties of organic moderated systems	OCMA	1959
AI, Bldg 9	Nuclear properties of sodium graphite systems	SCGA	1959
AI, Bldg 100	Nuclear properties of epithermal reactor systems	AETR	1960
ANL-ID	Fast critical mass determinations	ZPR-3	1955
ANL, Bldg 316, Cell A [42]	Parameters of thermal reactor systems	ZPR-4	1957
ANL, Bldg 316, Cell B	Interactions between two basic systems	ZPR-5	1956
	Physics experiments for ALFR	ZPR-7	1957

Operator and location within facility	Subject of current experiment or study	Designation	Start-up
Operable:			
AC,	Northern States Power Reactor critical experiment	CRBR–CX	1959
AI, Bldg 9	Nuclear properties of organic moderated systems	OCMA	1959
AI, Bldg 100	Nuclear properties of sodium graphite systems	SCGA	1959
ANL–ID	Fast critical mass determinations	AETR	1960
ANL, Bldg 316, Cell A [43]	Parameters of thermal reactor systems	ZPR–3	1955
ANL, Bldg 316, Cell B	Interactions between two basic systems	ZPR–4	1957
ANL, Bldg 316, Cell C	Physics experiments for AHFR	ZPR–5	1956
Bettis, Bldg CX, Cell 3	PWR core 1 physics	ZPR–7	1957
Bettis, Bldg CX, Cell 4	PWR core 2 physics	PWR–FA–1	1954
B&W, Cell 1	Consolidated Edison Reactor	PWR–FA–2	1957
B&W, Cell 2	Critical experiments with Nuclear Ship *Savannah* Production Fuel		1957
B&W, Cell 3 [43]	LMFBR physics data	BMI–CX	1958
BMI, Cell 1	Reflector control critical		1957
BNL, Bldg T–526	Exponential and critical assembly		1958
CE, Bldg 1, Cell 1	Vacant		1958
CE, Bldg 2, Cell 1	Boiling Nuclear Superheat Critical Experiment		1957
CE, Bldg 2, Cell 2	Integral nuclear superheat core configuration		1956
ETRC, ETR–MTR area (PPC)	ETR physics, core loading and core design	BONUS	
GDC, Cell 1	Zirconium-uranium hydride fuel	NUSI	1960
GDC	HTGR critical experiment	ETRC	1957
GE, Cell 1	Maritime gas cooled reactor critical experiments	CIRCA	1957
LASL, Kiva I	Commonwealth Edison reactor	HTGR–CX	1960
LASL, Kiva II	Cold criticals for ROVER reactors		1960
LASL	Physics measurements of thin enriched uranium foils in thick D_2O cold critical experiments	Honeycomb	1957
Martin, Cell 1	Cold Criticals for ROVER reactors	Cavity	
Martin, Cell 2	Martin power reactor experiments		1960
Martin, Cell 3	Homogeneous dispersions in a plastic of uranium, stainless steel and boron	ZEPO	1960
NASA, Materials and Stresses Bldg	Liquid fluidized bed reactor critical experiment facility		
NDA, Cell 1 [43]	NASA Test Reactor critical experiments		1957
ORNL–CF, Bldg 9213, Cell E	Development of research reactor	LFBR–CX	1958
ORNL–CF, Bldg 9213, Cell W	Uranium-paraffin experiments related to physics and safety of homogeneous reactors		1960
	Reactor physics experiments related to enriched uranium in water; TSR–2 tests; investigations of neutron absorbers as poisons in chemical processing equipment.	NDA–CX	1959
ORNL–PCA, Bldg 3010		CA–28	1957
MTR canal (PPC)	Physics research on reactivity effects		1960
ETR–MTR Area (PPC)	Reactor physics constants and reactivity changes caused by test reactor irradiation	PCA	1958
		RMF	1954
		AMRF	1960

See footnotes at end of table.

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B.1. Civilian—Continued

Operator and location within facility	Subject of current experiment or study	Designation	Start-up
Operable—Continued			
West, CES	Reactor-fuel-measurement facility design		1958
West, LRX	Physical constants of critical assemblies moderated with D_2O and containing as fuel slightly enriched uranium in the form of UO_2.	CVTR-CRX	1960
West, YCF	Loose lattice critical experiments		
Being built:			
ANL, Bldg 315	Basic fast reactor theoretical studies	ZPR-6	1961
ANL, Bldg 315	Coupled fast core-thermal breeder blanket investigations	ZPR-9	1961
Cornell	Zero Power Reactor	ZEPR	1960
HAN-CML	Critical Mass Laboratory	CML	1960
HAN-PRCF	Plutonium Recycle Criticals	PRCF	1961

B.2. Military

Operable:			
Alco	APPR-1A core design	APPR-s	1956
Bettis, Bldg C, Cell 1	Two region physics	TRX	1953
Bettis, Bldg CA, Cell 2	S5W	SPE-CX	1960
Bettis, Bldg CX, Cell 1	Surface ship physics [4]	SS-CFB	1957
Bettis, Bldg CX, Cell 2	Physics measurements	SPE-CBM	1960
Bettis, Bldg CY, Cell 1	High-temperature physics and mock-up	HTTF	1960
CANEL, Physics Bldg, Cell 1	Aircraft propulsion		1958
CANEL, Physics Bldg, Cell 2	Aircraft propulsion		1959
GEANP-1	Criticals for direct-cycle reactors	KEY	1960
GEANP-2	Criticals for direct-cycle reactors	SSR-RAG	1960
KAPL, Bldg F1, Cell 1	Physical data	PPA	1948
KAPL, Bldg F2, Cell 1	Reactor physics studies with plastic moderator and mock-up	PMA	1954
KAPL, Bldg F3, Cell 1	Submarine advanced reactor mock-up	ATR	1954
KAPL, Bldg F1, Cell 1	SAR physics and mock-up	FPR	1956
KAPL, Bldg E5, Cell 1	DIG cold-water mock-up	CWA	1958
KAPL	SAR high-temperature and -pressure physics and mock-up	PTR	1958
LAC	RER core configurations	CERF	1958
LASL	Enriched metal in 3-inch-thick uranium reflector	*Little Eva*	*1951*
LASL, Kiva I	Plated bare plutonium (to be replaced by U^{233}) sphere studies	*Jezebel*	*1954*
LASL, Kiva I	Critical configuration safety tests	*Comet*	
LASL, Outside Kiva II	Jacketed enriched-core lateral and base reflector of water studies, used as neutron sources for exponential column	*Hydro*	*1956*
LASL, Kiva II	Bare pseudo-critical bursts with plated bare enriched core	*Godiva II*	*1957*
LASL, Kiva II	Enriched metal cores in thick metal reflector	*Flattop*	*1957*
LASL	Critical configuration assay tests	*Planet*	
LASL	Bare critical experiments	*Honey*	*1958*
NAA-AP	Critical experiment tank for HTRE-2	HOTCM	1958
NTS, Nevada	Criticals for SNAP reactors	CET	1957
Being Built:	Hot criticals for Tory-II (Project PLUTO)		
KAPL	Water Reactor Test Cell	Hot Box	
Livermore, SAGA Bldg	Tory-II critical experiments		1960
			1960

B.3. Export

Operable:			
Canada, Gov't of (AECL) Chalk River	Natural uranium D_2O moderated power reactor lattice studies	ZEEP II	1960

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CANEL, Physics Bldg, Cell 1	Aircraft propulsion		1959
CANEL, Physics Bldg, Cell 2	Aircraft propulsion		1960
GEANP-1	Criticals for direct-cycle reactors	KEY	1960
GEANP-2	Criticals for direct-cycle reactors	SSR-RAG	1960
KAPL, Bldg F1, Cell 1	Physical data	PPA	1948
KAPL, Bldg F2, Cell 1	Reactor physics studies with plastic moderator and mock-up	PMA	1954
KAPL, Bldg F3, Cell 1	Submarine advanced reactor mock-up	ATR	1954
KAPL, Bldg F4, Cell 1	SAR physics and mock-up	FPR	1956
KAPL, Bldg E5, Cell 1	DIG cold-water mock-up	CWA	1958
KAPL	SAR high-temperature and -pressure physics and mock-up	PTR	1958
LAC	RER core configurations	CERF	1958
LASL	Enriched metal in 3-inch-thick uranium reflector	Little Eva	1951
LASL, Kiva I	Plated bare plutonium (to be replaced by U^{233}) sphere studies	Jezebel	1954
LASL, Kiva I	Critical configuration safety tests	Comet	
LASL, Outside Kiva II	Jacketed enriched-core lateral and base reflector of water studies, used as neutron sources for exponential column	Hydro	1956
LASL, Kiva II	Bypass prompt critical bursts with plated bare enriched core	Godiva II	1957
LASL, Kiva II	Spherical metal cores in thick metal reflector	Flattop	1957
LASL, Kiva II	Critical configuration safety tests	Planet	
NRTS, Idaho	Engineering tests of BORAX-V	BORAX-V	1956
NRTS, Idaho	Critical experiments for ARE reactor	ARE	1957
NTS, Nevada	Hot criticals for Tory-II (Project PLUTO)	Kiwi-A	1959
Being Built:			
KAPL	Water Reactor Test Cell	Hot Box	
Livermore, SAGA Bldg.	Tory-II critical experiments		1960
			1960

B.3. Export

Operable:			
Canada, Gov't of (AECL) Chalk River	Natural uranium, D_2O moderated power reactor lattice studies	ZED-II	1960
Planned:			
Japan, Gov't of (JAERI) Tokai-MURA	Aqueous homogeneous		
Japan, Gov't of (JAERI) Tokai-MURA	Semi-homogeneous		

FOOTNOTES

[1] The capacity figures for power reactors are based on the best available information. In some cases future modification in plans may cause changes.

[2] The Shippingport station is provided with a turbogenerator rated at 100,000 kw(e).

[3] Project under Power Demonstration Reactor Program.

[4] The net electrical kilowatt output for the Yankee's second core is expected to be 134,000.

[5] Of the total net output shown for the Consolidated Edison plant, 151,000 kw will be nuclear and 104,000 kw will be oil-fired superheat.

[6] The Enrico Fermi plant is to be provided with a turbogenerator rated at 150,000 kw(e) and may reach this gross output with later cores.

[7] The capacity of the Northern States plant includes about 17,000 kw(e) nuclear superheat.

[8] Approved as basis for the AEC contract negotiations under the Power Demonstration Reactor Program.

[9] The net output of the Elk River plant includes about 15,000 kw conventional superheat.

[10] Capacity of CVNPA plant includes about 2,000 kwe from conventional superheat.

[11] Capacity of SSNPP includes about 5,500 kwe from conventional superheat.

[12] EBWR was successfully operated at a power level of 62,000 kw of heat in experiments on March 20, 1958. It is now being converted to a 100,000 kw thermal plant, but its electrical output is limited by turbogenerator capacity.

[13] The power output of EGCR will depend on the operation of experimental loops to be provided in the core.

[14] LAPRE-1 was designed as a small reactor experiment that was to produce 2,000 kw of heat power. It operated only very briefly and never succeeded in reaching full power.

[15] Originally built and operated in 1954 as the Boiling Reactor Experiment No. 2 (BORAX-2). With the addition of a turbogenerator, it operated during 1955 as BORAX-3. BORAX-4 was a further modification which operated from December 1956 until June 1958 when the experiment was shut down.

[16] Gross electrical kilowatt output is shown for EBR-1 in the tabulation. In a trial run on December 21 and 22, 1951, EBR-1 generated the world's first electric power from nuclear energy. Criticality with the third core was achieved in November 1957.

[17] The purpose of this reactor is to investigate problems associated with high-temperature process heat reactors.

[18] BSR-2 is a stainless steel-UO_2 core that can be used alternately in the same facility with BSR-1 (aluminum alloy core).

[19] Reactors whose thermal power output is less than 50 watts are shown as having negligible power output. The thermal power of these reactors is as follows: AGN 201's, 100 mw; AGN 201 M's, 5 watts; AGN 201 P's, 20 watts; AGN 211's, 15 watts; AI's L-47 and L-77, 10 watts; ARSS' UTR-1, 1 watt; and NDA's PRR, 5 watts.

[20] In 1943, The Manhattan Engineering District disassembled Chicago Pile 1 and rebuilt it at Palos Park, Ill., as Chicago Pile 2. CP-2 had a thermal power level of 2 kw.

[21] LITR began as a mechanical model of the MTR. After MTR engineering aspects were proved, small amounts of nuclear fuel, control devices, shielding, and instruments were added; and the reactor, called MTR critical experiment, went critical for the first time in the spring of 1950. Research facilities were added, and power was increased to the present level in the fall of 1951.

[22] AE-6 (also designated WBNS) was built and first operated at Downey, Calif. It was moved to Santa Susana in 1957.

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FOOTNOTES—Continued

[23] Ownership of the Curtiss-Wright Research Reactor Facility has been transferred to Pennsylvania State University. The reactor is being maintained on a standby basis pending issuance of an operating license to the University.

[24] These reactors were shipped abroad for exhibition purposes in Pakistan and Egypt in 1960.

[25] This TRIGA–Mk II reactor was operated at the New Delhi World Agricultural Fair in 1960. It has been dismantled for storage in California by GDC.

[26] The original 10-kw research reactor at Raleigh, N.C., was started up in 1953 and was dismantled in 1955. The reactor was reactivated with a 500-watt core in March 1957. Early in 1959, the reactor was modified for 100 watt operation and moved to a new location in the Nuclear Science Laboratory and a new 10-kw heterogeneous-core Argonaut type reactor was built in the original RRR shield vacated by the homogeneous core.

[27] After the assembly and operation of this reactor in the Government exhibit at Geneva in September 1958, it was dismantled and returned to ANL where it is being rebuilt as a 250-kw(t) Juggernaut.

[28] Reactors in the Army power program are identified by symbolic nomenclature to reflect mobility characteristics, power range, development sequence and field sequence.

The first capital letter indicates mobility characteristics: *S*—stationary operation, not designed for subsequent relocation; *P* (portable)—semi-mobile, stationary operation, capable of being dismantled and reassembled for use in successive locations; *M* (mobile)—capable of being moved intact, or virtually intact, for use in successive locations.

The second capital letter indicates the power range, as measured by design capacity for continuous operation: *V* (very low)—less than 100 kwe; *L* (low)—100 to 1,000 kwe; *M* (medium)—1,000 to 10,000 kwe; *H* (high)—10,000 kwe or more.

Arabic numerals indicate order in which plants having the same mobility and power characteristics are initiated. Where not followed by an additional letter, the designation indicates a prototype or pilot plant.

The last capital letter (when present) indicates alphabetical order in which field plants of a specific type are initiated.

[29] PM–2A will produce 1 million Btu per hour of space heat in addition to electrical output.

[30] SM–1A, formerly known as APPR–1A, will produce 38 million Btu per hour for space heat in addition to electrical output.

[31] All reactors in the naval propulsion program are of the pressurized-water type except the sodium-cooled system formerly installed in the *Seawolf*. Symbols in the type column indicate (1) the ship type for which the reactor is designed, (2) the sequence number of the plant design by the prime contractor for each ship type, and (3) the designator letter for the name of the contractor responsible for the design of the reactor plant. When appearing as the first letter of the symbol, *S* indicates submarine; *D*, destroyer; *C*, cruiser; and *A*, large surface ship. The prime-contractor designation letters are *W* for Westinghouse, *G* for General Electric, and *C* for Combustion Engineering.

[32] USS *Seawolf*, originally commissioned with a sodium-cooled reactor in March 1957 was recommissioned with a pressurized water reactor on September 30, 1960.

[33] SL–1 can produce 1.3 million Btu per hour of space heat in addition to electrical output; this additional output is now being dissipated through a heat dump. The plant is now being operated by Combustion Engineering.

[34] PM–1, formerly known as APPR–2, will produce 7 million Btu per hour of space heat in addition to electric output.

[35] This reactor (HTRE–1) was partially dismantled in 1957. It could be made operable again if desired, but there are no present plans to do so.

[36] The design of this reactor incorporates features making possible conversion to permit power take-off should this be desirable at a later date.

[37] This is the 1965 Geneva Conference reactor rebuilt with increased power and now operating at Wuerenlingen, Switzerland.

[38] This TRIGA reactor was operated at the 1958 International Conference in Geneva prior to shipment to the University of Lovanium. The reactor began operating at the University of Lovanium in June 1959. It is the first reactor to be operated on the African continent.

[39] This L–77 reactor was operated in the commercial exhibit of the 1958 International Conference in Geneva. It is presently in storage at Interatom, Inc.

[40] The Netherlands research reactor was originally operated at the Amsterdam International Exhibition in June 1957. It is now in storage at Delft Technical University.

[41] AGN201–111 was operated in the commercial exhibit of the 1958 International Conference in Geneva prior to transfer to the University of Geneva.

[42] This reactor was operated in the International Science Section of the Brussels International Exhibition, April 15 to October 1, 1958, prior to transfer to the University of Basel.

[43] Zero-power experiments of historical interest previously conducted in ANL facility cells include the Nautilus core design (ZPR–1), the Savannah River reactor design (ZPR–2), and a series of fast-neutron studies (ZPR–4) and interactions between two basic systems (ZPR–6).

[44] H&W cells 2 and 3 share a control panel with only one cell capable of being operated at any one time.

[45] The NDA facility is designed to accommodate two experiments but has a present capability of one.

[46] The cell has one control panel but two pots. Experiments may be operated in either pot, but not simultaneously.

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...CTORS UNDER ACTI

(*Supplen*

CIVILIAN PO

...ber of Projects for Quarter Ended 6/30/60	
1	CVT
2	Flori
3	Enri
4	Halla
5	Pathi
6	City
7	Elk I
8	Yank
9	Huml
10	Dresc
11	India
12	EBR-
13	EGC
14	Peacl
15	TUR
16	LAM
17	EBW
18	PWR
19	Saxto
20	EOCI
21	BONI
22	Big R
23	BORA
1	Plum
2	WTR-
3	JANU
- -	Argon
4	HWC
5	PRTR
6	SPER
7	SPER
1	Brookl
2	Jugger
3	Puerto

APPENDIX 13

Under Active Design or Construction June 30, 1959, and June 30, 1960

(Supplement to Tables 1, 2 and 3, Chapter I)

Civilian Power Prototypes and Experiments

No. of Projects for Year Ended 6/30/60	
1	CVTR (Carolinas-Virginia Tube Reactor).
2	Florida West Coast Nuclear Group.
3	Enrico Fermi—Power Reactor Development Co.
4	Hallam—Consumers Public Power District of Nebraska.
5	Pathfinder—Northern States Power Co.
6	City of Piqua.
7	Elk River—Rural Cooperative Power Association.
8	Yankee Atomic Electric Co.
9	Humboldt Bay—Pacific Gas and Electric Co.
10	Dresden—Commonwealth Edison Co.
11	Indian Point—Consolidated Edison Co.
12	EBR–2.
13	EGCR (Experimental Gas Cooled Reactor).
14	Peach Bottom—Philadelphia Electric Co.
15	TURRET.
16	LAMPRE–1.
17	EBWR Modifications.
18	PWR Modifications.
19	Saxton Nuclear Reactor Project.
20	EOCR (Experimental Organic Cooled Reactor).
21	BONUS—Puerto Rico Water Resources Authority.
22	Big Rock Point—Consumers Power Co.
23	BORAX–5 (Modification of BORAX–4).

Civilian Testing

1	Plum Brook—National Aeronautics Space Agency.
2	WTR—Westinghouse Testing Reactor.
3	JANUS (Biological Research Reactor—ANL).
--	Argonne Fast Source Reactor (At NRTS).
4	HWCTR—Heavy Water Components Test Reactor.
5	PRTR—Plutonium Recycle Test Reactor.
6	SPERT–2.
7	SPERT–4.

Civilian Research

1	Brookhaven High Flux Beam Research Reactor.
2	Juggernaut (ANL).
3	Puerto Rico Nuclear Center Research Reactor.

space heat in addition to electrical output.

[3] All reactors in the naval propulsion program are of the pressurized-water type except the sodium-cooled system formerly installed in the *Seawolf*. Symbols in the column indicate (1) the ship type for which the reactor is designed, (2) the sequence number of the plant design by the prime contractor for each ship type, and (3) the designator letter for the name of the contractor responsible for the design of the reactor plant.

[4] The NRA reactor ... capability of one.

[5] The cell has one control panel but two pots. Experiments may be operated in either pot, but not simultaneously.

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CIVILIAN RESEARCH—Continued

Number of Projects for Quarter Ended 6/30/59	Number of Projects for Quarter Ended 6/30/60	
4	4	Texas A & M Research Reactor.
5	5	Ohio State University Research Reactor.
6	6	University of Virginia Research Reactor.
7	--	Worcester Polytechnic Institute Research Reactor.
8	--	North Carolina State College Research Reactor.
9	7	University of California at Los Angeles.
10	8	University of Kansas Research Reactor.
11	9	University of Washington Research Reactor.
12	10	Walter Reed Medical Center.
13	--	Virginia Polytechnic Institute Reactor.
14	11	Washington State University Research Reactor.
15	12	Georgia Tech Research Reactor.
16	13	Union Carbide Research Reactor (Sterling Forest, N.
17	14	Cornell TRIGA Reactor.
18	--	Stanford University Research Reactor.
19	--	Iowa State University Research Reactor.
--	15	University of Missouri (School of Mines).
--	16	University of Buffalo.
--	17	University of Illinois.
--	18	High Flux Isotope Reactor (ORNL).
--	19	University of Wisconsin.
--	20	University of Maryland.
--	21	GDC Flair Facility (TRIGA MARK F).
--	22	Lockheed Nuclear Products Training Reactor.
--	23	Ames Laboratory Research Reactor.

MERCHANT SHIP PROPULSION

1	1	N.S. Savannah.

MILITARY PROTOTYPES, EXPERIMENTS, & FIELD PLANTS

1	1	Destroyer Reactor Prototype (D1G).
2	2	Mobile Low Power Plant (ML–1) (NRTS).
3	3	Portable Medium Power Plant (PM–1) (Sundance, Wyoming).
4	4	Portable Medium Power Plant (PM–2A) (Camp Century, Greenland).
5	--	Small Submarine Reactor Prototype (S1C).
6	5	Stationary Medium Power Plant (SM–1A) (Fort Greely, Alaska).
7	--	Gas Cooled Reactor Experiment (GCRE).

MILITARY TESTING

1	1	Nuclear Test Plant (Army-NRTS).
2	2	SERF—Sandia Engineering Reactor Facility (Army-DMA).
3	--	TSR–2—Tower Shielding Reactor No. 2 (ANP-ORNL, Oak Ridge).

5007050

MILITARY TESTING—Continued

Number of Projects for Quarter Ended 6/30/60	
3	NETR—Nuclear Engineering Test Reactor (USAF-Dayton, Ohio).
4	Materials Research Reactor (USA-Watertown Arsenal).
5	Ordnance Pulsed Experimental Research Assembly (USA).
6	SPRF—Sandia Pulsed Reactor Facility (AEC).

MATERIALS PRODUCTION

1	NPR—New Production Reactor (Hanford).

Projects are *added* to this tabulation:
1. For projects under the cooperative demonstration program, during the quarter in which a basis for arrangements is submitted to the JCAE.
2. For Government projects not subject to licensing and not subject to the submission of a basis for arrangements to the JCAE, during the quarter in which Title I work begins. (However, Government projects are not added prior to a decision to proceed with construction at a specific location even though design work may be underway.)

Projects are *dropped* from this tabulation in the quarter following the calendar quarter in which they first operate at design power.

Modifications to existing projects are included only when a substantial increase in the reactor output will result.

5007054

APPENDIX 14

STATUS OF AGREEMENTS FOR COOPERATION IN THE CIVIL USES OF ATOMIC ENERGY AND SPECIAL AGREEMENTS

Cumulative numbers countries	Agreements	Country	Scope of Exchange
1	1	Argentina	**Research
2	2	*Australia	Research and power
3	3	Austria	Research
4	4	*Belgium	**Research and power
5	5	Brazil	**Research
6	6	*Canada	**Research and Power
7	7	China, Republic of	**Research
8	8	Cuba	Research
9	9	Denmark	**Research
10	10	Dominican Republic	Research
11	11	Ecuador	Research
12	12	France	**Research and power
13	13	Germany, Federal Republic of	**Research and power
	14	West Berlin, city of	Research
14	15	Greece	**Research
15	16	Guatemala	Research
16	17	Indonesia	Research
17	18	Iran	Research
18	19	Ireland	Research
19	20	Israel	**Research
20	21	Italy	Research and power
21	22	Japan	**Research and power
22	23	Korea, Republic of	**Research
23	24	*Netherlands	**Research and power
24	25	New zealand	**Research
25	26	Nicaragua	Research
26	27	Norway	Research and power
27	28	Peru	Research
28	29	Philippines	**Research
29	30	Portugal	**Research
30	31	South Africa	Research and power
31	32	Spain	Research and power
32	33	Sweden	**Research
33	34	Switzerland	Research
	35	*Switzerland	**Power
34	36	Thailand	**Research
35	37	Turkey	Research
36	38	*United Kingdom	**Research and power
37	39	Uruguay	Research
38	40	Venezuela	Research and power
39	41	Viet-Nam	Research

SPECIAL AGREEMENTS

1. European Atomic Energy Community (EURATOM). — Joint Nuclear Power Program. — Feb
2. European Atomic Energy Community (EURATOM). — Additional Agreement — July
3. International Atomic Energy Agency (IAEA) — Supply of Materials, etc. — Aug

5007052

Mutual Defense Purposes Agreements

Australia	Aug. 14, 1957
Canada*	July 27, 1959
France	July 20, 1959
Germany, Federal Republic of*	July 27, 1959
Greece	Aug. 11, 1959
Netherlands*	July 27, 1959
Turkey*	July 27, 1959
United Kingdom*	Aug. 4, 1958
(Amendment to U.K. Agreement)*	July 20, 1959

Summary

In effect: 27 research and 14 power agreements with 39 countries and West [illegible] 8 Mutual Defense Purposes Agreements, and 3 special agreements (IAEA [illegible] EURATOM).

Signed and awaiting completion of ratification are research and/or power [illegible]ments with Brazil, Costa Rica, Cuba, Iraq, Peru, and Panama.

Classified agreements.

*denotes agreement has been amended.

