NOTICE

**CERTAIN DATA
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PRODUCTS.**

SAFETY

SAFETY PERFORMANCE

The HAPO 1957 safety record was the best record attained since the project started. The disabling injury frequency rate was 25% lower than 1954, the target low, and the severity rate was 23% lower. Safety awards were granted to HAPO employees by the General Electric Company, the Atomic Energy Commission, the National Safety Council, and the State of Washington. These awards not only reflect improved working conditions, but of major importance, a safe and healthy working climate for our employees.

RADIATION PROTECTION

The operation at Hanford continued to keep a high level of performance in radiation protection. There were no injuries arising from radiation or the handling of radioactive substances. The average occupational exposure to external radiation was less than 0.3 rems. No exposures exceeded the National Committee on Radiation Protection and Measurement maximum annual limit of 15 rems and only three out of almost nine thousand employees exceeded the newly recommended average annual limit of 5 rems.

SAFETY

Classification Cancelled (Change
DECLASSIFIED W/DELETIONS

By Authority of CG-PR-2

S.E. GYDESON/STAFF

INFO SPEC

By Chris Mason

5/16/91

PA Thurmon
3/16/91

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Annual report

GE-AEC BUSINESS RECORD

ANFORD ATOMIC PRODUCTS OPERATION

GENERAL ELECTRIC

CLASSIFICATION REVIEW FOR
DECLASSIFICATION BUT LEFT
UNCHANGED

By *James A. Smith*
Date 1958 7 1973
U. S. AEC Division of Classification

This document consists of
45 pages. Copy No. 12
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MARCH 15, 1958

1957

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ATOMIC ENERGY COMMISSION BY THE
GENERAL ELECTRIC COMPANY
UNDER CONTRACT NO. W-31-109-ENG-152

AEC-GE RICHLAND, WASH.

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<i>11/12/61</i>	<i>703</i>	<i>J. R. MacArthur</i>
<i>4/8/63</i>		<i>4/8/63</i>
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DEL

ORGANIZATION

**HANFORD ATOMIC
PRODUCTS OPERATION**
DEC. 31, 1957 8,613

**HANFORD ATOMIC
PRODUCTS OPERATION**

TOTAL PERSONNEL AS OF
JAN. 1, 1957 9,203
DEC. 31, 1957 8,613

NUMBER OF
EMPLOYEES

HAPO WORK FORCE

INTRODUCTION

GENERAL ELECTRIC
COMPANY

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

U. S. Atomic Energy Commission
Hanford Operations Office
Richland, Washington

Attention: Mr. J. E. Travis, Manager

Gentlemen:

The following report of 1957 at Hanford is a summary of our accomplishments in the operation of one of the Commission's major facilities. Throughout the report, the story is one of greater production at lower cost accompanied by continuing research and development programs.

1957 was the first full year of operation under our new, decentralized organization. As you know, this organization was put in place to give managers responsibility for complete operations to the end that they could be held fully accountable for the performance of the components. A corollary to this is measurement of the results produced, and in practically all areas, our measurements indicate continued improved performance over prior years. Evidence is contained in the following pages.

Very truly yours,

General Manager

WE Johnson:

A PRIME CONTRACTOR FOR THE U. S. ATOMIC ENERGY COMMISSION

SUMMARY

SUMMARY OF PRODUCTION AND COST PERFORMANCE

Production in the reactors in 1957 increased 23% over 1956.

Production of plutonium as nitrate in 1957 increased 54% over 1956.

Production of UO_3 in 1957 decreased to 98% of 1956 production due to completing the uranium recovery program for material previously stored from the Bismuth Phosphate process.

IRRADIATION PRODUCTION

PERCENT

IRRADIATION PRODUCTION -- The 23% increase in irradiation production in 1957 was realized, primarily, from the K Reactors. Outages from the water plant modification project resulted in the equivalent of one reactor being shut down continuously for six months, yet production from the six old reactors increased slightly over 1956.

PLUTONIUM UNIT COST

PERCENT HIGH N/g-s PLUTONIUM

PLUTONIUM UNIT COST -- Uranium cost is based on AEC prices for fuel element received at HAPO and the value of depleted uranium at the time of plutonium nitrate separation plus uranium recovery costs. Conversion cost is the G.E. operating cost including shutdown cost but excluding startup and standby, uranium recovery, research and development and community. Depreciation is determined by a straight-line method of calculation using rates of 2 to 20% per year depending upon the estimated life of the property.

URANIUM PROCESSED

URANIUM PROCESSED -- Uranium dissolved and shipped reached a point of equilibrium during 1957 as a result of completing the recovery of uranium accumulated from the BiPO_4 process during prior years operations. The TBP plant was shutdown in March, 1957 and has been placed in lay-away status.

VALUE OF WORK IN PROCESS AND R & D S. S. MATERIAL INVENTORIES AT END OF EACH CALENDAR YEAR

MWD INPUT PER EMPLOYEE

PERCENT (EXCLUDING COMMUNITY)

MILLIONS OF DOLLARS

SUMMARY**HANFORD CAPITAL VALUE**

MILLIONS OF DOLLARS

CHEMICAL ENGINEERING AWARD - a committee of 99 senior educators, under the sponsorship of Chemical Engineering Magazine, selected General Electric to receive one of the Chemical Engineering National Achievement Awards, presented to companies which have made significant contributions in applying chemical engineering principles and processes in extractive metallurgy. The award was made for new and highly efficient processes developed at the Hanford Atomic Products Operation and at the Knolls Atomic Power Laboratory for extracting uranium and plutonium from irradiated fuel elements and for new methods of recovering large amounts of uranium from radioactive waste stored in underground tanks.

