SECRET

225 pages
2 of 4

UNCLASSIFIED

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

X-10

VOLUME 6 - OPERATION

CLASSIFICATION CANCELLED
OR CHANGED TO
BY AUTHORITY OF DOE/DPC
JOHN K. HARTSOCK 9/6/79
REVIEWED BY DATE

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW
1ST REVIEW DATE: 3/24/05
AUTHORITY: DC
2ND REVIEW DATE: 10/24/05
AUTHORITY: DD
DETERMINATION (CIRCLE NUMBER(S))
1. CLASSIFICATION RETAINED
2. CLASSIFICATION CHANGED TO:
3. CONTAINS NO DOE CLASSIFIED INFO
4. UNCLASSIFIED

31 December 1946

FOREWORD

This volume of the Manhattan District History has been written to present the work of the Operations Division of the Hanford Engineer Works during the period from about 1 January 1944 to 31 December 1946. Work during this period included preliminary preparations, consulting service to the Construction Division, and plant operation. It has been endeavored to accomplish this presentation with as little detail as is consistent with a clear and comprehensive discussion of relevant facts.

The summary contains an abstract of every major subject treated in the main text and is keyed to the text in such a manner that paragraph headings and numbers in the summary refer to the various sections of the text.

Supplementary material and references, necessary to a clear understanding of the narrative, are presented in five appendices. Appendix references have been made in the text as a combination of letters and numerals; the letters denote the appendix division and the numerals refer to the position of the item in the particular appendix. Thus (See App. A 12) would refer to Appendix A, item 12 of that appendix. The asterisk (*) has been used at the first occurrence of a word in the text to denote that it is defined in the Glossary.

Other phases of the history of the Pile Project are described in:

Book IV - Volume 1 - General Features

Book IV - Volume 2 - Research

Book IV - Volume 3 - Design

Book IV - Volume 4 - Land Acquisition

[redacted]

Book IV - Volume 5 - Construction.

31 December 1946

[redacted]

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 6 - OPERATION

TABLE OF CONTENTS

SECTION 5 - OPERATIONS RECORD

SECTION 12 - COMMUNICATIONS

SECTION 13 - PUBLIC & LABOR RELATIONS

SECTION 14 - PROPERTY ACCOUNTABILITY AND DISPOSAL

SECTION 15 - DEMOLITION OF HANFORD CAMP

SUMMARY

1. <u>Introduction.</u> - The large-scale manufacture of plutonium at the Hanford Engineer Works for ultimate use at the Los Alamos Project entails: (1) fabrication of canned slugs from the raw metallic uranium billets, (2) irradiation in the graphite lattice Piles, where the metal is enriched in the new element, plutonium-239, and (3) chemical processing of the enriched metal to separate the product from the associated uranium and highly radioactive fission products. In the Piles, immense quantities of heat are liberated and must be properly dissipated. In both the Pile and separation processes, radioactivity of heretofore unencountered intensity is present, necessitating extensive precautions in all buildings concerned with these processes, to detect radioactivity and eliminate hazards to operating personnel. In addition to plutonium, radioactive polonium is manufactured at Hanford and transferred to the Los Alamos site for further processing.

2. <u>Description of Plant Operations and Facilities.</u> - The primary manufacturing facilities of the Hanford Engineer Works are located in the Metal Fabrication and Testing (300) Area, the Pile (100) Areas, and the Separation (200) Areas.

The uranium metal is received at the Metal Fabrication and Testing Area in the form of billets. It is then extruded into rods, which are outgassed (hydrogen removed), straightened, and machined, to very close tolerances, into pieces called slugs. The slugs are coated with a bonding material, encased in aluminum "cans," hermetically sealed, and subjected to rigorous testing before use in the Pile.

The canned slugs are transferred to the Pile Areas, where they are placed into the 2004 cooling tubes which pierce each of the three graphite Piles. Within the Piles the slugs are subjected to bombardment by neutrons originating from the fission of uranium-235 in the chain-reacting Pile, which results in the transmutation of a small portion of the uranium-238 to plutonium-239. The Piles are essentially heat-producing units, and it is necessary to dissipate the heat within the Pile. This is accomplished by the cooling system which provides for pumping water from the Columbia River, filtering, refrigerating, storing, and distributing the water to the Pile cooling tubes. A dual power supply is provided to assure a continuous supply of water to the Piles. Helium is circulated through the Piles to displace all air and thus provide within them an atmosphere of high thermal conductivity and low neutron-absorption cross section. The helium circulation system provides for storing, drying, and purifying the gas. The Pile reaction is controlled by three types of control rods: regulating rods, which provide continuous control of Pile power output; shim rods, which are used in start-up and stopping of the Pile reaction; and safety rods, which provide for shutdown of the Piles.