5007053

APPENDIX 15

Foreign Reactors and Critical Assemblies Subject to U.S. Safeguards Including Those Expected to Go Critical in 1961 as of September 30, 1960

(62 REACTORS AND CRITICAL ASSEMBLIES IN 23 COUNTRIES)

Country	Facility name	Facility type	Site	Kilograms of material		Form	Percent enriched	Thermal	Reason for safeguards		
				Total element	Isotope				U.S. fuel	U.S. built	U.S. heavy water
Argentina [1]	RA-1	Argonaut	Buenos Aires	30.4	6.0	U_3O_8	20	10 KW	x		
Australia	HIFAR	Tank	Lucas Heights	5.4	4.9	U-Al Alloy [2]	90	10 MW			12 tons
Austria	ASTRA	Pool	Seibersdorf	6.4	5.7	Elements	90	5–12 MW	x	x	
(NC)		Triga MK II	Vienna	60.0	12.0	Elements (NS)	20	100 KW	x	x	
Belgium	BR-2	MTR	Mol	5.4	4.9	Elements	90	25 MW	x		
	BR-2 0	Core Mockup	Mol	4.9	4.4	Elements	90	50 KW	x		
	BR-3	PWR	Mol	2,277.0	91.0	Elements (NS)	4	40 MW	x	x	
Brazil		Pool	São Paulo	58.9	11.6	Elements	20	MW 5	x	x	
(NC)		Triga	Belo Horizonte	11.1	2.2	Elements (NS)	20	30 KW	x	x	
China, Republic of (NC)		Pool	Tsing Hua Univ.	20.0	4.0	Elements (NS)	20	1 MW	x	x	
[illegible]	TRIGA	Triga	[illegible]	10.0	2.0	Elements	20	10 KW	x	x	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Germany	FRM	Pool	Munich	24.9	4.9	Elements	20	1 MW	x	x	
	FRM	Pool	Munich	6.6	6.0	Elements	90	1 MW	x	x	
(NC)	SAR	Argonaut	Munich	30.2	6.0	Elements	20	10 KW	x		
	FR-2	Research	Karlsruhe			German Elements	Natural	12 MW			35 tons
	FR-2-0	CA	Karlsruhe			German Elements	Natural	0			9 tons
	FRF	Homogeneous	Frankfurt	9.1	1.8	UO_2SO_4	20	50 KW	x	x	
(NC)	FRB	Homogeneous	West Berlin	9.1	1.8	UO_2SO_4	20	50 KW	x	x	
		Homogeneous L–77	Duisburg			Display-No Fuel	20	10 W	x	x	
	FRH	Pool	Geesthacht	28.8	5.7	Elements	20	5 MW	x	x	
	RWE	Power	Kahl am Main	6,325.6	155.0	UO_2	2.5	60 MW	x	x	
		Argonaut	Grosswelzheim	37.7	7.4	U_3O_8	20	10 KW		x	
Greece		Sub-Critical	Athens	2,493.6		Elements	Natural	0	x		
(NC)		Pool	Athens								

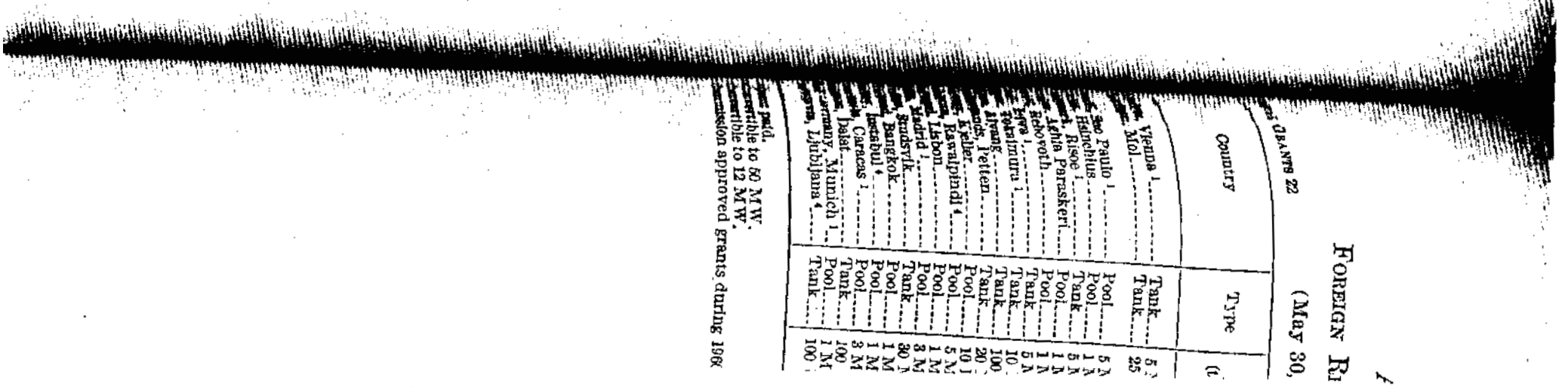
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Foreign Reactors and Critical Assemblies Subject to U.S. Safeguards Including Those Expected to Go Critical in 1961 as of September 30, 1960—Continued

(62 REACTORS AND CRITICAL ASSEMBLIES IN 23 COUNTRIES)—Continued

Country	Facility name	Facility type	Site	Kilograms of material		Form	Percent enriched	Thermal	Reason for safeguards		
				Total element	Isotope				U.S. fuel	U.S. built	U.S. heavy water
Norway	HBWR	Boiling Water	Halden	149.1	2.3	UO_2	1.5	5–10 MW	x		18 tons
Portugal (NC)		Pool	Sacavem	19.0	3.8	Elements (NS)	20	1 MW	x	x	
Spain	JEN-1	Pool	Moncloa	23.8	4.7	Elements	20	3 MW	x	x	
Sweden (NC)	R-2	Tank	Studsvik	7.1	6.4	Elements	90	30 MW	x	x	
(NC)	R-2-0	Tank	Studsvik	5.2	4.7	Elements	90	100 KW	x	x	
(NC)	R-2	Tank	Studsvik	2,131.1	32.0	UO_2	1.5	30 MW	x	x	
	R-3/ADAM	N.U	Stockholm			Swedish Fuel	Natural	125 MW			28 tons
Switzerland	SAPHIRE	Pool	Wurenlingen	30.6	5.9	Elements	20	1 MW	x	x	
(NC)	DIORIT	N.U	Wurenlingen			Non U.S	Natural	12 MW			18 tons
		AGN-201	Geneva	3.4	0.7	UO_2	20	20 W	x	x	
		AGN-211	Basel	4.0	0.8	UO_2	20	1 KW	x	x	
Turkey (NC)	ATATURK	Pool	KUCUK Cekmece	6.6	6.0	Elements (NS)	90	1	x	x	
Venezuela (NC)	RV-1	Pool	Caracas	24.7	4.9	Elements	20	3 MW	x	x	

[1] Has fuel fabrication facility which has processed or is processing U.S. supplied material.
[2] Material supplied for general research on fuel elements.
(NS) Not shipped.
(NC) Not critical.
CA Critical Assembly.



Foreign Re

(May 30,

Grants 22

Country	Type	
Vienna [1]	Tank	5
Mol	Tank	25
Sao Paulo [1]	Pool	5 M
	Pool	1 M
Halmstad	Tank	1 M
Risø [1]	Pool	5 M
Lahti Parasker	Pool	1 M
	Pool	1 M
Rehovoth	Tank	1 M
Ispra [1]	Tank	5 M
Trawsfynydd [1]	Tank	10
Harwell	Tank	100
Argonne	Tank	20
Idaho, Petten	Pool	10 I
	Pool	5 M
Keller	Pool	1 M
Rawalpindi [4]	Pool	1 M
	Pool	1 M
Lisbon	Pool	1 M
Madrid [1]	Pool	1 M
Studsvik	Tank	30 M
	Pool	1 M
Bangkok	Pool	1 M
Istanbul [4]	Pool	1 M
	Pool	1 M
Caracas [1]	Pool	3 M
Dalat	Tank	100
	Pool	1 M
Munich [1]	Pool	1 M
Germany, Ljubljana [4]	Tank	100

paid.
ertible to 50 MW.
ertible to 12 MW.
mission approved grants during 196

APPENDIX 16

Foreign Research Reactor Grants

(May 30, 1956–December 31, 1960)

Country	Type	Power (thermal)	Manufacturer	Estimated project cost (millions)
[illegible] [1]	Tank	5 MW [2]	American Machine and Foundry	$4.0
[illegible], Mol	Tank	25 MW [3]	Centre d'Etudes de l'Energie Nucleaire, Nuclear Development Associates.	10.01
[illegible] Paulo [1]	Pool	5 MW	Babcock and Wilcox	1.3
[illegible]	Pool	1 MW	International General Electric	1.0
[illegible], Risø [1]	Tank	5 MW	Foster-Wheeler	1.4
[illegible] Paraskeri	Pool	1 MW	American Machine and Foundry	1.3
[illegible]	Pool	1 MW	American Machine and Foundry	1.4
[illegible] [1]	Tank	5 MW	American Car and Foundry	3.6
[illegible]	Tank	10 MW	American Machine and Foundry	1.5
[illegible]	Tank	100 KW	General Atomic	1.1
[illegible], Petten	Tank	20 MW	American Car and Foundry	3.9
[illegible]	Pool	10 KW	Norstom	0.8
[illegible], Rawalpindi [4]	Pool	5 MW	American Machine and Foundry	3.5
[illegible], Lisbon	Pool	1 MW	American Machine and Foundry	1.0
[illegible], Madrid [1]	Pool	3 MW	International General Electric	1.0
[illegible], Stockholm	Tank	30 MW	American Car and Foundry	4.3
[illegible], Bangkok	Pool	1 MW	Curtiss-Wright	0.82
[illegible], Istanbul [4]	Pool	1 MW	American Machine and Foundry	2.88
[illegible], Caracas [1]	Pool	3 MW	International General Electric	5.0
[illegible], Izmir	Tank	100 MW	General Atomic	0.75
[illegible], Munich [1]	Pool	1 MW	American Machine and Foundry	3.1
[illegible], Ljubljana [4]	Tank	100 KW	General Dynamics	0.812

[illegible] paid.
[illegible] to 50 MW.
[illegible] to 12 MW.
[illegible] approved grants during 1960.

[1] Has fuel fabrication facility which has processed or is processing U.S. supplied material.
[2] Material supplied for general research on fuel elements.
(NS) Not shipped.
(NC) Not critical.
CA Critical Assembly.

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APPENDIX 17

Materials Shipments to Foreign Countries

January 1960–November 1960 [1]

Date	Country	Uranium		Other materials	Type of transaction	Purpose
		Kg U-235	Percent enrich. U-235			
Jan. 11, 1960	Sweden	0.072	90		Sale	Research
Jan. 11, 1960	Sweden			62 Gm Pu	Sale	Research
Jan. 12, 1960	Switzerland	0.059	20		Sale	Research
Jan. 21, 1960	Germany	(*)	20		Sale	Research
Jan. 22, 1960	Sweden	5.335	89.61		Lease	Fiss. Chamber
Feb. 9, 1960	Israel			160 Gm Pu	Sale	Fuel R-2
Feb. 11, 1960	Israel	(*)	90		Sale	Nelli Rabi
Feb. 16, 1960	Sweden	0.746	89.61		Lease	Fiss. Chamber
Feb. 17, 1960	Israel	6.545	89.62		Lease	Fuel R-2
Feb. 26, 1960	France	0.179	20		Lease	Fuel Element
Feb. 26, 1960	Italy	5.899	89.61		Lease	Fuel Measure
Mar. 1, 1960	United Kingdom			*lbs D_2O	Sale	Fuel Irrad.
Mar. 4, 1960	Brazil	67.0	Normal		Sale	U.K.
Mar. 7, 1960	Canada	(2.242)	90		Lease	Research
Mar. 7, 1960	Canada	(1.497)	90			Return for Reprocessing
Mar. 8, 1960	Sweden	(*)	90		Lease	Nuclear Lab.
Mar. 14, 1960	Egypt	3.387	90		Lease	Fiss. Counter
Mar. 18, 1960	Canada	4.490	90			U.S. Exhibit
Mar. 21, 1960	Brazil	(*)	20		Lease	NRX Reactor
Mar. 23, 1960	Belgium	0.736	90		Lease	Fission Counter for Sur. Pu
Mar. 25, 1960	Greece			2493 Kg Norm	Sale	Fuel Blk.
Mar. 28, 1960	Egypt	(*)	90			Sub-critical Assembly
Mar. 28, 1960	Egypt			16 Gm Pu		U.S. Exhibit
Mar. 29, 1960	Spain	(*)	20		Sale	U.S. Exhibit
Mar. 29, 1960	Sweden	31.639	1.5		Sale	Fiss. Counter
Mar. 30, 1960	Netherlands	(*)	90		Sale	Research Lab
Mar. 31, 1960	Israel	(*)	90		Sale	Fiss. Counter
Apr. 1, 1960	France			8.5 Bm U-233	Sale	Fiss. Counter
Apr. 4, 1960	Italy			10 Gm Pu	Sale	Research
Apr. 5, 1960	Netherlands	(*)	90		Sale	Research
Apr. 11, 1960	Japan			3.5 T D_2O	Sale	Fiss. Counter
Apr. 21, 1960	Germany			50 Mg Np 237	Sale	Research
Apr. 21, 1960	Germany			50 Mg Am 241	Sale	Research
Apr. 22, 1960	Netherlands			80 Gm Pu	Sale	Research
Apr. 26, 1960	Belgium	0.300	90		Sale	Res. U. of Ind.
Apr. 26, 1960	Belgium			10 Kg Depl. U	Sale	Research
May 6, 1960	United Kingdom			9.8 Kg Depl U	Sale	Research
May 10, 1960	Denmark	0.014	90		Sale	UK AEA
May 17, 1960	Sweden	0.291	89.63		Lease	Research
June 2, 1960	Denmark	6.506	90		Lease	Fuel R-2
June 2, 1960	Italy	0.197	89.62		Lease	Fuel Elem.
June 6, 1960	France				Lease	Fuel Irrad.
June 8, 1960	Austria			18 T. D_2O	Lease	Aquilon II
June 21, 1960	India			998 lbs D_2O	Sale	Research
June 21, 1960	Netherlands			499 lbs D_2O	Lease	Trombay Reactor
June 23, 1960	Venezuela	4.724	89.74		Lease	Fuel Pellet
June 23, 1960	Venezuela	4.914	19.92		Lease	Fuel Canning
June 23, 1960	Venezuela	(*)	90		Lease	Fiss. Chamber
July 1, 1960	Israel	(*)	90		Lease	Fiss. Chamber
July 6, 1960	Sweden	(*)	89.61		Sale	Research
July 8, 1960	Germany	2.337	89.65		Lease	Fuel R-2
July 8, 1960	Germany	83.874	2.33		Sale	Kahl Reactor
July 11, 1960	Canada	71.153	2.61		Sale	Kahl Reactor
July 13, 1960	Sweden	0.004	90.0		Lease	U Al Stac
July 15, 1960	Australia	2.323	89.69		Lease	Fuel R-2
July 25, 1960	Belgium			20 Gm Pu	Sale	Research
July 27, 1960	France	0.046	20	7 Kg Norm U	Sale	Research
July 28, 1960	Canada	4.881	6.89		Sale	Research
July 28, 1960	Canada	(0.076)	90		Sale	Research
July 31, 1960	Germany	7.441	19.76		Lease	Return
Aug. 9, 1960	France			50-Mg AM-241	Lease	Argonaut Stor. RWE
					Sale	Research

See footnotes at end of table.

5007058

MATERIALS SHIPMENTS TO FOREIGN COUNTRIES—Continued

January 1960–November 1960 [1]—Continued

Country	Uranium		Other materials	Type of transaction	Purpose and remarks
	Kg U-235	Percent enrich. U-235			
Japan	3.405	19.89			
Austria			112 Gm Pu	Sale	Fuel JRR-2.
Germany	5.954	89.94		Lease	Research.
Israel			5 Gm Pu	Lease	Munich Reac.
China	(*)	90		Sale	Research.
Australia			100 Mg NP-237	Sale	Fission Counter.
Austria	5.734	89.72		Sale	Research.
Austria	(*)	90		Lease	Res. Reactor.
France	1.047	20		Sale	Fission Counters.
Portugal	(*)	20		Sale	Research.
France	31.929	1.6		Sale	Fission Counter.
France				Lease	Fuel EL-3.
Belgium			*Deplu	Sale	Research.
United Kingdom	9.091	90	42 Mg AM-241	Sale	Fission Counter.
United Kingdom	(*)	90		Sale	Fuel.
Belgium				Sale	Fission Counters.
France			50 Mg AM-241	Sale	Research.
Germany			500 Mg AM-241	Sale	Research.
Netherlands			2T D_2O	Lease	Exp. Argonaut.
			1300 Kg Norm	Lease	Sub Critical Assembly.
Spain	9.238	20			
Brazil			2494 Norm	Lease	Fuel Argonaut.
				Sale	Sub Critical Assembly.
Brazil			20 Mg NP-237	Sale	Research.
Brazil			1 Mg AM-241	Sale	Research.
Italy			1 Gm U-233	Sale	Research.
United Kingdom	(*)		0.8 Kg Norm. U	Sale	UO_2 Samples Harwell.
Brazil	2.197	19.81		Lease	Belo Horizonte.
Brazil	(*)	20		Lease	Fission Counter.
Norway			0.5 T D_2O	Sale	Belo Horizonte.
Italy			200 Mg. Np-237	Sale	Halden Reactor.
United Kingdom			1.0 Kg Norm. U	Sale	Research.
Australia			16 Gm Pu	Sale	UO_2 Harwell.
Australia	0.002	90		Sale	Research.
Belgium			50 Mg Am-241	Sale	Fiss. Counter.
Norway			12,475 lbs D_2O	Sale	Research.
Japan	15.145	20		Sale	Physics Study.
Korea	2.500	20		Lease	Fuel Element.
Korea	0.003	90		Lease	Fuel Element.
Switzerland			10 Gm Pu	Sale	Fiss. Counter.
Australia			16 Gm Pu	Sale	Research.
Israel			16 Gm Pu	Sale	Research.
France			497 Gm Pu	Sale	Research.
France			7 Gm U-233	Sale	(Rapsody).
				Sale	Research.

[1] For shipment data see p. 282, Twenty-fifth Semiannual Report (July–December 1958), pp. 44–45, Twenty-fourth Semiannual Report (January–June 1958, and pp. 576–578, Annual Report for 1959.

* Less than reportable quantity of the reporting unit involved.

0007059

APPENDIX 18

COMMISSION COMMUNICATION ON COMMERCIAL-INDUSTRIAL ACTIVITIES OF THE GOVERNMENT PROVIDING PRODUCTS OR SERVICES FOR GOVERNMENTAL USE

February 10, 19[illegible]

Chamber of Commerce of the United States
Committee on Commercial Uses of Atomic Energy
Attention: Jack H. Abernathy, Chairman

National Association of Manufacturers
Nuclear Energy Committee
Attention: J. F. Fairman, Chairman

Manufacturing Chemists' Association, Inc.
Attention: R. C. Johnson

Gentlemen:

Your letters which submitted examples of Commission activities which [illegible] believe may constitute competition with industry within the meaning of [illegible] Bulletin 60-2 cover to a great extent the same activities. For this [illegible] single reply seems appropriate.

In carrying out its statutory responsibility to encourage widespread [illegible] atomic energy in such a manner as to strengthen free competition in [illegible] enterprise, the Commission has maintained a firm policy to procure goods [illegible] services from private industry wherever practical. From inception the Commission has turned to private industry to construct for the Government [illegible] major facilities required for the production of fissionable materials and [illegible] the comprehensive research and development program contemplated by the Atomic Energy Act. Government ownership of such facilities was found [illegible] essential, since no reasonable way could be found to provide adequate incentive for private ownership of such specialized and costly facilities.

Further, as a means of utilizing and expanding the skills of the entire national economy and to take advantage of "knowhow" and proven [illegible] experience, the Commission engaged industrial companies and educational institutions to operate and manage these facilities.

The continued use of existing Government facilities is clearly necessary in the public interest for the production of fissionable materials, the assembly of weapons, and the conduct of most advanced research and development. The facilities and skills of private industry are and will be employed when they are adequate to carry out specific activities in the military and peaceful applications of atomic energy at the rate required to attain our national objectives. It should be emphasized, however, that the Commission must exercise care in discontinuing a specific activity to assure that related activities which are closely integrated do not unduly suffer in development, cost or efficiency by reason of the divorcement.

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...new industry, the tempo of technological developments in many in... does not permit establishing precise specifications or assure a volume of ...orders necessary to attract the investment of private capital in the ...ired facilities, equipment, and personnel required. Consequently, there ...main areas of the Commission's work where it is premature to expect ...h work can be procured from private industry on a competitive basis. ...reover, we have a responsibility to avoid the concentration of services ...a single source of supply, particularly under circumstances where such ...ration might constitute a preemption of the market which would dis... widespread participation in the uses of atomic energy.

...recognize that as the atomic energy industry grows there will be areas ...ivity appropriate for transfer from Government to private operation. ...products and services formerly provided exclusively in Government ...are now procured commercially, major examples being fabricated ...shapes, hafnium and zirconium products, uranium hexafluoride, and ...ments for many non-production reactors. It is Commission policy to con... with private firms for the performance of Title I and Title II engineering of ...clear and non-nuclear portions of the plant unless the nature of the work ...circumstances clearly dictate otherwise. Also, it is Commission policy, ...ed in 1956, that the Commission will cease to provide any service or ...to the public whenever such service or product can be provided under ...able terms by private industry.

...examples presented in your letters are concerned, in large measure, with ...activities within a production or research and development complex. ...these activities have been carefully studied over a period of years for ...ity of separate contracting. A major reason for contracting with in... concerns was to have our facilities operated in accordance with sound ...proven business practices. Such business practices include procuring ...services from specialized concerns wherever such concerns can satis... furnish the product required and when to do so is sensible, economical, ...sistent with the efficiency of integrated operations.

...cal example of the practices applied is contained in the following state... policy of one of our major industrial contractors:

...determination of the method by which these services will be performed ...in accordance with normal private industrial criteria, modified to the ...necessary to comply with existing AEC directives and applicable ...law.

...criteria include, but are not necessarily limited to, the following:

...ts: By what method and by whom can the service be performed at ...least possible cost?

...tionship to the Manufacturing Process:* How dependent is the process ...the service being studied? Would an interruption in the service ...have a serious detrimental effect on the process?

...ability from Commercial Sources:* Is the service available com... mercially at a competitive price? Is there sufficient productive capacity ...commercial sources to assure delivery of needed quantities? Is the ...graphical location of the source or sources an advantage or dis...vantage?

...e of Work:* Is the volume sufficient to make it feasible for contract ...g?

...DUSTRIAL ACTIVITIES ...ERVICES FOR GOVER...

February 16, 19...

...ssion activities which ... ...hin the meaning of ... ...vities. For this reason, ...

...courage widespread ... ...free competition in ... ...olicy to procure goods ...

From inception the ... ...ct for the Government ... ...ssionable materials and ... ...gram contemplated by ... ...h facilities was found ... ...provide adequate ... ...facilities.

...; the skills of the entire ... ...whow" and proven ... ...companies and ...

...ties is clearly necessary ... ...materials, the ... ...earch and development ... ...ill be employed when ... ...tary and peaceful ... ...our national objectives ... ...sion must exercise care ... ...ed activities which are ... ...cost or efficiency by ...

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"5. *Security Requirements:* What effect do the related security requir... if any, have on the method of performing the service?

"6. *Developmental Aspects:* Is the design of the material or service ... ciently clear so that it is possible to contract without excessive ...

"7. *Contamination:* Is the material contaminated above limits which ... released to commercial sources?"

As applied to the Commission's operations, such typical business criteria ... supplemented as applicable by other Government criteria such as those ... in the recent Budget Bulletin 60–2. Such supplementation provides, for ex... that the elements of cost as provided for in Budget Bulletin ... considered in making comparisons between the cost of providing service ... the Government-owned plant and the cost of procurement from commer... sources. Furthermore, our contractors are specifically advised of acti... where it is Commission policy to subcontract to private industry. It is ... practice to make surveys and appraisals of operations at Government-... installations to review the continued application of these criteria. By effe... application of such criteria, evidenced by thousands of contract actions a... for research, engineering, construction, equipment, and supplies, a wide ... of enterprise in the atomic energy industry is being developed.

For each of the activities cited as examples in your letters, we have pre... comments which are attached. Many of the examples are in areas of fu... activities in which we look forward to either initial or increasingly gre... industrial participation on a commercial basis, while others generally fal... the following categories:

1. Activities where industry is already engaged in the normal conduct o... work.
2. Activities which are closely integrated with plant operation and in ... ance with accepted industry practice should remain integrated.
3. Activities which are in such a fundamental stage of development that ... coordinated use of the skill and facilities at Government-owned ... lations is still required.
4. Activities where large volume is dependent upon military requirements ... where extremely large plant investments have already been made ... the Government, or where the volume of activity is so small, sporadic ... and non-standardized as to make it impractical or uneconomical to ... tract for separately.
5. Activities for which there is no known competitive commercial ...

We trust that this letter and our attached comments on the examples ... have cited will provide a better understanding of the Commission's policy ... practice regarding the utilization of private enterprise in fulfilling its ... sibilities under the Atomic Energy Act. We will continue to examine commer... industrial activities of the Commission in the light of the growing capa... in the private atomic energy industry. For this purpose we will welcome ... any time expressions from industry of their capability to provide addi... services and products through ordinary business channels.

Attachment:
(As stated)

Sincerely yours,
JOHN F. FLOOD
Acting Chair...

ATTACHMENT TO THE
MERCE OF THE UN
CHEMISTS' ASSOCIA
of MANUFACTURERS

...ments on AEC activ
within the scope

FUEL ELEMENT DEVELO

...vital part of any re...
...ss or failure of a ...
...or depends strongly ...
...stitutes a suitable fuel ...
...zero power reactor ...
...the fuel are of control ...
...very little interest. O...
...up reactor must hav...
...must be tailored to ...
...ature. In the contin...
...the same experimental ...
...used only once. Th...
...lopment of suitable fu...
...and cladding materi...
...thermal properties, ...
...ing, and development ...
...g.

This program is so broa...
...atories and operating ...
...am is being conduct...
...h 13, 1959, contracts ...
...on were awarded to 18 ...
...side of purely exper...
...other development w...
...element manufacturin...
...ford and Savannah ...
...procure reactor mate...
...ities, skills and experi...
...ble can be met. In ...
...end-items containing ...
...aterials and fabricati...
...rements has increased ...
...ore of the requireme...
...illustrate the extent t...
...ssed, there follows a ...
...bed to all sources o...
...tion furnished in the ...
...g additional processi...