CHEMICAL ENGINEERING ACHIEVEMENT

1957 SUMMER INSTITUTE OF NUCLEAR ENERGY - CHEMICAL PROCESSING - under the sponsorship of the AEC and the American Society for Engineering Education, the first "Summer Institute of Nuclear Energy - Chemical Processing" was conducted at Hanford. Eight university professors and one AEC representative participated in this program which included the combined efforts of about 60 HAPO people who assisted with lectures, plant trips, problem counseling, and administration of the Institute.

IRRADIATION PROCESSING

PRODUCTION

Total plutonium irradiation production was 22.8% greater than 1956, as record quantities were produced.

The production gain, resulted from 23.5% higher power levels made possible by expanded water facilities and better operating practices.

Average time operated efficiency was slightly down due to project work. Reactor outage time for tube replacement was down 3.9%.

Fuel element failure frequency remained essentially unchanged at 16.7 per month average. Process tube leakage was reduced to 53.5% of 1956 experience, with 84 leaks compared with 157 leaks last year. Even better tube performance is anticipated as the replacement program is continued.

Radioisotope production reached new record levels this year as a wide variety of materials and elements were irradiated.

REACTOR INPUT PRODUCTION

(PERCENT OF JANUARY, 1956 - EXCLUDING ENRICHMENT BURNOUT)

REACTOR TIME OPERATING EFFICIENCY

PERCENT

REACTOR AVERAGE POWER LEVELS

PERCENT (PERCENT OF JANUARY, 1956-EXCLUDING ENRICHMENT BURNOUT)

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IRRADIATION PROCESSING

OPERATING ECONOMICS

ANNUAL INCREASE IN FIXED ASSETS

CAPITAL INVESTMENT

CAPITAL INVESTMENT -- In 1946 the irradiation processing plants consisted of three reactors. At the end of 1957 eight reactors were in operation and each was producing at a rate greater than the combined design capacity of the original three reactors.

Technological developments and operating experience have extended reactor lives from the original estimate of 7½ years to the currently estimated 25 years. At the close of 1957 physical assets were thirty per cent depreciated.

OPERATING IMPROVEMENTS AND NEW FACILITIES

FUEL ELEMENT PRODUCTION TEST

Internally-externally (I & E) cooled fuel elements have progressed from the status of laboratory development to a production fuel element. A number of small scale in-pile irradiations were performed on specific designs for the K Reactors, the C Reactor, and the older reactors.

Small-scale irradiations and semi-production scale processing of I & E fuel elements at the 100-C Reactor have shown that fuel elements of this design are greater than thirty-fold more resistant to failure than are the conventional solid uranium fuel elements. Of the approximately 60,000 new fuel elements loaded thus far, only one has failed. The

failure occurred at an exposure in excess of 2000 MWD/T at a specific power greater than 150% of current maximum specific power. This failure was experienced under a production test, which provided extremes in power through the use of enriched uranium cores.

ENRICHMENT TECHNIQUES

Enrichment has become an increasingly vital ingredient in Hanford loadings during the past year. It was used at the B, D, and F reactors for the first time to enhance production increases made possible by Project CG-558 water plant modifications. Enrichment was previously in use at the other Hanford reactors to provide the reactivity needed for high

operating levels and to improve temperature distribution. Fringe poison loadings for protection against shield deterioration went from a test to an operational status in CG-558 modified reactors; reactivity losses from these loadings are compensated by enrichment. The transition from weapons quality material to lightly enriched natural fuel elements was accomplished during the year to improve production economics and reactor safety. Approximately thirty-five tons per month of the latter type were being processed at year end.

The new I & E fuel element loading reactivity losses will be compensated by additional enrichment. Fringe poison loadings may be sufficiently attractive on an economic basis to warrant their expansion in the future.

EFFECT OF ENRICHMENT ON HANFORD REACTORS

REACTOR PLANT MODIFICATIONS FOR INCREASED PRODUCTION

Beneficial use of the last modified reactor was on June 28, 1957, five months ahead of certified schedule. Total reactor shutdown time was ten weeks less than scheduled - gaining ten weeks of production.

REACTOR PLANT MODIFICATIONS INCREASED WATER FLOW TO REACTORS (100-B, D, DR, F & H)

REACTOR PLANT MODIFICATIONS

Forty 10,400 gpm pumps, driven by 13.8 KVA, 4500 hp, GE synchronous motors, are housed in five new pumping stations. They deliver 100,000 gallons per minute more water to the reactors.

Power for the pumping stations was provided by adding transformers and switchgear to four existing substations and installing new underground power cables from the substations to the new pumping stations.

IRRADIATION PROCESSING

WATER PLANT IMPROVEMENTS

Improvement in the water treatment process were largely responsible for the smoothness with which the stringent treatment requirements imposed by the CG-558 project were met. Treatment and filtration of water at the rates specified in the CG-558 design had never been successfully accomplished anywhere except on a test basis at Hanford. It was expected that some production losses caused by filter plant failure would occur because of the new conditions. The losses did not occur. The principal reason for lack of

production loss was a new water treatment process developed at Hanford. This process consists of the addition of a few parts per billion of an organic chemical (Separan 2610) directly to the filters to prevent suspended matter from passing through. The new process was applied successfully at all of the water treatment plants during the year. Performance was also impressive because the river water was considerably more turbid than in previous years, while the total treated water production hit a new high.

In addition to operating performance, the new process resulted in cost savings of about \$530,000 during 1957. Savings in materials amounted to \$312,000 and savings to equipment amounted to \$220,000.

