TOP SECRET

UNITED STATES ATOMIC ENERGY COMMISSION

PROGRAM STATUS REPORT

June 30, 1955

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RD-Gp 1

UNITED STATES ATOMIC ENERGY COMMISSION

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PROGRAM STATUS REPORT

June 30, 1955

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Authenticated Aug 4, 1955
U. S. Atomic Energy Commission
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Document No LXXXI - 335 - 2 A

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CONTENTS

*Transmitted as a separate document.

Part I

Raw Materials

Procurement (SECRET)

Receipts of uranium concentrates by the United States and the United Kingdom during the six months ended June 30, 1955, were approximately 3,570 tons of U_3O_8. This amount was 430 tons greater than receipts during the preceding half year, but 190 tons less than forecast in January. Belgian Congo deliveries were at a somewhat reduced rate, which it appears may continue. Minor reductions in receipts from Canada, Australia, and Portugal were partially offset by greater domestic production. South African deliveries were about as anticipated. The total receipts of 6,710 tons for fiscal year 1955 were about 3 percent below the projection reported six months ago.

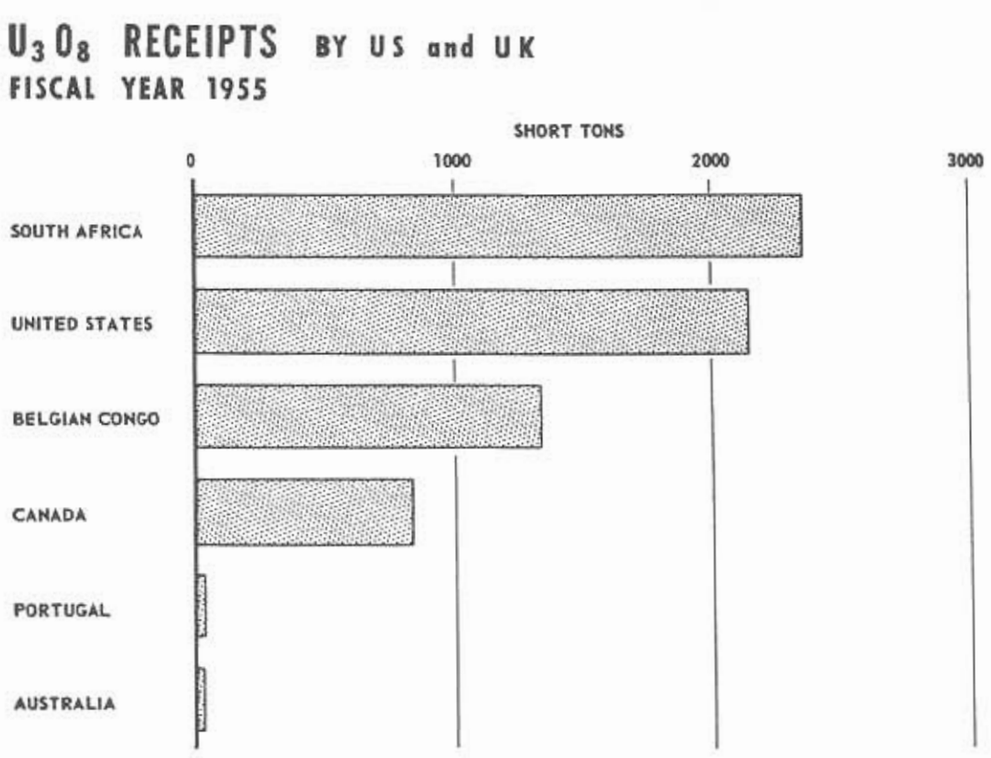


CHART I-A

Table 1 — U_3O_8 Receipts by United States and United Kingdom (Short Tons)

	Actual	Fiscal Year Projected				
	1955	1956	1957	1958	1959	1960
	Based Upon Reasonably Firm Production Plans					
North America						
United States	2,155	4,450	6,500	6,500	6,500	6,500
Canada	830	1,500	3,300	5,500	6,500	6,500
Subtotal North America	2,985	5,950	9,800	12,000	13,000	13,000
Overseas						
South Africa	2,351	3,600	4,700	5,500	6,000	6,000
Belgian Congo	1,319	1,200	1,200	1,200	1,200	1,200
Australia	25	250	400	400	400	400
Portugal	30	200	130	130	130	130
Subtotal Overseas	3,725	5,450	6,430	7,230	7,730	7,730
Total-Reasonably Firm	6,710	11,400	16,230	19,230	20,730	20,730
			Possible Additional			
United States	-	500	500	1,500	1,500	1,500
Canada	-	-	-	1,500	3,000	4,000
South Africa	-	-	300	500	500	500
Australia	-	-	-	200	400	400
Possible New Discoveries	-	-	200	1,500	2,500	2,500
Total-Possible Additional	-	500	1,000	5,200	7,900	8,900
Total-Reasonably Firm and Possible Additional	6,710	11,900	17,230	24,430	28,630	29,630

While South African production for fiscal year 1955 exceeded domestic production by about 200 tons, it is expected that within six months the United States will be producing at a greater rate than South Africa, and that for the next few years at least, the United States should be the foremost producer of uranium in the free world.

United Kingdom Allocation

Allocations agreed upon for calendar year 1955 provide for delivery of 750 tons of U_3O_8 to the United Kingdom, and shipments began in April. Recent discussions indicate that requirements of the United Kingdom for U_3O_8 will increase steadily over the next 10 years and will exceed 2,000 tons in 1963.

TOTAL RECEIPTS OF URANIUM CONCENTRATES BY US and UK

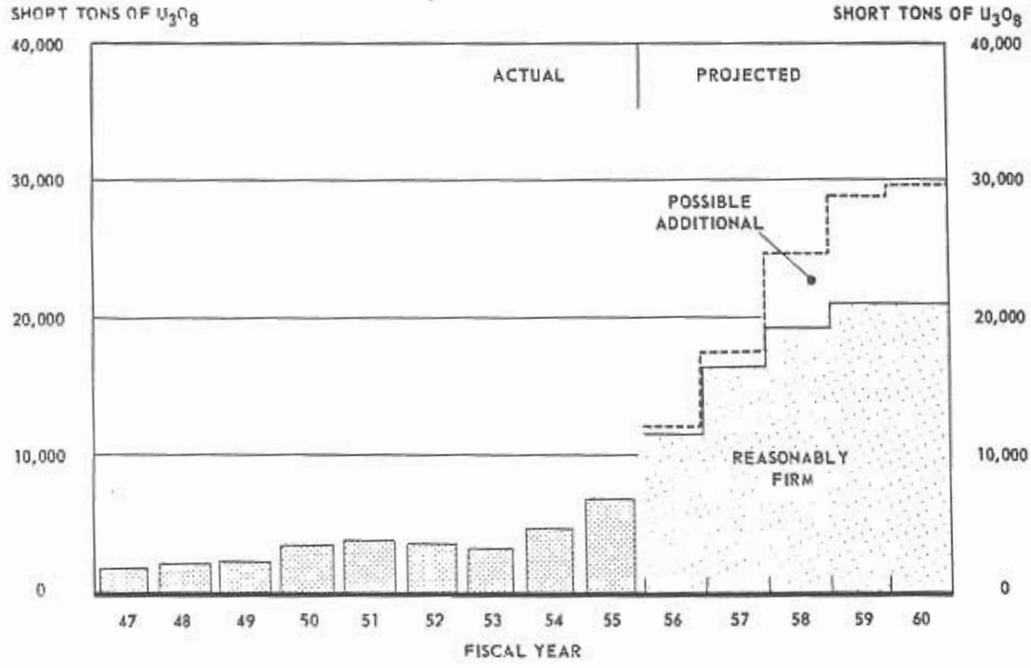


CHART I-B

New Procurement Goal

In June the Commission revised its permissive annual procurement goal from 20,000 to 22,500 tons of U_3O_8, with 17,500 tons annually continuing as the firm target to be achieved by 1960 if possible.

In Chart I-B and Table 1 are shown the tonnages of uranium concentrates now projected for receipt by the United States and the United Kingdom. The amounts shown in the upper half of the table, ranging up to a total of 20,730 tons in 1959 and 1960, include only tonnages covered by reasonably firm production plans. Possible additional production is shown in the lower half of the table. The latter quantities, ranging up to a total of 8,900 tons in 1960, include estimates of tentatively planned production from known sources now under development, as well as an allowance for possible new discoveries. Experience of the past three years suggests that by 1960 annual production from future discoveries could be substantially greater than the 2,500 tons shown in the table.

Although the table indicates that total annual tonnages of nearly 30,000 tons of U_3O_8 might be obtainable by 1960, the Commission has not authorized contract commitments which would increase the estimated annual receipts of the United States above 22,500 tons of U_3O_8.

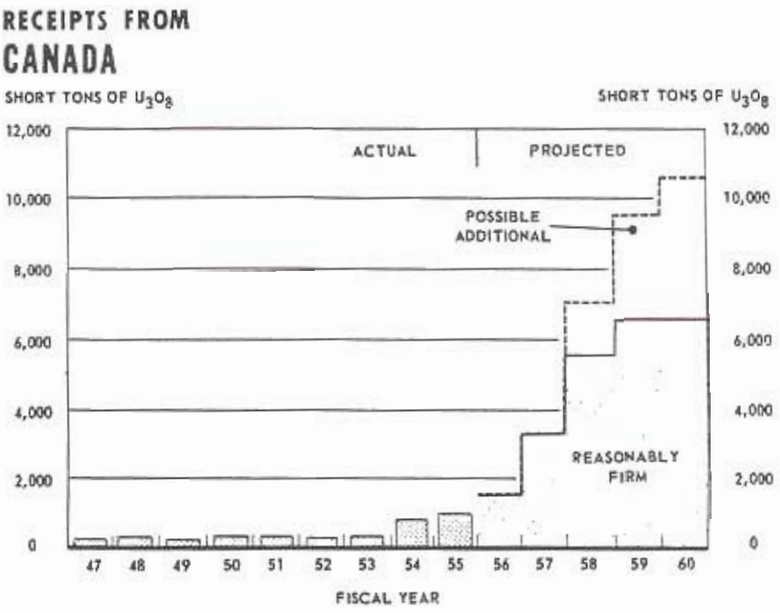


CHART I-C

FOREIGN OPERATIONS

Canada

Receipts of 830 tons of U_3O_8 during fiscal year 1955 fell about 8 percent short of the forecast for deliveries from Canada. The sharp drop during the fourth quarter resulted from supplying the pipeline required by the new Canadian refinery. Future deliveries to the United States will be largely in the form of UO_3 (orange oxide) meeting the purity specifications for production of uranium metal feed.

Expanding mining and mill operations are expected to bring receipts from Canada up to 6,500 tons in 1959, as shown in Chart I-C.

Beaverlodge. Since completion of its expansion in December, the Eldorado mill has operated steadily at 700 tons per day. Part of the mill feed consists of ore being purchased by Eldorado from three nearby properties.

Verna. At Eldorado's Verna property and at the adjacent Radiore property held by Eldorado under a lease arrangement, underground exploration and diamond drilling has been completed. Results indicate a large tonnage of ore of probable economic grade. An expansion of the Beaverlodge milling operation to handle Verna ore is now planned.

Gunnar. Preparations for open pit mining operations by Gunnar Mines, Ltd., are well advanced, and the 1,250-ton-per-day acid leach plant is expected to start trial operations about August 1, 1955. The Commission has contracted to repurchase from Eldorado approximately 4,000 tons of U_3O_8 in concentrates from this plant, to be delivered over a 5-year period beginning October 1, 1955. The contract price per pound of U_3O_8 is $9.50 (Canadian), plus handling and shipping charges.

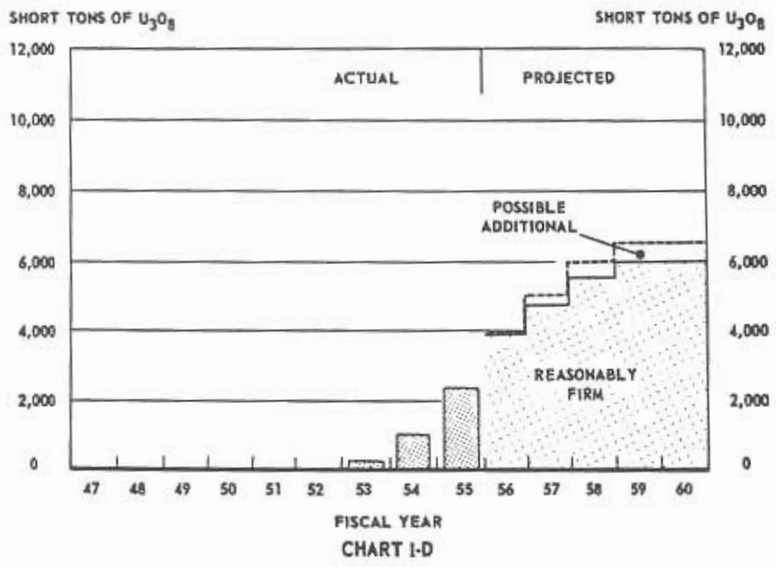


CHART I-D

Blind River. The Commission has negotiated unit price contracts with Eldorado to repurchase uranium concentrates to be received by Eldorado under its contracts with two mining companies in the Blind River area of Ontario, on the north shore of Lake Huron. The contracts cover 12,650 tons of U_3O_8, the prices to be Eldorado's cost, indicated below, plus handling and shipping charges.

Pronto Uranium Mines, Ltd., will deliver 2,750 tons of U_3O_8 in concentrates at $10.00 (Canadian) per pound. This tonnage will be produced by December 31, 1960, in a 1,000-ton-per-day plant scheduled for start-up by August 1, 1955.

Algom Mines, Ltd., will deliver by March 31, 1962, approximately 9,900 tons of U_3O_8 in concentrates at $10.45 (Canadian) per pound. The concentrates are to be produced in two 3,000-ton-per-day plants scheduled to start up in July 1956 and October 1956, respectively.

Eldorado may also enter into a contract with Consolidated Denison, which has outlined substantial ore bodies by diamond drilling and is reported to be considering construction of a 5,700-tons-per-day plant which might start up by September 1957.