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ATTACHMENT TO THE COMMISSION'S REPLY TO THE CHAMBER OF COMMERCE OF THE UNITED STATES (C OF C), THE MANUFACTURING CHEMISTS' ASSOCIATION (MCA), AND THE NATIONAL ASSOCIATION OF MANUFACTURERS (NAM)

Comments on AEC activities cited as examples of competition with industry within the scope of Bureau of the Budget Bulletin No. 60–2

FUEL ELEMENT DEVELOPMENT AND FABRICATION

...ntial part of any reactor is the fuel element with which it operates; the ...ess or failure of a particular reactor experiment, prototype, or power ... depends strongly upon whether a suitable fuel is available. Just what ...stitutes a suitable fuel depends upon the purpose of the experiment. Thus, ...ero power reactor the composition, weight, dimensions, and uniformity ... fuel are of controlling importance; resistance to irradiation damage is ... little interest. On the other hand, fuel for a high temperature, high ... reactor must have a high degree of irradiation stability. Thus, the ... must be tailored to fit the experiment. The fuel itself is experimental ...ture. In the continuing effort to improve the fuel, successive loadings ... same experimental reactor are usually different, each type of loading ...ed only once. The Commission carries on an extensive program in the ...ment of suitable fuel elements; this work included the development of ... cladding materials, the determination of their physical, mechanical ...rmal properties, and their behavior under irradiation and thermal ... and development of methods of melting, casting, fabrication and ...

... program is so broad that it involves not only most of the Commission's ...ries and operating contractors but also a very large portion of the ... is being conducted by commercial firms. In an action announced ... 13, 1959, contracts with contemplated expenditures totaling over $25 ... were awarded to 18 firms.

... of purely experimental tasks which must be closely coordinated ...her development work, it is the Commission's general policy to obtain ...ment manufacturing services, other than for the production reactors ...ford and Savannah River, from commercial sources. Our general policy ...cure reactor materials from commercial suppliers whenever adequate ... skills and experience exist in commercial laboratories and the time ... can be met. In addition, whenever it is feasible, we are now pro- ...ed-items containing nuclear materials rather than separately procur- ...erials and fabrication. The ability of industry to produce according to ...ments has increased very appreciably in the last 5 years or so and more ... of the requirements are being met from industrial sources.

...strate the extent to which procurement from commercial sources has ..., there follows a tabulation of the enriched uranium which has been ... to all sources outside the weapon's production chain, showing the ... furnished in the form of UF_6 compared to that furnished in a form ... additional processing in AEC facilities:

Sincerely yours,

JOHN F. FLOURNOY
Acting Chairman

5007063

Fiscal year	Total (kg)	Furnished in form other than UF_6		Furnished as UF_6	
		kg	Percent of total	kg	Percent of total
1958	45,000	21,000	47	24,000	
1959	116,500	6,500	6	110,000	
1960 (5 months through Nov. 30, 1959)	42,500	1,500	4	41,000	

Comments on specific cases mentioned in the letters follow:

Experimental Gas Cooled Reactor

CofC VI—1—"Enriched uranium and/or pellets for the Gas Cooled Re... Project at the Oak Ridge National Laboratory."

MCA–5—"Enriched uranium oxide and/or pellets for the Gas Cooled Re... Project at O.R.N.L."

NAM–A1b—"Supply of enriched uranium oxide, pellets, or metal for Gas Co... Reactor Project; . . ."

Oak Ridge National Laboratory (ORNL) is currently preparing the ... and specifications for the fuel element and materials so that the core loading ... be procured from industrial sources following normal procurement pract... In the development of this element, ORNL has attempted to procure fro... dustrial sources enriched UO_2 and/or UO_2 pellets which meet its specifica... Experience to date has been disappointing in that ORNL has been unable ... obtain the necessary quantities of acceptable materials. The yields have ... disappointingly low, the schedules have had to be changed at the conve... of suppliers, and in all cases ORNL has obtained the pellets it required ... by relaxing the specification.

Process Heat Reactor

CofC I–2—"The conversion and fabrication of fuel elements for the Pro... Heat Reactor project to be built at Point Lomas, San Diego, California."

MCA–4—"Conversion and fabrication of fuel elements for the Process ... Reactor project to be built at Point Lomas, San Diego, California."

NAM–A1a—"Conversion from UF_6 . . . for Process Heat Reactor to be ... at Point Lomas, California."

The invitation to reactor manufacturers to supply the reactor and ... primary system components included all of the internals and the reactor ... with 14 percent spares. This invitation was issued in October 1959, and a ... number of proposals from manufacturers had been received and were ... evaluated when the letters to which this reply is addressed were received. ... of the fixed price proposals received contemplate commercial supply of ... fuel elements by the selected proposer. The Commission is supplying UF... other services will be obtained commercially.

Bulk Shielding Reactor and Low Intensity Test Reactor

CofC I–1—"The Oak Ridge National Laboratory makes the fuel elements ... most of its reactors. Examples include the bulk shielding reactor and ... LITR."

...rivate sources of supp... ...LITR and BSR are n... ...elements, based on d... ...llowing average yearly ... ...number of replacemer... ...reactors operate. (T... ...LITR at 3 megawatts). S... ...assemblies, about 25 ... ...tandard. Dies and fixtu... ...small number require...

...terials Testing Reactor

...CA–7—"Supply of enriche...

...AM–A1b—"Supply of enri... ...daho, Idaho. . . ."

...The original MTR fuel ... ...ailability of commercial ... ...core for an AEC reacto... ...all cores have been fab...

...TR

...Replacement quantity 1*

...Replacement quantity 2*

...Replacement quantity 3*

...TR

...Original quantity, Babco

...Replacement quantity 1*

...While the Government furn... ...viously cited indicate the ... ...services from commerci... ...No. 3) the invitation r... ...cially procured metal or ... ...the Government metal w... ...dance with BOB Circula...

...lear Rocket Program—Pr...

...C I–3—"The conversion a... ...rocket program (Project Ro...

...A–6—"Conversion and fa... ...rocket program at Livermor...

...M–A1a—"Conversion from ...clear rocket program at L... ...sponsibility for all resea... ...ts (Project Rover) is a ...ched uranium metal for ... ...tained at Los Alamos for ... ...is performed in the same ... ...echniques is carried on f... ...latively small proportio...

...year's supply.

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...rate sources of supply for procurement of replacement fuel elements for ...LTR and BSR are not used for the following reasons: The demand for ... elements, based on data accumulated during the past 5 years, indicates the ...ing average yearly requirements: LITR, 15 elements; BSR, 5 elements. ... number of replacement elements is low because of the low power at which ... reactors operate. (The BSR operates from zero to 100 kilowatts and the ...s at 3 megawatts). Since the BSR and LITR are used to test experimental ... assemblies, about 25 percent of the replacement fuel elements are not ...ard. Dies and fixtures are available for these specific elements so that ... small number required can be produced by laboratory staff as "fill-in"

...ials Testing Reactor and Engineering Test Reactor*

...-7—"Supply of enriched uranium for ETR and MTR fuel elements."

...-41b—"Supply of enriched uranium . . . metal for . . . ETR and MTR at ... Idaho. . . ."

... original MTR fuel elements were fabricated at Oak Ridge prior to ...bility of commercial sources. The first MTR replacement also was the ...se for an AEC reactor to be obtained from a commercial fabricator. Since ... cores have been fabricated commercially:

...lacement quantity 1*, Babcock and Wilcox.
...placement quantity 2*, Clevite.
...lacement quantity 3*, General Electric.

...iginal quantity, Babcock and Wilcox.
...lacement quantity 1*, General Electric.

... the Government furnished metal in each of these cases, the statistics ...ly cited indicate the effectiveness of AEC'S efforts to obtain the proces- ...rvices from commercial sources. In the most recent case (MTR replace- ... No. 3) the invitation requested proposals on both bases (i.e., use of com- ...ly procured metal or use of Government-furnished metal). The decision ... Government metal was based on the price differential analyzed in ac- ...ce with BOB Circular 57–7 (the predecessor to BOB Circular 60–2).

...e Rocket Program—Project Rover*

...-5—"The conversion and fabrication of the fuel elements for the nuclear- ...e program (Project Rover)."

...-5—"Conversion and fabrication of fuel elements for the AEC's nuclear ...e program at Livermore."

...-11—"Conversion from UF_6 and fabrication of fuel elements for AEC ...e rocket program at Livermore; . . ."

...sibility for all research and development for the nuclear propulsion of ... Project Rover) is assigned to the Los Alamos Scientific Laboratory. ... uranium metal for Rover fuel elements is drawn from the inventory ...ed at Los Alamos for the weapons program, and fuel element fabrication ...erformed in the same facility in which development of uranium fabrica- ...iques is carried on for the weapons program. The material for Rover ...rely small proportion of the amount fabricated in that facility.

...r's supply.

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At present, every Rover reactor is different. Fuel elements requirements and technology are still in development, and cannot yet be described by definite and inclusive specifications. In view of the frequent and last-minute changes in design details and characteristics to be sought, fuel element fabrication for the current, research-type Rover systems must continue as an activity performed directly by the Los Alamos Scientific Laboratory.

At later stages when there are repetitive tests of a single design, the degree of standardization may permit commercial procurement of both the conversion and fabrication of uranium for Rover fuel elements.

Naval Reactors

CofC III–1—"Conversion of enriched . . . uranium from UF_6 as required in the 'Nuclear Navy' for metal, alloys or uranium compounds."

MCA–1—"Conversion of all enriched uranium from UF_6 as required in the 'Nuclear Navy' for metal, alloys or uranium compounds."

NAM–A1b—"Supply of . . . all uranium alloys or compounds for the 'Nuclear Navy'."

Practically all of the highly enriched uranium utilized in these cores is obtained from scrap metal in the form of trimmings left from material utilized in the weapons program. These trimmings are chopped into small pieces and shipped to the core manufacturer who performs all further processing and fabrication operations involved in the manufacture of the fuel elements.

There are now five private companies supplying reactor cores for the Naval Reactors program on a fixed price, competitive basis.

Through calendar year 1959, contracts totalling approximately $200,000,000 have been awarded to private industry for fuel fabrication.

These companies now manufacture all reactor cores for the Naval Reactors program with the exception of some first reactor cores of a type which are of a highly developmental nature. However, many of the parts, even for these first developmental cores, are manufactured by private industry rather than by the Commission's Bettis and Knolls Atomic Power Laboratories. In this connection it is also significant that a substantial portion of these parts for developmental cores which are subcontracted to private industry are in themselves of a developmental nature. This type of subcontracting from the Bettis and Knolls Atomic Power Laboratories to private industry has been increasing, commensurate with industry's capability to handle such work. Thus, the fuel fabrication work that remains in these Laboratories is only that which is of a highly developmental nature and pertains specifically to the first core of a new design being developed at the Laboratory.

Subcritical Training Reactors

MCA–12—"Conversion and fabrication of uranium elements required for subcritical training reactors for educational institutions."

NAM–A1a—"Conversion from UF_6 and fabrication of fuel elements . . . for subcritical training reactors. . ."

Educational institutions, as of January 1960, possess or are planning to acquire 2 enriched uranium and 84 natural uranium subcritical training reactors. The enriched fuel is furnished by the AEC without charge to the institutions. The enriched fuel is fabricated commercially and the natural uranium fuel is furnished by the AEC from its supply of reject slugs at Savannah River. It is anticipated

C

...s the next several years ...e subcriticals per year. ... since these are vital to ...overnment must rely fo... ...le to provide the facili... ...an benefit. Use of mate... ...ations is a suitable and ...aining program.

...uclear Ramjet Project

...fC VI–2—"Enriched u...

...On the original order f... ...D was performed by th... ...this job on the basis o... ...nique and stringent chen... ...source other than the ...ected to perform this ...eptable cost. It is an ...F, and the fabrication i... ...ding that commercial ca... ...es and upon the required

...ero and Hallam Reactor...

...A–13—"Production of ...eactors."

Present plans for both ...el conversion will be don... ...mics International, the ...In both cases arrangement...

...ctory Water Components ...

...A 11—"Production of u... ...uilt at Savannah River."

...C 14—"Savannah Rive... ...ncludes the conversion ... ...eavy water test reactor ...

...M–A1a—"Conversion fr... ...ater components test re... ...The driver and fuel ele... ...the Savannah River pl... ...cilities, Nuclear Metals, ...contract for this work ...suring concerns which ...ing tubular metallic f... ...number required res... ...as indicated, however ...quired, industry woul... ...HWCTR fuel elements ...development work ...

5007066

the next several years educational institutions will require approximately 25
doctoricals per year.
since these are vital to the educational programs on which both industry and
government must rely for new trainees for this expanding industry, it is desir-
able to provide the facilities so that the greatest number of training programs
may benefit. Use of material which does not meet the production reactor speci-
fications is a suitable and economical means of increasing the effectiveness of the
training program.

Nuclear Ramjet Project

VI-2—"Enriched uranium for the Nuclear Ramjet Project."

As the original order for fuel for the Tory II A, the conversion from UF_6 to
UO_2 was performed by the Commission's Oak Ridge Y–12 plant. Y–12 was used
for this job on the basis of a technical evaluation of capability. Because of the
volume and stringent chemical specifications for the U_3O_8 it was determined that
any source other than the highly experienced Y–12 plant could be reasonably
expected to perform this conversion job on the required schedule and at an
acceptable cost. It is anticipated that future requirements for conversion of
UO_2 and the fabrication into fuel materials will be obtained commercially, pro-
vided that commercial capability exists to provide these services at reasonable
costs and upon the required schedules.

Piqua and Hallam Reactors

A-13—"Production of enriched uranium metal for the Piqua and Hallam
reactors."

Present plans for both the Piqua and Hallam reactor projects are that the
conversion will be done commercially. Fabrication in both cases will be by
Atomics International, the AEC prime contractor for construction of the reactor.
In both cases arrangements have not yet been completed.

Heavy Water Components Test Reactor

11—"Production of uranium for heavy water component test reactor being
built at Savannah River."

14—"Savannah River is also doing fuel element development work. This
includes the conversion and fabrication of fuel elements for the fuel element
for heavy water test reactor being built at Savannah River."

A-14a—"Conversion from the UF_6 and fabrication of fuel elements for heavy
water components test reactor at Savannah River."

The driver and fuel elements for the HWCTR are not being manufactured
at the Savannah River plant. This work is being carried out in commercial
plants. Nuclear Metals, Inc., Concord, Mass., under a du Pont subcontract.
The contract for this work was awarded after a survey of 6 fuel element man-
ufacturing concerns which appeared to have the experience and facilities for
producing tubular metallic fuel elements. In the case of the driver tubes, the
large number required resulted in little interest by industry in this operation.
It was indicated, however, that should significantly larger numbers of tubes
be required, industry would be interested in submitting bids. In the case of
the HWCTR fuel elements, these are still in the development stage. Consid-
erable development work and testing are required before establishing a firm

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design for this element. Nuclear Metals has been engaged to do much of t
development work and to supply the necessary test elements during the d
opment period.

Savannah River and Hanford Production Reactors

CofC I-4—"The Savannah River site makes some fuel elements for its reac
Savannah River is also doing fuel element development work."
CofC I-5—"Fuel elements for the Hanford site are fabricated in Govern
facilities."

The manufacture of fuel elements for production reactors has been a
lished in Government-owned facilities operated by industrial contractors
the intiation of production activities during World War II. As the AEC
gram expanded, additional capability was provided to meet the increas
quirements. The current operating facilities at Fernald and Weldon S
represent a Government investment of about $165 million. These facilities
operated by industrial companies under cost type contracts.

There is no privately owned industrial facility in being which can
the requirements of the production program. It is not considered feasible
contract for production reactor fuel element fabrication in privately
facilities at fixed prices, chiefly because of the frequent and substantial ch
which are required in fuel element types, specifications, and quantities resul
from new conditions in the production reactors. The operation of fuel fa
rication plants must be closely integrated with production reactor opera
and thereby with weapons production schedules. In order to accommodate
operating requirements without delay any fixed price arrangement with a
private supplier would necessarily involve price renegotiation to offset cha
in costs as requirements change. Such an arrangement would approach clos
a cost type contract similar to those which now exist between the compa
operating AEC's fuel fabrication facilities and the AEC.

Because the level of production is directly related to weapons require
and reactor performance both of which are subject to substantial chan
short notice, because it is difficult to set firm specifications, because civilian
quirements are so low that this capacity could not be fully utilized for p
ful purposes for many years, and because of the large investment alre
made in AEC plants, the establishment of duplicate fabrication facilities
industry would not be in the best interests of either the Government
industry.

New Production Reactor

CofC VI-3—"Enriched uranium metal and/or fabrication for the new Han
Production Reactor."
MCA-8—"Enriched uranium metal and fabrication of fuel for the NPR
Hanford."
NAM-A1b—"Supply of enriched uranium . . . metal for . . . NPR at Ha
ford . . ."

The new Hanford production reactor, which is being built on an accelera
time schedule, will use metallic uranium fuel elements under temperature
ditions similar to those which are found in current power reactors. This
erating condition, representing a substantial departure from other AEC p
duction reactors, requires that an extensive fuel element process develop

program be conducte
techniques. This wo
construction of the r
the installation of th
with the construction
available. Since ever
subject to change as
for these fuel elemen
into a cost type con
between AEC and th
ties in existence or
equipment required to
fuel elements, the inc
However, since indu
performing these oper
group to review the
facilities. Their repo
and an opportunity to

H. REACTOR DESIGN AN

General

C1M-C1d—"Design, c
and reactor experim
Research, developme
reactor development
installations. The Cha
section VIII of its
ability be divorced fr
type reactor itself.
To the maximum ex
the desired techni
of a particular reactor
prototype plants under
it is highly desirable
systems to secure infor
mance and operation.
its own sites only if
ticable. All power re
a utility or Commi
private companies
their conceptual desig
such specific parameter
which the reactor is inte
With respect to exp
for the most part des
of the design which is
being furnished by ar
are assigning to the la
are: (1) they are ge
program and as such.

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...gram be conducted to develop specifications and fabrication and testing ...niques. This work is being performed concurrently with the design and ...struction of the reactor. To avoid delay in startup of the new reactor, ... installation of the fabrication facilities must also proceed concurrently ...h the construction of the reactor, even though firm specifications are not ...ilable. Since even process specifications are not firm and would not be ...ject to change as operating experience is gained, contracting with industry ... these fuel elements at this time could only result in the AEC's entering ... a cost type contract for the operation, similar to those now in effect ...ween AEC and the contractors operating plants. Since the AEC already ... in existence or will install for the development program much of the ...pment required to process the uranium and fabricate the proposed type of ...el elements, the incremental AEC investment required will not be major.

However, since industry has indicated possible interest and capability for ...forming these operations, arrangements have been made for an industrial ...up to review the question of production of NPR fuel elements in private ...ilities. Their report has now been received but the Commission has not ...had an opportunity to evaluate its recommendations.

Reactor Design and Development

General

...M-C1d—"Design, construction and testing of reactors, reactor prototypes, ...and reactor experiments for which industrial capacity and capital exists."

Research, development, and experimentation in the general field of advanced ...ctor development by AEC laboratories is a prime responsibility of such ...allations. The Chamber of Commerce itself recognizes this role of the AEC ...section VIII of its letter. The design of an advanced reactor cannot in ...ity be divorced from the development effort leading up to the actual pro...ype reactor itself.

To the maximum extent consistent with the paramount objective of obtaining the desired technical data for which it is necessary to build a prototype ...a particular reactor type, it is the intention of the Commission to construct ...ype plants under cooperative arrangements with utilities, public or private. ...s highly desirable to have power reactor prototypes integrated into power ...ems to secure information on compatibility and performance and on main...ce and operation. The Commission plans to construct such facilities on ...n sites only if responses to invitations are not received or are not ac...table. All power reactor prototypes constructed by the Commission, whether ...utility or Commission site, are designed and constructed under contract ...rivate companies with the Commission generally specifying only the re... conceptual design, approximate power size, and general objectives, plus ...pecific parameters as are necessary to assure obtaining the information ... the reactor is intended to provide.

...respect to experimental reactors and reactor experiments, these are ... most part designed by Commission laboratories, with that portion ... design which is not a direct outgrowth of the experimental program ...furnished by architect-engineers. Among the more important reasons ...signing to the laboratories the primary responsibility for such projects ...(1) they are generally merely an extension of a planned laboratory ...m and as such, are of more benefit when designed, operated, and

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altered, as needed to accomplish the project objective, by the laboratory ... sonnel; (2) due to the experimental nature of the project, specifications ... developed as the work proceeds and a complete set of specifications ... available for the solicitation of bids from industry; (3) in many cases, ... experiments are merely modifications of previous experiments; and (4) ... lary equipment already existing at Commission sites can be used which ... the cost of the project and the time and effort required for setting up ... experiment.

Detailed comments are given below and, in general, these comments ... applicable to the general design, construction, and testing of AEC ... Current policy is that conceptual design will be made by the best qualified ... organization. However, Title I and Title II type work is normally contracted ... for with engineering firms.

Oak Ridge Research Reactor

CofC II–3—"Oak Ridge National Laboratory's Title 1 and Title 2 ... of ORR."

The Oak Ridge National Laboratory had responsibility for the design of the ORR. However, Titles I and II design services required for this facility were by no means accomplished exclusively by members of the ORNL engineering staff. A private organization—the McPherson Company of Greenville, S.C.—performed a significant amount of the Title II design work. The McPherson Company participation in the design of the ORR included the design and preparation of working drawings and specifications for the complete reactor building, building services, utilities, reactor shield, reactor pool, and reactor cooling system. Oak Ridge National Laboratory, as the Commission's operating contractor, had direct responsibility for initiating and developing the over-all concept for the facility, for the preparation of design criteria for all phases of the project, and for the definitive design of the reactor proper including instrumentation and controls.

The latest figures on total cost of the ORR show that less than 6 percent was expended by Oak Ridge National Laboratory engineering forces on design which could be considered as Title I or Title II engineering. Approximately one-third of the 6 percent was expended in preliminary work required to develop design criteria and specifications necessary for the design work to proceed. The remaining 4 percent was expended in coordination of the work with the architect-engineer and in design of the reactor proper and the reactor control system.

High Flux Isotope Reactor

CofC II–1—"Oak Ridge National Laboratory's design of a high-flux isotope producing reactor."

It is anticipated that all Title I and Title II design of all portions of the job will be performed by an architect-engineer except for the design of the ... and control systems. The control system components will be purchased from industry. Those portions of the job to be designed by an architect-engineer are a major fraction of the project.

The performance of this reactor will exceed by a large factor the performance of any existing reactor and is higher by a factor of nearly ... any other proposed high-flux reactor. It represents a sizeable extrapolation ...

...ting technology. ... necessary to advance ... purpose of our nati...

...m Research Reactor

...C II–2—"Brookhave... research reactor."

The high-flux beam ... require external ...ergies. The concept ...tor was largely an ... experimentors, the ... as determined b... cost, safety, and gen... was assisted by ... interest concerning all ...agement of constru... companies. Nine propo... negotiating with one of ...

...dia Test Reactor

...C II–5—"Sandia and ... as of December 31, ...pected to go critical in ... all design aspects of ... reactor and associa... outside concerns. The ... used almost entirely ...sistence and involved ...ort for the reactor an... ...000 in outside desig... used Sandia and Los ...lamos effort in this a... panel sufficiently knowl... to do its job and to pr...

...ocess Heat Reactor

...C II–7—"Argonne N... heat reactor."

The ANL made an ev... ...ken to see if any suc... The AEC also requested ...sign for the selected ... development program fo... ...t Reactor was not p...

...ural Circulation Rea...

...C II–8—"Knolls Atom... ...eactor for the Navy."

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...ling technology. In order to accomplish the research aims of the reactor it ...ecessary to advance the limits of current technology. We believe it to be ...urpose of our national laboratories to perform this type of development.

...m Research Reactor*

...t II-2—"Brookhaven National Laboratory's preliminary design of the beam ...search reactor."

...e high-flux beam reactor will be used principally for research projects ...d require external beams of neutrons at both thermal and epithermal ...rgies. The conceptual design study of a new and advanced research re... was largely an effort to develop the best compromise of the needs of ...e experimentors, the actual performance of a chosen fuel and moderator ...f as determined by critical experiments, and engineering considerations ...t, safety, and general feasibility. Even on this conceptual study Brook... was assisted by an industrial company, and in July 1959, statements of ...t concerning all phases of the design, equipment procurement, and ...rement of construction of the reactor were solicited from 12 industrial ...anies. Nine proposals were subsequently received and we are currently ...iating with one of the companies for this work.

...a Test Reactor*

...t II-5—"Sandia and Los Alamos design work for the Sandia Test Reactor."

...s of December 31, 1959, this facility was 31 percent complete and is ...ected to go critical in late 1960.

...e design aspects of the building and practically all design aspects of ...e reactor and associated equipment were handled through contracts with ...ode concerns. The designs of the reactor and associated equipment were ...d almost entirely on other components and fuel elements already in ...ence and involved only minor design modifications. The total design ...t for the reactor and associated equipment was covered by approximately ...an in outside design contracts plus approximately 4 man-years of com... Sandia and Los Alamos time over a 3-year period. The Sandia-Los ...os effort in this area was the minimum necessary to keep Sandia per... sufficiently knowledgeable to insure that it would get what it needed ...s its job and to provide a background for the operation of the reactor.

...en Heat Reactor*

...t II-7—"Argonne National Laboratory's Title I design of the process ...t reactor."

...e ANL made an evaluation study of those reactor concepts which are ...t to see if any such concept is particularly suitable for this application. ...e AEC also requested the Laboratory to provide a report on the conceptual ...n for the selected reactor concept and an outline for the research and ...opment program for such a reactor. The Title I design of the Process ...r Reactor was not performed by Argonne but by Sargent and Lundy.

...ral Circulation Reactor*

...t II-8—"Knolls Atomic Power Laboratory's work on a Natural Circulation ...tor for the Navy."

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The development of a reactor plant for naval operation is quite different in many respects from the development of a stationary reactor plant. The compactness of the reactor system, the high power density, the shock and vibration requirements, the maneuvering capabilities, and the operation of the plant under varying conditions of inclination give rise to problems not encountered in a land plant. The natural circulation reactor plant is a new concept for naval application and its successful and timely completion as well as its further advancement requires full exploitation of pertinent naval reactor technology. The Commission laboratories which have specialized in naval research and development work for about 10 years are, to our knowledge, the only organizations having the necessary technical talent, experience, and special facilities for undertaking this project in the most expeditious manner.

Army Low Power Reactor

CofC–II–11—"Argonne National Laboratory's development of the Army Low Power Reactor."

NAM–C1e—"The first reactor in the Army Low Power Reactor program was fabricated by an industrial concern at its own facilities, but the second was to be fabricated in a Government-owned facility."