POISON SPLINE

A prototype poison spline system, used to supplement reactor controls, is in use at D Reactor. Splines containing neutron absorbing material are inserted through selected nozzle caps as needed during operation. A two per cent production increase resulted from the use of this system at D Reactor by improving flux or temperature distribution. It is expected that all reactors will be equipped with this system.

EQUIPMENT DEVELOPMENT

RESISTANCE TEMPERATURE DETECTORS

Recent developments in primary sensing elements for process tube temperature monitoring are shown above. On the left are Lewis immersion types specifically designed to reduce vibration, the cause of failure of present detectors. Elimination of detector failures like the one shown on the right will improve production continuity.

STATIC SWITCHING

Testing was recently started on the first HAPO installation of static switching. Static switching, which is accomplished electronically, is expected to be more reliable than control relaying. The particular prototype will perform a complex interlocking function between process radiation monitors and the pressure monitoring protective system.

RUPTURE DETECTION SYSTEM

The photograph below shows the prototypic installation of a rupture detection system at C Reactor which was developed to pinpoint the specific tube in which a rupture has occurred.

EQUIPMENT
DEVELOPMENT
CONTINUED

IRRADIATION PROCESSING

TUBE THICKNESS GAUGE

The photo above shows a process tube thickness gauge being used to locate thin walls in the tubes before leaks occur.

Probes are inserted in the tubes and using the eddy current principle, transmit process tube wall variances to a chart recorder.

SILICONE FOAM GAS SEAL

Pictured on the left is a neoprene, gas-seal bellows removed from one of the KW Reactor process tube gunbarrels. It shows the hardening, cracking, and breaking caused by high temperature. At the right is a sample of unicellular silicone foam developed for the first time at HAPO for injection into these bellows to reduce helium losses. Foam may be injected into both front and rear bellows without removing nozzles or pigtails. First reactor application of this technique to seal some badly leaking bellows reduced background radiation level on the front face by a factor of two. This is a temporary solution to the gas loss problem until new silicone seals can be procured, evaluated, and installed.

TUBE WRAPPER

Improved equipment for tube removal is shown being tested. This machine pulls the old process tubes from the reactor core and coils the tube as shown in the inset. The coiled tube is ejected into the storage basin.

46 FT. CYLINDER

A forty-six foot long hydraulic cylinder was developed to speed tube removal operations by pulling tube splitters and channel broaches through the reactor. Use of this equipment with the tube wrapper should reduce tube replacement time.

CHARGE-DISCHARGE WHILE OPERATING

111 tubes of ball valve equipment were installed in the 100 C Reactor to facilitate testing of the "Charge-Discharge While Operating" process. With the reactor operating, several ruptured fuel elements were detected and discharged.

HW-54000 DEL

IRRADIATION PROCESSING

Testing a remotely operated charging machine. A fuel element magazine is shown suspended from cables.

Control console for "Charge-Discharge While Operating" equipment.

Sequencing relays in charging machine for fully automatic operation.

VERTICAL ROD TEST TOWER

Testing vertical safety rods for HAPO's reactors, present and future, is done in this Test Tower. Insets show top and bottom of proposed air driven rods. Development is underway to reduce rod insertion time from approximately 1.8 seconds to 0.8 seconds for additional reactor safety with higher power levels and to improve rod materials, surfaces, and seals to permit operation at higher reactor temperatures and to reduce helium gas losses.

MAINTENANCE PROGRAMS

Maintenance improvement programs require continuous study of the work efficiency of maintenance craftsmen.

Production maintenance programs avert emergency outages.

FUELS PREPARATION

FUELS PREPARATION SUMMARY

Increased total production and the diversified products produced to fulfill reactor requirements were the outstanding achievements in fuels activities during 1957. Increased production yields, reduced unit costs, and increased productivity were achieved. A Pilot Plant was completed and operated to facilitate the development of superior fuels.

PRODUCTION

Production of lead-dip canned uranium fuel elements reached an all-time high in 1957, averaging 33% above 1956, and 40% above 1955.

To meet the reactor requirements for fuel elements capable of withstanding increased reactor power and exposure, many new products were produced during the year. During 1955 and 1956 only two principle products were produced. In 1957 the number of prin-

ciple products had increased to eight. In addition, twenty-one variations to the eight were produced, ranging from various interlocking end contours to various enrichments of uranium.

The quantity of I & E (internally and externally cooled) fuel elements produced per month increased approximately 20 fold from June to December, 1957. This increase was required due to the accelerated use of the new fuel elements in the C and K Reactors. No reactor failures occurred in normal uranium

PRODUCTION YIELD

LEAD-DIP CANNING PROCESS FOR INTERNALLY

PRODUCTION

PERCENT

I & E fuel elements, whereas, the failure rate for normal cored and solid uranium fuel elements was in the order of 1.21 per 10,000 irradiated in 1956 and 1.05 per 10,000 in 1957.

A new aluminum alloy (M-388) jacketing material was introduced for fuel elements to improve the corrosion resistance of the jacket to abnormally high surface temperatures

caused by local hot spots on the jacket surface. The production yield of solid and cored fuel elements has remained about 80% over the past two years. However, the production yield of I & E fuel elements has increased from an average of 36.5% during the introduction period to greater than 60% after production of large quantities.