Some 30 mining companies are now actively exploring properties in the 1,200-square-mile Blind River area.

Bancroft area. In the Bancroft area of southeastern Ontario, two major properties, Centre Lake Uranium Mines and Croft Uranium Mines, have merged with the objective of pooling ore reserves estimated to be sufficient for a 1,000-ton-per-day milling plant, although the ore contains less than two pounds of U_3O_8 per ton. Eldorado is now studying a production proposal.

South Africa

Shipments of uranium concentrates from South Africa, shown in Chart I-D, totaled 2,351 tons during fiscal year 1955, about 2 percent less than the amount forecast. At the end of

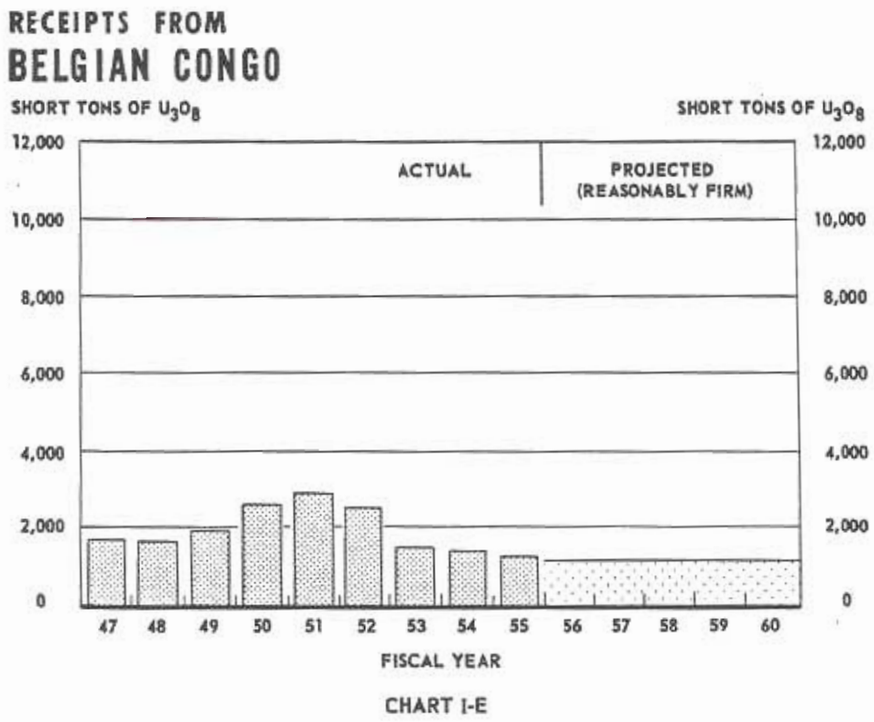


CHART I-E

June, 12 uranium treatment plants were in operation, and the 13th plant was scheduled to start up in July. The remaining two authorized plants are scheduled to start up later in calendar year 1955, and in the first half of 1956, respectively. The combined annual capacity of the 15 plants is expected to be about 5,000 tons of U_3O_8.

Belgian Congo

Production of concentrates from the Shinkolobwe mine was lower during the second half of fiscal year 1955 as a result of the steady decline in the grade of ore being mined at greater depths. Total deliveries for the year were 1,319 tons. As shown in Chart I-E, annual production is now projected as only about 1,200 tons of U_3O_8. An adjacent mineralized area is being prospected and will be developed during the next few years by a new shaft and underground workings. However, estimates of the tonnage and grade of this ore body will not be available nor will production be possible before 1958. With the bilateral agreement with Belgium concluded, a commercial contract will be negotiated promptly to cover deliveries beyond February 1956.

Australia

The Radium Hill mine and treatment plant was officially opened on November 10, 1954, and low-grade mechanical concentrates are being stockpiled there until the Port Pirie chemical plant opens in July.

First shipments from the Rum Jungle ore processing plant, officially started up on December 19, 1954, arrived in the United States in May. Full production from the Rum Jungle plant has been delayed temporarily by processing difficulties.

Widespread exploration continued in Northern Australia, with the Alligator River district in the Northern Territory and the Mt. Isa district in Queensland still appearing to be areas of potential production.

Portugal

An agreement was concluded in June with the Portuguese Government with respect to the Combined Development Agency's uranium operations in Portugal. The agreement extends the period of operation from the end of 1957 to the end of 1962, and increases the total quantity of uranium subject to export from 700 to 1,325 metric tons. At the end of 1962, or upon earlier export of 1,325 metric tons of U_3O_8, the mines and facilities are to become the property of the Portuguese Government. During the intervening period approximately $3.85 per pound of U_3O_8 exported will be paid to the Portuguese Government in lieu of high export taxes it originally intended to impose. The payment is related to the known cost of production and is designed to give Portugal the same treatment as Australia and some of the other countries supplying uranium to the program. Considering the entire period of operation before the transfer of the property, 1952 to 1962, the estimated cost of U_3O_8 to the Combined Development Agency, including amortization, will be slightly less than $9.00 per pound.

FOREIGN EXPLORATION

Geological exploration continues in Peru and French Morocco under arrangements which would make uranium discovered available to the Commission. As yet, no discoveries have been made which appear to be sources of economical production.

Negotiations are in progress with Chile, Argentina, and Spain for the establishment of cooperative reconnaissance programs which would be initiated early in fiscal year 1956.

The Philippine Government is furnishing information concerning exploration being carried out by the Philippine Iron Mines on their property near Larap, Camarines Norte, Luzone, on which radioactivity was discovered in mid-1954. As yet no significant production potential has been established.

DOMESTIC OPERATIONS

United States production of 2,155 tons of U_3O_8 during fiscal year 1955 exceeded by 155 tons the projection reported six months ago. As shown in Chart I-F, this rate of production will be approximately doubled in fiscal year 1956 and trebled in fiscal year 1957.

Domestic mill capacity increased by 600 tons per day during the second half of fiscal year 1955, reaching 3,250 tons per day by June 30, 1955. This expansion and the construction of additional capacity now in progress are in keeping with the growth of domestic ore reserves to approximately 14,000,000 tons as of June 15, 1955, and with the present ore stockpile, which totaled approximately 1,225,000 tons on June 30, 1955. The major portion of this ore stockpile is at locations where mills are under construction or where large additions to present capacity have been undertaken.

RECEIPTS FROM
UNITED STATES SOURCES

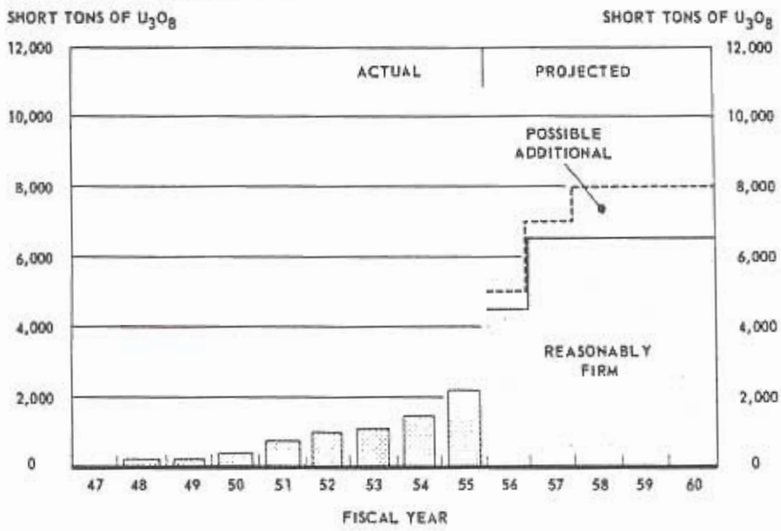


CHART I-F

Mill Capacity

Present and projected ore processing capacity is summarized in Table 2.

Nine mills have been in operation throughout the past six months. Two additional mills under construction now are expected to come into operation in June 1956, one at Moab, Utah, (Uranium Reduction Company) and one at Edgemont, South Dakota, (Mines Development, Inc.). A 12th plant, to be constructed by Rare Metals Corporation near Cameron, Arizona, is also expected to start up in June 1956.

Improvements in mill performance and steps to increase capacity are summarized as follows:

Monticello. The 400-ton-per-day acid leach section is scheduled to start up on October 1, 1955, and will increase the mill's capacity to 600 tons per day. Present facilities are being converted to a single raw carbonate leach circuit with a capacity of 200 tons per day which is expected to begin operation in July 1955.

Durango. Vanadium Corporation of America has been operating the Durango mill at a rate about 10 percent greater than its design capacity of 400 tons per day.

Naturita. The present operating rate of 300 tons per day is expected to be increased about 10 percent by August 1955.

Uravan. United States Vanadium Corporation is now operating the Uravan mill at an average rate of 420 tons per day. Negotiations have been completed for an expansion of its capacity, and it is expected that the enlarged mill will be able to process 850 tons per day.

Grand Junction. Enlargement of this plant was completed in May, and it is now operating at its design capacity of 300 tons per day, with an excellent possibility of exceeding that rate by 50 tons per day.

Table 2—Daily Ore Processing Capacity (Short Tons)

Location	Mill Contractor	Actual Dec. 1954	Actual June 1955	Projected Dec. 1955	Projected June 1956	Projected Dec. 1956
Monticello, Utah	The Galigher Co.[a]	150	150	600	600	600
Durango, Colo.	Vanadium Corp. of America	400	400	440	440	440
Naturita, Colo.	Vanadium Corp. of America	200	300	330	330	330
Uravan, Colo.	U. S. Vanadium Co.	400	400	400	800	850
Rifle, Colo.	U. S. Vanadium Co.	250	250	250	250	250
Grand Junction, Colo.	Climax Uranium Co.	150	300	300	300	300
Salt Lake City, Utah	Vitro Uranium Co.	300	350	400	400	400
Bluewater, N. M.	Anaconda Copper Mining Co.	400	700	2,000	2,000	2,200
Shiprock, N. M.	Kerr-McGee Oil Industries, Inc.	400	400	400	400	400
Edgemont, S. Dak.	Mines Development, Inc.	0	0	0	200	200
Moab, Utah	Uranium Reduction Co.	0	0	0	1,000	1,500
Cameron, Ariz.	Rare Metals Corp.	0	0	0	200	200
Total Daily Capacity		2,650	3,250	5,120	6,920	7,670

[a] Plant owned by AEC.

Salt Lake City. Ore is now being treated in excess of 350 tons per day with an increase to 400 tons per day expected in the near future.

Bluewater. The carbonate leach circuit is now operating at a rate of 750 tons per day. Operations of the 1,250 to 1,500-ton-per-day acid leach section is scheduled to start in October 1955.

Shiprock. Kerr-McGee started up this plant in November 1954 and is now processing ore at the rate of 350 tons per day.

Edgemont. Construction of the 200-ton-per-day mill began in June and is expected to require 10 to 12 months.

Moab. Construction started in June on the 1,000 to 1,500-ton-per-day mill, with completion expected in 12 months.

Cameron. Negotiations have been completed with Rare Metals Corporation for the construction and operation of a 200-ton-per-day mill in the Cameron-Tuba City area of the Navajo Indian Reservation in Arizona.

New Ore-Buying Stations

Moab, Utah. The mechanical sampling plant began steady operation on February 1, 1955.

Riverton, Wyoming. This station opened for receipt of ores on March 1, 1955.

Globe, Arizona. Receipt of ores began in June 1955.

DOMESTIC EXPLORATION

Domestic uranium ore reserves at June 30, 1955, were greater than 14,000,000 tons. Approximately 70 percent of this total is in deposits of 100,000 tons or more. The large Anaconda deposits in the Laguna Indian Reservation, New Mexico, alone account for 45 percent of the total reserves, and the deposits of the Big Indian Wash-Lisbon Valley area in

Utah represent another 17 percent. Total drilling by the Government was reduced to approximately 350,000 feet during the January-June period, while private drilling is estimated as more than six times this amount.

The production area has been extended by new, major discoveries in central Colorado, south-central Texas, and the area north of Spokane, Washington. The finding of uranium in geologic horizons and environments not previously known to contain it has greatly enlarged the extent of potentially favorable ground.

Development of Uranium Extraction Processes

The U. S. Bureau of Mines Experimental Station at Salt Lake City, Utah, the National Lead Company, Inc., operating the Raw Materials Development Laboratory at Winchester, Massachusetts, the Battelle Memorial Institute, the Dow Chemical Company, and Arthur D. Little, Inc., are all continuing to work on the development of both new and improved processes for Colorado Plateau uranium ores.

Chattanooga uraniferous shale process studies continued on a laboratory and bench scale at Columbia University.

New ore testing facilities for both acid and alkaline processes for western ores are now in operation at the pilot plant at Grand Junction, Colorado. This pilot plant, operated by National Lead Company, Inc., now has four separate processing circuits.

Studies on the recovery of uranium as a single product from Florida phosphatic leached-zone materials were completed. Although it was demonstrated that uranium can be recovered from the leached-zone material, this process is not considered economical by present standards.

Studies are being conducted to develop economic processes for the treatment of the newly discovered ore-grade lignites of South and North Dakota.

THORIUM

The Commission's procurement goal is 2,500 tons of contained thorium by June 30, 1957. Upon the basis of present procurement planning, deliveries to that date would total approximately 2,649 tons as follows:

AEC owned material	804 tons
GSA monazite	325
Lindsay Chemical Co.	516
Heavy Minerals Co.	70
France	290
India	104
Brazil	540*
Total	2,649 tons

Total commitments for delivery by June 30, 1960, amount to 2,864 tons. The additional 215 tons to be received subsequent to June 30, 1957, represent remaining deliveries from Heavy Minerals Company and from the processing of GSA monazite.

* An offer to purchase the last 220 tons of the 540 tons listed is still outstanding but has not been accepted by the Brazilians.

Part II

Special Nuclear Materials

(SECRET)

Highlights in the production of special nuclear materials during the second half of fiscal year 1955 are as follows:

a. All remaining authorized production reactors were started up: C reactor at Savannah River and KW and KE reactors at Hanford.

b. Thirteen units of the Portsmouth gaseous diffusion plant were placed in production. At June 30, 1955, 17 units of the projected 29 units were in operation and the project was 83 percent complete.

c. Eight units of the new lithium 6 plants at Oak Ridge were started up. The remaining two authorized units are expected to be in production by September 1955.

d. Construction was begun on additions to plants to increase feed materials capacity at Fernald, St. Louis, Weldon Spring and Paducah.

e. Production of plutonium, uranium 235, and lithium 6 was at record high levels.