We assume that the SM–1 plant at Ft. Belvoir is the "first reactor" and the SL–1 (formerly ALPR) at the National Reactor Test-Station is the "second."

In the light of a known interest of the Department of Defense in a nuclear power plant of approximately 1/10 the capacity of the SM–1 at Ft. Belvoir, two separate reactor concepts were investigated to determine which could best meet the requirements of the Department of Defense. These studies were made between January and June 1955. Of the various systems investigated, the boiling water system study by the Argonne National Laboratory appeared to be most suitable for this purpose.

Inasmuch as there was no industrial experience with power reactor systems developed at that time, Argonne was requested to undertake development and construction of the prototype 200–300 KWe plant which the Department of Defense requested in September 1955. In the course of constructing this plant, Argonne used subcontracts with many industrial firms. An industrial firm was awarded a contract to fabricate the fuel elements but defaulted because it was unable to fabricate elements meeting the prescribed standards. In order that the project completion date would not be jeopardized, the fabrication of the core was undertaken by Argonne Laboratory. Since completion the plant has been operated by Combustion Engineering.

III. THORIUM

CofC VI–8—"Supplying A.E.C.'s needs for thorium alloy, thorium oxide, thorium carbide. . . ."

MCA–14—"Supply of thorium oxide for the homogeneous development program at ORNL."

MCA–15—"Supply of thorium metal for special projects at Los Alamos, Sandia and Lawrence Radiation Laboratory at Livermore."

NAM–C1a—"Supply of thorium oxide for homogeneous reactor development at ORNL."

NAM–C1b—"Supply of thorium metal for special projects at Los Alamos, Sandia, Lawrence Radiation Laboratory at Livermore."

The AEC presently
of the processing of
special types of thori
for a thorium metal
short period. Since
basis for the Fernal
shut down in 1955 a
the plant produced a
which the small nee
It is intended that f
be supplied from this
On the other hand, is
oxide having desirabl
program. Oak Ridge
chemistry for testing. I
supported by AEC fun
agencies. The developm
of an oxide has been
a specification can be
homogeneous reactors

Current thorium ope
use of this element in
may be a continuing re
would exceed the curr
metal by procurement

IV. DESIGN OF FACILIT

Hot Cells at Argonne

CofC II–4—"Argonne
cells for its new resea

It is assumed that r
Fuels Technology Cent
designs of the buildin
engineer (Singmaster
used by Argonne. T
core hardware is bein
nature of the design c
being designed so that t
time without the need
a complete departure f
advancement in all asp
metallurgy facility must
type of master slave ma
Although the need for t
open forums, no com
of our knowledge.

It was also felt that
scientists and engineers
with other problems in

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AEC presently has no production capacity either operating or available processing of thorium to metal. A small pilot plant for preparation of types of thorium oxide powders is in operation at ORNL. Several years thorium metal pilot plant was built at Fernald site and operated for a period. Since the anticipated requirements for thorium which were the for the Fernald pilot plant effort did not materialize, the facility was down in 1955 and has been dismantled. During its period of operation, plant produced a small inventory of thorium metal and compounds from the small needs which have developed since 1955 have been supplied. intended that future requirements of comparable size would continue to supplied from this inventory as long as available. The ORNL pilot plant, other hand, is preparing thorium oxide powders in an effort to produce having desirable slurry properties for use in the homogeneous reactor Oak Ridge has also procured sample quantities of oxide from in- for testing. Development work on preparation of acceptable powders ted by AEC funds has been carried out by ORNL and several private com- The development program at ORNL is still under way. At such time oxide has been developed having the desired slurry properties for which cification can be set, we would seek to obtain thorium oxide for use in geneous reactors from commercial sources.

rent thorium operations are limited to development efforts on the utiliza- this element in AEC programs. There are some indications that there a continuing requirement for modest quantities of thorium metal which exceed the current inventory. Should such develop, AEC will obtain the by procurement from commercial sources.

SIGN OF FACILITIES AND EQUIPMENT

cells at Argonne National Laboratory

II-4—"Argonne National Laboratory's Title 1 and Title 2 design of hot for its new research laboratory."

assumed that reference is made to the hot cell area in Wing F of the Technology Center, now under construction. The Title I and Title II of the building were carried out completely by a private architect- (Singmaster and Breyer) on the basis of preliminary designs pre- by Argonne. The design of the manipulator, windows, and internal ardware is being carried out by Argonne because of the experimental of the design concept. In this particular case the cave equipment is signed so that the operations can be carried out for extended periods of without the need for access by personnel. The design concept represents ite departure from present operating techniques and requires a large ment in all aspects of remote handling equipment. This new research facility must be gastight to contain an inert atmosphere. No existing master slave manipulator is designed to operate under these conditions. the need for this new approach to remote handling has been discussed forums, no commercial company is working on this problem to the best knowledge.

also felt that the design of these features should be carried out by and engineers who have already used such facilities and are acquainted problems in the design of remote handling and viewing systems.

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Nuclear Ramjet Engines

CofC II–6—"The Government's University of California Radiation Laborato... design, test and fabrication of nuclear ramjet engines."

The function of this program is to determine the feasibility of and constru... a nuclear reactor as a ramjet engine and does not include design, test, an... fabrication of nuclear ramjet engines on a production basis. The Laborator... is subcontracting as much of this project as is feasible, considering the techn... requirements and schedules involved. Subcontracts with industry curren... amount to about 45 percent of the laboratory's budget for the project.

Thermionic Cells

CofC II–9—"Los Alamos' experimental work on thermionic cells to convert fissio... energy directly to electricity."

This item refers to the "plasma thermocouple", a present research project a... the Los Alamos Scientific Laboratory. As far as we are aware, the basic idea... originated at LASL where technology in the exotic materials involved, (ura... nium and zirconium carbide), scientific competence, and adequate laborator... facilities required are available.

This field of research is unclassified and completely open to industry. The... AEC welcomes parallel research by industry and the publication of the result... of such research. LASL has published numerous documents in this area and... has briefed many industrial organizations upon their work. We encourage our... laboratories to undertake frontier research of this nature.

V. Depleted Uranium

CofC III–1—"Conversion of depleted uranium from UF_6 as required in the 'Nuclear Navy' for metal, alloys or uranium compounds."

CofC III–2—"Depleted uranium metal for an AEC shielding cask project a... Schenectady."

MCA–2—"Depleted uranium for all activities at the national laboratories with specific attention directed to the conversion of depleted uranium from UF_6 and the fabrication of blanket fuel elements for the Zero Power Reactor a... Argonne National Laboratory."

MCA–3—"Conversion from UF_6 of depleted uranium required for shielding cask at Bettis Field representing approximately 40 tons of cylindrical casting."

MCA–9—"Depleted uranium metal for AEC shielding cask at General Electric... Schenectady."

NAM–A2a—"Supply of blanket fuel elements for Zero Power Reactor at Argonne National Laboratory."

NAM–A2b—"Conversion from UF_6 of depleted uranium required for shielding cask at Bettis Field."

NAM–A2c—"Supply of depleted metal for shielding cask project at Schenectady"

Depleted uranium metal is used to a very limited extent in the Naval Reactors program as a shielding material in certain refueling equipment where compactness is required. Specifically, it has been used in the refueling equipment for the S3G and A1W type reactor plants. The depleted uranium for this equipment was fabricated into the desired shapes at Oak Ridge. The events leading to the decision to do the work at an AEC facility can be summarized as follows: In 1957, representatives from eleven private industrial concerns were invited to a pre-bid conference called to determine whether commercial vendors were tech...

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capable of fabricating the depleted uranium shielding components for refueling machine developed and being manufactured by the United Machinery Corporation. Three companies responded. As a result of this ference, the decision was made to perform the fabrication work at Oak Ridge the capability of the three interested commercial vendors was uncertain, as it was evident that Oak Ridge had an established capability to perform work. All three of the interested vendors lacked experience in casting the depleted uranium alloy, and it was questionable whether their facilould handle the size of the castings required. Similarly, starting in 1956, ited Shoe Machinery Corporation designed and developed for the Bettis tory a maintenance and refueling machine for use with the A1W type 1 reactor cores. Depleted uranium for this machine was also procured Oak Ridge.

probable that the questions concerning the ZPR refer to the ZPR–VI blanket for which procurement was initiated in November 1959. (The procurement for ZPR–III was in 1957-58.) Bids were requested for conof UF_6 to metal and commercial suppliers have been selected for both sion and fabrication steps.

another case, that of the EBR II blanket material, an exception was made general policy of using commercially available facilities, based on the at price differential that existed.

Irradiation Services

7—"Preference should be accorded private irradiation facilities in place the current preference for loading Government facilities first. This is the way of encouraging more private capacity. Underloaded commercial cilities exist whereas it is our impression that the Government owned facilare heavily loaded. AEC's practice of offering space in the Government MTR and ETR should be limited to only those specific cases where vate facilities are unavailable."

-8—"The AEC should announce a policy to utilize privately-owned reactors materials testing to the extent that industry is able to provide space. This private reactors should be in preference to the use of a similar Governowned facility. The current use of MTR and ETR for Governmentsored research, which constitutes the great majority of the materials business, results in severe competition for the private test reactors."

tiations currently are underway to determine the extent to which irradservices required for Commission programs can be obtained from either Westinghouse or General Electric test reactors. As announced last summer, tions are also being conducted with the Babcock and Wilcox Company construction of an additional test reactor. Irradiations will be continued mission test reactors depending upon the type of irradiation required and of outside service.

Chemical Processing

Uranium Scrap

-7—"Chemical processing of cold industrial scrap."

-8—"Recovery of cold fabrication scrap, both high and low enriched, from above projects."

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In early 1959, AEC took the initial steps to acquire more scrap recovery ser-
ices from industry. In March 1959, AEC began to send bid invitations to com-
mercial scrap recovery firms. to provide this service. On November 4, the
AEC assigned the responsibility for developing the domestic unirradiated ura-
ium scrap industry to New York Operations Office. That Office is acting as a
central point for the AEC and its contractors for the placement and administra-
tion of contracts for commercial recovery of uranium scrap generated under the
reactor development program. From March through November 1959, approx-
imately 11 awards were made aggregating 344 kilograms of uranium with a total
of $180,200 for recovery charges.

The New York Operations Office is currently establishing a system whereby
the scrap available for commercial recovery will be reported by other offices and
invitations for bids will be solicited from private firms. As a result of these
steps it is expected that the commercial recovery of cold scrap will grow sub-
stantially in the future.

Irradiated Fuel Elements

CofC VII—"It is recognized that the reprocessing of irradiated fuel elements
represents an area that is difficult to assess commercially. However, there
is no reason to believe that many chemical firms could not handle the job
if pricing, regulatory and load problems could be successfully met. While
the Government is spending large sums on developing new processes which
inhibit industrial investment in known processes it can speed the transition
toward a desirable commercial mode of operation by making maximum use
of industrial firms in research and development and possibly the construction
and operation of reprocessing plants."

NAM–A–3—"In the area of reprocessing of irradiated fuel elements, the Gov-
ernment can and should greatly aid in the transition to a commercial mode
of operation by making maximum use of industrial groups in process research
and development and in construction of, and operations related to, reprocess-
ing plants. To promote the growth of a healthy industry in this area, Gov-
ernment funds should be used to finance research and development projects
in privately-owned facilities in preference to Government-owned facilities."

The Commission has made a continuing effort to bring private industry into
the field of chemical reprocessing of irradiated fuel elements. At the present
time, a group of five electric utilities and a chemical company are studying the
technical and economic feasibility of the design, construction, and operation of
a privately owned facility for the processing of spent nuclear fuels. This study
will take approximately 6 months, at the end of which time it is expected that
industry will have a much clearer view as to the potential in this field. The
study has the full support of the AEC. Other groups making similar studies
would have the same AEC support.

Since there are a number of approaches to the problems of private operation
in this field, and technology must be developed in order to find a satisfactory
solution to the general problem, development programs must proceed concurrently
with the objective of obtaining economic nuclear power. AEC believes that the
absence of adequate technology necessitates the constinuation of its program.

Although to our knowledge there are no facilities outside of AEC capable of
undertaking major development programs on recovery of spent fuel elements,
AEC is prepared to receive proposals for research and development to improve
fuel recovery technology.

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INSTRUMENT DEVELOPMENT AND MANUFACTURING

II-10—"Oak Ridge National Laboratory's Instrument Development Sec- which in some instances is working on the development of instruments competition with commercially available equipment."

II-12—"Each of the major Government projects have developed their and different: hand and foot monitors, scalers, survey meters and multi- radiation analyzers in competition with commercially available equipment."

VI-6—"Instrument production work at Los Alamos, Oak Ridge and the University of California (Berkeley)."

C1g—"Personnel radiation monitors are developed and produced in in- production sections at Government-owned laboratories. There is instrument industry capable of furnishing such monitors and it should be used."

C1h—"Government construction of radiation measuring equipment is also direct competition with the private instrument industry."

the express policy of all of the laboratories to procure instruments which available commercially rather than to fabricate them. A survey of all lab- and industrial establishments made in 1954 showed that over 80 per- radiation instruments of all types were procured from private industry. more recent survey indicates this percentage ranges from 90 percent to 100 depending upon the mission of the facility.

is true that some instrument development work is continuing at major stories. Such work is necessary for the following reasons:

a. To modify or create instruments to meet the specific requirements of a search project where the time and engineering effort necessary to prepare specifications, issue bids, instruct outside personnel, inspect for precision, and return for corrections, make outside procurement impractical.

b. To develop designs in instances where commercially available instru- ments have proven unsatisfactory in performance and private companies have not improved their products on their own initiative but will adopt lab- oratory-developed designs.

While it may appear that each loboratory develops its own instruments, our survey indicates that such development is undertaken only when necessary to meet a particular condition for which a commercially available instrument is not adaptable. The facts in respect to specific instruments are:

a. *Hand and Foot Monitors.* Obtained commercially. Developed initially by the laboratories. One laboratory has recently developed an improved design for greater reliability.

b. *Scalers.* Such instruments typically must be modified to meet specific needs. The laboratories use commercial sub-assemblies.

c. *Survey meters.* While these meters are purchased from private indus- try, the laboratories have had to undertake development of more reliable designs in the absence of such development by industry.

d. *Multi-channel analyzers.* To our knowledge, the only development work on these devices is that necessary to achieve devices for special applications. As an example, one laboratory assembled one such device in calendar year 1954 at a cost of $12,000, while in the same year it procured $192,000 worth of such devices commercially.

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IX. Production of Radioisotopes

Cobalt 60 for the High Intensity Radiation Development Laboratory

CofC VI–4—"Supply and/or fabrication of high purity cobalt for the High Intensity Radiation Development Laboratory at the Brookhaven National Laboratory."

MCA–10—"Supply and/or fabrication of high purity cobalt for the High Intensity Radiation Development Laboratory at the Brookhaven National Laboratory."

NAM C1c—"Supply of high purity cobalt for High Intensity Radiation Development Laboratory, Brookhaven."

The high purity cobalt in the form of nickel plated targets for the Brookhaven radiation development facility was furnished commercially. All such cobalt is and has been supplied by commerical vendors to AEC. The canning of the cobalt for use in a reactor is controlled by the reactor operator to insure the safety and integrity of all material inserted into the reactor. Approximately 500,000 curies of cobalt 60 are needed for the Brookhaven National Laboratory program and are being produced in the Engineering Test Reactor. At the time the radiation was begun no commercial sources of cobalt 60 existed.

Production of Certain Radioisotpes

CofC IV—"The Government is currently producing certain radioactive isotopes in a commercial way (e.g. Cobalt 60, Iodine 131, Carbon 14, Sulfur 35, Phosphorus 32). The demand for these radioactive isotopes is now at a level which makes commercial production feasible and commercial facilities exist which should be utilized."

CofC VI–8—"Supplying A.E.C.'s needs for . . . high purity cobalt and radioisotopes."

AEC's needs for radioisotopes are small in relation to AEC sales to others, representing 14 percent of the dollar sales. Until such time as commercial producers can supply the requirements, AEC production of radioisotopes will be necessary to meet all or part of its own needs. Commercial production of radioisotopes is small at the present time except for cobalt 60.

The Government is producing some, but not all, radioisotopes in a commercial way. In 1955, AEC discontinued the production of cyclotron produced radioisotopes because commercial sources were in a position to produce and market these products at reasonable prices. Also, many of the radioisotopes currently distributed by AEC are produced on a laboratory or semi-works scale because of the small demand, principally for research and developmental uses.

The AEC has never competed with the pharmaceutical industry in the manufacture and distribution of pharmaceuticals containing radioisotopes. The AEC has also turned over to private industry the following related services:

a. synthesis and marketing of C–14 labeled organics.
b. cobalt-60 encapsulation services.
c. cobalt-60 gamma irradiation services.

The foregoing demonstrates the way AEC policy has been carried out when private industry is ready to produce or perform services at reasonable prices.

The statement is made that the demand for certain radioisotopes is now at a level which makes commercial production feasible. The five leading commercial producers are:

Cobalt 60—
Iodine 131—
Phosphorus
Polonium 2
Carbon 14—

Total—

includes research disc
grants research support

These five radioisot
cobalt 60 requi
in plant facilitie
of sales is not sufficie
be operated with a
examinations of AEC
facilities for undertakir
test and the market to
of the total program.
Commission has receiv
produce isotopes. W
irradiating cobalt,
and distribution of
facilities. Power
producing radioisotopes
The nature and ext
being explored. Ind
the Commission's f
source sources. One of
radioisotopes. Success
achieving large-s
active is reached, the
used to attract privat
activity of radioisotope

MISCELLANEOUS SER

Badge Processing

VI–5—"Servicing
C1f—"Furnishing
number of industr
formed at Oak Ridg

servicing of film bad
part of the operating
employees. The proc
interpretation and o
exposure could reach d
certain tones, quick detec
personnel protecti
going on a commerci

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	FY 1959 Sales[1] *(in thousands)*
Cobalt 60	$659
Iodine 131	325
Phosphorus 32	171
Polonium 210	208
Carbon 14	263
Total	1,626

[1] ...cludes research discounts of about $207,000 granted to users under the AEC radio... research support program.

...five radioisotopes represented 65 percent of AEC's dollar sales. All ... cobalt 60 require radiochemical processing with attendant high invest... in plant facilities. Indications until recently have been that the volume ... sales is not sufficient to attract private capital. In fact, the Commission ...operated with a number of private companies who have made very detailed ...ations of AEC isotope production activities and the commercial oppor... for undertaking the total isotope program. These private groups did ...and the market to be sufficiently attractive for a commercial venture involv... the total program. It has only been within the last few months that the ...ission has received concrete evidence of private interest and intention ...duce isotopes. We understand that two existing commercial test reactors ...radiating cobalt, and that one commercial company is considering produc... and distribution of iodine 131 to be produced in another company's irradia... facilities. Power reactor operators have thus far indicated no interest in ...ing radioisotopes.

...nature and extent of private interest in the production of cobalt 60 ...explored. Industry plans will be taken into consideration in determin... Commission's future plans to meet requirements, particularly for mega... sources. One of the objectives of AEC is to develop large scale uses for ...topes. Success in this objective is dependent on solving technical prob... achieving large-scale availability, and lowering prices. When this ob... is reached, the demand for radioisotopes should be at a high enough ...to attract private capital and make commercial production of a wider ...of radioisotopes economically feasible.

...ELLANEOUS SERVICES

...adge Processing

...ff-3—"Servicing of film badges by AEC contractors."

...ff—"Furnishing of film badge service for personnel monitoring. Although ...mber of industrial firms offer this sevice, competing services are per... at Oak Ridge, Brookhaven, Savannah River, Sandia, etc."

...ing of film badges at most AEC installations is regarded as an integral ... the operating procedures established to protect the health and safety ...oyees. The processing and reading of film badges is intimately related ...pretation and other steps in a monitoring system. Wherever radiation ...could reach dangerous levels or where personnel must work in radia... ...s, quick detection and rapid estimation of exposure are needed for ...onnel protection and control of perations; any time delay involved in ...h a commercial contractor to provide these services is unacceptable.

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One AEC contractor engaged in the processing of unirradiated source ma-
rials is understood to be considering the use of commercial film badge ser-
Another, responsible for operation of an AEC laboratory, is giving serious
sideration to cancelling its commercial contract in favor of a return to
its own film badge work because of several years of unsatisfactory exp
with inaccuracies and errors on the part of two commercial contractors.

Printing

CofC VI–9—"Printing facilities at Government facilities."

Except for the printing establishment maintained for the production and
semination of scientific and technical reports by the Technical Infor
Services Extension at Oak Ridge, AEC printing facilities are an integral
of the administrative support for routine management and operation at
AEC installation. Day-to-day operational needs are characterized by
numbers of short production runs with short lead time.

Provision of printing equipment for an AEC installation requires prior
thorization by the Congressional Joint Committee on Printing, which period
reviews production reports to assure that equipment continues to be
Typically, AEC installations procure from commercial sources a large volu
unclassified printing when large production runs are involved and lead
permits.

Transportation

CofC VI–10—"Operation and maintenance of automotive equipment and
portation facilities (bus and rail) at Government installations."

In the provision of automobile service at AEC installations, our contr
operate fleets of Government-owned vehicles of varied types. Where
vehicles are obtained from Government motor pools. Peak loads are
by renting equipment. Automobile service at most AEC installations
integral supporting activity which can be provided most efficiently by
operating contractor rather than an outside commercial source.

At AEC installations which are in relatively isolated or rural locations
icing and maintenance of motor vehicles are generally performed in AEC
shops. There are, however, many locations where reliance on commercial
and facilities is the practice because it has been found to be practical
more economical.

Bus transportation is provided by our operating contractors at some
AEC installations. Because of the isolation of these facilities, experi
demonstrates that commercial bus service cannot be provided on a pay
and operating conditions make it impractical to contract for such service
reasonable cost.

Intraplant railroad service is performed at several installations by
operating contractor. At Oak Ridge prior to 1956, the plant railroad was
under contract by one of the major railroad companies. Cost studies pre
the AEC to transfer responsibility for maintenance and operation of the
railroad to its operating contractor. Since 1956 the estimated cost has been
than one-third of the minimum amount payable under the earlier contract
the railroad company.

In general, intermittent low-volume operations within our plant sites
involving special equipment and handling, are best performed as a part
integrated responsibility of the plant operating contractor.

CO

Distribution

VI–11—"Power distr
ctric power distribu
dance with the norm
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of the initial step-dow
erally, responsibility
llation is such an inte
ctor for carrying o
rate contract for powe
special situation exist
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ed.

unication

VI–12—"Communicat
lephone, teletype, and
installations. Only
an a lease-maintena
ities of radio equipme
ntially all teletype
ies such as American
Corporation of Ame
and tie lines provid
Government network.
rly all AEC telephon
ican Telephone and T
lephone companies.
notable exception is
owned telephone syst
not undertake to serv
rving the business
portions directly and
by AEC and operate
rious analyses have
nical than would be t
the rates established

Shop Facilities

VI–13—"Machine Sh
hine shop jobs are p
shops when (1) th
are not able to perfor
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recent years steps
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allations, our contractors
types. Where available
Peak loads are also
AEC installations is
most efficiently by
rcial source.
d or rural locations,
performed in AEC
iance on commercial
ound to be practical

ontractors at some
hese facilities,
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eral installations by
plant railroad was
ies. Cost studies
and operation of the
estimated cost has
er the earlier contract

ithin our plant sites
performed as a part
ctor.

Power Distribution

61-11—"Power distribution in connection with Government installations."
ric power distribution systems at AEC installations are operated in
nce with the normal industrial practice under which the consumer owns
erates the distribution system beyond the point of delivery, usually the high
the initial step-down transformer.
rally, responsibility for the distribution of electric power within an AEC
ation is such an integral part of the over-all responsibility of the operating
ctor for carrying out the principal mission of the installation that a
ate contract for power distribution services could not be tolerated.
special situation exists at Los Alamos, where many private residences are
ed from the distribution system. The feasibility of eventually disposing of
art of the distribution system which serves the town facilities is now being
ed

nication

61-12—"Communications systems at Government installations."
phone, teletype, and radio communication equipment is regularly used by
installations. Only recently has it become possible to obtain radio equip-
on a lease-maintenance basis from commercial sources, and substantial
ties of radio equipment are being secured under such arrangements.
ntially all teletype facilities used by the AEC are leased from public
such as American Telephone and Telegraph Co., Western Union Co., and
Corporation of America. Teletype traffic of AEC is processed over net-
and tie lines provided by public utilities as well as over the military and
overnment networks.
ost all AEC telephone service is provided by public utilities such as the
Telephone and Telegraph Co., Bell Telephone companies, and independ-
phone companies.
notable exception is at Hanford, where during World War II a Govern-
ned telephone system was built because the local telephone company
not undertake to serve so large a site. Major portions of the Hanford sys-
erving the business and residential areas, were sold to a public utility.
portions directly and exclusively serving the Hanford plant areas are still
by AEC and operated by the AEC prime contractor.
ous analyses have indicated that the present arrangement is more
ical than would be the purchase of the service from a telephone company
the rates established for that geographical area. Further studies will be

Shop Facilities

61-13—"Machine Shop Facilities at the Argonne National Laboratory."
ine shop jobs are performed in the Argonne National Laboratory's own
shops when (1) there is urgency to complete the job, (2) private com-
are not able to perform the work, and (3) shop fabrication must be carried
ncident with design, development, and proof testing of the apparatus
uilt. When these factors are not present, it is the policy of the Laboratory
the work from private enterprise.
recent years steps have been taken to develop commercial sources for
fabrication having the qualifications and experience to perform the type
generated by the Laboratory. A large number of qualified companies is
ilable.

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APPENDIX 19

Principal Terms of Uranium Concentrate Purchase Contracts

(As released to the press November 18, 1960[1])

The Atomic Energy Commission has contracts for the purchase of uranium concentrate (U_3O_8) from 26 domestic processing mills, one of which is under construction. Under one additional contract, the company may, at its option, build its own mill or arrange for treatment of its ore at some existing plant.

The Government buys uranium concentrates from privately owned and operated mills under the terms of individually negotiated contracts. During the period ending March 31, 1962, the price per pound paid for concentrates varies from mill to mill, depending principally upon the size and location of the mill, the grade and character of ore processed and the type of treatment process used. During the pre-1962 period (prior to April 1, 1962) these prices are subject to escalation based on Bureau of Labor Statistics indices.

For concentrates purchased subsequent to March 31, 1962, the price paid by the AEC will be at the established price of $8.00 per pound of U_3O_8 with a few minor exceptions. These exceptions include final deliveries under contracts terminating March 31, 1962, and some deferred deliveries as a result of stretch-out provisions in some contracts extending beyond that date.