AND EXTERNALLY COOLED (I&E) FUEL ELEMENTS

DEL

FUELS PREPARATION

PRODUCTION AND UNIT COST

PRODUCTS PRODUCED BY THE LEAD-DIP CANNING PROCESS DURING 1957

URANIUM CORE SHAPES

SOLID

CORED

LARGE SCALE CANNING DISCONTINUED IN JUNE 1957 IN FAVOR OF I & E FUEL ELEMENT

INTERNALLY AND EXTERNALLY COOLED (I&E)

INTERLOCKING END CONTOURS

BLUNT-NOSED TRUE-LINE

UNIVERSAL TRUE-LINE

SIZE AND TYPE OF URANIUM CORE	ALUMINUM JACKET ALLOY
8 in. Normal Uranium	M-388
8 in. Depleted Uranium	1245
4 in. Normal Uranium	1245
6 in. Enriched Uranium (0.94% U-235)	1245
8 in. Enriched Uranium (1.44% U-235) (1.60% U-235)	1245
6 in. Normal Uranium 1/2 in. Bore	1245
6 in. Enriched Uranium (0.94% U-235) 1/2 in. Bore	M-388
8 in. Enriched Uranium (1.44% U-235) 1/2 in. Bore	1245
"C" Reactor - 6 in. Normal Uranium	M-388
"C" Reactor - 6 in. Enriched Uranium (0.94% U-235)	1245
"C" Reactor - 6 in. Normal Uranium	1245
"K" Reactors - 8 in. Normal Uranium	1245
"O" Old Reactors - 8 in. Normal Uranium	M-388

8 in. Solid Normal Uranium	M-388
8 in. Cored Normal Uranium 1/2 in. Bore	1245
6 in. Solid Enriched Uranium (0.94% U-235)	M-388

Same Size, Type and Alloy as I & E Above

Indicates Principle Products Canned in 1957

COSTS

Higher production, increased mechanization, and better utilization of manpower has reduced the unit product cost 17.5% and increased the productivity 52.9% for solid fuel elements from the 1956 levels. An increase in unit product cost for cored fuel elements in the latter part of 1957 was due to the small amount of material being canned. The large decrease in unit costs and large increase in productivity in July for I & E fuel elements was due to the increase in production yields, higher production, and a reduction in the canning cycle time.

The increase in production resulted in an increase in the number of canning line shifts per day from 8 in 1956 to the present level of 10 in July, 1957. Improvements in the canning line equipment and arrangement permitted the reduction of a canning line crew from 5 to 4 men.

SEMI-AUTOMATIC BALANCE

Determination of fuel element corrosion losses in the reactors requires accurate weighings of the fuel elements being tested before and after irradiation. A semi-automatic balance installed in the Pre-Irradiation Measurements Area has increased the number of weighings per unit time by 20 fold over the previous manually operated swing balances.

NEW FACILITIES

In May, 1957, the fuel element Pilot Plant (306 Building) began operation and provided HAPO with the first facility devoted exclusively to developing and piloting the fabrication of better reactor fuels. This facility is comparable in size and scope to one complete regular manufacturing fuel element canning line and includes complete facilities for component preparation, canning, finishing, and all inspections except autoclaving. The primary use of the Pilot Plant has been to develop improved canning procedures for I & E lead-dip canned fuel elements. The Pilot Plant, with a floor space of 7200 sq. ft.,

FUELS PREPARATION

has a potential capacity of over 40 tons per month on a one-shift basis. The cost of the Pilot Plant was \$403,500.

Two canning lines in the Manufacturing facility were converted to I & E production and required the installation of new equipment and the conversion of some existing equipment to handle I & E fuel elements. Other equipment changes were made throughout the process to improve fuel element quality, manpower utilization, safety, and equipment performance.

BOND-PENETRATION TEST AREA

The bond-penetration test machines for solid fuel elements (foreground) and for I & E fuel elements (background) test the dip-brazed fuel elements for acceptability of (1) jacket-core bond and (2) residual thickness of aluminum jacket. Accurate measurements of both of these qualities are necessary for maximum reactor performance. The machines are equipped with automatic load, unload, and reject mechanisms. Conveyors feed the machines and send the tested fuel elements on to the fuel element etch machine (right background), and then to the autoclaves (far background).

TRANSFORMATION TEST EQUIPMENT

The transformation test machine equipped with an automatic load-unload mechanism tests bare uranium cores to assure that the uranium has been completely transformed into the beta phase during heat treatment after rolling at Fernald. Cores not completely transformed are likely to distort during irradiation resulting in fuel element failures.

PRODUCTION
FACILITY

PILOT PLANT CANNING LINE

A conveyor system feeds components to the duplex furnace (left background) and the canning furnace (center). The canning line is controlled by an electric-pneumatic controller (not shown). In the foreground is a tray of I & E cap-spire aluminum components. In the right foreground is a tray of can-sleeve assemblies. The steel sleeves protect the aluminum can during immersion in the AlSi bath.

PILOT PLANT WELDING AREA

The semi-automatic welders can be fed batch-wise (as shown) or by a conveyor system against the rear wall.

PILOT
PLANT

PILOT PLANT PROTOTYPE BOND-PENETRATION TESTER

The prototype bond and penetration tester shown simultaneously tests the exterior and interior surfaces of I & E fuel elements for acceptability of (1) jacket-core bond and (2) residual thickness of aluminum jacket. The tester is equipped with an automatic load, unload, and reject mechanism.

HW 54000

DEL

CHEMICAL PROCESSING

> The Chemical Processing facilities are located in two restricted areas.
> Wide dispersal of the facilities is maintained for reasons of safety. > > >

CHEMICAL PROCESSING

PUREX OPERATION

PUREX

Significant improvements in plant capacity, product recovery, and unit costs were achieved in the Purex Plant during the year. Purex produced 71 % of the total plutonium output, and in October a new record high for plutonium production was established. Sustained instantaneous rates of 20 tons per day were demonstrated on a routine basis.