FEED MATERIALS

New Plants

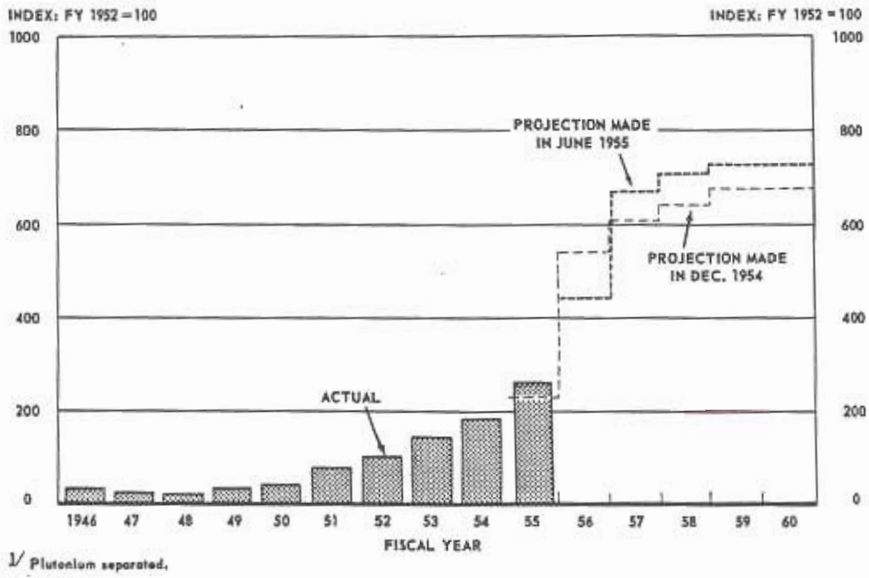
Provision of enlarged capacity for the preparation of metal feed, authorized in October 1954, is proceeding satisfactorily. Construction of the new plants at Fernald and St. Louis and site preparation at Weldon Spring began in March. Construction of the plant to convert uranium hexafluoride to metal at Paducah was started March 28. The scheduled completion date for the facilities at Fernald is July 1, 1956, for the metal reduction plant at Paducah is January 1, 1957, and for the new units at St. Louis and Weldon Spring is July 1, 1957.

Reactor Feed

Shipments of finished uranium slugs from Fernald to Hanford are now on schedule, after lagging slightly during the third quarter of fiscal year 1955. Receipts of ore concentrates have not been sufficient to meet the growing requirements of metal feed for the reactors, and side-stream withdrawals of uranium hexafluoride from the gaseous diffusion plants were necessary to provide uranium of normal (0.71 percent) isotopic content for this purpose. During the January–June period 834 tons of uranium were withdrawn, compared with 575 tons during the preceding six months. Larger receipts of ore concentrates are expected to permit a reduction in such withdrawals during fiscal year 1956. (End of SECRET section.)

PRODUCTION OF SPECIAL NUCLEAR MATERIALS

PLUTONIUM 1/



1/ Plutonium separated.

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CHART II-A

Feed for Gaseous Diffusion Plants (SECRET)

Production of uranium hexafluoride (UF_6) feed for the gaseous diffusion plants was limited during the third quarter of the fiscal year by reduced shipments of depleted orange oxide (UO_3) from Hanford. During much of the past six months all UF_6 feed production was performed at the Paducah plant and the Oak Ridge feed plant was shut down for equipment modification. Larger quantities of depleted UO_3 became available in the fourth quarter and it is expected that increased quantities of UO_3 will be converted to UF_6 in subsequent quarters. Shipments from the Savannah River separations plant have increased steadily, and those from Hanford have recently increased as a result of the record tonnages of uranium processed by the Redox plant and the improved operation of the TBP plant, now modified to permit recovery of uranium stored for shorter periods and therefore more radioactive.

Feed Stocks

Amounts of uranium feed available for reactor and gaseous diffusion plant operations are shown in Chart II-B. The total stock of normal uranium, 8,024 tons on June 30, 1955, is virtually unchanged from December 31, 1954. Included in the latter amount are 2,469 tons of uranium in unprocessed ore purchased by the Commission, most of which is awaiting treatment (See Part I—Raw Materials, p. 11) by ore processing mills now being built or expanded. The small tonnages of mill concentrates on hand have limited the operations of the Fernald refinery during recent months, but sufficient metal has been produced from gaseous diffusion plant sidestream withdrawals to maintain an adequate supply of metal feed for the Hanford and Savannah River reactors at all times.

There has been an increase in the quantities of irradiated uranium discharged from the reactors and awaiting chemical separation, shown on the chart as "in recovery process". Stocks of reactor depleted uranium have therefore increased in spite of the larger quantities delivered and fed to gaseous diffusion plants.

PLUTONIUM

Hanford continues to produce plutonium meeting two sets of specifications. Low ngs plutonium is being produced for use in current designs of thermonuclear weapons, and high ngs plutonium for other weapon uses in which the higher rate of spontaneous neutron emission (neutrons per gram per second) is not so critical a factor. At Savannah River only low ngs plutonium is being produced.

Plutonium Formation

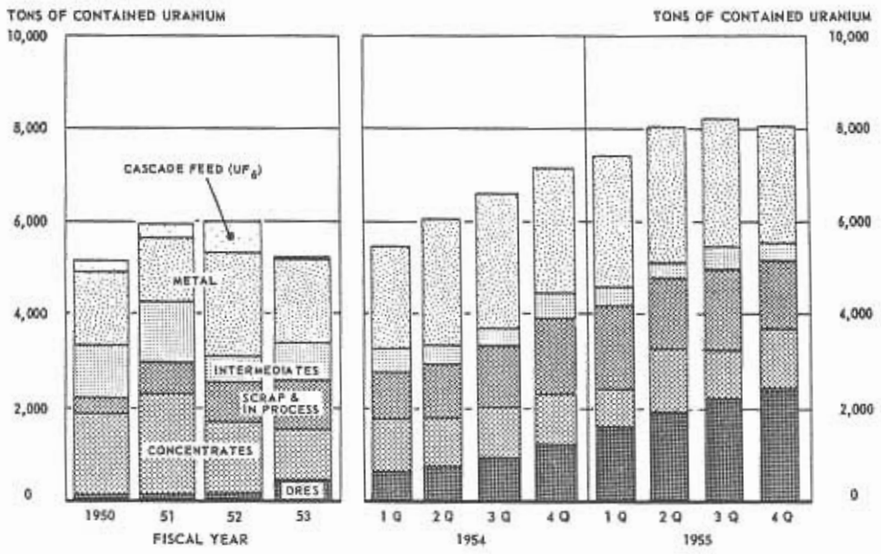
Hanford. Plutonium formed in the Hanford piles during the January–June 1955 period was 24 percent higher than during the preceding six months. The greater production resulted from higher power levels in the first six piles and from the start-up of the new KW and KE piles.

Production began in the KW pile on January 4, but the pile was shut down on January 5 and remained out of production until March 11. This period was required to repair damage caused by an accidental stoppage of flow of cooling water and the consequent melting of fuel elements in one tube of the reactor. The KE pile began production on April 17.

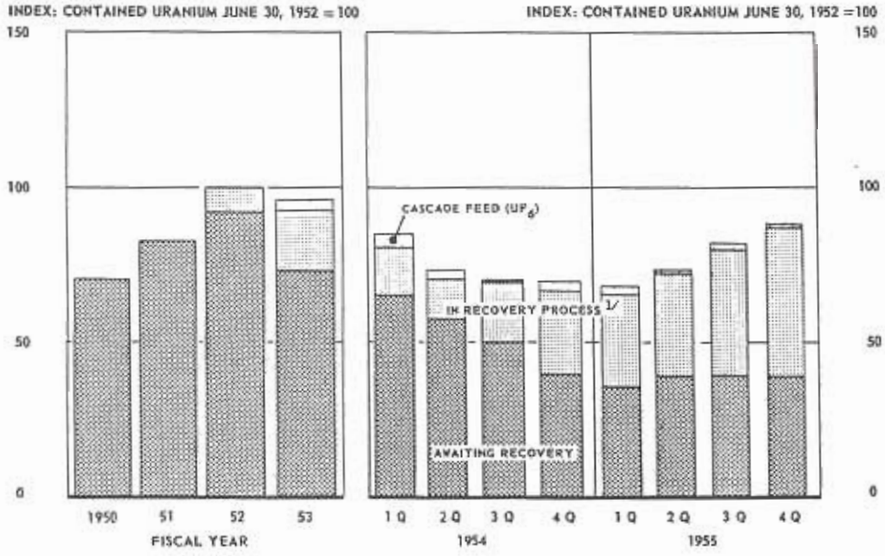
Savannah River. Plutonium formation in the five heavy water reactors at Savannah River during the January–June period was 94 percent greater than in the preceding six months, and was 29 percent of the total for both Savannah River and Hanford. The new C reactor reached criticality on March 28 and during May maintained a power level higher than has been reached by any other Savannah River reactor.

FEED STOCKS (end of period)

NORMAL URANIUM



REACTOR DEPLETED URANIUM



1/ Includes slugs in cooling basins, materials in Redox and Purex separations and TBP recovery processes, and subsequent steps in the manufacture of hexafluoride.

CHART II-B

SLUG FAILURES (Normal Uranium)
AND ASSIGNED TIME LOST

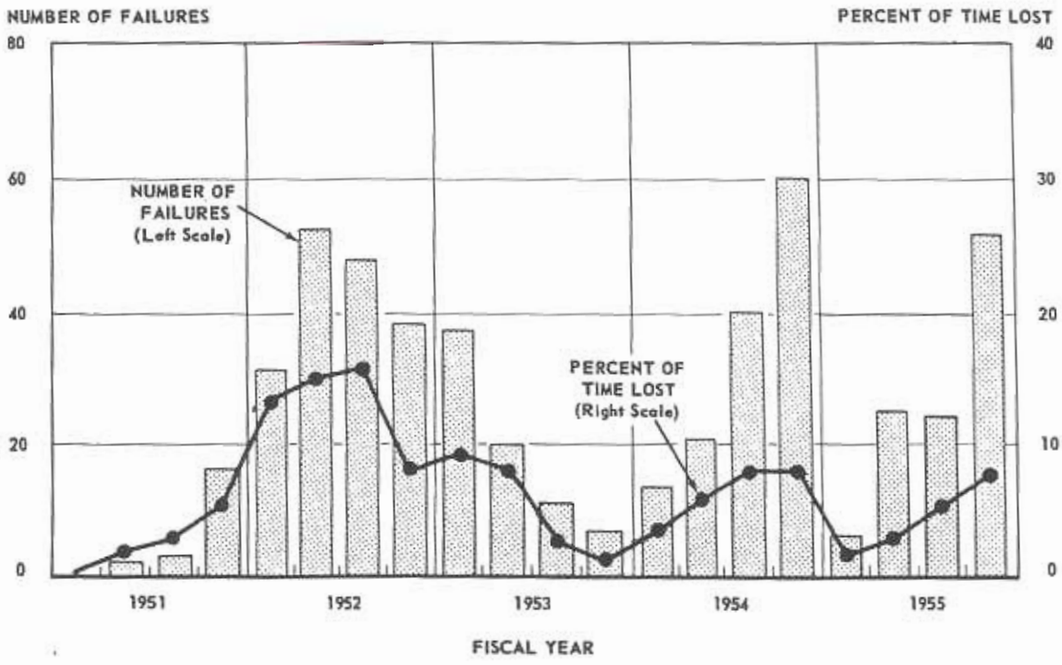


CHART II-C

Hanford Slug Failures

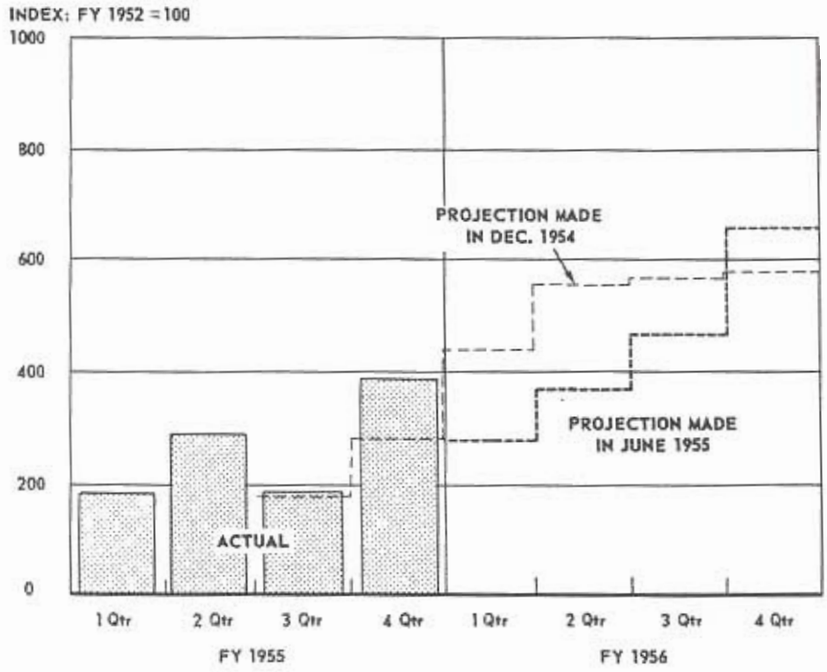
Chart II-C shows that 24 normal uranium slugs failed in the Hanford piles during the third quarter of fiscal year 1955, one fewer than during the preceding quarter. Assigned loss of production time, however, rose from 3.1 percent to 5.3 percent. Failures in the fourth quarter rose to 51 and caused a loss of 8.0 percent of the total operating time of the reactors.