Fifteen uranium concentrate procurement contracts with milling companies have been extended in accordance with the Commission's announcement of November 24, 1958, which provides for the purchase of uranium concentrates (U_3O_8) in the 1962–1966 period.

The remaining 12 contracts provide essentially for purchase of concentrates in the pre-1962 period although in a few instances their terms extend into the post-1962 period. These contracts are being reviewed with the intent to bring them into accord with the November 24, 1958 announcement. These reviews include studies of ore reserves, the establishment of annual quotas, and related matters.

Upon executing additional milling contracts and contract extensions, the AEC will make public a summary of each contract's major provisions.

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[1] Since issuance of this statement the contracts with Kermac Nuclear Fuels Corp., Grants, N. Mex., and Susquehanna Western, Inc., Riverton, Wyo., have been extended in accordance with the November 24, 1958, announcement. Following is a summary of the approximate quantities and prices involved in the current contracts:

Kermac Nuclear Fuels Corp. The amended contract, effective as of November 1, 1960, provides for the purchase through December 31, 1966, of approximately 31,027,000 pounds of U_3O_8 in concentrate having a total value of $237,000,000 at an average price of $7.64 per pound.

The price will average $7.18 per pound for approximately 13,877,000 pounds which is estimated will be produced by June 1, 1963. The remaining 17,150,000 pounds will be deliverable at $8.00 per pound. Variation from the $8.00 price early in the post-1962 period is due chiefly to stretch-out or deferral of pre-1962 production into the post-1962 period.

Susquehanna Western, Inc. The extended contract, effective as of June 1, 1960, provides for the purchase through December 31, 1966, of 5,775,000 pounds of U_3O_8 valued at approximately $47,000,000.

Under the terms of the new contract, approximately 1,503,000 pounds of U_3O_8 are to be delivered between June 1, 1960, and April 1, 1962, at a unit price of $8.635 per pound, and 4,272,000 pounds are deliverable after that date at $8.00 per pound.

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URCHASE CONTRACTS
960 ')

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contracts. During the
for concentrates vary
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treatment process used
se prices are subject to

1962, the price paid is
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liveries under contracts
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with milling companies
ssion's announcement
of uranium concentrates

purchase of concentrates
eir terms extend into the
with the intent to bring
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nnual quotas, and related

tract extensions, the AEC
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Kermac Nuclear Fuels Corp.
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Following is a summary of the
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proximately 31,027,000 pounds
) at an average price of $[illegible]

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price early in the post-1962
production into the post-1962

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,03,000 pounds of U_3O_8 may be
nit price of $8.635 per pound
3.00 per pound.

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the 15 contracts completed in accordance with the November 24, 1958 announcement have several provisions in common applicable to the post-1962 period (April 1, 1962 through December 31, 1966). The ores to be treated will come only from properties designated in the contracts, including both company-owned and independent ores. The contracts give the Commission the option of purchasing at any time specified quantities of U_3O_8 produced by independent mine operators from eligible properties. Subject to suitable license arrangements, there are no restrictions on commercial sales by the milling companies above the amount to be sold to the Commission.

Beginning with July 1, 1960, the aggregate quantity of U_3O_8 in concentrates which has been contracted for under all outstanding contracts is approximately 190,674,000 pounds of U_3O_8, of which 74,307,000 pounds are scheduled for delivery during the pre-1962 period and 116,367,000 pounds in the post-1962 period. Estimated cost to the Government is $1,552,800,000 of which $621,300,000 will fall in the pre-1962 period and $931,500,000 in the post-1962 period. The foregoing figures do not include additional purchases which will result from contract extensions to be negotiated.

The following is a summary of the approximate quantities and prices involved in the milling contracts. The quantities indicated and total costs may be affected by failure of mining properties to produce the requisite amount of ore to fulfill the contract.

CONTRACTS EXTENDED IN ACCORDANCE WITH NOVEMBER 24, 1958 ANNOUNCEMENT

Anaconda Co., operates a 3,000 ton-a-day processing mill in the Grants, N. Mex., area. The current contract extends through December 31, 1966. There remained approximately 5,250,000 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.79 per pound. Post-1962 quantity contracted for is 10,708,500 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible],000.

Atlas Uranium Co., operates a 330 ton-a-day processing mill at Grand Junction, Colo. This contract was effective August 1, 1960 and extends through December 31, 1966. There remained approximately 1,036,700 pounds of U_3O_8 to be delivered between August 1, 1960 and April 1, 1962, at a unit price of $8.00 per pound. Post-1962 quantity contracted for is 1,560,800 pounds of U_3O_8 at a unit price of $8.00 per pound.

Total cost of remaining contract quantity from August 1, 1960 is approximately $21,000,000.

Cotter Corp. operates a 200-ton-a-day processing mill at Canon City, Colo. Contract runs from March 1, 1960 through February 28, 1965. There remained approximately 898,000 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.62 per pound. Post-1962 quantity contracted for is 1,503,100 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960, is approximately $[illegible],000.

Dawn Mining Co., operates a 400-ton-a-day processing mill at Ford, Wash. The current contract extends through December 31, 1966. There remained approximately 999,200 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $9.27 per pound. The post-1962 quantity contracted for is 2,610,400 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960, is approximately $[illegible],000.

Federal-Radorock-Gas Hills Partners, operates a 520-ton-a-day processing [illegible] at Fremont County, Wyo., with a contract extending through December 31, [illegible]. There remained approximately 1,363,200 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.15 per pound. Post-[illegible] quantity contracted for is 3,700,200 pounds of U_3O_8 at a unit price of $[illegible] per pound. Total cost of remaining contract quantity from July 1960 is approximately $41,000,000.

Globe Mining Co., operates a 490-ton-a-day processing mill in Natrona [illegible], Wyo., with a contract extending through December 31, 1966. There remained approximately 1,138,800 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.30 per pound. Post-1962 quantity contracted for is 3,091,000 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $34,000,000.

Gunnison Mining Co., operates a 200-ton-a-day processing mill at Gunnison, Colo. This contract extends through December 31, 1962. There remained approximately 823,200 pounds of U_3O_8 to be delivered between July 1, 1960 and July 1, 1962, at a unit price of $9.19 per pound. The pre-1962 price continues to July 1, 1962 due to stretch-out. The quantity contracted for between July 1, 1962 and December 31, 1962, is 205,800 pounds at a price of $8.00 per pound. Total cost of remaining contract quantity is approximately $9,200,000.

Homestake-Sapin Partners, operate a 1,500-ton-a-day processing mill at Grants, N. Mex., with a contract extending through December 31, 1966. There remained approximately 4,020,600 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.00 per pound. Post-1962 quantity contracted for is 10,680,000 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960, is approximately $118,000,000.

Kerr-McGee Oil Industries, Inc., operates a 300-ton-a-day processing mill at Shiprock, N. Mex. The current contract runs from November 1, 1959 through June 30, 1965. There remained approximately 942,200 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is 872,700 pounds at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $14,500,000.

Petrotomics Co., operates in the Shirley Basin Area of Wyoming. This contract, signed on August 12, 1960 extends through December 31, 1966. It provides for the purchase of 1,024,000 pounds of U_3O_8 contained in eligible ore in the pre-1962 period, and for the purchase of U_3O_8 in concentrate in the post-1962 period. The Petrotomics Co. may, at its option in the post-1962 period, build a mill for the production of uranium concentrates or make arrangements with existing mills for the treatment of its ore. In the post-1962 period [illegible] has contracted to buy a total of 3,158,800 pounds of U_3O_8 in concentrates at a unit price of $8.00 per pound . Total cost of the contract quantity of U_3O_8 in concentrate is approximately $25,000,000.

Phillips Petroleum Co., operates a 1,725 ton-a-day processing mill at [illegible], N. Mex., and with a contract extending through December 31, 1962. There remained approximately 5,861,700 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $7.75 per pound. Post-1962 quantity contracted for is 13,345,500 pounds of U_3O_8, including the quantity deferred from the pre-1962 period. The average unit price will be $7.96 per pound due to stretch-out. Total cost of remaining contract quantity from July 1, [illegible] approximately $152,000,000.

Susquehanna-Western, [illegible] near Falls City, Tex. This contract extends through December 31, 1966. [illegible] quantity is 337,500 pounds of U_3O_8. Total quantity contracted for is [illegible] pounds. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

Uranium Reduction Co., operates a [illegible] ton-a-day processing mill at [illegible] and with a contract extending through December 31, 1966. There remained approximately 6,175,500 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $[illegible] per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $169,000,000.

Utah Construction and Mining Co., operates a 980 ton-a-day processing mill at [illegible] through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $7.90 per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

Western Nuclear Corp., operates a [illegible] ton-a-day processing mill at [illegible], Wyo., and with a contract extending through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is 8,526,900 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

The approximate quantities of remaining mill contracts [illegible] otherwise noted, the prices [illegible] are subject to escalation [illegible] process. All of these contracts [illegible] quantities of amenable ore.

Homestake-New Mexico Partners, operates a [illegible] ton-a-day processing mill at Grants, N. Mex., and with a contract extending through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

Minerals Engineering Co., operates a [illegible] ton-a-day processing mill at [illegible] and with a contract extending through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

Ranchers Exploration and Development Co., operates a [illegible] ton-a-day processing mill at [illegible], N. Mex., and with a contract extending through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

Atlas Corp., operates a [illegible] ton-a-day processing mill at [illegible], Utah, and with a contract extending through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

Rare Earths Inc., operates a [illegible] ton-a-day processing mill at [illegible], Utah, and with a contract extending through December 31, 1966. There remained approximately [illegible] pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $[illegible] per pound. Post-1962 quantity contracted for is [illegible] pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $[illegible].

[illegible] footnote on page 494.

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...quehanna-Western, Inc., now building a new 200 ton-a-day processing mill ... Falls City, Tex. This contract was executed July 25, 1960, and runs through ...mber 31, 1966. Starting with the opening of the mill, pre-1962 contract ...ity is 337,500 pounds of U_3O_8 at a unit price of $9.90 per pound. Post-1962 ...ly contracted for is 1,247,400 pounds of U_3O_8 at a unit price of $8.00 per ... Total cost of entire contract quantity is approximately $13,300,000.

...nium Reduction Co., operates a 1,500 ton-a-day processing mill at Moab, ... and with a contract extending through December 31, 1966. There remained ...imately 6,175,500 pounds of U_3O_8 to be delivered between July 1, 1960 and ... 1, 1962, at a unit price subject to upward or downward changes in accord- ... with an incentive-type formula. The current price is $8.15 per pound. ...1962 quantity contracted for is 14,773,000 pounds of U_3O_8 at a unit price of ... per pound. Total cost of remaining contract quantity from July 1, 1960, is ...imately $169,000,000.

... Construction and Mining Co. (formerly Lucky Mc Uranium Corp.), ...es a 980 ton-a-day processing mill in Fremont County, Wyo. This contract ... through December 31, 1966. There remained approximately 2,961,400 ... of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit ... of $7.90 per pound. Post-1962 quantity contracted for is 8,432,700 pounds ...$_8$ at a unit price of $8.00 per pound. Total cost of remaining contract ... from July 1, 1960 is approximately $91,000,000.

... Nuclear Corp., operates an 845 ton-a-day processing mill at Jeffrey ...Wyo., and with a contract running through December 31, 1966. There ...ed approximately 2,828,600 pounds of U_3O_8 to be delivered between July ... and April 1, 1962, at a unit price of $7.72 per pound. Post-1962 quantity ...ted for is 8,526,900 pounds of U_3O_8, at a unit price of $8.00 per pound. ... cost of remaining contract quantity from July 1, 1960, is approximately ...00.

Remaining Contracts

...ximate quantities and prices are given in the following summaries of ...al mill contracts for the twelve contracts under review. Except as ... noted, the prices stated in the following contracts are base prices ...s are subject to escalation up or down depending on the grade of ore fed ... All of these contracts require the milling companies to accept certain ...es of amenable ore from independent producers.

...ntake-New Mexico Partners, operates a 750 ton-a-day processing mill in ...ts, N. Mex., area. The current contract extends through March 31, ... There remained approximately 3,459,600 pounds of U_3O_8 to be delivered ... July 1, 1960 and April 1, 1962 at a unit price of $8.31 per pound. Total ... remaining contract quantity from July 1, 1960, is approximately ...00.

... Nuclear Fuels Corp.,[1] a combine of four companies (Kerr-McGee Oil ..., Inc., Pacific Uranium Mines Co., Anderson Development Corp., and ... Lake Uranium Corp.), operates a 3,300 ton-a-day processing mill in the ...rea of New Mexico with a contract extending through December 31, 1966. ...ained approximately 16,269,000 pounds of U_3O_8 to be delivered between ...1960 and April 1, 1962 at a unit price of $7.46 per pound. Post-1962 ... contracted for is approximately 21,375,000 pounds of U_3O_8 at a unit ...8.00 per pound. Total cost of remaining contract quantity from July ... approximately $292,000,000.

...note on page 494.

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Lakeview Mining Co., operates a 210 ton-a-day processing mill at Lakeview, Oreg., with a contract extending through November 30, 1963. There remains approximately 805,000 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962 at a fixed unit price of $9.27 per pound for company-controlled ores. Post-1962 quantity contracted for is 766,600 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $13,600,000.

Mines Development, Inc., operates a 400 ton-a-day processing mill at Edgemont, S. Dak., with a contract extending through March 31, 1962. There remains approximately 938,600 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962 at a unit price of $9.87 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $9,300,000.

Rare Metals Corp. of America, operates a 300 ton-a-day processing mill at Tuba City, Ariz. This contract extends through March 31, 1962. There remained approximately 1,096,000 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962 at a unit price subject to upward or downward change in accordance with an incentive-type formula. The current price is $10.70 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $11,700,000.

Susquehanna-Western, Inc.,[1] operates a 500 ton-a-day processing mill at Riverton, Wyo., with a contract extending through October 31, 1963. There remained approximately 1,435,000 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.74 per pound. Post-1962 quantity contracted for is 1,298,300 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $22,900,000.

Texas-Zinc Minerals Corp., operates a 1,000 ton-a-day processing mill at Mexican Hat, Utah. This contract extends through December 31, 1966. There remained approximately 3,097,500 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $8.95 per pound. Post-1962 quantity contracted for is 8,407,500 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $95,000,000.

Trace Elements Corp., operates a 300 ton-a-day processing mill at Maybell, Colo., with a contract extending through March 31, 1962. There remained approximately 1,255,500 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $9.29 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $11,700,000.

Union Carbide Nuclear Co., operates a 1,000 ton-a-day processing mill at Rifle, Colo., with a contract extending through March 31, 1962. There remained approximately 5,772,800 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $9.65 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $56,000,000.

Union Carbide Nuclear Co., operates a 1,000 ton-a-day processing mill at Uravan, Colo., with a contract extending through March 31, 1962. There remained approximately 2,490,500 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962, at a unit price of $9.65 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $24,000,000.

Vanadium Corp. of America, operates a 750-ton-a-day processing mill at Durango, Colo. This contract extends through March 31, 1962. There remained approximately 1,750,000 pounds of U_3O_8 to be delivered between July 1, 1960 and April 1, 1962 at a fixed unit price of $9.27 per pound for company-controlled ores. Post-1962 quantity contracted for is 766,600 pounds of U_3O_8 at a unit price of $8.00 per pound. Total cost of remaining contract quantity from July 1, 1960 is approximately $13,600,000.

[1] See footnote on page 494.

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1, 1962 at a fixed unit price of $8.02 per pound. Total cost of remaining
ract quantity from July 1, 1960 is approximately $14,000,000.

ffro Chemical Co., operates a 600 ton-a-day processing mill at Salt Lake City,
with a contract extending through March 31, 1962. There remained
ximately 1,403,100 pounds of U_3O_8 to be delivered between July 1, 1960 and
1, 1962 at a unit price of $9.69 per pound. Total cost of remaining con-
quantity from July 1, 1960 is approximately $13,600,000.

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APPENDIX 20

Status and Prospects of Gas Centrifuge Technology

Statement by John A. McCone, Chairman

After careful study and discussions with many qualified scientists about the gas centrifuge process, it is my conclusion that practical use of this method by any nation for producing weapons material is several years away. There is an enormous amount of development work still to be done. We foresee that the centrifuge ultimately can be used to separate uranium 235 from uranium 238 to produce weapons-grade materials. But this cannot be done satisfactorily with present technology. We do not think that the problems that remain are insurmountable but they certainly will take time to solve.

This process will not be simple nor cheap. Apparently, as we see the problem of future development it will take thousands of gas centrifuge machines to produce material for weapons. With auxiliaries, these machines might cost several thousand dollars each.

A country that is advanced scientifically and industrially would require a number of years—perhaps as many as eight—to perfect the gas centrifuge to the point where it could produce enough material for a nuclear weapon. Less industrialized countries will take much longer; the period of time depends upon how much outside assistance they receive.

We do not minimize the potential importance of this process, however. Although the gas centrifuge does not pose an immediate prospect for production of weapons material, there is no doubt in my mind it will introduce an additional complicating factor in the problems of nuclear arms among nations and our hopes for controlled disarmament. If successfully developed, a production plant employing the gas centrifuge method could be simply housed. Its power requirements would be relatively small, and there would be no effects of the operation which would easily disclose the plant. Therefore, a clandestine plant would not be as easy to detect as a gaseous diffusion plant.

The attached comprehensive report by the Commission on the gas centrifuge process has been prepared to elaborate further on this matter and to place it in better perspective.

AEC Report on Status of Gas Centrifuge Technology

The following report on the status of technology on the gas centrifuge method for the separation of isotopes discusses the principle of the gas centrifuge, the possible advantages of this process and its possible use in the production of weapons material. The report also outlines the development work being done by the United States and other countries and lists some of the problems which still must be solved.

I. Principle of the Gas Centrifuge

The theory of the gas centrifuge process is to pass uranium in gaseous form (uranium hexafluoride) through a centrifuge which spins at very high

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is a slight difference in the weight of the uranium 238 and uranium 235 Consequently, it is theoretically possible to separate these isotopes one can separate cream from milk by centrifugation. It must be ized, however, that although the same principle is involved, the gas uge is a good deal more complex than the "cream separator" or other industrial centrifuges.

the uranium 235 portion of natural uranium (U^{235}) is fissionable be used for weapons purposes. Uranium 235 constitutes only 0.7 of ntage point of natural uranium. The other 99.3 percent of uranium no use for weapons. Therefore, it is necessary to separate the uranium uranium 238.

SIBLE ADVANTAGES

possible advantages of the gas centrifuge method, as compared with seous diffusion process we now use for uranium isotope separation, are ential lower requirement of a centrifuge plant for electric power and its l requirement for fewer units in series in order to produce the desired ent of uranium 235. Further, it appears to be particularly well suited apacity installations.

centrifuge process has the interesting theoretical property that the e work performed varies with the fourth power of the speed, all other being equal. This means that doubling the speed would, in theory, the separative work performed by the unit by a factor of 16. potential, as progress is made in materials of construction and equip- ign, enthusiasm rises for the application of this process to the separation isotopes. In at least one respect this is a desirable situation since processes should be developed for uranium 235 separation as a step ssible improvement in the economics of nuclear power.

FOR WEAPONS MATERIAL

ew by the Commission of available information on the gas centrifuge built both here and abroad indicates that these machines cannot now in a production plant without further development work. So far, units have been operated only as single laboratory models for isotope These machines are complex and expensive.

after substantial improvements have been made, thousands of gas probably would be required to produce enough enriched uranium rude weapon per year. Including auxiliaries, a plant of this type several thousand dollars per centrifuge. Compared with development ited States, the time period would be much longer for a country not engaged in centrifuge research and development and not having dvanced technical and industrial capability.

LOPMENT PROBLEMS

reas in which problems still must be solved before a satisfactory ossible with the current centrifuges include:

ility of the present experimental machines for continuous, long ervice with uranium hexafluoride must be proved out.

del of the machine satisfactory for mass production of identical units e developed.

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(3) A method must be developed to provide for the introduction and re
of gas when the machines are grouped as would be necessary in a pr
tion plant.
(4) The auxiliary processes, services and instrumentation necessary for
operations have to be determined.

None of these problems is simple to solve. Excellent technical and in
trial talent are required.

V. Development Work by United States

The United States has followed development of this process for some
The gas centrifuge was one of the methods investigated during World War
Development work on the centrifuge method had not progressed so far as
methods when it became necessary to select the processes to be used in pr
tion plants. The United States temporarily discontinued work on the centri
and went ahead with gaseous diffusion, thermal diffusion and the electr
magnetic methods for production of uranium 235.

Although the United States ultimately continued to employ the gas
diffusion method as the most economical process available, the Commission
not lost sight of the gas centrifuge's possibilities. The AEC resumed research
the centrifuge method in 1953 and expanded this work gradually as the tech
nology advanced. Most of the Commission's research work has been carried
out at the University of Virginia.

As the technology advances, it will be possible to make more realistic
praisals of the economic attractiveness of this method for the separation
uranium 235. The Commission has recently increased the United States effort
on the development of the centrifuge program. It is now expected that the
total effort will be at a level of roughly $2 to $3 millions per year. Because
of its potential significance to production of weapons materials, however, the
program is classified.

The technology of centrifuge separation is not now developed to a point
where this process can produce uranium 235 at a cost competitive with the
product from AEC's current gaseous diffusion plants. On the other hand,
projections of possible gains in the gas centrifuge process indicate the possi
bility that the process may become attractive from the economic standpoint
in the future. However, this would require very substantial further advances
in the technology. In this country, the gaseous diffusion method remains
the most economical process for large-scale production of uranium 235 at this
time.

Since there has been considerable commercial interest expressed in possi
ble industrial application of the gas centrifuge process to the development of
economic nuclear power, the Commission has approved a program under
which private industry in the United States will be permitted to work on
the centrifuge process with private funds, under appropriate conditions of
security.

VI. Work in Other Countries

Scientists in West Germany and the Netherlands also have worked to
develop the potential of the gas centrifuge process for its

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...ecessary in a ...

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... technical and ...

process for some ...
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gressed so far as ...
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...le, the Commission ...
EC resumed research ...
... gradually as the ...
work has been ...

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the United States ...
... now expected that ...
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materials, however, ...

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ost competitive with ...
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the economic stand...
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n of uranium 235 as ...

erest expressed in ...
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...proved a program ...
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ppropriate conditions ...

...lds also have ...
ocess for its ...

and commercial possibilities. They have been particularly interested in the potential of the centrifuge for the production of low enriched ...m for civilian research and power reactors.

...July of 1900 representatives of the Department of State and of the Atomic ...Commission discussed centrifuge technology with the West German ...Netherlands Governments and the United States asked that Germany ...the Netherlands give consideration to the control of gas centrifuge technology. The two countries shared the concern of the United ...over the possible application of the centrifuge process for weapons ...sion.

...West German Government recently announced that it has taken steps ...trol the dissemination of information on the gas centrifuge process. ...United States understands that the Netherlands Government is actively ...the question of applying controls to its work.

...United States also discussed the gas centrifuge question with the ...Kingdom. The United Kingdom follows classification criteria simi... those of the United States on the gas centrifuge process.

...ERE METHODS FOR PRODUCING FISSIONABLE MATERIAL

...are already two methods—available today—to produce weapons ma... These proven methods are (1) the gaseous diffusion method of pro...enriched uranium and (2) the use of reactors, which produce plutonium. ...nuclear powers, the United States, the United Kingdom and the ...nion, have built gaseous diffusion plants to produce uranium 235 ...pons purposes. In each case this has been a very costly undertaking ...each case the technology has been held very secret. Gaseous diffusion ...are inherently of substantial capacity and require very large amounts ...trical power. For various reasons, it is unattractive for many coun... proceed with the necessary effort to build even a small gaseous dif...plant.

...for example, while planning to build a gaseous diffusion plant, ...its first nuclear device from plutonium produced in reactors fueled ...ral uranium.

...logy applicable to the production of plutonium in reactors has been ...seminated in the course of the program for the development of the ...ses of the atom, and this technology could be used to assist any ...attaining a weapons capability.

...example, it is possible for a country to develop a plutonium production ...to produce one crude weapon per year with an investment on ...of $50 million.

...plication of plutonium technology, the additional development work ...construction of a small plutonium production complex would not be ...sk. In order to accomplish this within a period of four to five ...country must have a substantial technical and industrial capability ...l, or it must receive assistance from a country that has such a ...

...TROL PROBLEM

...ited States has supported broad international safeguards to insure ...ium, as well as any other nuclear material used or produced in ...rograms, are not diverted to weapons uses.

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The General Conference of the International Atomic Energy Agency, ... met in Vienna in September, endorsed proposed safeguards to apply to ... actors and special nuclear materials that will be subjected to IAEA ... The principle of these safeguards can be extended to apply to the ... centrifuge.

The United States also has sought agreement among supplier nations ... natural uranium to control international traffic in this material to ... that it will be used only for peaceful purposes. In over forty bilateral ... agreements for cooperation in civil uses of atomic energy, the United States ... has obtained guarantees from its cooperating partners that any material ... equipment received or produced as a result of such cooperation will not be ... used for military purposes. The United States has been given rights of in- ... spection in order to assure that these guarantees are met.

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EMORANDUM FOR CHA
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The Annual Financial Re... year 1960 is transmitted ... setting forth the financia... operations for fiscal year ... These financial statement... by the AEC internal audit ...

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Energy Agency, which
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cooperation will not
been given rights of

APPENDIX 21

(COMMISSION'S FINANCIAL REPORT FOR FISCAL YEAR 1960

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D. C.

September 30, 1960

MEMORANDUM FOR CHAIRMAN McCONE
COMMISSIONER GRAHAM
COMMISSIONER WILSON
COMMISSIONER OLSON

The Annual Financial Report of the Atomic Energy Commission for fiscal year 1960 is transmitted herewith. The report contains financial statements setting forth the financial position of AEC at June 30, 1960, the results of operations for fiscal year 1960 and other unclassified financial information. These financial statements have been independently examined and certified by the AEC internal audit staff.