Residual fission product activity in the plutonium product has been reduced 25 fold below design specifications and the uranium product gamma contamination has been reduced to the threshold of analytical detection. The re-use of nitric acid recovered from the uranium fuel element dissolution operation and from the uranium oxide calcination operation has contributed appreciably to the economies which have been attained.

PUREX CENTRAL CONTROL ROOM

All chemical and process flows and process conditions of the solvent extraction equipment are controlled at this central location.

SEPARATIONS PROCESS PLANT

The heavily shielded canyon area in the Purex Plant. Process equipment is located in large concrete cells beneath cover blocks which can be removed by overhead cranes. Access to these process areas is closely controlled.

REDOX

In order to permit optimum processing in the Purex Plant, the amount of uranium processed in Redox Plant was slightly less than the comparable amount for 1956. The output of plutonium, however, was 104 % of the 1956 production, which reflects the processing of higher irradiation exposure uranium. The reduced processing rates were reflected in slightly higher unit conversion costs for both plutonium and uranium.

During the year the processing of irradiated fuel elements from foreign sources was initiated. Three shipments of fuel elements from Atomic Energy of Canada, Limited were processed. Special handling and process techniques were developed to permit the processing of this material.

TELEVISION VIEWING ROOM

Maintenance work in radiation zones has been improved by refined use of the remote TV camera. Craftsmen, prior to taking over where others leave off due to exposure time limits, can readily understand the work required. Oral orientation time is eliminated. Radiation exposure time is controlled from the TV room.

DELIVERY OF FOREIGN FUEL ELEMENTS TO REDOX PLANT

Three carriers containing irradiated fuel elements from AECL have been transferred to a project flat car in preparation for charging into a Redox dissolver.

REDOX OPERATION

PERCENT CUMULATIVE PRODUCTION

CHEMICAL PROCESSING

Unit costs of unfabricated plutonium and fabricated cores showed a slight reduction from comparable figures in 1956.

Completion of the uranium recovery program, reduced UO_3 production slightly below the 1956 output.

Subsequent to the activation of the remainder of the continuous UO_3 calciners early in the year, all uranium was processed through the continuous units.

The unit cost of UO_3 increased over 1956 as a result of higher maintenance costs required to maintain operating continuity prior to equipment changes which have been completed.

PLUTONIUM PROCESSING - A view of the fabrication facility (234-5 Building) showing the south and east sides. In the center can be seen the large underground exhaust air building and stack which daily returns millions of cubic feet of filtered air to the atmosphere.

UNFABRICATED PLUTONIUM

RADIATION PROTECTION

Part of the fabrication line where specialized neutron and gamma measuring instruments are used to collect shielding data on several types and thicknesses of materials used in the enclosures.

URANIUM OXIDE

INTER-PLANT URANIUM SHIPMENT

Tank trucks from the Purex plant unload their cargo of UNH at the Uranium Reduction Plant for conversion to UO₃ and subsequent shipment offsite.

CHEMICAL PROCESSING

UO₃ FACILITIES - Uranium Reduction facility (224-U, UA Buildings). In the upper right is the new structure housing six continuous calcining units together with their powder handling and loadout equipment.

OPERATING IMPROVEMENTS AND NEW FACILITIES

RADIOIODINE REMOVAL AND NITRIC ACID RECOVERY FACILITIES REDOX AND PUREX PROCESS

New facilities installed at the Redox and Purex Plants remove radioiodine from dissolver off-gases. These facilities also recover nitric acid in dissolver off-gases for reuse and permit a reduction in the inventory of stored irradiated fuel elements.

The advances made in the continuous processing of radioactive materials permitted the shut-down and lay away of the Bismuth Phosphate Process (B and T Plants), the Isolation Process (231 Building), and the batch-wise calcination process for UO₃ (224-U Building). The new facilities provide continuous processing, more economical operation with increased capacity, and greater potential for further advancement.

A waste scavenging program recovered over 13 million gallons of storage space in existing waste tanks.

An additional 4 million gallons of waste storage tank space was gained by self-concentration of wastes by heat generated by fission products.

New facilities were installed at Redox Plant and Purex Plant to provide for more effective removal of radioiodine from gases discharged to the atmosphere. The facilities also provide for the recovery of nitric acid, which is re-used in the process.

SAFE REMOVAL OF CONTAMINATED PUMPS FROM RADIOACTIVE WASTE STORAGE TANKS

Due to processing conditions or mechanical failures, the removal of deep-well pumps from radioactive waste tanks is frequently necessary. Use of a large plastic sheath or tube to seal off radioactive equipment has proven successful in the elimination of radioactive contamination spread.

CONTINUOUS PLUTONIUM PROCESSING

Continuous processing equipment installed in the 234-5 Building to provide required increased capacity. Plastic hood walls provide maximum visibility and containment of hazardous plutonium. Plastic bag access ports located at frequent intervals in the hood walls facilitate maintenance and removal of process equipment.

CONTINUOUS UO_3 CALCINERS

The calciners convert liquid uranyl hexahydrate to UO_3 powder in a continuous operation. Reduction in required manual labor and personnel radiation exposure have been achieved along with greater production capacity.

HW-54000

RESEARCH AND DEVELOPMENT

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Research and development work during the year was directed to:

1. Continued support and improvement of the existing reactor and chemical separations plants.
2. Development of technology and process design of a new production reactor with the potential for ultimate power generation.
3. Development of technology aimed at demonstration of the feasibility of recycling plutonium as reactor feed in a self-sustaining or nearly self-sustaining cycle.
4. Long range studies in biology and biophysics relating to operation of Hanford and to other atomic energy activities.