Approximately 55 percent of the slug failures during the third and fourth quarters have occurred in the C pile, where a number of exceptional conditions exist. For example, the maximum power developed in individual slugs of the C pile exceeds that of other piles by approximately 60 percent. The production of low ngs plutonium in this pile requires frequent shutdowns for discharge and charge of slugs, and it is possible that the alternate heating and cooling contributes to the failure rate. Also, 20 of the 42 failures in C pile were in test slugs deliberately irradiated until rupture occurred.

Plutonium Separation

The quantities of plutonium separated during the third and fourth quarters correspond to annual rates of 188 and 387 in terms of the index used in Chart II-D. Rates of 180 and 286 were projected for these quarters in the preceding report. Higher than forecast rates were achieved in the fourth quarter at Hanford when the Redox plant resumed the separation of high ngs plutonium.

PLUTONIUM PRODUCTION 1/



1/ Plutonium separated.

CHART II-D

Hanford. As projected, the quantity of plutonium separated declined sharply during February and March when the Redox plant was used to separate low ngs plutonium. When the desired product is low ngs plutonium, the quantity of plutonium in each ton of irradiated uranium is smaller than when longer irradiation has been permitted and the product is high ngs plutonium. In April the Redox plant resumed the processing of more highly irradiated uranium and operated at record levels during the fourth quarter.

The T canyon separations plant produced low ngs plutonium throughout the period, but its output was limited during April because of difficulties with iodine emission from the stacks.

The new Purex plant was turned over to operating forces on May 8, and is scheduled to begin production in November 1955.

Savannah River. Performance of the F Purex plant continued to improve during the third and fourth quarters. The H Purex plant was turned over to operating forces on March 1 and was expected to be processing irradiated material by the end of July.

Plutonium Forecast

Chart II-D shows that production of separated plutonium during the first and second quarters of fiscal year 1956 is now expected to be appreciably less than projected in the preceding report. There are two main reasons for this downward revision of the projection.

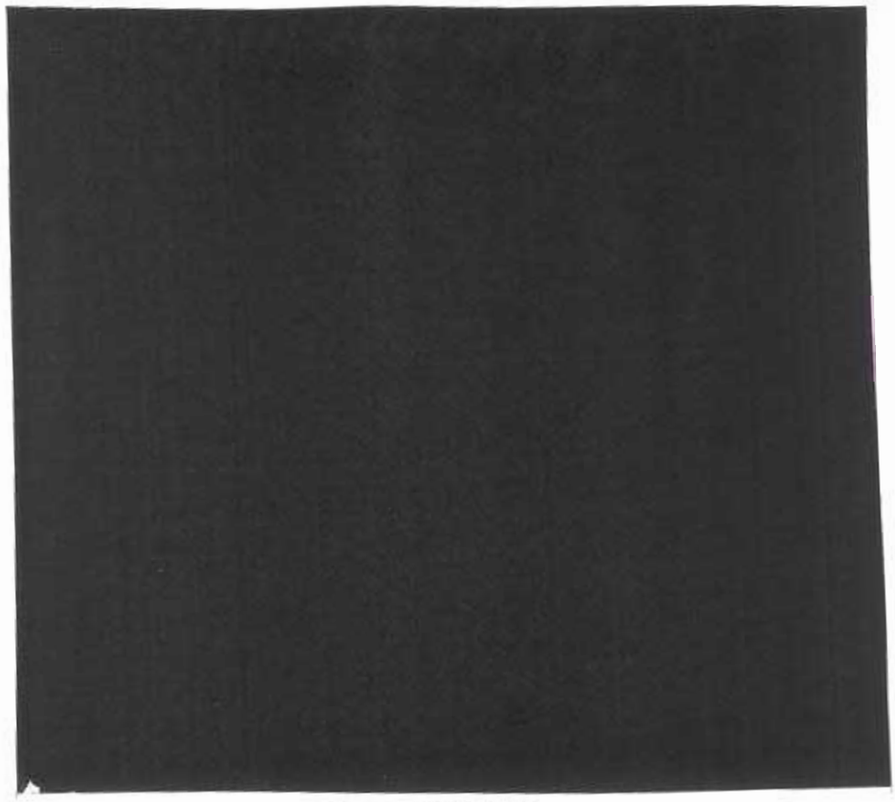


CHART II-E

First, the record high production of the Redox plant in the fourth quarter of 1955 largely eliminated the accumulation of high ngs material awaiting separation. Secondly, increased requirements for low ngs plutonium will again require that the Redox plant be used for the separation of this type of product during the greater portion of fiscal year 1956. High ngs material accumulating during this period will not be separated until the second half of the year. This fact and expected increases in the power levels of the reactors account for the upward revision in the projection for the last quarter of fiscal year 1956.

The projection for steady state plutonium production in 1959 and 1960 is 9 percent greater than in the preceding report. There is increasing confidence that potential improvements will be realized in the performance of the Hanford and Savannah River reactors.

URANIUM 235

Production of enriched uranium 235 during the last six months of fiscal year 1955 was about one percent less than projected in the preceding report. In terms of the index used in Chart II-E, rates of 495 and 551 were achieved in the third and fourth quarters, the projected rates for those quarters being 501 and 556. Production was limited by the shortage of feed in the early months of the period, and by the sacrifice in top product due to the unexpectedly large

sidestream withdrawals of uranium hexafluoride of normal isotopic content for preparation of reactor feed.

Thirteen more units of the Portsmouth plant were started up during the period, bringing the number of units in full operation to 17 out of a projected total of 29 units for the completed plant. The three units of X-27 were placed on stream February 7, April 1, and June 30; the first five units of X-29 on February 21, March 14, April 4, May 18, and June 25; the fifth and last unit of X-31 on January 29; and the first four units of X-33 on April 1, April 25, May 20, and June 30. Remaining on June 30 to be completed were the seven units of X-25 comprising the top of the cascade, one unit of X-29, and four units of X-33.

The gaseous diffusion plants at Oak Ridge, Paducah, and Portsmouth are now being operated as a single cascade system. Enriched uranium is withdrawn at Oak Ridge, uranium of normal isotopic content is being withdrawn at Paducah, and depleted uranium for certain weapon requirements is being withdrawn at Portsmouth. Reactor depleted uranium is being fed into the system at both Paducah and Portsmouth, in a ratio which is adjusted as additional Portsmouth equipment is added to the cascade.

Barrier Improvement

[redacted]

Plans are being developed for a sharp expansion of the established practice of replacing obsolete barrier with improved types.

Uranium 235 Forecast

Projected uranium 235 production during fiscal year 1956 is now expected to be about 7 percent higher than was projected in the preceding report. The upward revision is based primarily on the rapid construction progress at Portsmouth which has permitted units to be placed in operation well ahead of the target schedule.

The upward revision in the production rates now projected for the years 1957–60 is based on the expectation of improved cascade performance.

OTHER MATERIALS

Lithium 6

Production of lithium 6 has increased sharply. In terms of the index used in Chart II-F, output has increased from 143 in the second quarter of fiscal year 1955 to 296 in the third quarter and to 981 in the fourth quarter. Rates of 200 and 496 had been projected for the third and fourth quarters.

The two production lines of the ADP plant (Beta 4) have continued in operation, and the six lines of the Alpha 5 plant and two of the four lines of the Alpha 4 plant have come into operation ahead of schedule. All lines are expected to be in full operation by September. The Alpha 5 lines were started up on January 20, February 21, March 11, March 23, April 17, and April 30; the first two Alpha 4 lines on May 27 and June 26.

At the present time isotopic enrichments of 40, 60, and 95 percent lithium 6 are being produced for various weapon requirements.

The output of lithium 6 is now projected at a substantially higher rate than in the preceding report. Experience to date indicates that the actual capacity of the Alpha 5 plant is significantly greater than design.

LITHIUM 6 PRODUCTION

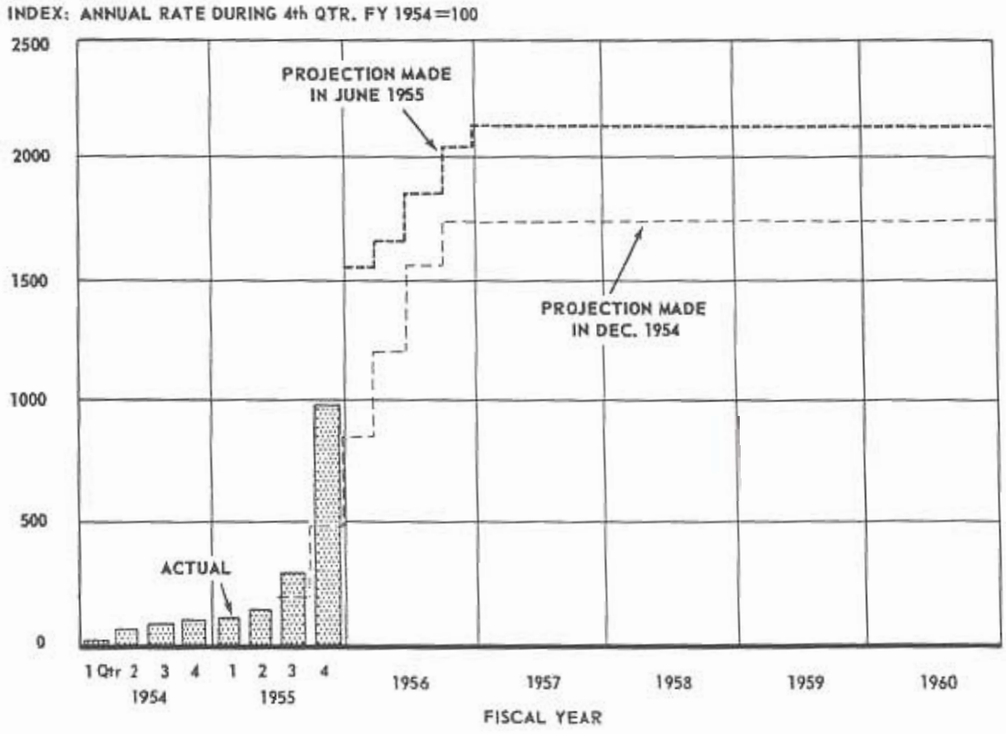


CHART II-F

Uranium 233

Irradiation tests of thorium metal for the production of uranium 233 indicate problems which make it a less attractive and less economical substitute for low ngs plutonium than was previously assumed. Highly radioactive products resulting from the decay of other isotopes might require the development of new processes and the construction of costly new separations facilities in order to separate uranium 233 with safety.

Also, recent weapon test results indicate that uranium 233 is less valuable as a substitute for plutonium than had been previously estimated. Other developments indicate that the long-range weapons requirement for either uranium 233 or low ngs plutonium may be reduced.

For these reasons, the full-scale irradiation of thorium to produce uranium 233 has been postponed, pending the outcome of additional research and development. The equivalent of one full thorium loading of a Savannah River reactor is now planned as a supplement to the production of uranium 233 now in progress in the C and H piles at Hanford, which contain partial thorium loadings. All irradiated thorium will be separated at Oak Ridge. Plans to construct a production-scale thorium refinery at the Mound Laboratory were canceled on May 6. Engineering design for the facility will be completed.

Tritium

Discharge of the special loadings of enriched uranium and lithium slugs for the production of tritium in the C and DR piles at Hanford was completed during March. Small amounts of tritium will continue to be produced in the lithium slugs used to absorb excess reactivity in the Hanford and Savannah River reactors.

Heavy Water

The Dana and Savannah River heavy water plants are being operated at capacity, a rate which will permit the heavy water inventory to increase at a rate of approximately 500 tons per year. The large requirement for initial charging of the Savannah River reactors has been met, and only a small part of the heavy water capacity is needed for replacing normal usage and for the expected rate of deuterium production.

Deuterium gas. Deuterium gas requirements for thermonuclear weapons continue to be produced at Savannah River. Plans for enlarging the capacity of the Savannah River deuterium gas plant by 15 percent have been canceled. A deuterium plant with a capacity one half that at Savannah River will be constructed at Oak Ridge. (End of SECRET section.)

Part III

Weapons

This part of the PROGRAM STATUS REPORT
has been transmitted as a separate document.

Part IV

Reactor Development

NAVAL REACTORS (SECRET)

Many of the advantages expected from the use of nuclear power for submarine propulsion have been demonstrated during the past six months. Following three months of successful sea trials, the USS *NAUTILUS* was accepted on a preliminary basis by the Navy on April 22, 1955. The land-based prototype for a second submarine, the USS *SEAWOLF* generated useful power for the first time on May 18, 1955. Full power operation of the prototype at West Milton, New York, was attained on June 6.

With the first submarine reactor system completed and with the second in the latter stages of development, the Commission is expanding its effort to provide the Navy with reactors suitable for the propulsion of naval vessels in a range of power ratings covering all feasible applications. Three new reactor designs are now being developed: the Submarine Advanced Reactor, the Submarine Fleet Reactor, and the Large Ship Reactor. Development of a fourth application, the Submarine Reactor Small, will start this summer. A fifth project, the Task Force Escort Reactor, is under consideration by the Department of Defense.

Submarine Thermal Reactor (STR)

In the period from January 17 to July 8, 1955, the USS *NAUTILUS* powered by the STR Mark II, was under way for a total of 1,287 hours, of which 662 were traveled while submerged. The submarine during this time steamed 13,761 miles, of which 7,365 were traveled while submerged, and made 198 dives. Maximum speed to date has been estimated at 24.1 knots. During a trip to San Juan, Puerto Rico, in May, the *NAUTILUS* stayed continuously submerged for 89 hours while cruising 1,380 miles at an average speed of 15.3 knots.

With the completion and testing of the *NAUTILUS* and the successful operation of the ship as an active naval vessel, plans have been made to convert the STR Mark I plant at the National Reactor Testing Station from a land prototype for the *NAUTILUS* power plant to a general test facility for investigating new design features for water-cooled power reactors. An important phase in this transition will be the replacement this summer of the first STR Mark I reactor core, which has operated for more than two years and has exceeded its initially anticipated useful life. At the same time, the plant will be modified to permit higher reactor power outputs and higher operating temperatures and pressures in the primary and secondary heat transfer systems. Just prior to core removal the reactor was operated under extreme conditions which were not considered possible during the *NAUTILUS* prototype tests. These tests have provided extremely valuable information on operating characteristics when the water in the coolant system is boiling and when a fuel element has ruptured.