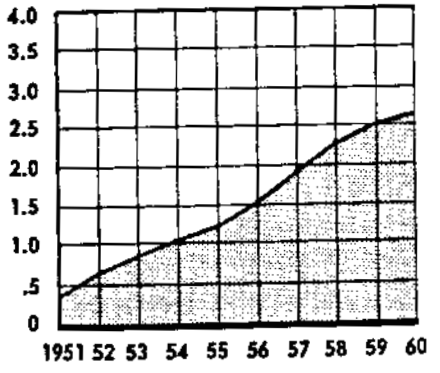
Don S. Burrows

DON S. BURROWS
Controller

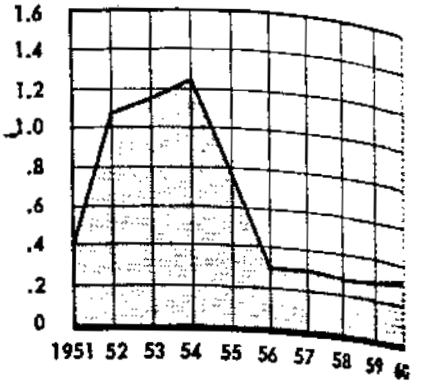
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COST OF OPERATIONS



PLANT & EQUIPMENT EXPENDITURES

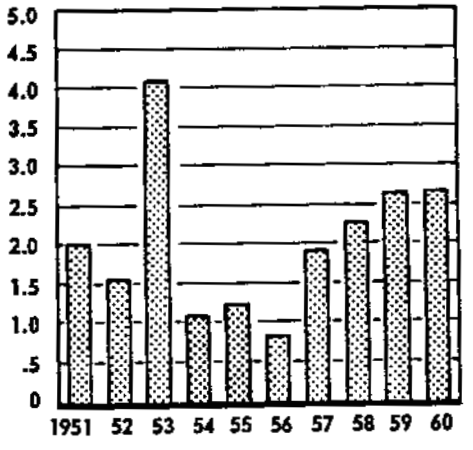


FINANCIAL TRENDS

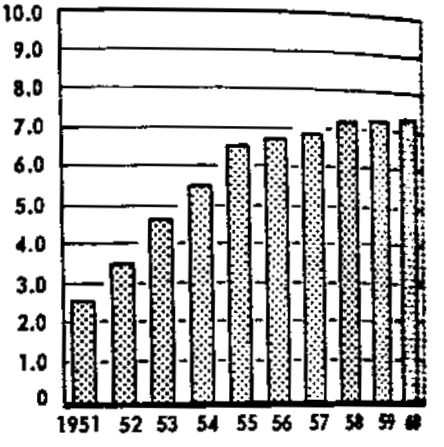
FISCAL YEARS 1951 - 1960

(BILLIONS OF DOLLARS)

FUNDS APPROPRIATED - NET



PLANT INVESTMENT AT JUNE 30

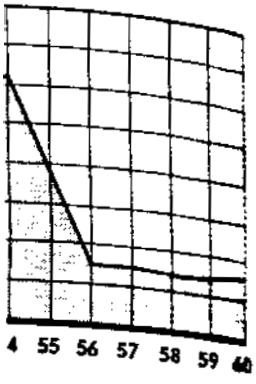


Highlights

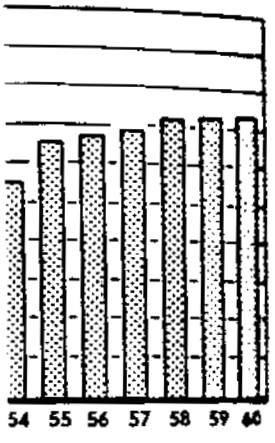
- Procurement and productio of AEC costs. In 1960 thes operating costs.
- Development of power and million in 1960. Costs in 19
- A measure of AEC's efforts the growth in the value of n In 1960 this totaled $99 mill
- The cost of physical resear million was for controlled th physics.
- The effects of radiation in th continued to be studied. In 1959 were $43 million.
- Additional plant now under c

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IIPMENT EXPENDITURES



MENT AT JUNE 30



Highlights

Procurement and production of nuclear materials continue to provide the major portion of AEC costs. In 1960 these activities cost $1.4 billion or 55 per cent of AEC's total operating costs.

Development of power and propulsion reactors and other reactor research cost $399 million in 1960. Costs in 1959 were $356 million.

A measure of AEC's efforts to develop peaceful uses of atomic energy is indicated by the growth in the value of materials leased domestically and to foreign organizations. In 1960 this totaled $99 million compared to $72 million in 1959.

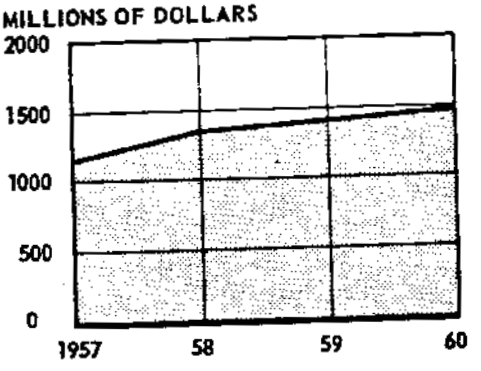
The cost of physical research amounted to $133 million in 1960. Of this amount $32 million was for controlled thermonuclear research, and $32 million was for high energy physics.

The effects of radiation in the environment — air, land, and water — on living organisms continued to be studied. In 1960 costs for this research totaled $49 million. Costs in 1959 were $43 million.

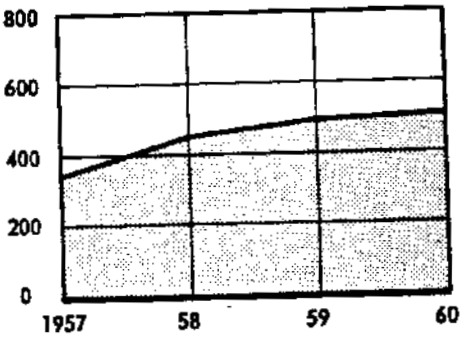
Additional plant now under construction or authorized totaled $1.2 billion.

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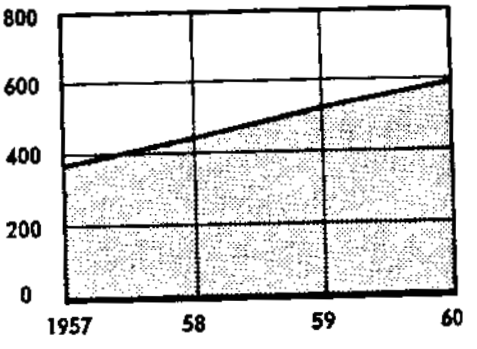
COST TRENDS



PROCUREMENT & PRODUCTION OF NUCLEAR MATERIALS



WEAPONS DEVELOPMENT & FABRICATION



REACTOR DEVELOPMENT & OTHER RESEARCH

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960 and $11 million in 195
sotopes
ther special materials

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ompleted plant and equipmen
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onstruction work in progress

EPAYMENTS AND SPECIAL I

TOTAL ASSETS

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Financial Statements

UNITED STATES ATOMIC
COMPARATIVE

ASSETS	June 30, 1960	June 30, 1959
	(in thousands)	
...ES IN U. S. TREASURY	$1,510,056	$1,483,389
...CATIONS FROM OTHER FEDERAL AGENCIES	105,129	166,196
...E ON HAND AND WITH CONTRACTORS	27,812	29,958
...UNTS RECEIVABLE (less allowance for uncollectible ... amounts of $80 thousand in 1960 and $183 thousand in ...)	16,906	12,246
...FROM OTHER FEDERAL AGENCIES	10,491	4,821
...NTORIES		
...ium and nuclear materials leased and at research ...allations	459,326	402,390
...ecial reactor material	102,940	111,934
...ials (less allowance for loss of $12 million in ...958 and $11 million in 1959)	93,953	91,346
...erials	9,864	8,634
...ther special materials	19,910	18,050
	685,993	632,354
...ty		
...pleted plant and equipment	7,018,062	7,043,027
...s-Accumulated depreciation	2,005,589	1,900,265
	5,012,473	5,142,762
...struction work in progress	326,689	249,757
	5,339,162	5,392,519
...MENTS AND SPECIAL DEPOSITS	45,080	43,287
TOTAL ASSETS	$7,740,629	$7,764,770

...ODUCTION
...TERIALS

...S DEVELOPMENT
...ABRICATION

REACTOR DEVELOPMENT
& OTHER RESEARCH

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ENERGY COMMISSION
BALANCE SHEET

LIABILITIES AND AEC EQUITY	June 30, 1960	June [illegible]
	(in thousands)	
LIABILITIES		
Accounts payable and accrued expenses	$ 262,975	$ [illegible]
Advances from other Federal agencies	91,547	[illegible]
Funds held for others	9,747	[illegible]
Deferred credits	1,784	[illegible]
TOTAL LIABILITIES	366,053	[illegible]
AEC EQUITY, JULY 1	7,363,566	[illegible]
Additions		
Funds appropriated—net	2,649,614	[illegible]
Nonreimbursable transfers from other Federal agencies	3,187	[illegible]
	2,652,801	[illegible]
Deductions		
Net cost of operations	2,665,654	[illegible]
Less—Costs charged to inventories of source and nuclear materials leased and at research installations	84,384	[illegible]
	2,581,270	[illegible]
Nonreimbursable transfers to other Federal agencies	60,448	[illegible]
Funds returned to U. S. Treasury	73	[illegible]
	2,641,791	[illegible]
AEC EQUITY, JUNE 30	7,374,576	[illegible]
TOTAL LIABILITIES AND AEC EQUITY	$7,740,629	[illegible]

The notes on the following page are an integral part of this statement.

1 The balance sheet does not i
2 Certain inventories for s
3 84,751,316 troy ounces o
use as electrical conducto
silver had a value of $59.
4 Plant and equipment on
$100 million.
5 Contested claims against
6 The balance sheet does not i
7 Contingent liabilities rel
Ridge, Paducah, and Por
given at June 30, 1960, the
8 Contingent liabilities as g
9 Contingent liabilities for
approximately $13.2 milli
10 Commitments for accrued
11 Commitments for payme
Atomic Bomb Casualty
nability would have amoun
12 Under provisions of Secti
the delivery of domestic u
minimum prices for uraniu
April 1, 1962 to Decembe
$8 per pound has been e
1962 and before Decembe
through 1966 for the purc
and overseas sources. Th
at June 30, 1960.
13 Commitments under Secti
special nuclear material
mount of the commitmen
price established for the
delivered by domestic licer
14 Outstanding contracts, pur
obligations of $944 million

5007098

, 1960	June 30, 19[illegible]
(in thousands)	
2,975	$ 232,[illegible]
1,547	
9,747	158,[illegible]
1,784	[illegible]
	1,[illegible]
6,053	401,[illegible]
33,566	7,[illegible]
19,614	2,[illegible]
3,187	[illegible]
52,801	2,[illegible]
65,654	2,[illegible]
84,384	[illegible]
581,270	2,[illegible]
60,448	[illegible]
73	[illegible]
541,791	2,[illegible]
374,576	7,[illegible]
740,629	$7,[illegible]

NOTES TO THE BALANCE SHEET

The balance sheet does not include in assets:

a. Certain inventories for security reasons.

b. 84,751,816 troy ounces of silver loaned to AEC by the Treasurer of the United States for use as electrical conductors in plants. Based on market quotations at June 30, 1960, this silver had a value of $59.2 million.

c. Plant and equipment on loan from other Federal agencies at June 30, 1960 amounting to $180 million.

d. Contested claims against others of $1.1 million.

The balance sheet does not include in liabilities:

a. Contingent liabilities related to contracts for the supply of electric power for the Oak Ridge, Paducah, and Portsmouth production facilities. If cancellation notice had been given at June 30, 1960, the estimated liabilities would have amounted to $316 million.

b. Contingent liabilities as guarantor of loans to the extent of $65 million.

c. Contingent liabilities for claims against the Federal government or AEC contractors of approximately $13.2 million.

d. Commitments for accrued annual leave of AEC employees of $6.6 million.

e. Commitments for payment of involuntary termination allowances to employees of the Atomic Bomb Casualty Commission. If terminated at June 30, 1960, the estimated liability would have amounted to $652 thousand.

f. Under provisions of Section 66 of the Atomic Energy Act of 1954, AEC has contracts for the delivery of domestic uranium concentrates through March 31, 1962, and has guaranteed minimum prices for uranium ores through March 31, 1962 and concentrates for the period April 1, 1962 to December 31, 1966. Subject to certain specified limitations, a price of $[illegible] per pound has been established for U_3O_8 in concentrates delivered after March 31, 1962 and before December 31, 1966. The Commission also has long-term commitments through 1966 for the purchase of U_3O_8 in concentrates and orange oxide from Canadian and overseas sources. The commitments for procurement of uranium totaled $2.9 billion at June 30, 1960.

g. Commitments under Section 52 of the Atomic Energy Act of 1954 for the acquisition of special nuclear material within or under the jurisdiction of the United States. The amount of the commitments is $8 million at June 30, 1960, based upon estimates (at the prices established for the period ending June 30, 1963) of plutonium to be produced and delivered by domestic licensees during the period for which prices have been established.

h. Outstanding contracts, purchase orders, and other commitments represented by unpaid obligations of $944 million.

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UNITED STATES ATOMIC ENERGY COMMISSION
COMPARATIVE STATEMENT OF OPERATIONS

(includes depreciation)

	Fiscal Year Ended June 30, 1960	June 30, 19[illegible]
	(in thousands)	
Production		
Procurement of raw materials	$ 716,507	$ [illegible]
Production of nuclear materials	731,348	[illegible]
Weapons development and fabrication	505,448	[illegible]
	1,953,303	[illegible]
Development of nuclear reactors		
Civilian nuclear power development	117,786	[illegible]
Naval propulsion	88,799	[illegible]
Aircraft propulsion	69,687	[illegible]
Missile propulsion	31,777	[illegible]
Auxiliary power sources	11,480	[illegible]
Army reactors	11,965	[illegible]
Merchant ships	7,424	[illegible]
General research and development	60,334	[illegible]
	399,252	[illegible]
Research		
Physical research	132,845	[illegible]
Biology and medicine research	48,878	[illegible]
Peaceful application of nuclear explosives	6,392	[illegible]
Isotope development	3,808	[illegible]
	191,923	[illegible]
Community Operations		
Expenses	17,582	[illegible]
Revenues	(10,492)	[illegible]
	7,090	[illegible]
Sales of materials and services		
Cost	12,192	[illegible]
Revenue	(14,726)	[illegible]
	(2,534)	[illegible]
Education and training	7,675	[illegible]
AEC administrative expenses	51,197	[illegible]
Security investigations	7,057	[illegible]
Other expenses – net	4,180	[illegible]
Net cost of operations*	2,619,143	[illegible]
Special Items		
Transfer of community property	43,958	[illegible]
Adjustments to costs of prior year – net	2,553	[illegible]
Net cost of operations – after special items	$2,665,654	[illegible]

* Includes depreciation of $284 million in 1960 and $285 million in 1959.

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FINANC

U.
IN T

Appropriation payments – ne
National Defense Researc
Office of Scientific Resea
War Department (includin
Fiscal year 1943
Fiscal year 1944
Fiscal year 1945
Fiscal year 1946
Fiscal year 1947 – part

Atomic Energy Commissi
Fiscal year 1947 – part
Fiscal year 1948
Fiscal year 1949
Fiscal year 1950
Fiscal year 1951
Fiscal year 1952
Fiscal year 1953
Fiscal year 1954
Fiscal year 1955
Fiscal year 1956
Fiscal year 1957
Fiscal year 1958
Fiscal year 1959
Fiscal year 1960

Total payments – net

Unexpended balance of funds i
June 30, 1960*

Total funds appropriate

Less
Collections paid to U. S. Tr
Property and services trans
without reimbursement, n
other Federal agencies
Cost of operations including
from June 1940 through Ju

AEC Equity at June 30, 1960 a

* Appropriations of $2,664 m
† Excludes $7.2 million net tr

U. S. GOVERNMENT INVESTMENT IN THE ATOMIC ENERGY PROGRAM

From June 1940 through June 1960

	Amount (in millions)	
Appropriation payments – net		
National Defense Research Council	$ .5	
Office of Scientific Research and Development	14.6	
War Department (including Manhattan Engineer District)		
Fiscal year 1943	77.1	
Fiscal year 1944	730.3	
Fiscal year 1945	858.6	
Fiscal year 1946	366.3	
Fiscal year 1947 – part	186.0	
		$ 2,233.4
Atomic Energy Commission		
Fiscal year 1947 – part	146.1	
Fiscal year 1948	477.6	
Fiscal year 1949	627.3	
Fiscal year 1950	534.3	
Fiscal year 1951	920.5	
Fiscal year 1952	1,669.4	
Fiscal year 1953	1,812.7	
Fiscal year 1954	1,930.5	
Fiscal year 1955	1,861.8	
Fiscal year 1956	1,633.4	
Fiscal year 1957	1,931.3	
Fiscal year 1958	2,267.9	
Fiscal year 1959	2,541.1	
Fiscal year 1960	2,622.8	
		20,976.7
Total payments – net		23,210.1
Unexpended balance of funds in U. S. Treasury June 30, 1960*		1,510.1
Total funds appropriated		24,720.2†
Collections paid to U. S. Treasury	54.1	
Property and services transferred to other Federal agencies without reimbursement, net of such transfers received from other Federal agencies	145.0	
Cost of operations including depreciation and obsolescence from June 1940 through June 30, 1960	17,146.5	
		17,345.6
Net Equity at June 30, 1960 as shown on Balance Sheet		$ 7,374.6

*Appropriations of $2,664 million for fiscal year 1961 were approved September 2, 1960.
†Includes $7.2 million net transfers from AEC appropriations to other Federal agencies.

Operations

PROCUREMENT OF RAW MATERIALS

Uranium and other raw materials procured in fiscal year 1960 cost $717 million as compared with $700 million in 1959.

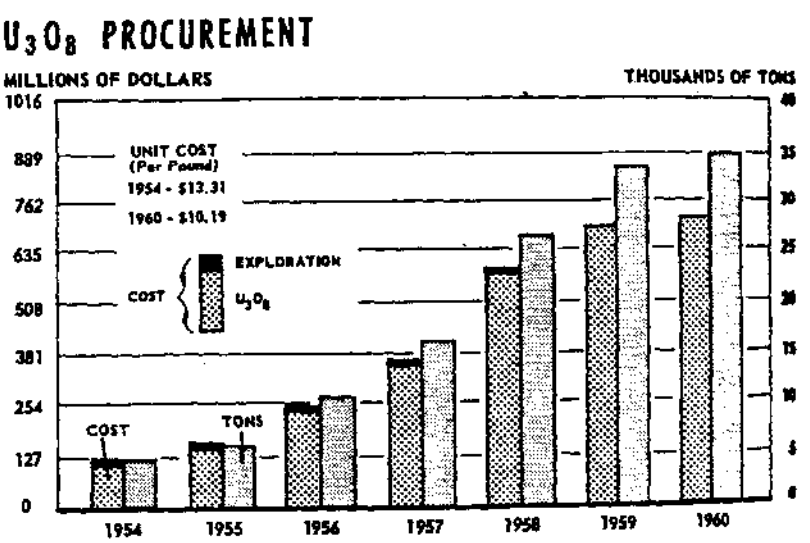
URANIUM CONCENTRATES (U_3O_8)

The total quantity of uranium concentrates purchased in fiscal year 1960 increased 4 per cent over 1959. Foreign purchases remained at the 1959 level but domestic purchases increased 9 per cent. The average cost of U_3O_8 decreased 15 cents to $10.19 per pound.

	Total Cost		Quantity		Average Cost	
	1960	1959	1960	1959	1960	1959
	(in thousands)		*(tons U_3O_8)*		*(dollars per lb.)*	
Domestic	$297,800	$285,168	16,567	15,162	$ 8.99	$ 9.40
Canadian	296,796	293,618	13,443	13,506	11.04	10.87
Overseas	109,852	110,294	4,572	4,658	12.01	11.84
Total	$704,448	$689,080	34,582	33,326	$10.19	$10.34

The costs shown above represent all costs incurred by the Commission in connection with procurement of uranium concentrates, including bonus payments to miners for the stimulation production of ore. The prices paid to suppliers for U_3O_8 produced in privately owned domestic mills averaged $8.78 per pound in fiscal year 1960 as compared with $9.18 in fiscal year 1959.

The chart below shows the cost and quantities of U_3O_8 procured in fiscal years 1954 through 1960.



5007182

PRODUCTION OF SPECIAL NUCLEAR MATERIALS

...tal cost of production of special nuclear materials including uranium-235, plutonium, and ... materials to meet the weapons production schedule, other military needs, and the re... for peaceful uses of atomic energy increased in 1960 to $731 million compared ... $713 million in 1959, an increase of 2.5 per cent. Although the total cost increased, the ... cost of production continued to decrease in 1960.

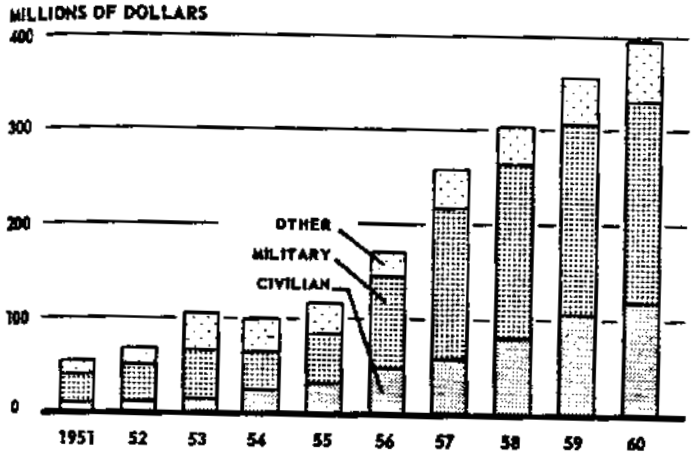
WEAPONS DEVELOPMENT AND FABRICATION

...ost of development and fabrication of weapons, weapons parts, weapons storage, surveil... and directly related activities, was $505 million in fiscal year 1960 as compared with ... million in fiscal year 1959. These amounts exclude the cost of source and special nuclear ...ials contained in weapons or used in weapons research. The investment in completed ... and equipment for weapons production, research, and storage at June 30, 1960 was $803 ...

REACTOR DEVELOPMENT

...mic Energy Commission continued to develop nuclear reactors for both military and ... uses. The total cost in 1960 amounted to $399 million compared with $356 million in ... The following chart shows the growth in reactor development from 1951 through 1960.

DEVELOPMENT OF NUCLEAR REACTORS



...below compares the cost of reactor development in 1951 with 1960.

	1960	1951
	(in millions)	
Civilian	$118	$ 3
Military	213	30
Other	68	11
	$399	$44

...972—61——34

5007103

REACTOR DEVELOPMENT COST SUMMARY

	Research and Development Costs*			Capital Costs†		
	Cumulative through June 30, 1960	Fiscal Year 1960	Fiscal Year 1959	Cumulative through June 30, 1960	Additional Construction Authorized	
	(in millions)					
CIVILIAN NUCLEAR POWER REACTORS						
Pressurized light water	$ 125.0	$ 22.1	$ 26.1	$ 50.0	$ 25.0	$
Boiling light water	39.8	10.5	5.9	9.4	27.1	
Heavy water	36.4	17.9	10.8	23.3	7.1	
Organic moderated	23.9	8.4	6.1	3.4	11.6	
Gas cooled	32.3	19.0	9.5	5.2	24.8	
Sodium cooled	111.1	27.5	24.3	35.3	26.9	
Fluid fuel	102.9	10.0	21.6	4.1	.1	
Other studies & development	4.3	2.4	1.0	2.6	3.9	
Total	475.7	117.8	105.3	133.3	126.5	
ARMY REACTORS						
Pressurized water	7.0	2.6	1.7	3.1	6.5	
Boiling water	3.4	1.0	.8	1.7	.3	
Gas cooled	19.0	6.8	6.4	1.7	.8	
Other studies & development	2.9	1.6	.5	.8	.2	
Total	32.3	12.0	9.4	7.3	7.8	
MERCHANT SHIP REACTORS	14.6	7.4	4.7	14.7	11.6	
AIRCRAFT REACTORS						
Manned Aircraft						
Direct cycle	220.4	42.6	50.3	31.6	17.9	
Indirect cycle	156.7	22.8	17.0	.9		
Other studies & development	24.2	4.3	4.5	5.5		
Total	401.3	69.7	71.8	38.0	17.9	

REACTOR D

	Cum thr June
MISSILE PROPULSION	
Rocket (Project Rover)	$
Ramjet (Project Pluto)	
Total	
AUXILIARY POWER SOURCES	
NAVAL REACTORS	
Submarines	
Large ship prototype	
Guided missile cruiser	
Destroyer prototype	
Other studies & development	
Total	
GENERAL	
Total reactor development costs	$2,

*Includes AEC depreciation
† Equipment has not been al

5007104

REACTOR DEVELOPMENT COST SUMMARY (CONTINUED)

	Research and Development Costs*			Capital Costs†		
	Cumulative through June 30, 1960	Fiscal Year 1960	Fiscal Year 1959	Cumulative through June 30, 1960	Additional Construction Authorized	Total
	(in millions)					
MOBILE PROPULSION						
Rocket (Project Rover)	$ 49.0	$ 15.4	$ 14.0	$ 18.3	$ 32.5	$ 50.8
Ramjet (Project Pluto)	34.9	16.3	8.8	9.7	17.8	27.5
Total	83.9	31.7	22.8	28.0	50.3	78.3
AUXILIARY POWER SOURCES	24.4	11.5	7.7	2.3	1.2	3.5
NAVAL REACTORS						
Submarines	327.1	31.1	35.6	129.3	19.4	148.7
Large ship prototype	117.6	21.0	25.9	33.3	1.7	35.0
Guided missile cruiser	11.4	2.3	3.0			
Destroyer prototype	42.8	20.0	13.4	23.6	12.1	35.7
Other studies & development	57.9	14.4	12.7	7.6	.2	7.8
Total	556.8	88.8	90.6	193.8	33.4	227.2
GENERAL	437.3	60.4	43.3	318.2†	45.2	363.4
Total reactor development costs	$2,026.3	$399.3	$355.6	$735.6	$293.9	$1,029.5

*Includes AEC depreciation but does not include funding by other Federal agencies.
†Equipment has not been allocated but is included in the general category.

5007105

Cooperative Power Reactor Projects

In its Power Demonstration Reactor Program the Atomic Energy Commission cooperates with other organizations—both private and public—in nuclear power plant demonstration projects. On August 19, 1960, the reactor constructed by the Yankee Atomic Electric Company became critical and was thus the first nuclear power plant under the cooperative program to achieve criticality.

The table below and on the next page shows AEC and private industry participation in cooperative projects for the development and construction of nuclear power plants.