CONTINUED SUPPORT AND IMPROVEMENT OF EXISTING PLANTS

Study and experimentation on fuel elements has continued in an effort to achieve further improvement of their performance in the Hanford reactors. The internally and externally cooled fuel element canned by the lead dip process has moved into limited production. Development work continues on alternate methods of fabrication of this type of element. Several hundred self-supporting fuel elements have been prepared for test use. This design seeks to give greater assurance of centering in the process tubes with resulting more nearly symmetrical temperature gradients in the elements. Other designs such as one of uranium wafers and one of two coaxial uranium tubes are subjects of experimental study.

New alloys of aluminum with small amounts of iron, titanium and nickel show promise of being more corrosion resistant as fuel jackets or process tubes than the alloys with nickel only. A few ribbed zircaloy-3 process tubes have been successfully fabricated. Zircaloy tubes even at a much higher cost per tube may be more economic than aluminum because of greater corrosion resistance.

Reactor heat transfer experiments confirmed that stable operation can be maintained at higher cooling water outlet temperatures than previously specified. This has permitted increases in reactor power levels.

Laboratory work has indicated ways to improve and simplify steps in the chemical

EXPERIMENTAL COAXIAL FUEL ELEMENT

A fuel element design has been conceived which may improve the operating performance and increase the service life of fuel elements for Hanford-type reactors. The drawing shows a fuel element arrangement of one uranium tube inserted coaxially into another uranium tube. This arrangement may offer the increased resistance to split type failure of a large inner diameter cored uranium fuel element without the accompanying reactivity loss. A low level, but high power irradiation of one test specimen showed good stability.

processing of both uranium and plutonium. In-line instrumentation for the chemical processing plants has been further developed. Newly developed fabrication methods make practicable the use of highly corrosion resistant titanium process equipment.

Further improvements have been developed in the processes for recovery of fission products and neptunium-234. Experimental measurements have established the criteria for nuclear safety for processing enriched power reactor fuels. A new Zirflex process for dissolving zirconium jackets of power reactor fuels in ammonium fluoride has been developed.

RESEARCH AND DEVELOPMENT

NEW PRODUCTION REACTOR DESIGN

At midyear the Commission requested General Electric Company to proceed with an engineering study which would show, on the basis of preliminary design, the competitive economics of various single purpose and dual purpose applications of Hanford-type reactors.

Work on the study is currently in progress and the report is scheduled for submission to the Commission on March 1, 1958.

The study is being concentrated on a pressurized water cooled, graphite moderated design. Substantial programs for zirconium tube development and fuel element development are under way both at Hanford and through offsite development contracts. Current indications are that reactor operation would be possible about four years after availability of funds if such a reactor were authorized.

CLUSTER FUEL ELEMENT

This seven rod cluster fuel element viewed through a lead glass port in a radiometallurgy cell was irradiated in the KE Reactor at 60 kw/ft to 1000 MWD/T exposure. Cluster fuel assemblies have an advantage over solid fuel rods particularly in high temperature water as in a pressurized water reactor. Experiments in high temperature water show severe reduction or complete stoppage of flow when solid rods corrode after a cladding failure. Three rods of a seven rod cluster fuel element may corrode without serious coolant flow blockage. The KE reactor is now operating with a four rod cluster fuel charge in one test loop with a coolant temperature up to 235 C.

METALLURGY OF ZIRCONIUM

This is an electron micrograph of the surface of a zircaloy-2 specimen at 9000 power magnification. The surface was prepared by a special technique of ion bombardment. Zircaloy-2 is likely material to use for fuel element cladding or process tubes in a high temperature water reactor. Interpretation of micrographs such as this, contribute to the development of processes and designs for the effective use of this or other special metals. The micrograph — on the right — is one of a set prepared at Hanford that was judged best of class at the 1957 World Metallurgical Congress.

LATTICE PARAMETER DETERMINATION

An operator is shown inserting a neutron counter in a graphite moderated exponential pile in which nuclear measurements are being made on seven-rod cluster fuel elements of uranium. Data from these measurements are used in designing lattice arrangements for possible fuel elements for a new production reactor.

IN-REACTOR RECIRCULATION TEST LOOPS

Test use of the four high pressure water recirculation loops in one of the new reactors started in May, 1957. Some of the typical piping and pumps associated with these loops are shown below. The loop tubes through the reactor are 2.1 inches i.d. Zircaloy-2. Data have been obtained on stainless steel jacketed four-rod cluster elements in demineralized water at outlet temperatures up to 235° C. Other tests have been made on elements with special aluminum alloy jackets and with fairly acid water at a pH of 4.5. These loops are being used in design development work on the new production reactor.

REACTOR INCIDENTS ANALYSIS

The complicated series of events which could take place in the unlikely event of a reactor accident are electrically simulated on this GEDA, A-14 analog computer. In this way engineers can determine the safeguards required to minimize the consequences of such accidents. Studies of this type have been carried out as part of the program for obtaining increased production from the existing reactors and also to build maximum safety into new reactor designs such as the Plutonium Recycle Program Reactor.

RESEARCH AND DEVELOPMENT

PLUTONIUM RECYCLE PROGRAM

On continued study and experimentation plutonium recycle continues to appear physically feasible and economically attractive. Plutonium recycle might be employed with natural, depleted or enriched uranium reactor feed in a self-sustaining operation. Under some conditions an operation somewhat less than self-sustaining may be more economic. An original amount of enrichment may serve a reactor through its entire useful life in an operation that is something less than fully sustaining.

The emphasis on the Plutonium Recycle Program research and development work increased from a rate of \$1.2 million in the fiscal year ending June 30, 1957 to a rate of about \$3.5 million for the fiscal year beginning July 1, 1957. The work was directed to development of plutonium containing and uranium oxide fuels, nuclear physics data, and scope designs of a test reactor for use in demonstrating a satisfactory fuel element design and the feasibility of continuous recycling of plutonium.