Submarine Intermediate Reactor (SIR)

The SIR Mark A land prototype for the USS *SEAWOLF* has been completed by the General Electric Company at West Milton, New York. The plant was made critical for the first time on March 20, 1955, and generated useful power for the first time on May 18. Full power was first achieved on June 6. Testing to date has been without significant nuclear difficulties.

The USS *SEAWOLF*, which will be powered by the SIR Mark B, is now 72 percent complete at Groton, Connecticut. The submarine was launched on July 21, 1955; dock trials are scheduled to begin early in 1956.

Submarine Advanced Reactor (SAR)

The SAR project represents an effort to utilize recent technological developments in designing a two-reactor submarine propulsion system. The General Electric Company is developing a reactor plant which will have simpler controls, longer core life, greater reliability, and less weight per shaft horsepower than can be obtained with the STR and SIR designs.

A land prototype will be constructed at the West Milton site. The plant will consist of a section of a submarine hull containing one reactor and associated steam and propulsion equipment. A high performance submarine, to be propelled by the SAR two-reactor system, has been included in the Navy's fiscal year 1956 shipbuilding program.

Critical experiments are being performed in the Advanced Test Reactor (ATR) to test various control rod configurations and to measure power distribution, reactivity, and temperature coefficients.

Submarine Fleet Reactor (SFR)

The Submarine Fleet Reactor will be based on STR technology, and its development will not therefore require construction of a prototype. The project will be financed entirely by the Navy, but the Commission has authorized the use of some AEC facilities at Bettis Plant for this purpose. This reactor system, which Westinghouse is developing, will be used in two submarines in the Navy's fiscal year 1955 shipbuilding program. Additional submarines using an improved SFR system are included in the fiscal year 1956 Navy program.

Large Ship Reactor (LSR)

The land prototype of the LSR is also being developed by Westinghouse at Bettis Plant. This reactor is intended for installation on a multiple-reactor basis and will be applicable to installation in various types of large surface ships. General design studies for such ships are being made by the Newport News Shipbuilding and Dry Dock Company. The Commission has selected the National Reactor Testing Station as the site for the LSR prototype and has appointed a board to select an architect-engineer for design of the site facilities.

Submarine Reactor Small (SRS)

To meet a specific Navy requirement for a reactor suitable for small submarines the Commission has approved the development of a reactor system of 2,000 to 3,000 shaft horsepower, which would be suitable for a small attack or killer submarine; a two-reactor system could propel a medium-sized attack submarine.

Because both Westinghouse and General Electric are fully engaged in other reactor projects, the Commission concluded that it would be desirable to assign the development of the Submarine Reactor Small to a third contractor. After careful evaluation of the companies ex-

pressing an interest in this work, the Commission selected the Combustion Engineering Company, with which a contract is being negotiated.*

AIRCRAFT NUCLEAR PROPULSION

During the past six months the Commission and the Department of Defense have taken steps to accelerate the development of reactors for aircraft propulsion. In the spring of 1955 the Air Force formally established a requirement for a nuclear propelled strategic bomber and has assigned its highest priority and preference rating to the nuclear propulsion program. The Commission meanwhile has concentrated its development efforts on the two most promising approaches to the aircraft reactor: the direct cycle and the circulating fuel systems. During the past year there have been important experimental accomplishments, particularly in the development of fuel materials and core configurations, and work on both approaches is being expanded sharply.

On June 23, 1955, in a joint memorandum, the AEC Chairman and the Secretary of Defense informed the President of actions taken to accelerate work on the aircraft reactor, and specifically, to begin full-scale tests of a ground prototype in 1959.

The Direct Cycle Approach

The direct cycle system, in which air for the turbojets would be heated directly by the reactor fuel elements, is being developed by the General Electric Company under joint AEC and Air Force contracts. The design and heat testing of smaller components, such as fuel elements, control rods, and moderators, are being done at Lockland, Ohio. Tests of larger components and of the complete reactor system will be performed at the National Reactor Testing Station (NRTS) in Idaho.

The primary objective is to begin ground tests of a full-scale prototype using the direct cycle system during calendar year 1959. The first step in achieving this objective is the operation this year of the Heat Transfer Reactor Experiment (HTRE) No. 1, which, by simulating some of the operating conditions of the prototype, will assist in answering questions of design, fabrication, and operation of the reactor. The experiment will consist of an air-cooled, 20-megawatt reactor containing metallic fuel elements and operating a modified J-47 turbojet engine, a type now in production for the F-86 aircraft. This test will mark the first attempt to operate a turbojet with a nuclear heat source.

The design and fabrication of HTRE No. 1 itself has been a major activity of the General Electric group during the past year. Various fuel element configurations and small reactor components have been subjected to radiation tests in the Materials Testing Reactor in Idaho. Such components have also been tested at extremely high temperatures in an effort to find metals with suitable properties up to 2,300 degrees Fahrenheit. In addition, a complete mock-up of all mechanical and electronic equipment for the HTRE No. 1 was constructed and tested before being shipped to the Reactor Testing Station in May.

Operation of HTRE No. 1 will be followed by experiments in 1957 with a larger reactor. HTRE No. 2 will operate at higher temperatures and will be capable of supplying power for some of the early models of the turbojet engines which will be developed for the nuclear powered aircraft. As a result of recent studies, the reactor will also have a solid rather than a liquid moderator. A critical experiment using a solid moderator is scheduled for late this year.

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*Reported to the Joint Committee by letter of July 7, 1955.

To approach more nearly the actual aircraft propulsion system, HTRE No. 2 will supply power to several engines operating in parallel. General Electric early this year successfully demonstrate this concept by operating modified J-47 engines in parallel with a chemical heat source.

Circulating Fuel Approach

In the circulating fuel system, heat is removed from the reactor by the fuel itself, which in molten form circulates at high speed between the reactor core and a primary heat exchanger. The successful operation last year of the Aircraft Reactor Experiment at Oak Ridge National Laboratory (see preceding Program Status Report) gave added impetus to the joint effort of Oak Ridge National Laboratory and Pratt and Whitney on this concept. Pratt and Whitney is assisting in work at Oak Ridge and is also leasing and planning to construct under an Air Force contract new laboratory facilities near Middletown, Connecticut. A ground test installation will probably be constructed at NRTS.

The schedule for development of the circulating fuel approach calls for operation of a 60-megawatt Aircraft Reactor Test (ART) at Oak Ridge in the summer of 1957 and of a full-scale ground prototype in 1960.

Specifications for the ART will be established and design work will begin within the next few months. Fabrication and procurement of component parts will begin during fiscal year 1956 and continue into 1957. A "hot" critical experiment will be performed at Oak Ridge in early fiscal year 1956 to obtain experimental information on the ART critical mass and temperature coefficients. A full-scale mechanical mock-up (nonnuclear) of the ART will be fabricated during the coming year and will be assembled and operated in the autumn of 1956.

Pratt and Whitney is scheduled to establish design specifications for the full-scale ground prototype within the next year. Final design is to be completed and fabrication started in the winter of 1957-58. Engines for the ground prototype will be operated in the summer of 1958 with a chemically heated sodium-potassium mixture (NaK), the material expected to be used as the secondary coolant in the prototype reactor. Testing of full-scale components and subsystems, assembly of the propulsion unit, and mechanical shakedown of the ground prototype are scheduled for fiscal year 1959.

Tentative specifications for the ART call for an all-inconel system employing a molten fuel of zirconium, sodium, and uranium fluorides, which would be similar to the fuel successfully demonstrated last year in the Aircraft Reactor Experiment. Inconel-clad niobium and stainless steel are being tested as possible substitutes for an all-inconel core, which more readily absorbs neutrons and thereby requires a larger critical mass. Critical experiments, however, indicate that an all-inconel core can be used if necessary. A lower power loop containing zirconium-base fluoride fuels was operated in the Low Intensity Test Reactor at Oak Ridge for more than 700 hours with less than 0.001 inch of corrosion. However, the power densities, flow rates, and temperature differentials in this experiment did not simulate ART operating conditions.

New Aircraft Reactor Concepts

In addition to the two primary aircraft reactor approaches, the Commission is continuing a relatively modest research and development effort on advanced aircraft reactor concepts, including a heterogeneous reactor. The effort on the heterogeneous reactor will be carried over the next several years as a possible alternate to the circulating fuel approach.

Nuclear Propulsion of Missiles

The progress in the development of nuclear reactors for aircraft has encouraged studies of possible applications to missiles. Special study is being given to the possibility of using nonmetallic fuel elements, which might better withstand the high temperatures required in reactors for missile propulsion. A number of research groups at AEC laboratories have expressed an interest in studying nuclear missile design problems.

National Reactor Testing Station (NRTS)

The Aircraft Nuclear Propulsion Program is becoming a predominant activity at the NRTS. The facilities required to support the HTRE No. 1 were essentially complete on June 30. The Materials Testing Reactor (MTR) is continuing to serve as the major facility for irradiating smaller components for aircraft reactor prototypes. Because the MTR is inadequate for the needs of the aircraft and other reactor programs, the Commission has approved the requirement for an additional facility, to be called the Engineering Test Reactor.

The schedule for flight testing an aircraft propulsion system requires that testing of a ground prototype occur not later than 1959. Design of ground test facilities at NRTS will be undertaken during fiscal year 1956.

STATIONARY MILITARY REACTORS

Army Package Power Reactor (APPR-1)

The APPR-1, a 10-megawatt pressurized water prototype reactor system, is being developed at Fort Belvoir, Virginia, by AEC and the Army Corps of Engineers as the first step in the joint effort to develop land-based nuclear power plants which will meet the requirements of all three military services.

ALCO Products, Inc. (formerly the American Locomotive Company), has just completed the first phase of its contract, which included the submission of a preliminary schedule, a flow diagram, and heat balancing data for its reactor design. The second phase of the contract, which includes a presentation to the Advisory Committee on Reactor Safeguards, has been started.

Low Power Reactors

In addition to the basic power reactor data to be provided by APPR-1, conceptual design work is beginning on a 1-megawatt reactor system which might be used in isolated Distant Early Warning (DEW-line) stations. Preliminary design studies by several private companies and Government laboratories have been completed and are now being evaluated to select the best concept for further development.

Other Studies

Under an AEC contract Columbia University will study by means of electrical transients the phenomenon of heat transfer from thin metal plates to air or water under high heat flux conditions. The results, to be furnished by May 1, 1956, are expected to be useful in understanding the phenomena accompanying unexpected reactor performance.

A study contract has also been awarded to the Glenn L. Martin Company to produce a conceptual design of a small nuclear power plant system representing the practical limits in packaging a transportable reactor system for military use.

CIVILIAN APPLICATIONS

The Commission has taken additional steps to enable private industry to assume greater responsibilities in the development of atomic energy for peaceful purposes. To accomplish this end, (1) the Division of Civilian Application was established to administer the licensing program and other activities related to civilian uses of atomic energy, (2) proposed regulations have been published governing the issuance and administration of various types of licenses, (3) the study agreement plan permitting organizations and individuals to be granted access to restricted data for peaceful uses has been broadened and simplified, and (4) the Commission is considering proposals for the construction of power demonstration reactors, as submitted by four utility groups in response to the Commission's invitation announced on January 10, 1955. In addition, the Commission is accelerating and broadening the development projects in progress at AEC laboratories on the most promising reactor concepts for civilian power application.

Licensing

Four basic regulations establishing the procedures and criteria for issuance of licenses have been published in the Federal Register since April 1 as Notices of Proposed Rule Making. They are now being revised for final issuance in light of comments and suggestions received from more than 25 organizations, including other Federal agencies. These regulations govern the granting of licenses for: (1) the receipt, possession, use, and transfer of special nuclear materials; (2) the manufacture, acquisition, or possession of production or utilization facilities; (3) operation of such facilities; and (4) the safeguarding of restricted data in possession of licensees. Additional regulations prescribing standards for protection against radiation hazards and rules of practice are nearing completion and will be published shortly in the Federal Register. Regulations governing the use of source and by-product materials under the Atomic Energy Act of 1946 are being revised.

Before obtaining a facilities license, an organization or individual must under the regulations first secure a construction permit for the proposed facilities. Permits for the construction of research reactors have been granted to four research institutions, and applications for construction permits for similar facilities have been received from three other institutions. Two utility companies have applied for permits to construct power reactors, and one manufacturer has applied for a license to operate a fuel element fabrication facility.

Access Permits

By April 1955 study agreements were in effect with 25 groups representing 78 different organizations. On April 20 the Commission announced that it was simplifying and broadening this earlier approach by making needed information more generally available under "access permits." Procedures and criteria for obtaining access permits were published in the Federal Register on May 24. Confidential restricted data related to civilian uses of atomic energy and not primarily of military significance may be made available to persons or organizations which can evidence a potential use or application of the data in their business, profession, or trade, such access being granted on the basis of the simplified "L" clearance. Secret restricted data of this type may be made available only upon a showing of a specific need, limited to a definite period of time, for specific data having immediate or significant effect upon their business, profession, or trade. Access will then be granted only on the basis of the full "Q" clearance. By June 30, the Commission had received 214 applications for access permits, of which 148 had been approved. The remainder were under consideration.

Power Demonstration Reactor Program

Private industry has been quick to accept the Commission's invitation to take greater initiative in the development of nuclear power for civilian uses. In response to the Power Demonstration Reactor Program* announced by the Commission on January 10, three privately owned and one publicly owned utility group submitted proposals under which they would develop, design, construct, and operate experimental power reactors, largely with their own financial and technical resources. The Commission evaluated these proposals in terms of the following criteria: the probable contribution of the proposed project toward achieving economically competitive power; the cost to AEC in funds and material; the risk to be assumed by the proposer; the competence and responsibility of the proposer; and the assurances given by the proposer against abandonment of the project.

The Commission has determined that the proposals by the Nuclear Power Group and by the Detroit Edison group would significantly advance power reactor technology and hasten the advent of economically competitive power. Negotiations leading to definitive contracts with these two groups will be started soon. Further discussions will be held with the Yankee Atomic Electric Company and the Consumers Public Power District of Columbus, Nebraska, in an effort to obtain necessary modifications in their proposals.