	Date of Criticality Plant Capacity ekw (net)	Cumulative Costs Through June 30, 1960		Total Estimated Costs	
		AEC Assistance	Participant's Costs	AEC Assistance*	Participant's Costs
		(in millions)			
Yankee Atomic Electric Company, Rowe, Mass.	August 1960 136,000 ekw				
Research and development		$ 4.8	$ .2	$ 5.0	$ .3
Plant, equipment and land			35.9		52.5
Waiver of use charges		.5		3.7	
Total		5.3	36.1	8.7	53.8
Power Reactor Development Company, Lagoona Beach, Michigan	December 1960 94,000 ekw				
Research and development			14.4		20.2
Plant, equipment and land			42.0		56.3
Waiver of use charges		1.0		3.7	
Total		1.0	56.4	3.7	76.5
Rural Cooperative Power Association, Elk River, Minnesota	November 1960 22,000 ekw				
Research and development		.2		2.2	
Plant, equipment and land		5.8	3.4	8.8	3.4
Fuel fabrication				.7	
Total		6.0	3.4	11.7	3.4
City of Piqua Piqua, Ohio	May 1961 11,400 ekw				
Research and development		3.5		4.7	
Plant, equipment and land		1.7	3.7	8.3	3.7
Fuel fabrication				1.2	
Total		5.2	3.7	14.2	3.7
Consumers Public Power District, Hallam, Nebr.	March 1962 75,000 ekw				
Research and development		12.9		21.1	
Plant, equipment and land		9.7	11.1	26.7	18.2
Fuel fabrication		.1		2.9	
Total		22.7	11.1	50.7	18.2
Northern States Power Co. Sioux Falls, S. D.					
Research and development					
Plant, equipment and land					
Waiver of use charges					
Total					
Carolinas-Virginia Nuclear Power Assoc., Inc. Parr, South Carolina					
Research and development					
Plant, equipment and land					
Waiver of use charge					
Total					
Central Nuclear Group, I Florida West Coast Nuclear Group, Western Fla.					
Research and development					
Plant, equipment and land					
Waiver of use charges					
Total					
Philadelphia Electric Co. York County, Pa.					
Research and development					
Plant, equipment and land					
Waiver of use charges					
Total					
Puerto Rico Water Resources Authority, Punta Higuera, Puerto Rico					
Research and development					
Plant, equipment and land					
Fuel fabrication					
Total					
Fast breeder technology					
Summary					
Research and development					
Plant, equipment and land					
Fuel fabrication					
Waiver of use charges					
Total					

*Includes estimated costs for

5007106

	Date of Criticality / Plant Capacity ekw (net)	Cumulative Costs through June 30, 1960		Total Estimated Costs	
		AEC Assistance	Participant's Costs	AEC Assistance*	Participant's Costs
		(in millions)			
Northern States Power Co. Sioux Falls, S. D.	June 1962 62,000 ekw				
Research and development		$ 4.3		$ 8.5	$ 1.2
Plant, equipment and land			$ 5.3		22.6
Waiver of use charges		.2		1.8	
Total		4.5	5.3	10.3	23.8
Carolinas-Virginia Nuclear Power Assoc., Inc. Parr, South Carolina	July 1962 16,950 ekw				
Research and development		3.9	1.2	13.9	7.5
Plant, equipment and land			.2		17.7
Waiver of use charge				1.2	
Total		3.9	1.4	15.1	25.2
Jersey Central Nuclear Group, Inc.-Florida West Coast Nuclear Group, Western Fla.	50,300 ekw				
Research and development		.9	1.3	11.7	18.0
Plant, equipment and land					28.9
Waiver of use charges				1.5	
Total		.9	1.3	13.2	46.9
Philadelphia Electric Co. York County, Pa.	December 1963 40,000 ekw				
Research and development		5.5	1.5	14.5	5.6
Plant, equipment and land			.7		29.2
Waiver of use charges				2.5	
Total		5.5	2.2	17.0	34.8
Puerto Rico Water Resources Authority, Punta Higuera, Puerto Rico	December 1962 16,300 ekw				
Research and development		.1		.8	.3
Plant, equipment and land		.1		9.6	3.6
Fuel fabrication				.6	
Total		.2		11.0	3.9
Fast breeder technology		1.8		4.5	
Summary	523,950 ekw				
Research and development		37.9	18.6	86.9	53.1
Plant, equipment and land		17.3	102.3	53.4	236.1
Fuel fabrication		.1		5.4	
Waiver of use charges		1.7		14.4	
Total		$57.0	$120.9	$160.1	$289.2

*Includes estimated costs for five years after operations commence.

5007107

Army Reactors

AEC costs of research, development, fuel fabrication, test operations, and other costs nec-
sary in developing compact, lightweight, economical power plants for military bases under
to $12 million in 1960 compared to $9 million in 1959.

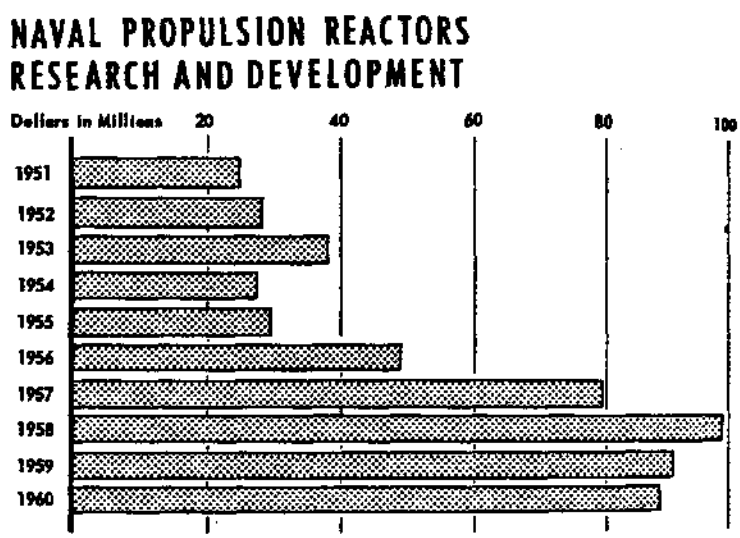
The following table shows a comparison of costs for 1960 and 1959 by reactor concept:

	Fiscal Year	
	1960	1959
	(in thousands)	
Gas-cooled	$6,811	$6,344
Pressurized water	2,531	1,706
Boiling water	1,009	791
General support and advanced studies	1,614	535
	$11,965	$9,376

Naval Propulsion Reactors

The development of nuclear propulsion plants and long-life reactor cores to meet naval require-
ments cost $89 million in 1960. The cost in 1959 was $91 million.

The chart below shows the change in total cost of research and development for naval propul-
sion reactors from 1951 to 1960.



5007108

...ble below shows costs for fiscal year 1960 and 1959 for research, development and op... of test facilities:

	Fiscal Year 1960	Fiscal Year 1959
	(in thousands)	
Submarines	$31,114	$35,601
Large ship prototype	20,951	25,826
Guided missile cruiser	2,332	3,011
Destroyer prototype	19,977	13,439
Operation of test facilities and other costs	14,425	12,737
	$88,799	$90,614

...ft Propulsion Reactors

...t of research, test operations and experiments of aircraft propulsion reactors was ...n in 1960 compared with $72 million in 1959.

...wing table compares costs of the direct cycle, indirect cycle and general research for ...1959:

	Fiscal Year 1960	Fiscal Year 1959
	(in thousands)	
Direct cycle reactor	$42,566	$50,361
Indirect cycle reactor	22,797	16,975
General research and development	4,324	4,486
Total	$69,687	$71,822

...k Propulsion Reactors

...t of research and development of missile propulsion systems increased to $32 million ...from $23 million in 1959, an increase of $9 million. As shown in the table below this ...e is largely due to cost of research and development of the ramjet approach.

	Fiscal Year 1960	Fiscal Year 1959
	(in thousands)	
Rocket (Project Rover)	$15,462	$14,010
Ramjet (Project Pluto)	16,315	8,810
Total	$31,777	$22,820

...Rover, the test operation of the first experimental reactor (Kiwi-A) was successfully ...at the Nevada Test Site. Research and development effort on nuclear rocket propul... directed toward the fabrication, assembly and initial testing of the second and third ...al reactors.

...d other costs ...ilitary bases ...

...tor concept:

...meet naval ...

...ient for naval ...

...100

...3

5007109

Auxiliary Power Sources

The cost of research and development of long-term, light-weight sources of auxiliary power in space vehicles and for other applications amounted to $11 million in 1960 compared with $8 million in 1959.

The table below shows a comparison of 1960 and 1959 research and development costs for radioisotope and reactor space power systems:

	Fiscal Year 1960	Fiscal Year 1959
	(in thousands)	
Radioisotope power systems	$ 3,100	$3,568
Reactor space power systems	8,380	4,128
Total	$11,480	$7,696

The radioisotope-fueled thermoelectric generator demonstrated in FY 1959 culminated in the receipt of requirements from the Coast Guard for prototype units for use in light buoys and from the Navy for prototype units for use at remote weather stations and navigational satellites.

In 1960 an experimental lightweight (250 lb.) reactor (SER) was successfully operated for an accumulated 2900 hours, 100 hours of which were continuous.

General Reactor Research and Development

Research and development effort on general reactor systems, fuel and fuel cycles, fuel element separations systems, and disposal of radioactive wastes cost $60 million in fiscal year 1960, an increase of $17 million over 1959.

	Fiscal Year 1960	Fiscal Year 1959
	(in thousands)	
Reactor fuels and materials development	$17,359	$10,379
Engineering physics and advanced reactor development	16,158	9,431
Reactor components development	2,624	1,903
Fuel element separations systems development	7,218	6,037
Waste storage and disposal systems	4,700	3,620
Reactor safety	10,205	8,427
Operations of service facilities and miscellaneous	2,070	3,505
Total	$60,334	$43,302

5007110

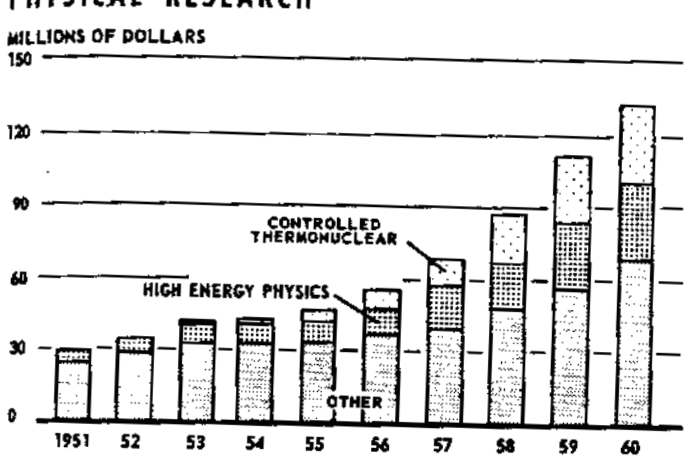
PHYSICAL RESEARCH

...vestigations of the laws of nature, including nuclear interactions at high energies, the ...s of irradiations on the behavior and properties of materials, and research effort to ...ase thermonuclear energy are the major areas under study in physical research.

...llowing table shows a comparison of costs in major scientific areas for fiscal years 1960 ...

	Fiscal Year	
	1960	1959
	(in thousands)	
Controlled thermonuclear research	$ 32,148	$ 27,685
High energy physics	32,263	27,517
Chemical properties and reactions	23,116	19,356
Nuclear structure and neutron physics	17,894	14,518
Metallurgy and materials research	12,672	9,348
Chemical process research	5,811	5,712
Physical and chemical methods of isotope separation	2,405	2,733
Computer research and development	2,856	2,191
Other physical research	3,680	3,258
Total	$132,845	$112,318

...art below shows the growth in the total cost of physical research in the last ten years and ...e increasing emphasis on research in high energy physics and controlled thermonuclear ...rch.



Controlled Thermonuclear Research

In fiscal year 1960 the cost of the program leading to the future development of thermo... energy for the production of power was $32 million. The cost in 1959 was $28 million.

Laboratory	Fiscal Year 1960 Scientific Effort (man-years)	Fiscal Year 1960 Research and Development Costs (dollar amounts in thousands)	Fiscal Year 1960 Construction Costs (dollar amounts in thousands)	Cumulative Costs through June 30, ... (dollar amounts in thousands)
Lawrence Radiation Laboratory				
Pinch and collapse, magnetic mirror and astron	91	$ 5,657	$ 443	$ ...
Los Alamos Scientific Laboratory				
Pinch and collapse	36	2,302	87	...
Oak Ridge National Laboratory				
Hot ion trapping	91	5,575	1,058	...
Princeton University				
Stellarator	248	14,483	3,149	...
Other sites				
General research	49	4,131		...
Total	515	$32,148	$4,737	$...

High Energy Physi

...scal year 1960 costs o... ...se 17 per cent over fisc... ...attempts to learn as m... ...through research with hig... ...operation or under c... ...scal year 1960 by Midw... ...research studies directed ...been authorized.

Particle	
Energy	
Start-up	
Plant at June 30, 1	
Original	
Modifications:	
Completed	
Not completed	
Fiscal year 1960 c... costs	

Particle	
Energy	
Start-up	
Estimated cost of construction*	$

*Includes 1961 autho...

5007112

High Energy Physics

Fiscal year 1960 costs of high energy physics were $32.3 million, an increase of $4.7 million or 17 per cent over fiscal year 1959. The major effort in high energy physics centers around attempts to learn as much as possible about the fundamental properties of nuclear matter through research with high energy particle accelerators. In addition to the major accelerators in operation or under construction shown below, costs of $2.7 million were incurred during fiscal year 1960 by Midwestern Universities Research Association and Stanford University for research studies directed toward the design of accelerators on which construction has not yet been authorized.

HIGH ENERGY ACCELERATORS
(One billion electron volts or greater)

(dollar amounts are in millions)

In Operation

	Lawrence Radiation Laboratory (Bevatron)	Brookhaven National Laboratory (Cosmotron)	California Institute of Technology (CIT)
Particle	Proton	Proton	Electron
Energy	6.2 BEV	3.2 BEV	1.2 BEV
Start-up	FY 1953	FY 1952	FY 1953
Plant at June 30, 1960:			
Original	$ 9.7	$9.3	$1.3
Modifications:			
Completed	4.2	3.5	.3
Not completed*	9.6		
Fiscal year 1960 operating costs	10.0	4.6	.3

Under Construction

	Brookhaven Nat'l Lab. (AGS)	Argonne Nat'l Lab. (ZGS)	Harvard U. and MIT (CEA)	Princeton U. and U. of Pa. (PPA)
Particle	Proton	Proton	Electron	Proton
Energy	25-30 BEV	12.5 BEV	6 BEV	3 BEV
Start-up	FY 1961	FY 1963	FY 1962	FY 1962
Estimated cost of construction*	$31.0	$42.0	$11.5	$22.0

*Includes 1961 authorization.

BIOLOGY AND MEDICINE RESEARCH

The cost of AEC research in the life sciences amounted to $49 million in 1960. The cost in this was $43 million. Increased efforts were made in environmental research required to assess the public safety from radiation hazards. Research activities have continued in the utilization of atomic energy including its tools and by-products in the biomedical and agricultural sciences.

The following table shows a comparison of costs and scientific effort in fields of research in biology and medicine:

	Research Costs		Scientific Effort	
	FY 1960	FY 1959	FY 1960	FY 1959
	(in thousands)		*(man-years)*	
Fields of research				
Cancer	$ 4,753	$ 4,294	226	
Medical	14,572	12,828	690	
Biological	17,123	15,309	811	
Radiological physics, dosimetry & instrumentation	4,574	4,047	171	
Radiation ecology and marine sciences	3,344	2,237	136	
Fallout studies	2,897	2,474	135	
Nuclear energy civil effects and other costs	1,615	1,592	6	
Total	$48,878	$42,781	2,175	

a major portion of AEC
ities operated by educa
ided AEC-owned researc
research and development
and research devices.

The research and develop
military reactor design an
research to improve nucle
reactors shown below are
ating costs of these lal
allations and the cost o
other privately-owned org
shown throughout this repo

Los Alamos Scientific Labo
Los Alamos, New Mexico
Argonne National Laborato
Argonne, Illinois
Oak Ridge National Labora
Oak Ridge, Tennessee
Brookhaven National Labor
Upton, Long Island, New
Lawrence Radiation Labora
Livermore & Berkeley, C
NRTS Field (including Nav
Facility at NRTS, Idaho)
Pittsburgh, Pennsylvania
Knolls Atomic Power Labo
Schenectady, New York
Ames Research Laboratory
Ames, Iowa
Aircraft Nuclear Propulsio
including facilities at NF
General Electric–Lockla
Connecticut Aircraft Nuclea
Laboratory–Pratt-Whitn
Middletown, Connecticut
Battelle Laboratory
Richland, Washington
Savannah River Laboratory
Aiken, South Carolina

*Equipment only.

5007114

RESEARCH LABORATORIES

[illegible] portion of AEC research and development is conducted in government-owned laboratories operated by educational institutions and industrial concerns. The investment in completed AEC-owned research facilities at June 30, 1960 was $1.3 billion. These facilities include research and development reactors, accelerators, and general laboratory buildings, equipment and research devices.

The research and development work conducted in AEC-owned laboratories includes civilian and military reactor design and development; physical research; research in the life sciences; and research to improve nuclear materials production processes and techniques. The twelve laboratories shown below are the principal centers of the Commission's research effort. The operating costs of these laboratories together with the costs incurred at other AEC-owned installations and the cost of work performed in facilities owned by universities, industrial, and other privately-owned organizations are included in the costs of the various research areas discussed throughout this report.

	Investment in Completed Plant June 30, 1960	Operating Costs 1960	Operating Costs 1959
	(in thousands)		
Los Alamos Scientific Laboratory Los Alamos, New Mexico	$145,505	$ 64,660	$ 61,657
Argonne National Laboratory Lemont, Illinois	117,248	44,295	38,797
Oak Ridge National Laboratory Oak Ridge, Tennessee	144,726	66,201	56,559
Brookhaven National Laboratory Upton, Long Island, New York	87,069	23,451	20,634
Lawrence Radiation Laboratory Livermore & Berkeley, California	107,964	90,465	74,258
Idaho Field (including Naval Reactor Facility at NRTS, Idaho) Westinghouse Pittsburgh, Pennsylvania	102,558	57,074	59,779
Knolls Atomic Power Laboratory Schenectady, New York	72,897	41,388	34,389
Ames Research Laboratory Ames, Iowa	7,897	4,136	3,749
Naval Nuclear Propulsion Facilities (excluding facilities at NRTS, Idaho) General Electric – Lockland, Ohio	46,981	39,023	49,424
Connecticut Aircraft Nuclear Engineering Laboratory – Pratt-Whitney Middletown, Connecticut	4,618*	20,414	16,278
Hanford Laboratory Richland, Washington	56,375	27,428	24,056
Savannah River Laboratory Aiken, South Carolina	46,335	13,842	13,648

*Equipment only.

5007115

EDUCATION AND TRAINING

The continuation of financial assistance to colleges, universities, teachers and students, for the purpose of encouraging more interest in the curriculum and courses offered in the field of atomic energy, amounted to $8 million in 1960. In addition, the AEC has source and special nuclear materials on loan to educational institutions valued at $8 million on which use charges are waived.

	Fiscal Year 1960 *(in thousands)*
Grants for the purchase of equipment	$3,076
Operation of schools and courses	1,826
Training institutes – 651 teachers	1,116
Fellowships – 300 fellows	919
Other costs	738
	7,675
Waiver of use charges	263
Security clearances	37
Total	$7,975

Grants for the purchase of equipment. Financial assistance in the form of grants for the purchase of training equipment was made to 167 American colleges and universities. The cost was $3 million in fiscal year 1960.

Operation of schools and courses. The following table shows the number of students in attendance and the cost of operating two schools and seven courses in the field of nuclear technology:

	Number of Students		Net Operating Cost
	Foreign	Domestic	*(in thousands)*
Schools			
International Institute of Nuclear Science & Engineering – ANL	134	12	$ 585
Puerto Rico Nuclear Center	26	52	554
Courses			
Industrial Radioisotope Training Course – ORINS	25	104	102
Reactor Supervisors Training Course – Shippingport	11	19	8
Nuclear Reactor Operations Supervision Course – ORNL	12	1	69
Nuclear Reactor Hazards Evaluation Course – ORNL	10	2	69
Radioisotopes Special Training Course – ORINS	71	283	178
Traveling Science Teachers Course – ORINS	2	76	15
Mobile Isotope Training Course – ORINS		104	32
TOTAL	291	653	$1,592*

*After deducting revenue of $234 thousand.

5007116

SALE OF MATERIAL AND SERVICES

...from sales of materials and services for fiscal year 1960 amounted to $15 million as ...ared with $9 million for fiscal year 1959. The table below shows the major sources of ...ome:

	Fiscal Year	
	1960	1959
	(in thousands)	
Source and special nuclear materials	$ 4,061	$1,353
Heavy water	4,867	3,327
Radioisotopes	2,426	2,498
Vanadium Pentoxide	1,581	
Other materials	279	396
Services	1,512	1,032
Total	$14,726	$8,606

...e and special nuclear materials and heavy water with licensees and foreign governments ...sed to $99 million at June 30, 1960 from $72 million at June 30, 1959. These amounts ...ent the established value of the material. The following table shows the value of material ...t of licensee and the amount of material subject to use charges versus that on which use ...s were waived at June 30, 1960 as compared to June 30, 1959. Use charges waived during ...r 1960 were $1.5 million.

SOURCE AND SPECIAL NUCLEAR MATERIALS AND HEAVY WATER LEASED

	Total Inventory*		Subject to 4% Use Charge		Not Subject to Use Charge	
	6/30/60	6/30/59	6/30/60	6/30/59	6/30/60	6/30/59
	(in thousands)					
...ic:						
...trial organizations	$82,994	$58,909	$47,816	$37,080	$35,178	$21,829
...tional and research ...itutions	8,074	8,355	32		8,042	8,355
...r Federal agencies	903	1,354			903	1,354
...n countries	6,731	3,389	6,731	3,389		
Total	$98,702	$72,007	$54,579	$40,469	$44,123	$31,538

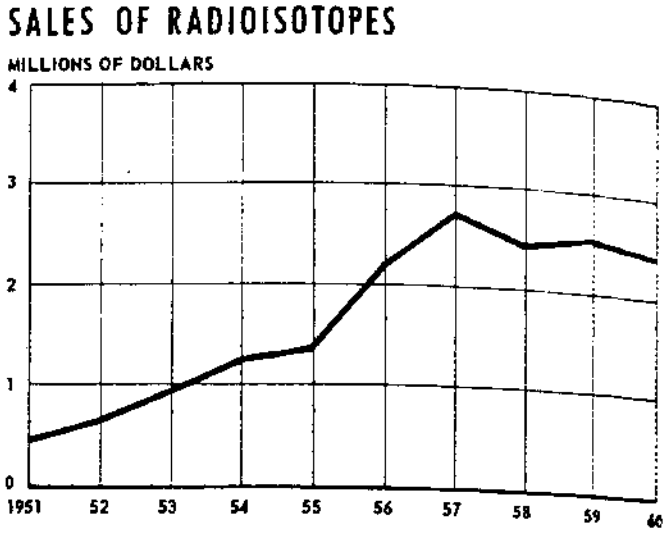
*At established prices.

5007137

Sales of Radioisotopes

Radioisotope sales in fiscal year 1960 amounted to $2.4 million as compared to $[illegible] for fiscal year 1959. Foreign sales of radioisotopes decreased to $391 thousand [illegible] less than in fiscal year 1959.

The chart below shows sales of radioisotopes from FY 1951 through FY 1960. The [illegible] of sales has leveled off due to substantial price reductions in recent years in the [illegible] radioisotopes such as Cobalt-60, Iodine-131, and Carbon-14.



The following table shows a comparison of sales of radioisotopes for fiscal years [illegible]

	Sales			
	Quantity		Dollars*	
	1960	1959	1960	1959
	(curies)		*(in thousands)*	
Cobalt-60	162,684	208,769	$ 539	$ 659
Polonium-210	4,610	4,882	246	208
Carbon-14	15	12	227	263
Iodine-131	609	748	216	323
Phosphorus-32	129	165	148	171
Cesium-137	72,282	13,885	123	27
Iridium-192	8,767	6,203	62	20
Krypton-85	3,515	2,089	57	33
Tritium	15,952	15,804	32	31
Promethium-147	1,648	501	6	2
Strontium-90	239	88	3	1
All others			767	756
			$2,426	$2,498

*Includes research discounts granted to users under the AEC radioisotope research support program of $259 thousand in 1960 and $304 thousand in 1959.

...ber of licenses granted for use of radioisotopes increased 14 per cent from June 30, ... June 30, 1960. The following table gives a comparison of the number of licensees by ...rganizations:

ORGANIZATIONS WITH RADIOISOTOPE LICENSES

	June 30	
	1960	1959
Medical institutions and physicians	2,455	2,098
Industrial organizations	1,724	1,511
Federal and state laboratories	1,152	1,027
Colleges and universities	277	269
High schools, foundations, and other institutions	106	123
Total	5,714	5,028

COMMUNITIES

...cial progress has been made in the disposal of community facilities at Oak Ridge, Ten... and Richland, Washington, as authorized under Public Law 221, approved in 1955. ...ity functions including utilities at both Oak Ridge and Richland have been transferred ...ly established city governments. Real estate sales and financing have been conducted ...Housing and Home Finance Agency through 1960. Property with a net book value of ...has been transferred to communities and property with a net book value of $73 mil... been sold by HHFA. In 1960 AEC community operating costs totaled $17.6 million. The ...were $10.5 million. However, under Public Law 221, certain costs are being incurred ...assistance to the city governments during the transition period and until they become ...lished municipalities. The Act provides that assistance payments where necessary ...made for a 10-year period from the date of the transfer. The amount of such payments ...was $2.9 million.

...estment in completed community facilities at June 30, 1960 was as follows:

	Total	Oak Ridge	Los Alamos	Richland	Other
			(in millions)		
...-June 30, 1959	$179.0	$65.6	$72.9	$33.6	$6.9
...-Fiscal Year 1960	6.3	3.4	1.1	1.8	
...ales	(21.3)	(17.2)		(4.1)	
...ransfers	(73.9)	(47.1)		(26.8)	
...ecrements	(4.6)	(2.5)	(0.9)	(0.7)	(0.5)
...-June 30, 1960	85.5	2.2	73.1	3.8	6.4
...ated depreciation	(25.6)	(1.0)	(21.1)	(1.5)	(2.0)
...ment-June 30, 1960	$59.9	$1.2	$52.0	$2.3	$4.4

...1960 there remained at Oak Ridge and Richland $3.5 million in property still to be ...ransferred.

...72—61——35

5007119

INTERNATIONAL ACTIVITIES

The United States has 42 active foreign agreements as of June 30, 1960, which provide for ... operation, aid and assistance in developing peaceful uses of atomic energy. In addition, ... ments have been entered into which provide support and assistance to the European ... Energy Community (EURATOM) and the International Atomic Energy Agency.