PLUTONIUM FUEL ELEMENT DEVELOPMENT

The technician is adjusting the end fitting of a 19-rod cluster fuel element of plutonium-aluminum alloy. This is a type of element intended for use in the Plutonium Recycle Program test reactor. Fuel elements containing plutonium oxide or graphite impregnated with plutonium are also being considered.

LATTICE PARAMETER DETERMINATION

Measurements made in the versatile Physical Constants Testing Reactor have produced nuclear data for reactor lattices suitable for use with recycled plutonium fuel. A "concentric tube" fuel element of uranium oxide is shown positioned in a PCTR test core arrangement. In one of the fuel arrangements proposed for the Plutonium Recycle Program Reactor, the central rod of some of the fuel elements of this type will contain recycled plutonium.

CERAMICS FUEL ELEMENTS

Techniques have been developed which allow simultaneous compaction and cladding of uranium dioxide powders by a process of rotary swaging. Zircaloy clad, swaged uranium dioxide fuel elements have been irradiated in the Materials Testing Reactor with encouraging results. Swaging shows considerable promise as a relatively inexpensive method of fabricating ceramic powder fuel elements. These containing highly

REACTOR LAYOUT AND DESIGN - This scale model of the Plutonium Recycle Program Reactor was built to facilitate study of layout and design. The transparent plastic dome simulates the 80 ft. diameter, 120 ft. high steel containment vessel for the reactor. The portion of the reactor building below ground level is exposed in this model with the ground cut away. The reactor is being designed for maximum flexibility in testing fuel elements and demonstrating the recycle concept. It is not a prototype of a power reactor.

FLUID DYNAMICS OF REACTOR DESIGN

Tests to demonstrate the adequacy of apparatus to control the heavy water moderator liquid level will be performed on a full scale geometrical mock-up of the Plutonium Recycle Program Reactor. The photo below shows the arrangement of process tubes within the reactor core. This assembly of tubes on which stripes have been painted to facilitate visual study of fluid dynamics is installed in the upper vessel of the simulated reactor assembly shown in the photo to the right. The tank on the ground is the heavy water sump. It will be positioned directly below the reactor core vessel and connected to it with piping.

BIOLOGY**DISTRIBUTION OF RADIOACTIVITY
IN AQUATIC LIFE**

Radioactive cesium is being added to an artificial pond. The pond contains aquatic life of many types -- plants, frogs, fish, algae, and others to form a balanced ecological community. A study is being made of the transfer of this fission product from the water to and among members of the community. This is one of the first relatively large scale experiments in radioecology. Knowledge gained will enable more accurate prediction of the hazards from radioactive wastes that may enter natural water resources.

**CALCIUM DILUTION ON STRONTIUM 90
DEPOSITION**

A lamb is shown receiving a ration of milk dosed with strontium 90 and calcium. This is part of an investigation of the effect of calcium on decreasing the bone deposition of radioactive strontium in milk. This and other studies with plants and rats are causing revision of earlier concepts of strontium-calcium relationships. Although the deposition on bone of strontium 90 may be decreased by calcium, the effect has been found to be less than that predicted by earlier theories.

**EFFECT OF RADIOACTIVE PARTICLES
ON THE LUNGS**

The air in this plastic chamber in which mice are kept contains particles of radioactive ruthenium oxide. Knowledge of the effects of inhaling and depositing such radioactive dusts in the lungs will be obtained in these experiments. Early work has shown that high concentrations can induce lung cancer in mice. Further work over many years will be needed to define maximum safe concentrations.

EFFECTS OF RADIOACTIVE EFFLUENT ON FISH

With the Hanford reactors releasing small amounts of radioactive phosphorus into the Columbia River, constant studies are being made to determine the effect of this isotope on fish. This study shows young trout being fed gelatin containing radioactive phosphorus. Samples of representative life forms taken from the river are regularly analyzed for radioactive contamination.

DISPERSION OF GAS RELEASES IN STABLE ATMOSPHERE

The photo above shows the slow dispersion of a test stream of smoke emitted from about halfway up the 400 foot meteorological tower at Hanford under conditions of a typical early morning air temperature inversion. This slow dispersion leads to relatively dense plumes up to several miles from the point of release. Information from studies of dispersion is used at Hanford in establishing procedures for release of normal discharges to the atmosphere. It is also useful in precautionary planning to minimize the dangers from any accidental release of radioactive material. The information is proving of value to other segments of both the atomic energy industry and industry in general.

MEASUREMENT OF PERMEABILITY OF GROUND STRATA

An experimental "packer" being lowered into one of many exploratory wells to measure strata permeability at points within the water table near radioactive waste disposal sites. This is one of several instruments and techniques developed and exploited in hydrology and soil chemistry research to better define factors influencing optimum, safe disposal of radioactive effluents to earth formations. Well pumping experiments and other field studies permitted better definition of volumes, rates, and direction of ground water flow. This knowledge is of importance in predicting the fate of radioactive wastes placed in the ground and in the development of new methods for safe disposal.

SUPPORTING OPERATIONS

CONSTRUCTION ENGINEERING

463 engineering designs were made in 1957 at a cost of \$1,200,000.

Construction completed during the year totaled \$8,910,000 for 659 projects or work orders. Fixed price construction and shop fabrication business by a CPFF construction contractor was established during the year. This business amounted to \$251,800 for the period of February through December.

DESIGN ENGINEERING

Design of a precision instrument with required shielding and foundations.