Power Reactor Development

The original Five-Year Reactor Program, described in previous Program Status Reports, included the design and construction of five reactor systems. The technology of the Pressurized Water Reactor was considered to be sufficiently understood to permit the immediate construction of a full-scale plant. The Sodium Reactor Experiment will be one step removed from a full-scale plant. The more difficult concepts, including the boiling water, breeder, and homogeneous reactors, are being developed in a series of prototype steps. The Commission is now giving serious consideration to two additional projects, a hydrocarbon reactor and a liquid metal fueled reactor, which are described below.

The first of these reactors or prototypes to generate power was the Boiling Water Experimental Reactor, called Borax II, which was placed in operation at NRTS in June 1955. By the end of 1957 these reactors will be producing a total of 75,000 kilowatts of electric power, most of which will come from the Pressurized Water Reactor.

Because most of the information on the Power Reactor Development Program is unclassified, extensive descriptions of these projects have been published in numerous public documents, including the Commission's Semiannual Reports to the Congress. More recent accomplishments were noted in the Reactor Development report transmitted to the Subcommittee on Research and Development on July 11. The following paragraphs are included as a brief summary of major developments during the last six months.

Pressurized Water Reactor (PWR). Design work on the reactor and turbogenerator portion of the PWR was 17 percent complete on June 30. Major construction work has begun at Shippingport, and excavation for the entire plant has been completed. Lump-sum contracts have been awarded for supplying foundation concrete and for the fabrication and erection of the steel structures which will house the reactor. Procurement of reactor components has been started and all major equipment for the turbogenerator section has been ordered.

*Described in the preceding Program Status Report, page 34.

Work is continuing on the development of fuel elements for the PWR. Sample fuel elements and fuel element assemblies are being test-irradiated in the Materials Testing Reactor. On the basis of these and other tests uranium oxide has been selected as the fuel material in the first PWR core. The PWR plant is scheduled for completion in July 1957, when the reactor core will be inserted in the pressure vessel.

Experimental Boiling Water Reactor (EBWR). Borax II, the second small-scale prototype, leading to the EBWR, has been operating at NRTS since October 1954.* A 3,700-kilowatt (electrical) turbogenerator has been installed at the Borax II site to operate on the steam produced by the experimental reactor. It is expected that operation of the turbogenerator will provide data on the amount of radioactivity which would be carried from the EBWR to the turbine, condenser, and feedwater pumps now planned for use with the full-scale plant. The Borax II generator system will also serve as a pilot plant for a package-power reactor of the boiling water type, which is of interest to the Army.

Structural work on the generator building was completed and a new core fabricated at Argonne was installed in the reactor during June. In test operations during July, the reactor produced 15 megawatts of heat, or 2,000 kilowatts of electricity.

The full-scale EBWR will be constructed at Argonne National Laboratory. Architect-engineering work on the reactor, building, and power equipment is continuing, and construction work has just begun. The plant is expected to be ready for power generation in about two years.

Sodium graphite reactors. During the past six months detailed design work and site preparation have been largely completed for the Sodium Reactor Experiment (SRE), which North American Aviation is constructing at Santa Susana, California. The fuel slugs have been delivered, and the fuel elements for the first core are being fabricated and assembled in the engineering test building recently completed on the site. Operational plans for the SRE were approved by the Advisory Committee on Reactor Safeguards in April.

Original plans for the SRE did not provide for any equipment to convert the heat generated by the reactor to useful energy. However, early in May the Southern California Edison Company offered to purchase the heat and install, at its own expense, all necessary electrical generating equipment. In accordance with section 44 of the Atomic Energy Act of 1954, all other publicly and privately owned utility companies within a 100-mile radius of the site were invited to submit proposals. Of the six companies expressing an interest in the power, none except Southern California Edison was willing to submit a proposal without a firm commitment on the amount of power to be made available.

Homogeneous reactors. Oak Ridge National Laboratory is continuing the design work begun last summer on the Homogeneous Reactor Experiment (HRE) No. 2. During the past six months the basic reactor concept has been modified rather significantly. It is now believed that the new design will provide a more versatile reactor for experimental purposes

*Borax I and II were described in the Program Status Reports for December 31, 1953, and June 30, 1954.

and will make available most of the technology which, according to earlier plans, would have been obtained from the next larger prototype.

HRE No. 2 is being constructed in the original HRE No. 1 building at Oak Ridge. Erection of the underground steel-lined reactor cell was completed in May 1955. Contracts were awarded and fabrication started on all major equipment, including heat exchangers, the core tank pressure vessel, and circulating pumps. Because the scope of the HRE No. 2 project was increased in January, the scheduled start-up has been changed from 1955 to early 1956.

Fast breeder reactors. The eventual construction of a full-scale fast breeder reactor power plant will be based upon the technology derived from the Experimental Breeder Reactor (EBR) No. 1, built at NRTS several years ago, and from EBR No. 2, which Argonne National Laboratory is now developing. EBR No. 2 is to be a sodium-cooled, enriched uranium and plutonium reactor which will generate 62.5 megawatts of heat and produce 15 megawatts of electricity. Accurate data for the detailed design of the core of EBR No. 2 will be obtained from a zero-power fast critical assembly, which the Argonne staff is constructing at NRTS. Construction of EBR No. 2 will start in 1956, and the reactor is scheduled to be in operation early in calendar year 1958.

An essential part of the EBR plant will be a facility for the development, fabrication, and reprocessing of fuel elements containing plutonium. Architect-engineering for such a facility at Argonne has been completed, and a lump-sum construction contract is expected to be awarded soon. The building is scheduled for completion on January 1, 1957.

Organic moderated reactor experiments. The use of hydrocarbons as reactor moderators has been suggested by such anticipated advantages as low induced radioactivity, low corrosion of fuel elements, and a high boiling point. These characteristics would be particularly useful in small reactors. It is not known, however, what sort of deposits the organic compounds would leave on heat transfer surfaces. Tests of deposit formation are now being made, and results should be known in August 1955. If results are favorable, a very simple reactor experiment may be built on the order of Borax II.

Liquid-metal fueled reactor. A reactor fueled with liquid metal would have the advantage of simplified fuel processing, such as that which can be used with an aqueous homogeneous reactor. Another advantage would be the higher temperature operation at low pressure common to liquid-metal cooled systems. Brookhaven National Laboratory has developed the liquid-metal fueled concept to the point where a reactor experiment appears feasible and justified. A group of industrial firms are now examining Brookhaven's data to determine the technical feasibility of the system and to identify important problems for further investigation. Further development of this technology will depend upon the results of this study.

Chemical Processing

The cost of chemically processing irradiated fuel could be a decisive factor determining the relative economy of various reactor designs. Development of appropriate processes for the fuel elements of each existing reactor project will receive major emphasis, in anticipation that additional fuel recovery capacity will be needed to service the numerous power reactors and prototypes being planned.

REACTOR SAFEGUARDS

Experiments on the reaction of water with molten reactor construction materials have shown that explosions can occur when pressures exceed 5,000 pounds per square inch. The Aerojet General Corporation is searching for additive materials which may inhibit this reaction. (End of SECRET section.)

Part V

Physical Research

Project SHERWOOD (SECRET)

Continued interest in Project SHERWOOD is justified by the large amounts of energy and free neutrons which are theoretically available from a controlled thermonuclear reaction in deuterium. Research over the last few years* has been concentrated upon methods of heating an ionized gas or "plasma" to temperatures of 10 to 100 million degrees Centigrade and of confining the plasma by magnetic fields rather than by a material container.

At Princeton University the plasma is contained in a figure-8 shaped tube called a Stellerator. In the first model of this device, the plasma is confined with magnetic fields of roughly 20,000 gauss and is heated in two successive steps to about 200,000 degrees Centigrade. The second model, of the same size but incorporating a third heating step, is now being assembled and in it the plasma is expected to reach about 5 million degrees Centigrade. The next larger research model, conceptually capable of 100 million degrees Centigrade, will not be designed until further theoretical and experimental studies determine whether certain instabilities would prevent its successful operation.

The Los Alamos group is attempting to create a current within a plasma in a toroidal tube sufficient in strength to confine the plasma by means of the magnetic field resulting from this current and to heat the plasma to several million degrees. To achieve the necessary densities and temperatures the plasma must be "pinched" into a narrow filament. As a result of a recent new theory which allows deeper insight into the mechanism of the "pinch effect", much higher voltage gradients are being applied to the plasma in an effort to achieve the pinch in the short interval before instabilities develop in the plasma.

The Livermore group has been developing an apparatus which would confine the plasma by a system of "magnetic mirrors." Temperatures of confined plasmas above five million degrees Centigrade have been achieved with small models of this type, and larger models are being assembled. A smaller group at Livermore has begun research similar to that at Los Alamos in an effort to achieve high temperatures by ingenious use of the pinch effect.

Although many serious problems remain to be solved, work on all three approaches is promising and will be continued. (End of SECRET section.)

Electron Analogue at Brookhaven (UNCLASSIFIED)

Development work began about a year ago on the alternating gradient synchrotron (AGS), which is expected to accelerate protons to energies of 25 billion electron volts (Bev). To provide design information in the most economical and effective manner, an analogue with many

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* This earlier work was summarized in the Program Status Report, June 30, 1954, p. 37.

of the design features of the AGS, has been constructed at Brookhaven. Because the analogue uses electrons rather than the much heavier protons, it is possible to study many design problems at energies 2,000 times lower than those which will be necessary in the AGS.

After the vacuum chamber of the AGS was exhausted, electrons were injected into the circular orbit. Without further acceleration the electron beams were maintained for 20,000 revolutions before dying out. Extensive studies of the persistence of the beam under various perturbations enable the scientist to determine design parameters of the large machine and the dimensional tolerances which must be achieved in its construction. Eventually the electron beam in the analogue will be accelerated to simulate fully the performance of the AGS proton accelerator. (End of UNCLASSIFIED section.)

Centrifugal Separation of Isotopes (SECRET)

Although the centrifuge method of separating isotopes has never been adopted for production purposes in the atomic energy program, the method theoretically offers sufficient advantages for separating heavy isotopes to warrant its further investigation. The physical principle involved is the same as that used in a cream separator in which fluids of different weights may be separated by centrifugal force when the mixture is placed in a rapidly rotating bowl. Research related to this method of isotope separation is being conducted on two aspects of the problem: (1) a study of the preparation and properties of plutonium hexafluoride as a possible feed for the centrifuge and (2) the design, construction, and testing of a prototype centrifuge.

Studies of PuF_6. Plutonium hexafluoride is a key material in the centrifugal separation of plutonium isotopes because it is the only known plutonium compound to exist as a gas at reasonable temperatures. After small quantities of PuF_6 were produced, it was possible to evaluate some of the earlier studies of the properties of this material. In most cases it was found that PuF_6 is easier to produce and handle than was previously believed. It had been assumed that PuF_6 would be difficult to handle because of its decomposition due to radioactive decay of the plutonium. Further study showed, however, that decomposition is relatively slow when the material is in gaseous form. It was also learned that it is relatively stable against decomposition by heat if kept at temperatures below 120 degrees Centigrade. Although somewhat reactive with ordinary construction materials, PuF_6 does not differ greatly from UF_6 in this respect. PuF_6 is gaseous at 75 degrees Centigrade and can be handled in welded nickel, hard-soldered copper tubing, glass, and quartz. The extreme toxicity of plutonium, however, requires more health safeguards in handling PuF_6 than are required for UF_6.

Centrifuge prototype studies. A group at the University of Virginia has been studying the problem of high-speed rotation of the "long bowls" used in gas centrifuges. [redacted]

As in the gaseous diffusion process, the separation of isotopes by the centrifuge method is accomplished in steps, which taken together form a "cascade." The staff of the Walter Kidde Nuclear Laboratories have been making theoretical studies of the separative efficiency and economy of various cascade systems when used for separating plutonium 240 from 239, or uranium 232 from 233.

[redacted] Operation of the prototype is expected to indicate the feasibility of a full-sized centrifuge. A number of companies have already expressed interest in working on the project.

Chemical Separation of Isotopes

Whereas the centrifuge appears to be an effective instrument for separating isotopes of the heavy elements, chemical exchange systems are more efficient for isolating isotopes of some of the lighter elements such as lithium 6, boron 10, and deuterium. These systems are based on the principle that, when two suitable compounds containing two or more isotopes of a given element are brought together under the proper conditions, a chemical exchange will occur in such a way that the light isotope will tend to concentrate in one of the compounds and the heavy isotope in the other. Oak Ridge National Laboratory has discovered a promising chemical system for separating boron 10 from boron 11. The two compounds used in this exchange system are boron fluoride and an organic complex of the same material (BF_3-anisole · BF_3). The system has a large separation factor and is easily recharged.

High Temperature Research

In developing atomic energy the Commission has required extensive information on materials and chemical reactions at unusually high temperatures. The trend in reactor development, for example, toward fused salt and liquid metal systems represents an effort to achieve higher operating temperatures for power and propulsion reactors. High temperatures are also essential in a variety of systems for processing feed materials and irradiated reactor fuel elements. In order to lay a more substantial foundation for these developments, the Commission is expanding its basic work on high-temperature chemistry and metallurgy in both AEC and university laboratories.

Chemistry. The Aircraft Reactor Experiment at Oak Ridge has given impetus to chemical studies of fused salt systems. Measurements have been made of the heats and free energies of formation in reactors of some refractory compounds which might be used as moderators.