REACTOR AND EQUIPMENT GRANTS*

	Approved During FY 1960	Total Approved Through June 30, 1960	Commitments Outstanding at June 30, 196...
		(in thousands)	
Latin American	$ 163	$1,325	$ 964
European	150	3,398	3,246
Near Eastern	650	1,161	1,084
Asian	491	2,839	2,486
South Pacific		298	298
International Agency	194	194	197
Total	$1,648	$9,215	$8,284

*A major part of the funds required for grants is provided by the Mutual Security Program.

MATERIALS LEASED*

	June 30, 1960		Use Charges Earned
	SS Material	Heavy Water	Fiscal Year 196...
		(in thousands)	
Latin American	$ 283		$ 13
European	3,315	$1,639	125
Near Eastern	112		2
Asian	32	840	1
Total	$3,742	$2,479	$141

*At sales value.

FINANCIA...

CO...

GRANTS
Reactor
Equipment
IAEA Laboratory

TRAINING AND EDUCATIO...
Schools
Special courses

OTHER COSTS
Special and Topical Confe...
Advisory and Consultant S...
Nuclear Energy Exhibits
Nuclear Materials Contro...
Direct Salary and Travel
Euratom-Research & Dev...
IAEA World-Wide Researc...

Total Costs

5007120

COSTS OF INTERNATIONAL ACTIVITIES
Fiscal Year 1960

	AEC Direct Costs	Mutual Security Program Costs	Total Costs
		(in thousands)	
GRANTS			
Reactor	$ 325	$	$ 325
Equipment		246	246
IAEA Laboratory	600		600
	925	246	1,171
TRAINING AND EDUCATION			
Schools	1,122		1,122
Special courses	167		167
	1,289		1,289
OTHER COSTS			
Special and Topical Conferences	63	44	107
Advisory and Consultant Services	63	68	131
Nuclear Energy Exhibits	824		824
Nuclear Materials Control System	547		547
Direct Salary and Travel Expense	1,345		1,345
Euratom-Research & Development	494		494
IAEA World-Wide Research	114		114
	3,450	112	3,562
Total Costs	$5,664	$358	$6,022

5001121

Ten-Year Summary of Financial Data

UNITED STATES ATOMIC ENERGY COMMISSION TEN-YEAR SUMMARY OF FINANCIAL DATA

(in thousands of dollars)

	1960	1959	1958	19[illegible]	1956	1955
Cost of operations*	$2,619,143	$2,496,648	$2,298,589	$1,[illegible]	$1,607,973	$1,289,535
Procurement of raw materials	716,507	699,996	596,391	[illegible]	278,946	193,586
Production of nuclear materials	731,348	713,247	750,178	[illegible]	730,972	588,445
Weapons development and fabrication	505,448	491,981	443,536	[illegible]	280,765	258,706
Development of nuclear reactors	399,252	355,600	306,225	[illegible]	168,853	114,557
Civilian	117,786	105,233	78,732	[illegible]	45,880	28,064
Military	213,708	202,328	184,868	[illegible]	101,410	53,011
Other	67,758	48,039	42,625	[illegible]	21,563	33,482
Physical Research	132,845	112,318	87,719	[illegible]	56,547	48,221
Controlled thermonuclear	32,148	27,685	19,012	[illegible]	7,066	4,718
High energy physics	32,263	27,517	19,146	[illegible]	11,981	8,583
Other	68,434	57,116	49,561	[illegible]	37,500	34,920
Biology and medicine research	48,878	42,781	35,958	[illegible]	29,849	28,898
Community operations – net	7,090	9,892	11,162	[illegible]	8,954	10,321
Administrative expenses	51,197	50,135	46,435	[illegible]	38,195	34,027
Other expenses and income – net	26,578	20,698	20,985	[illegible]	14,892	12,774
Plant construction and equipment costs incurred during the year	$ 331,516	$ 298,979	$ 289,744	$ [illegible]	$ 301,682	$ 842,504
Total AEC assets, excluding inventories of certain products at June 30	$7,740,629	$7,764,770	$7,652,764	$[illegible]	$7,368,272	$8,077,836
Plant investment at June 30 (gross)	$7,344,751	$7,292,784	$7,110,797	$[illegible]	$6,713,061	$6,487,301
Production plants	5,458,201	5,552,646	5,494,440	[illegible]	5,212,776	4,645,750
Research and development facilities	1,271,253	1,124,543	937,682	[illegible]	753,468	707,107
Communities	85,523	179,013	229,197	[illegible]	299,292	299,290
Other	203,085	186,825	178,332	[illegible]	200,501	206,202
Plant construction in progress at June 30	326,689	249,757	271,146	[illegible]	247,024	628,952
Funds appropriated – net	$2,649,614	$2,635,335	$2,333,974	$[illegible]	$ 834,227	$1,209,860
Operations	2,387,114	2,385,406	2,225,470	[illegible]	1,146,400†	1,098,978
Plant acquisition and construction	262,500	249,929	108,504	[illegible]	(312,173)†	110,882
Employment at June 30	122,646	121,858	120,973	[illegible]	116,143	112,555
AEC employees	6,835	6,785	7,021	[illegible]	6,583	6,013
Operating contractor employees	104,612	105,195	103,290	[illegible]	90,238	82,936
Construction contractor employees	11,199	9,878	10,662	[illegible]	13,322	23,606

*Includes depreciation.

†Includes transfer to operations of $571 million appropriated in prior years as plant and equipment funds.

5007122

ES ATOMIC
SUMMARY
(in thousands

1957
9 $1,918,25[illegible]
1 397,81[illegible]
8 762,81[illegible]
6 337,18[illegible]
5 255,68[illegible]
2 58,19[illegible]
8 108,72[illegible]
5 28,74[illegible]
9 69,65[illegible]
2 11,17[illegible]
6 17,80[illegible]
1 40,93[illegible]
8 33,14[illegible]
2 8,89[illegible]
5 38,48[illegible]
5 14,57[illegible]
4 $ 317,022
4 $7,397,811
7 $6,907,896
0 5,392,464
2 792,633
7 267,281
2 144,28[illegible]
6 311,21[illegible]
4 $1,896,700
0 1,740,405
4 158,300
3 119,35[illegible]
1 8,62[illegible]
0 98,17[illegible]
2 14,30[illegible]

ant and equip

ENERGY COMMISSION
OF FINANCIAL DATA
(dollars)

1956	1955	1954	1953	1952	1951
$1,807,973	$1,289,535	$1,039,178	$ 904,596	$ 684,181	$ 494,638
278,946	193,586	142,793	82,153	72,510	47,490
730,972	588,445	409,735	318,255	205,746	140,822
280,765	258,706	250,025	257,488	229,178	163,594
168,853	114,557	99,334	104,091	64,448	44,472
45,880	28,064	20,103	10,201	5,903	3,202
101,410	53,011	42,010	53,209	39,501	30,011
21,563	33,482	37,221	40,681	19,044	11,259
56,547	48,221	43,630	41,846	34,671	29,833
7,066	4,718	1,741	800	150	50
11,981	6,583	7,802	8,644	5,948	5,262
37,500	34,920	34,087	32,402	28,573	24,521
29,849	28,898	26,974	26,295	24,536	21,245
8,954	10,321	11,822	15,157	16,363	17,322
38,195	34,027	34,671	35,514	31,432	24,541
14,892	12,774	20,194	23,797	5,297	5,319
$ 301,682	$ 842,504	$1,215,141	$1,125,579	$1,082,174	$ 459,192
$7,368,272	$8,077,836	$8,144,414	$8,014,455	$4,692,584	$3,680,333
$4,713,061	$6,487,301	$5,705,405	$4,579,089	$3,496,957	$2,516,014
3,212,776	4,645,750	2,957,784	2,118,137	1,327,335	1,287,447
753,468	707,107	616,548	548,009	338,836	233,702
299,292	299,290	300,248	298,454	287,999	281,727
200,501	206,202	215,691	184,913	179,705	121,936
247,024	628,952	1,615,134	1,429,576	1,363,082	591,202
$ 834,227	$1,209,860	$1,042,492	$4,136,476	$1,605,756	$2,032,143
1,146,400†	1,098,978	886,483	808,935		
(312,173)†	110,882	156,009	3,327,541		
116,143	112,555	141,949	146,799	149,371	99,126
6,583	6,013	6,123	6,894	6,662	5,646
90,238	82,936	73,312	71,775	58,101	47,745
13,322	23,606	62,514	70,130	84,608	45,735

500 123

Plant and Equipment

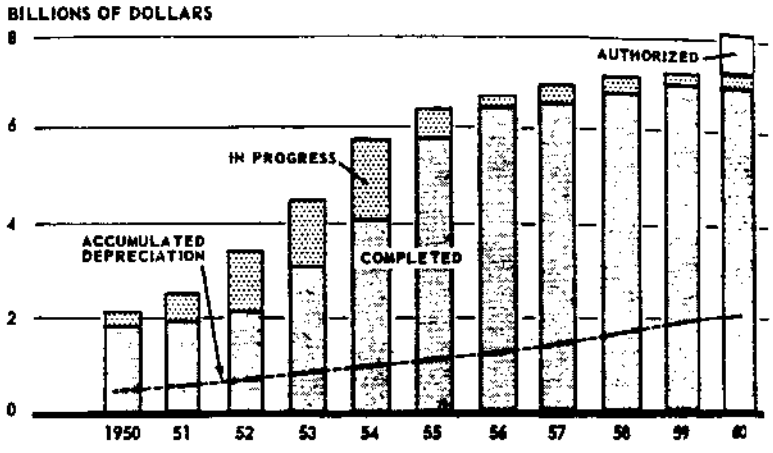
PLANT AND EQUIPMENT

AEC-owned plant and equipment includes plants for the preparation of feed materials; gaseous diffusion plants for the separation of the fissionable isotope uranium-235 from the stable isotope uranium-238; reactors for the production of plutonium, isotopes and other reactor products; facilities for the fabrication and test of weapons; reactors for testing materials and equipment components; reactor prototypes; and research laboratories. AEC-owned plant, at cost, amounted to $7.0 billion at June 30, 1960—substantially the same as at June 30, 1959.

The estimated cost of plant under construction or authorized at June 30, 1960 totaled $1,[illegible] million. Costs incurred through June 30, 1960 on plant under construction amounted to $[illegible] million, leaving the estimated costs to be incurred subsequent to June 30, 1960 at $839 million. A major portion of this authorized plant expansion is for construction of reactors and related facilities and for facilities to be used in high energy and controlled thermonuclear research.

The chart below shows the investment in completed plant, accumulated depreciation, and costs incurred on partially completed plant projects at the end of each fiscal year from 1951 through 1960. For fiscal year 1960, the chart also shows plant projects authorized prior to June 30, 1960 for construction or completion in subsequent periods.

INVESTMENT IN PLANT & EQUIPMENT



INVES

Production
- Raw materials
- Feed materials
- Gaseous diffusion plants
- Production reactors and separations areas
- Weapons production and storage
- Heavy water
- Other production facilities

Total production

Research and development
- Laboratories
- Reactors
- Accelerators
- Weapons test facilities

Total research

Communities
Other

Total

[illegible]s in investment in plant and e

[illegible]estment—June 30, 1959
[illegible]nstruction and equipment costs
[illegible]itions to completed plant
[illegible]nt transfers and retirements
[illegible]e of community facilities by HHFA

[illegible]estment—June 30, 1960

5007124

INVESTMENT IN PLANT AND EQUIPMENT

June 30, 1960

(at cost)

	Completed Plant	Construction in Progress	Total
		(in thousands)	
Production			
Raw materials	$ 9,910	$ 10	$ 9,920
Feed materials	253,441	2,988	256,429
Gaseous diffusion plants	2,333,564	8,970	2,342,534
Production reactors and separations areas	1,622,435	34,512	1,656,947
Weapons production and storage	803,182	17,870	821,052
Heavy water	163,365		163,365
Power production facilities	272,304	5,884	278,188
Total production	5,458,201	70,234	5,528,435
Research and development			
Laboratories	898,546	83,585	982,131
Reactors	244,382	121,519	365,901
Accelerators	69,652	44,917	114,569
Weapons test facilities	58,673	201	58,874
Total research	1,271,253	250,222	1,521,475
Facilities	85,523	7	85,530
[illegible]	203,085	6,226	209,311
Total	$7,018,062	$326,689	$7,344,751

[illegible] investment in plant and equipment during the fiscal year are as follows:

	Completed Plant	Construction in Progress	Total
		(in thousands)	
[illegible]–June 30, 1959	$7,043,027	$249,757	$7,292,784
[illegible]truction and equipment		331,516	331,516
[illegible]s to completed plant	254,584	(254,584)	
[illegible]nsfers and retirements	(258,247)		(258,247)
[illegible] community facilities			
[illegible]FPA	(21,302)		(21,302)
[illegible]–June 30, 1960	$7,018,062	$326,689	$7,344,751

5007125

AEC PLANT AND EQUIPMENT
(at cost)

By Location
June 30, 1960

Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	Tota
	(in millions)			
CALIFORNIA				
Lawrence Radiation Laboratory, University of California				
Berkeley	$ 40.1	$ 10.6	$ 12.7	$
Livermore	67.8	13.4	2.7	
Research facilities, Sandia Corporation, Livermore	9.0			
Medical research facilities, University of California, Los Angeles	1.2		.2	
Salton Sea Base, Sandia Corporation, Salton Sea	7.6			
Research facilities, California Institute of Technology, Pasadena	1.9			
Reactor and research facilities, Atomics International Division, North American Aviation, Inc., Canoga Park	16.5	8.3	1.5	
COLORADO				
Uranium handling, sampling, and general facilities, Lucius Pitkin, Inc., Grand Junction	5.3			
Rocky Flats Plant, Dow Chemical Company, Boulder	73.2	4.5	.4	
CONNECTICUT				
Connecticut Aircraft Nuclear Engine Laboratory, Pratt and Whitney, Middletown	4.6*†			
Linear accelerators, Yale University, New Haven	2.8	1.0		
Submarine reactor facilities, Combustion Engineering, Inc., Windsor	12.8	1.7		
FLORIDA				
Pinellas Plant, General Electric Company, Clearwater	10.6	1.0	.1	
IDAHO				
National Reactor Testing Station				
Phillips Petroleum Company				
Chemical processing plant	49.9	12.6	3.2	
Materials testing reactor	14.3	1.2		
Engineering test reactor	12.5	.1		
Reactor facilities	15.2	13.1	7.1	
General facilities	19.2	3.9		
Total	111.1	30.9	10.3	

Location and Contractor

IDAHO Cont'd
Westinghouse Electric C
Large ship reactor
Submarine thermal re
Other research faciliti
Total
Aircraft nuclear propuls
facilities, General Ele
Company
Reactor facilities, Argon
National Laboratory
Organic moderated react
periment, North Amer
Aviation, Inc.
Knolls Atomic Power La
General Electric Comp
Total, NRTS

ILLINOIS
Argonne National Labora
University of Chicago,
Argonne Cancer Researc
University of Chicago,
Materials Research Lab
University of Illinois,

INDIANA
Radiation Laboratory, U
of Notre Dame, Notre

IOWA
Research Laboratory, Io
College, Ames
Iowa Ordnance Plant, Ma
Hanger, Burlington

KENTUCKY
Paducah
Gaseous Diffusion Pla
Union Carbide Nucle
Feed Materials Plant,
Union Carbide Nucle
Total, Paducah

5007126

Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	Total
		(in millions)		
IDAHO Cont'd				
Westinghouse Electric Corporation				
Large ship reactor	$ 28.8	$ 2.2		$ 31.0
Submarine thermal reactor	12.0			12.0
Other research facilities	16.5	1.8		18.3
Total	57.3	4.0		61.3
Aircraft nuclear propulsion facilities, General Electric Company	36.6	16.4		53.0
Reactor facilities, Argonne National Laboratory	2.9	34.1		37.0
Organic moderated reactor experiment, North American Aviation, Inc.	2.4	.6		3.0
Knolls Atomic Power Laboratory, General Electric Company	1.6		$18.5	20.1
Total, NRTS	211.9	86.0	28.8	326.7
ILLINOIS				
Argonne National Laboratory, University of Chicago, Argonne	114.4	81.6	3.6	199.6
Argonne Cancer Research Hospital, University of Chicago, Chicago	4.6	.2		4.8
Materials Research Laboratory, University of Illinois, Champaign			5.6	5.6
INDIANA				
Radiation Laboratory, University of Notre Dame, Notre Dame			2.2	2.2
IOWA				
Research Laboratory, Iowa State College, Ames	7.9	2.4	3.6	13.9
Iowa Ordnance Plant, Mason and Hanger, Burlington	30.3‡	1.8	.4	32.5
KENTUCKY				
Paducah				
Gaseous Diffusion Plant, Union Carbide Nuclear Company	753.7	3.8	1.0	758.5
Feed Materials Plant, Union Carbide Nuclear Company	25.8	.4		26.2
Total, Paducah	779.5	4.2	1.0	784.7

5007127

Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	Total
		(in millions)		
MARYLAND				
AEC Headquarters, Germantown	$ 16.6	$ .7	$ .6	$
MASSACHUSETTS				
Cambridge electron accelerator, Harvard University, Cambridge	3.8	8.1		
Raw materials development laboratory, National Lead Company, Winchester	1.3			
MINNESOTA				
Linear accelerator, University of Minnesota, Minneapolis	1.8*			
Boiling water power reactor, Rural Cooperative Power Association, Elk River		9.5		
MISSOURI				
Kansas City Plant, Bendix Aviation Corporation, Kansas City	27.9§	5.3	2.9	
Feed Materials Plant, Mallinckrodt Chemical Works, Weldon Spring	56.7	.9	.6	
NEBRASKA				
Sodium graphite power reactor, Consumers Public Power District, Hallam	.3	26.7		
NEVADA				
Mercury				
Nevada Test Site, Reynolds Electrical and Engineering Company	37.8	15.0	19.5	
Laboratory facilities, Lawrence Radiation Laboratory	1.4	14.2		
Total, Mercury	39.2	29.2	19.5	
Tonopah				
Research facilities, Reynolds Electrical and Engineering Company	.6		.3	
Research facilities, Sandia Corporation	1.3	.4		
Total, Tonopah	1.9	.4	.3	

FINANCIA

Location and Contractor
NEW JERSEY
Merchant ship reactor, Ca
New Brunswick Laboratory
Atomic Energy Commiss
New Brunswick
Picatinny Arsenal Ordnanc
Facility, Atomic Energy
Commission, Dover
Princeton
Princeton-Pennsylvania accelerator, Princeto University
Model C stellarator faci Princeton University
Research facilities, Pri University
Total, Princeton
NEW MEXICO
Albuquerque
Sandia Laboratory, Sand Corporation
South Albuquerque Work Industries, Inc.
Total, Albuquerque
Los Alamos
Los Alamos Scientific Laboratory, Univer of California
Community and gener maintenance faciliti The Zia Company
Los Alamos Hospital, Alamos Medical Ce Inc.
Total, Los Alamo
NEW YORK
Brookhaven National Labo
Associated Universities Upton
New York City
Computing and other re facilities, New York U
Accelerator and researc facilities, Columbia U
Total, New York Ci

5007128

Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	Total
		(in millions)		
NEW JERSEY				
Merchant ship reactor, Camden		$ 27.8		$ 27.8
New Brunswick Laboratory, Atomic Energy Commission, New Brunswick	$ 2.1			2.1
Picatinny Arsenal Ordnance Facility, Atomic Energy Commission, Dover	1.4‡			1.4
Princeton				
Princeton-Pennsylvania proton accelerator, Princeton University	.8	10.3	$11.7	22.8
Model C stellarator facilities, Princeton University	4.6	5.2		9.8
Research facilities, Princeton University	4.3	.1		4.4
Total, Princeton	9.7	15.6	11.7	37.0
NEW MEXICO				
Albuquerque				
Sandia Laboratory, Sandia Corporation	77.3	11.4	4.6	93.3
Albuquerque Works, ACF Industries, Inc.	20.8	.1	.1	21.0
Total, Albuquerque	98.1	11.5	4.7	114.3
Los Alamos				
Los Alamos Scientific Laboratory, University of California	143.0	22.5	11.5	177.0
Community and general maintenance facilities, The Zia Company	129.9	3.4	1.2	134.5
Los Alamos Hospital, Los Alamos Medical Center, Inc.	2.9			2.9
Total, Los Alamos	275.8	25.9	12.7	314.4
NEW YORK				
Brookhaven National Laboratory, Associated Universities, Inc., Upton	87.1	30.4	15.4	132.9
New York City				
Computing and other research facilities, New York University	1.5			1.5
Accelerator and research facilities, Columbia University	1.8	.8		2.6
Total, New York City	3.3	.8		4.1

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Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	Total
		(in millions)		
NEW YORK Cont'd				
Boron plant, Olin Mathieson Chemical Corp., Niagara Falls	$ 7.8			
Research laboratory, University of Rochester, Rochester	5.0	$ .5	$ .1	$
Knolls Atomic Power Laboratory, General Electric Company, Schenectady	39.4	1.9		
Knolls Atomic Power Laboratory, General Electric Company, West Milton	33.5	35.5		
OHIO				
Aircraft nuclear propulsion facilities, General Electric Company, Lockland	10.4*†			
Portsmouth				
Portsmouth Gaseous Diffusion Plant, Goodyear Atomic Corporation	754.3	2.8	1.1	
Feed Materials Plant, Goodyear Atomic Corporation	8.0			
Total, Portsmouth	762.3	2.8	1.1	
Feed Materials Plant, National Lead Company, Fernald	111.6	2.7	3.3	
Mound Laboratory, Monsanto Chemical Company, Miamisburg	30.0	3.5	.3	
Organic moderated power reactors				
City of Piqua, Piqua		8.3		
PENNSYLVANIA				
Bettis Plant, Westinghouse Electric Corporation, Pittsburgh	45.2	11.8		
Accelerator and research facilities, Carnegie Institute of Technology, Pittsburgh	1.3			
Pressurized Water Reactor, Duquesne Light Company, Shippingport	48.8	1.0	9.0	
SOUTH CAROLINA				
Savannah River Plant, E. I. du Pont de Nemours and Co., Inc., Aiken				
Production reactor facilities	620.7	11.0	8.7	
Separations facilities	261.2	15.3	1.6	
Feed materials production facilities	6.1		.1	

Location and Contractor	Total
SOUTH CAROLINA Cont'd	
Heavy water production f	
Works laboratory	
General facilities	
Total, Aiken	
TENNESSEE	
Oak Ridge	
Research laboratory, Oak	
Institute of Nuclear Stu	
Agriculture Research La	
and Farm, University o	
Tennessee	
Experimental gas cooled	
Oak Ridge Gaseous Diffu	
Plant, Union Carbide N	
Company	
Fabrication and developm	
facilities, Union Carbic	
Nuclear Company	
Oak Ridge National Labor	
Union Carbide Nuclear	
Service facilities	
Total	
Community services, Oak R	
TEXAS	
Pantex Plant, Mason and Ha	
Amarillo	
UTAH	
Monticello	
Uranium ore processing p	
Lucius Pitkin, Inc.	
Community services, Luc	
Pitkin, Inc.	
Total, Monticello	
WASHINGTON	
Hanford Works, General Ele	
Company, Hanford	
Production reactor facili	
Separations facilities	
Feed materials productio	
facilities	
Works laboratory	
General facilities	
Total	

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Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	Total
	(in millions)			
SOUTH CAROLINA Cont'd				
Heavy water production facilities	$ 163.4			$ 163.4
Works laboratory	46.3	$ 12.4	$ .2	58.9
General facilities	163.4	6.2	.2	169.8
Total, Aiken	1,261.1	44.9	10.8	1,316.8
TENNESSEE				
Oak Ridge				
Research laboratory, Oak Ridge Institute of Nuclear Studies	3.3	.2	.3	3.8
Agriculture Research Laboratory and Farm, University of Tennessee	1.0	.4	.2	1.6
Experimental gas cooled reactor	.1	30.6		30.7
Oak Ridge Gaseous Diffusion Plant, Union Carbide Nuclear Company	834.7	10.3	2.1	847.1
Fabrication and development facilities, Union Carbide Nuclear Company	379.5	10.0	8.8	398.3
Oak Ridge National Laboratory, Union Carbide Nuclear Company	144.7	41.8	19.0	205.5
Service facilities	21.6	.5		22.1
Total	1,384.9	93.8	30.4	1,509.1
Community services, Oak Ridge	2.2			2.2
TEXAS				
Pantex Plant, Mason and Hanger, Amarillo	24.3‡	.6	.4	25.3
UTAH				
Monticello				
Uranium ore processing plant, Lucius Pitkin, Inc.	5.6			5.6
Community services, Lucius Pitkin, Inc.	.5			.5
Total, Monticello	6.1			6.1
WASHINGTON				
Hanford Works, General Electric Company, Hanford				
Production reactor facilities	484.1	165.1	8.1	657.3
Separations facilities	204.7	4.3	5.8	214.8
Fuel materials production facilities	38.3	.1	.6	39.2
Works laboratory	56.4	16.7	3.4	76.5
General facilities	140.7	7.8	.2	148.7
Total	924.2	194.0	18.3	1,136.5

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Location and Contractor	Completed Plant and Equipment	Estimated Cost of Projects Under Construction	Projects Authorized Construction Not Started	
		(in millions)		
WASHINGTON Cont'd				
Community services, General Electric Company, Richland	$ 3.8			
WEST VIRGINIA				
Huntington pilot plant, International Nickel Company, Huntington	4.7			
WYOMING				
Army Package Power Reactor No. 2, The Martin Co., Sundance	.4	$ 3.0		
PUERTO RICO				
Puerto Rico Nuclear Center, University of Puerto Rico, Mayaguez	.5	3.8		
Nuclear superheat power reactor, Punta Higuera		.4	$ 8.5	
JAPAN				
Research facilities, National Academy of Science, Hiroshima	2.0	.1	.1	
MARSHALL ISLAND				
Eniwetok Proving Grounds, Holmes and Narver, Inc., Eniwetok	35.5¶			
ALL OTHER				
Various locations				
Weapons storage facilities	186.4	2.2		
Other	57.7	16.6	114.1	
Total, All other	244.1	20.8	114.1	
Total	$7,018.1	$838.9	$327.6**	

* Equipment only.
† Basic plant owned by U. S. Air Force.
‡ Basic plant owned by U. S. Army.
§ Basic plant owned by U. S. Navy.
¶ Transferred to the Department of Defense in July 1960.
** Includes plant projects of $221 million authorized in Public Law 86-457 approved May 11, 1960.

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