Scope assistance and detail design of a structure and containment vessel.

Scope assistance and functional design of a high temperature and high pressure system.

Design of high capacity power supply for heat transfer testing.

INSPECTION

Example of equipment inspected for compliance with exacting HAPO standards.

Inspection was made on 1112 orders, in 441 vendor plants -- representing a total value of \$11,800,000.

Installation of 66 inch Effluent Line from a Hanford Reactor to a Retention Basin.

Inspection of Reactor Effluent Line which empties into the Columbia River.

One of the varied types of vessels fabricated in the Construction Shops.

SUPPORTING OPERATIONS

AUXILIARY SERVICES

TRANSPORTATION AND MAINTENANCE

Transportation and maintenance functions were reorganized for maximum efficiency making it possible to reduce total manpower from 638 employees to 573 during the year.

Studies on utilization of automotive and heavy mobile equipment resulted in a reduction of 60 units of equipment.

A comparison of parts inventories with a commercial bus operation of the same size shows HAPO parts inventory costs of \$268.70 per coach as compared to \$769.82 for the commercial operation.

Roads were maintained again in 1957 at 60% of the cost per mile of the State of Washington roadways.

METAL VAN-TYPE TRUCK FLEET -- The new weather tight trucks are an improvement in the protection of stores items being delivered.

PURCHASING AND STORES

Purchase orders for \$20,000,000 comprising 24,000 separate orders were placed during 1957 for materials and equipment. This volume of purchases represents a 9% decrease from 1956, principally in process equipment for plant expansion. Personnel engaged in purchasing activities decreased 10%. Excess equipment from other AEC locations was transferred to Hanford at a net saving, over new equipment, of \$170,000.

Maximum use of data processing methods and adaption of an Economical Order Quantity formula have contributed to improved management of inventories.

Inventories consist of general supply materials valued at \$1,700,000 and spare parts valued at \$4,500,000.

PRIMARY SUBSTATION

Operators at the seven primary substations perform emergency or routine switching, and continually inspect station operations to safeguard equipment and the flow of electricity.

ELECTRICAL UTILITIES

The demand for production power from the electrical transmission-distribution network rose 40%, to 297,700 KW, during the year, as increased pumping loads of the Water Plant Expansion Program and the 100-K Areas were successfully assumed by the system facilities.

On July 1, 1957, the Community telephone system, serving 7,000 residential and commercial customers, was sold to the General Telephone Company.

HIGH SPEED IBM PRINTER

The high speed IBM Type printer, recently installed for data processing, has a printing speed of 500 lines per minute. This is over three times faster than the conventional models. A report listing all HAPO employees can be prepared in less than 15 minutes.

DATA PROCESSING

Several new applications were installed on the IBM Type 702 Electronic Data Processing Machine during 1957. Of particular importance was a scientific inventory control system designed in cooperation with the Purchasing and Stores Operation for some 30,000 general supplies items.

The time and cost of installing data processing systems has been substantially reduced through (1) the use of advanced programming techniques, (2) generalized file maintenance, (3) generalized sorting, and (4) generalized report preparation.

The IBM Type 702 Electronic Data Processing Machine installed at HAPO in 1955, is running very close to maximum utilization. The average usage during 1957 was 637 hours per month - 90% of the total available hours.

SUPPORTING OPERATIONS

EMPLOYEE AND COMMUNITY RELATIONS

Returns from the 1957 Employee Attitude Survey indicate that HAPO employees generally enjoy a high degree of job satisfaction. As shown on page 2, the total Hanford payroll was reduced from 9203 on January 1 to 8613 on December 31, 1957. Of this reduction, 248 employees were laid off and 342 were the result of attrition.

A questionnaire sent to 500 community leaders indicated that Hanford is enjoying a favorable relationship with this key group. Plant tours by the press, community leader groups, educational groups and employees' families contributed to this improved understanding.

SECURITY

HOO Security continued to rate HAPO's protection and security education efforts as excellent. The number of unaccounted for classified documents was reduced from 194 to 171. A major change was made in employee identification and security clearance procedures which permits use of a single film badge in all production areas. This resulted in a considerable cost savings in badge processing and also expedited personnel movement.

RADIATION PROTECTION

Improvements made throughout the year in the evaluation of radiation exposure and the maintenance of records are providing improved control of radiation exposure at lower cost. Use of a new film badge together with the conversion of records to electronic data processing and altered procedures for use of dosimeters will result in a savings in 1958 of at least a quarter of a million dollars.

← NEW PLASTIC HEALTH FILM BADGE
DEVELOPED AT HANFORD

COMMUNITY

The first segment of government-owned residential property in Richland was offered for sale on June 12, 1957. As of December 31, 1957 1,578 parcels out of 4,805 were offered and 695 sold. General Electric continued to manage, operate and maintain the community during 1957 while working closely with the A.E.C. and Community Council in preparation for a smooth transition to an incorporated city with a target date of March 1, 1959.

NEW COMMUNITY FACILITIES -- One of two new fire stations constructed in 1957.

● **COMMUNITY
HEALTH**

The crude death rate for Richland (1.9 per 1000 population) was less than a fourth the national rate. Infant mortality (9.7 per 1000 births) was less than half the expected rate, and the community's zero maternal mortality record was maintained. There have been no deaths among mothers due to child birth in more than 13 years, with about 10,000 births during that period.

The death rate of 3.0 for General Electric's HAPO employees was 25 % below the expected rate for a comparable U. S. population.

Many programs sponsored by Public Health helped to make the health records possible. Good examples were the adult polio vaccinations which attracted over 5000 residents and the flu inoculations which were given to more than 6000 employees.

END

**DATE
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