Experiments have also been conducted with systems involving an alkali metal and a salt of the same metal. For example, in tests

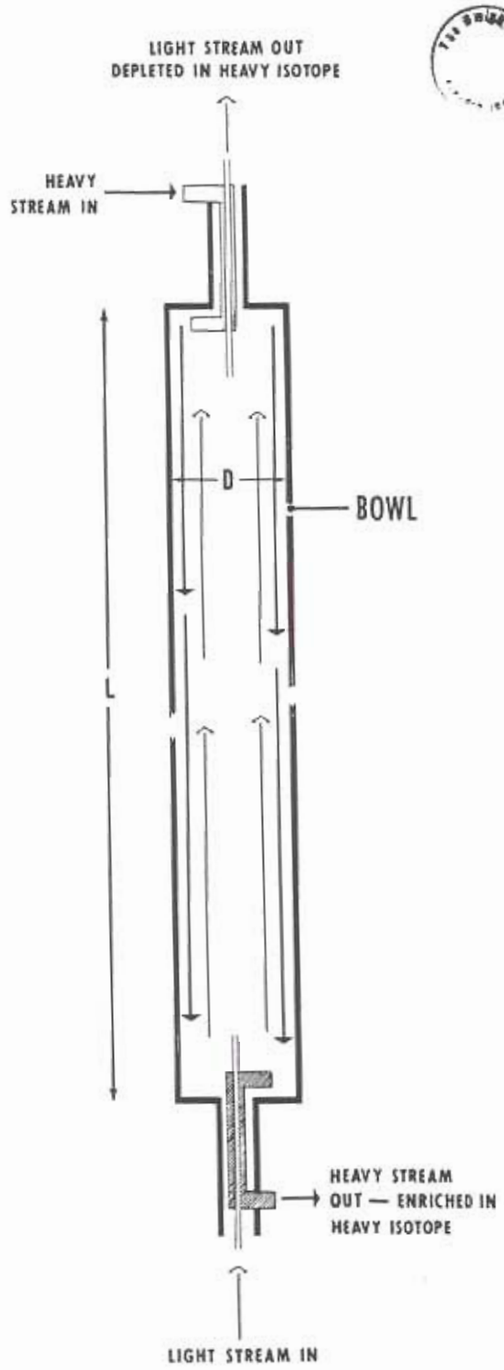

Fig. 1—Schematic drawing of gas centrifuge unit.

using a cesium-cesium iodide system, the metal and the salts were found to be completely miscible at 626 degrees Centigrade, the melting point of the salt.

Collection, compilation, and distribution of basic high-temperature data are also being accelerated. Because of the shortage of trained scientists in this field, universities are being encouraged to undertake research in high-temperature chemistry.

Metallurgy. Oak Ridge National Laboratory has been developing a semicontinuous process for producing thorium, called the Metallex process. It uses reagents costing less than those used in the present batch method and the material produced is of high purity. It may be fabricated by remelting and extrusion, or possibly by extrusion alone. If the process is as successful as anticipated, it will be very economical.

Inhibiting Aluminum Corrosion

Investigations are continuing at Argonne National Laboratory on the corrosion of aluminum in water, as noted in the preceding Program Status Report. At temperatures above 200 degrees Centigrade serious corrosion ordinarily occurs in high-grade aluminum. Apparently, hydrogen produced in the water-aluminum reaction diffuses into the metal and creates pressure pockets inside the aluminum. These eventually rupture and permit the water to attack fresh metal, thus producing more hydrogen and propagating the process. This difficulty can be overcome by adding nickel sulfate solutions to the water. Nickel metal from these solutions is deposited on the aluminum surface where it liberates the hydrogen before it diffuses into the aluminum. Tests conducted at 275 degrees Centigrade for 120 days showed a remarkable effect of the nickel sulfate.

Aluminum alloyed with 0.5 to 2 weight-percent nickel also showed excellent corrosion resistance when tested at 315 degrees Centigrade for 41 days and at 350 degrees Centigrade for 14 days in pure water. On the basis of these promising results, Argonne National Laboratory plans to use this alloy for cladding the next fuel elements for the Borax III experiment now producing power at the Idaho test station. (See Part IV, Reactor Development.)
(End of SECRET section.)

Part VI

Biology and Medicine

(UNCLASSIFIED)

The Commission continues to emphasize biomedical research to determine the effects of radiation on living things and to establish effective safety and control measures against radiation hazards. Advantage has been taken of the opportunity afforded by weapon tests to conduct specific biomedical experiments and to develop monitoring procedures for analytical and quantitative measurement of radiation exposure.

Continuing study is also being made of the long-range effects, in terms of time and distance, of weapon test fallout on plants, animals, and humans. Preliminary data collected during recent months are described in this report.

The Commission also supports a great variety of research projects in biology and medicine at both AEC and university laboratories and hospitals. Most of this research is unclassified and current projects are described in the Eighteenth Semiannual Report to the Congress.

WEAPON TEST ACTIVITIES

Operation TEAPOT

The nuclear test series held in the spring of 1955 at the Nevada Test Site ended with the fourteenth and final shot on May 15. The nationwide monitoring system was activated for full-scale operations throughout the test period. Preliminary analyses of the radioactive fallout exposures have been made and appear generally to be less than levels experienced during the 1953 tests (UPSHOT-KNOTHOLE). The highest exposure for any populated community was found to be about 3 roentgens at Elgin, Utah, which has a population of 40 people. This exposure is less than the operational guide of 3.9 roentgens established by AEC for weapon test activities. To date no cases of radiation injury to animals have been reported. Radioactive fallout reported in certain areas across the country created a few instances of public reaction. However, the amounts of fallout measured in these localities were far below those which would produce any hazard to health. A detailed summary of fallout studies is included in the Commission's Eighteenth Semiannual Report to the Congress.

The improved procedures adopted for use in predicting weather conditions and the use of higher towers for detonations contributed to a great extent in preventing the occurrence of heavy fallout outside the test area. Considerable effort was made to assure a careful and deliberate evaluation of the proper conditions necessary before detonating each device.

The procedures and safety criteria used in the recent tests were based upon a formal document prepared for this purpose and approved by the Commission. The objectives of the

guide are to protect the health and welfare of the public both from radiation exposure and from possible hazards, hardships, or inconveniences resulting from the disruption of normal activities during test operations. The test personnel were able to use the guide to determine the need for possible emergency measures such as evacuation of personnel, restriction of personnel indoors, decontamination of personnel and property, and restrictions on use of foodstuffs. No such emergency measures were required during the recent tests. The criteria will be revised in light of any new information gained from future test series. (End of UNCLASSIFIED section.)

RADIOLOGICAL MONITORING OF MARSHALL ISLANDS (CONFIDENTIAL)

Extensive radiological surveys have been continued in and around the northern atolls of the Marshall Islands, which were in the path of the fallout resulting from the March 1, 1954, detonation at Bikini during the CASTLE test series. Only two of these atolls, Rongelap and Utirik, were inhabited at the time of the fallout, and these people were evacuated. The Utirik inhabitants were returned to their home island in May 1954. Those from Rongelap, however, are in temporary residence at Ejit Island in the Majuro Atoll.

Evaluation of results from the radiological survey has not been completed, but preliminary data show that considerable radioactivity exists in the plant and marine life of Rongelap Atoll. The external gamma radiation levels at Rongelap Island in February 1955 were approximately 0.1 roentgen per week. In the more northern islands the highest level was over 1 roentgen per week, compared to the maximum permissible level in AEC installations of 0.3 roentgen per week.

Those Rongelap inhabitants who had been exposed to radiation fallout have recovered and are generally in good health. It has been the Commission's intention that these people be permitted to return to their home islands as soon as is feasible. However, the Commission has advised the High Commissioner of the Trust Territory of the Pacific Islands that radioactivity on the islands is still too high to permit unrestricted occupation by the former inhabitants. They could either be detained at Ejit Island until the radioactivity at Rongelap declines or they could be restricted to the portions of the atoll south of Eniwetak Island and be prohibited from eating crabs or clams, which are still appreciably radioactive.

In reply, the Deputy High Commissioner indicated that it would be advisable to keep the Rongelap people at Ejit for at least another six months or until they could be repatriated without restrictions.

OPERATION WIGWAM

Operation WIGWAM consisted of the underwater detonation of a small fission weapon in the eastern Pacific on May 14. This test was conducted by the Department of Defense and AEC for the purpose of obtaining weapon effects information which could be used, for example, in the development of defensive tactics against submarines. (See Part III, Weapons.) (End of CONFIDENTIAL section.)

West Coast Monitoring Activities (UNCLASSIFIED)

As a part of the test, the Commission established a monitoring system on the West Coast to detect the possible presence of any radioactivity in marine food fish as a result of the detonation. The area within which the test group operated was determined as a result of long-term marine studies by the Scripps Institute of Oceanography and the Office of Naval Research.

Data from these studies indicated that the test area was free of fish of commercial importance and that the test therefore would not create a hazard for the fishing industry of the United States or other nations.

Also hand monitoring instruments were distributed to the small canneries, and automatic survey counting equipment was installed at the large canneries. No radioactive contamination was found in marine food fish monitored through the end of June. Hand monitoring operations were discontinued on July 7, and the automatic counting equipment will be removed from the canneries early in August.

Since the beginning of the monitoring program (May 12–June 18), 29,386,900 pounds of fish in the Los Angeles and San Diego areas have been monitored at Terminal Island.

Aerial Survey

Also in conjunction with the WIGWAM test, the Commission's New York Health and Safety Laboratory cooperated with the U. S. Naval Radiological Defense Laboratory in providing instrumentation and in planning assistance in collecting data on radioactivity over the shot area. Prompt and accurate information was essential to determine whether Task Force ships could enter certain areas for evaluation of test results.

The equipment and aerial survey techniques set up for the operation were based on the types previously utilized during the CASTLE and TEAPOT test series.

Three carrier-based airplanes were equipped with radiation detectors, telemetering equipment, and radio transmitters. This equipment permitted the automatic relaying of radiation data in the range from 0.005 milliroentgen per hour (normal background) to 1,000 roentgens per hour in the aircraft. In addition, a duplicate channel of telemeter-radio-transmitting equipment was set up to allow the transmission of water temperatures taken by the Scripps Institute for use in their monitoring studies.

Automatic radio-altimeter control compensators were also developed for the test operation and were installed in the radiation reading circuits to record and automatically correct readings to sea level. The readings were then translated into pulses, fed to radio transmitters, and sent to the Task Force Control center aboard the USS *Mount McKinley*, where they were automatically decoded and transcribed. The data were checked at the New York Health and Safety Laboratory.

This system provided reliable data promptly for the test group in the initial phases of post-detonation activities. The areas of radioactivity were defined in terms of point-to-point activity, "hot spot" areas, and the character and extent of fallout over the entire area of the shot zone. According to preliminary reports, the aircraft survey data appear to be confirmed by information collected by the Task Force ships which later entered the shot zone. (End of UNCLASSIFIED section.)

PROJECT GABRIEL (SECRET)

The objective of Project GABRIEL is to evaluate the effects of bomb debris or radioactive fallout disseminated over the earth's surface as the result of nuclear detonations. The project was begun by AEC in 1949 and was expanded in 1952 to include a sampling of the amount of strontium 90 in soils, plants, milk, animals, and humans in various parts of the world. This sampling program, called Project SUNSHINE, has been extended during the past year to include other critical radioisotopes produced in atomic weapon tests: iodine 131, ruthenium 106, barium 140, and others.

These projects have led to a number of significant findings about the long-range effects of nuclear detonations:

1. By September 1954, less than 1 percent of the bomb debris produced in the 1954 Pacific test series (Operation CASTLE) had been deposited on land areas.

2. Residual air activity in the autumn of 1954 was apparently less than 2 percent of the total bomb debris yield of the CASTLE series. However, the possibility cannot be excluded that the true value is considerably higher since atmospheric sampling has not yet been sufficiently extensive to give a firm estimate of the figure.

3. A survey was made in the spring of 1955 of radioactivity in Pacific Ocean currents transporting the close-in fallout from Operation CASTLE. The localized areas in which radioactivity from fallout was great enough to be measured were found to be widely distributed over the region of the Pacific bounded by Eniwetok, the Philippines, Japan, and the Hawaiian Islands. Although these "islands" of radioactivity in the ocean account for at least several percent of the CASTLE fission yield, the fission product activity was less than natural radioactivity found in the ocean water and was not considered hazardous.

4. Analyses have been made of the strontium 90 content in the ribs of deceased humans in the United States. In terms of age groups in the eastern United States, the amounts of strontium 90 found in individuals under 25 or 30 years of age were about 0.1 percent of the maximum permissible concentration currently accepted for occupational exposure to strontium 90. For ages greater than 25 or 30, radioactivity was even lower.

5. Attention has been given during the past year to the trend of strontium 90 content in milk, animal bones, and human bones. Present levels range from the same to three times the levels of last year, depending on location and type of sample.

6. Observations on vegetation have made it apparent that the retention of fallout by leaves may be as important a mechanism of contamination as is uptake from the soil.

7. During the recent weapon test series in Nevada, extensive measurements were made of the concentration of iodine 131 in vegetation and in animal and human thyroids. These data are being evaluated. While initially the iodine 131 dose rates are higher than those from strontium 90, the short half-life of the isotope and the natural resistance of the thyroid to radioactivity make it unlikely that iodine 131 would present as serious a hazard as would strontium 90 in the event of the use of nuclear weapons in warfare.

No significant change has been made during the past year in the general estimate of the amount of debris, if uniformly deposited over the earth's surface, required to produce hazardous worldwide levels of radioactivity. However, earlier evidence has been supported that most of the radioactivity from surface detonations falls to earth within a few hundred miles from the point of detonation. This evidence strengthens the belief that in the event of war the effects of close-in fallout in the bombed areas would greatly exceed the effects of long-range fallout over the earth's surface. (End of SECRET section.)

Appendix A

NOTES ON INTERNATIONAL MATTERS

Notes on International Matters

BILATERAL AGREEMENTS FOR COOPERATION (UNCLASSIFIED)

During the six months ended June 30, 1955, bilateral agreements for cooperation were negotiated with 26 countries.

An agreement with the Government of Turkey became effective on June 10, 1955, following approval by the President and submission to the Joint Committee for a period of 30 days, as required by Section 123 of the Atomic Energy Act of 1954. This agreement provides for the exchange of unclassified information on the design, construction, operation, and utilization of research reactors; for an exchange of unclassified materials not available commercially; and for the transfer of unclassified equipment and devices. The exchange of unclassified materials includes the leasing of a maximum of six kilograms of uranium 235 contained in uranium enriched in uranium 235 to a maximum of 20 percent. The Government of Turkey agreed to safeguard all materials transferred under the agreements and to use them for nonmilitary purposes only. Agreements with similar provisions were initiated with the Governments of Brazil, Colombia, Israel, Spain, the Philippines, Switzerland, the Netherlands, Argentina, Lebanon, the Republic of China, Denmark, Italy, Portugal, Venezuela, Japan, Chile, Pakistan, Uruguay, Greece, Peru, Korea, and Sweden. These agreements were approved by the President, transmitted to the Joint Committee, and will be executed after the statutory 30-day waiting period. It is probable that agreements with Uruguay, Peru, Korea, and Sweden will not become effective during the first session of the 84th Congress.

The agreement with Switzerland will include the sale to that country of the "swimming pool" type reactor constructed at Geneva as a part of the United States exhibit for the International Scientific Conference. According to the terms of the State Department agreement with the Philippines, a research reactor will be given to that country as a gift of the United States.

Bilateral agreements with Belgium, the United Kingdom, and Canada have also been approved by the President and sent to the Joint Committee. The agreements provide for the exchange of both classified and unclassified information related to peaceful applications of atomic energy; for an exchange of research materials not available commercially, including special nuclear materials; and for the transfer of equipment and devices. The agreements provide, however, that the only classified information to be exchanged will be that related to current or projected programs and that Restricted Data primarily of military significance or which relates to the design or fabrication of atomic weapons will not be exchanged. The proposed agreements also provide that AEC will not transfer materials or equipment and devices which, in its opinion, are primarily of military significance. The Canadian and United Kingdom agreements provide for the mutual use of research and testing facilities, but not including those of military significance.

It is provided in the proposed agreements with Belgium and Canada that AEC will sell to these countries such quantities of uranium enriched in the 235 isotope as may be required during the period of the agreements for the Belgian research and power reactor program and for the Canadian power reactor program. These provisions, however, are subject to the limitation that the quantity of enriched uranium in the possession of either country will not be of military significance, as determined by the Commission. The enrichment of uranium sold under these agreements will be limited to 20 percent uranium 235. The Government of Canada will give AEC the first refusal on any special nuclear material which it may desire to transfer from Canada, when such materials have been produced by the irradiation of fuel elements enriched with uranium 235 purchased from the Commission. The Government of Belgium will give the Commission an option to purchase any special nuclear materials produced in Belgium, the Belgian Congo, or Ruandi-Urundi, from materials which were purchased from AEC and which are in excess of Belgium's needs in its peacetime atomic energy program. The agreements with Belgium and Canada also provide for the continued collaboration with these countries in the procurement of raw materials. The agreement with Canada provides for the continued use of Canadian reactors for special and unique irradiations for the Commission's weapons program.

URANIUM 235 FOR FOREIGN REACTORS

The President has approved the Commission's recommendation that an additional 100 kilograms of uranium 235 contained in uranium enriched to 20 percent or less be allocated for use in small-scale reactors or for other research purposes in foreign countries with which agreements for cooperation may be concluded. This amount is in addition to the 100 kilograms of contained uranium 235 approved by the President in November 1954 for these purposes. The additional amount was determined by the Commission to be necessary in view of the fact that the 23 agreements thus far negotiated all provide for the transfer of uranium 235.

HEAVY WATER FOR FOREIGN REACTORS

The Commission approved the sale of 61 tons of heavy water for use as a moderator in research reactors to be constructed in India, Italy, Australia, and France. All agreements for cooperation thus far negotiated provide for the transfer of this material for use in reactors if needed and if unavailable commercially. Before heavy water is transferred, the recipient government must have agreed that the material will be used for the stated purposes and will not be transferred beyond its jurisdiction.

INTERNATIONAL SCIENTIFIC CONFERENCE

On December 4, 1954, the General Assembly of the United Nations approved a resolution which, among other things, directed the Secretary General, in consultation with an advisory group composed of representatives of Brazil, Canada, France, India, the USSR, the United Kingdom, and the United States, to issue invitations to an international conference on the peaceful uses of atomic energy. The Secretary General was also directed to prepare and circulate to the interested nations a detailed agenda for the conference and to provide the necessary staff and services.

The President designated Dr. I. I. Rabi, Chairman of the General Advisory Committee to the Atomic Energy Commission, to be United States representative on the Secretary General's advisory committee. The other representatives are Dr. J. Costa Robeira (Brazil), Dr. David Keys (Canada), Dr. Bertrand Goldschmidt (France), Dr. H. J. Bhabha (India), Dr. D. V.

Skobeltsyn (U.S.S.R.), and Sir John Cockcroft (United Kingdom). Dr. H. J. Bhabha was appointed President and Professor Walter Whitman Secretary-General of the conference.

The advisory committee met in January, February, and May and will hold its final meeting on August 3, 1955. Following the recommendations of the committee, the conference will be held in Geneva, Switzerland, during the period August 8–20, 1955. Invitations were issued to those countries which are members of the United Nations or one of its specialized agencies. The committee also recommended rules of procedure and the topical agenda for the conference. The rules of procedure are designed to ensure that the conference will be conducted for the exchange of scientific information and to reduce to a minimum the possibility that any country might use the conference for political purposes. The agenda covers reactor theory and technology and the application of atomic energy in medicine, agriculture, and industry. In addition, lectures will be given on the basic sciences.

To ensure that United States participation in the conference is carried out as effectively as possible, a special organization was established within AEC under the direction of Dr. George L. Weil, formerly Assistant Director of the AEC's Division of Reactor Development. Following issuance of invitations by this group, approximately 1,100 abstracts of proposed papers were submitted by personnel of the AEC, AEC contractors, and private universities and institutions. Over 150 abstracts have been selected for oral presentation at the Conference.

An exhibit on the peaceful uses of atomic energy, including an operating "swimming pool" type research reactor, is being set up at the Conference.

TRAINING OF FOREIGN STUDENTS

Three training operations for foreign nationals were initiated during the first half of 1955 as a part of the President's "Atoms-for-Peace" program: the reactor training courses at Argonne National Laboratory, a special course in radioisotope techniques at the Oak Ridge Institute of Nuclear Studies, and a tour of cancer hospital facilities in the United States.

The School of Nuclear Science and Engineering at Argonne National Laboratory began its first seven months' unclassified session in reactor theory and technology and other related peacetime applications of atomic energy on March 14, 1955, with an attendance of 31 students sponsored by 19 foreign nations. Countries in South and Central America, Western Europe, the Near and Far East, and Africa are represented. The second and third sessions of the school are scheduled to commence on November 7, 1955, and March 5, 1956, respectively. While the curriculum for the first session of the school was designed primarily for beginners, it is expected that advanced courses will be added for the second and third sessions.

A special four weeks' course in the techniques of using radioisotopes was held for 30 scientists and physicians from 21 countries at the Oak Ridge Institute of Nuclear Studies during May 1955. Countries in North, South, and Central America, Western Europe, and the Middle and Far East were represented. Because of the large number of applications, another special course for foreign nations will begin on October 17, 1955. In addition, 17 students from 14 countries have been accepted for the three regular courses at the Institute this summer.

A five weeks' tour of cancer hospitals and laboratory facilities in the United States began on June 20, 1955, for 23 leading foreign doctors and surgeons from 11 countries in South America, Western Europe, the Far East, and Africa. The purpose of the tour was to acquaint the group with research and clinical uses of radioisotopes and other sources of ionizing radiation in the field of cancer. Another tour will be sponsored in the autumn of 1955.

TECHNICAL LIBRARIES

In a speech before the United Nations General Assembly on November 5, 1954, Ambassador Lodge stated that the United States was prepared to provide ten unclassified technical libraries on the peaceful uses of atomic energy to foreign countries in exchange for their official unclassified literature in this field. He further stated that additional libraries would be made available to foreign countries if a larger number were needed. AEC has received requests from, and has approved transmittal of such libraries to, 25 countries from South America, Western Europe, Africa, and the Near, Middle, and Far East. Libraries will also be made available to the European Nuclear Research Organization and the United Nations library in Geneva.

INTERNATIONAL ATOMIC ENERGY AGENCY

In an address before the United Nations General Assembly on December 8, 1953, and again in a speech on September 6, 1954, the President proposed the establishment of an international atomic energy organization. Subsequently, Secretary of State Dulles elaborated on the proposals in an address before the Assembly on September 23, 1954.

A draft statute for an international atomic energy agency has been developed by the Department of State for consultation with the AEC, and is under study by the Governments of Belgium, Canada, France, the United Kingdom, Portugal, Australia, and the Union of South Africa. It is expected that an agreed draft will be ready for general distribution and study in the near future and that it will be presented to the United Nations General Assembly when it convenes in September 1955.

UNITED NATIONS DISARMAMENT COMMISSION

On February 25, 1955, the Five-Nation Subcommittee of the United Nations Disarmament Commission convened in London for meetings which continued through June 1. Consultants from AEC and the Department of Defense provided the subcommittee with technical assistance both before and during the conference. Two AEC scientists served as consultants with the American delegation in London. The May 10 proposals by the Soviet Union and subsequent political developments indicate the need for continuing technical studies of disarmament plans. An AEC working group has recently completed a review of some of these problems in replying to a series of questions raised by Mr. Harold Stassen, Special Assistant to the President for Disarmament. (End of UNCLASSIFIED section.)

Appendix B

CONSTRUCTION PROGRESS SCHEDULES

CONSTRUCTION STATUS OF PRINCIPAL TECHNICAL FACILITIES

Project Name and Location	Percent Construction Completion						Construction Dates		Estimated Cost[a] (In Millions of Dollars)
	Fiscal Year 1955 (Actual)		Fiscal Year 1956 (Scheduled)				Start	Scheduled or Actual Completion	
	Mar. 31	June 30	Sept. 30	Dec. 31	Mar. 31	June 30			
FISSIONABLE MATERIALS									
HANFORD OPERATIONS									
Graphite reactors (KW and KE)	99	100					Sept. 10, 1952	Apr. 15, 1955	167.9
KE reactor	100						Dec. 22, 1952	Feb. 7, 1955	Included in above
Separations plant	99	100					Feb. 3, 1953	Apr. 8, 1955	86.0
Pile modification facilities for increased production (Phase 1)[b]	5	11	*25*	*36*	*49*	*58*	June 29, 1954	Dec. 1957	27.5
OAK RIDGE OPERATIONS									
Oak Ridge:									
Gaseous diffusion plant (K-33)	99	100					July 16, 1952	June 1955	260.6
Alpha plants	81	94	*98*	*100*			Oct. 22, 1953	Dec. 1955[c]	238.0
Paducah:									
Gaseous diffusion plant (expansion)	100						Aug. 26, 1952	Mar. 4, 1955	320.3[d]
Feed materials expansion[b,e]	f	7	*26*	*44*	*63*	*82*	Jan. 7, 1955	Jan. 1957	12.8
Portsmouth:									
Gaseous diffusion plant	67	83	*95*	*98*	*99*	*99*	Oct. 20, 1952	Nov. 1956[c]	910.0
X-30 process building	95	98	*100*				Mar. 24, 1953	Sept. 1955	Included in above
X-26 process building	52	65	*85*	*95*	*99*	*99*	July 1, 1953	July 1956	Included in above
X-33 process building	46	83	*98*	*99*	*100*		Sept. 29, 1953	Jan. 1956[c]	Included in above
St. Louis:									
Feed materials expansion	f	3	*9*	*18*	*32*	*52*	Mar. 7, 1955	July 1957	39.8
Fernald:									
Feed materials expansion	f	4	*15*	*38*	*74*	*99*	Mar. 7, 1955	July 1956[g]	20.1

SAVANNAH RIVER OPERATIONS									
Savannah River production plants[h]	90	91	*92*	*93*	*93*	*94*	Jan. 18, 1951	Oct. 1958	1,282.2
Production reactors	92	92	*92*	*93*	*93*	*93*	June 1, 1951	Oct. 1958	609.2
R Area	93	93	*93*	*93*	*93*	*93*	June 1, 1951	Apr. 1958	Included in above
P Area	93	93	*93*	*93*	*94*	*94*	July 27, 1951	Oct. 1958	Included in above
L Area	91	91	*91*	*91*	*91*	*91*	Oct. 3, 1951	Apr. 1958	Included in above
K Area	90	90	*91*	*91*	*91*	*91*	Oct. 29, 1951	Jan. 1958	Included in above
C Area	92	92	*93*	*94*	*95*	*96*	Feb. 27, 1952	July 1957	Included in above
Separations facilities	82	84	*87*	*89*	*90*	*92*	June 8, 1951	Apr. 1958	295.0
F Area	92	93	*95*	*97*	*99*	*99*	June 8, 1951	Jan. 1957	Included in above
H Area	73	74	*79*	*80*	*81*	*85*	Sept. 24, 1951	Apr. 1958	Included in above
REACTOR DEVELOPMENT									
CHICAGO OPERATIONS									
Pittsburgh:									
Pressurized Water Reactor[i]	f	5	*6*	*15*	*28*	*47*	Mar. 1, 1955	July 1957[g]	32.8
IDAHO OPERATIONS									
Aircraft Nuclear Propulsion (Phase I)	95	99	*99*	*100*			Sept. 16, 1952	Oct. 1955[g]	14.8
SCHENECTADY OPERATIONS									
West Milton:									
Submarine Intermediate Reactor (Mark A)	100						Apr. 8, 1952	Jan. 1, 1955	27.8
PHYSICAL RESEARCH									
NEW YORK OPERATIONS									
Brookhaven:									
Alternating gradient synchrotron	4	4	*5*	*6*	*10*	*16*	Mar. 1, 1954	July 1960	20.0

[a] Based upon fiscal year 1956 budget.

[b] Initial report on this project.

[c] Construction schedule and/or completion date revised to reflect target schedule.

[d] Estimated cost and completion date exclude Feed Plant Addition.

[e] Construction schedule, dates and estimated cost cover both Feed Plant Additions and Reduction and Metal Plant.

[f] Less than one percent.

[g] Construction schedule and/or completion date revised since previous report.

[h] Percentages of construction completion and estimated completion dates have been revised to reflect rescheduling of work to be performed under the productivity improvement and thermonuclear programs. The last of the five production reactors, reactor "C", was placed in operation March 28, 1955, and the last of the two separations facilities, "H", is scheduled for initial operation in July 1955.

[i] Construction schedule and starting and completion dates reflect combined AEC and Duquesne Light Company participation, but estimated cost is for AEC participation only.