After discharge from the Piles, the uranium slugs enriched with plutonium are transferred to the Separation (200) Areas for further processing. Facilities are provided for short-term storage of the slugs, during the period necessary for the intense radioactivity to diminish through decay. After the decay storage period, the metal is transferred to the Separation Building, where the plutonium is separated by chemical methods from the uranium and from the majority of the fission products (decontamination); and thence to the Concentration Building, where the solution is decreased in volume and decontaminated further. At this point the starting solution has been reduced in volume by a factor of 1300 and in radioactivity by a factor of 10,000,000, so it can be handled in the small scale, unshielded equipment of the Isolation Building, where the plutonium is purified and prepared for delivery. The chemical process consists of dissolution of the metal slugs; separation of plutonium by carrier-precipitation, first on bismuth phosphate and then on lanthanum fluoride, and purification by precipitation as the peroxide of plutonium. All process wastes which contain appreciable amounts of uranium, plutonium, or fission products are stored in large underground tanks. The scheduling of plant operations is guided by meteorological forecasts because of the necessity for favorable atmospheric conditions to provide proper dilution of the radioactive gases evolved in dissolving the metal.

3. Specifications for Final Product. - Because of the extreme difficulties and uncertainties relating to the manufacture and use of plutonium at the time the Prime Contract was signed, in November 1943, it was agreed that unavoidable variances from the initial specifications might exist. After that time, satisfactory agreement was reached on most major points of purity and assay methods, through several conferences and continual contact with the Consumer at Los Alamos, New Mexico, but in 1945 existing specifications for plutonium were revised by a decision to limit enrichment of the uranium metal, to avoid production of undesirable quantities of plutonium-240 caused by excessive irradiation.

4. Operating Problems and Developments. - Several problems which have arisen in plant operation and seem worthy of mention are: the canning of uranium slugs, including the fabrication of the initial charge for the production Piles, the development of extrusion, machining, and canning techniques, and the development of rigid testing methods, such as the "frost test" and the autoclave test, to eliminate the possibility of slug failure within an operating Pile; poisoning of the Pile due to the formation of xenon-135; film formation and corrosion on aluminum surfaces in the Pile; changes in physical properties or atomic structure of the graphite in the Piles due to neutron bombardment; replacement of gaskets in the Separation Plants; reduction of chemical processing time cycles in the Separation Plants; and increasing the production capacity of each Separation Plant to 150 per cent of design capacity. The majority of these problems have been solved in very satisfactory manner and have led to many important developments and improvements in the manufacturing process. For example, studies on film formation and corrosion indicated that deaeration and demineralization of the Pile cooling water were not necessary, and these processes were eliminated, affording a significant saving in materials and manpower. Some of these studies are still being carried on, particularly in connection with the Pile graphite where expansion has become a serious problem, to the extent where future possibilities include inoperability of the Piles. Because of this finding, made clear by such evidence as bowing of process tubes, efforts have been directed toward corrective measures, of which annealing offers one possibility, mechanical alterations another. To offset the probability that all

Piles, if operated simultaneously, will reach the end of operability at the same time, the 100-B Pile was placed in a stand-by condition in May 1946.

Additional waste storage tanks became a necessity toward the close of 1946 as existing facilities gradually filled up with sludge and a by-pass from the 300 Area to empty tanks in the 200 Area was resorted to as an emergency expedient. Bids for a new tank farm were invited and other means for waste storage were under consideration in December 1946.

Blistering of slugs and recovery of uranium metal scrap became problems during 1946. Tests with specially extruded and cast slugs failed to eliminate causes of blistering and experiments went on with slugs fabricated from rolled metal. Scrap recovery, for briquetting and recasting into billets, was necessary to recover all possible uranium metal and, after various methods had been tried, such as shipment in scrap condition and shipment as an oxide, the General Electric Company was requested to study the feasibility of melting uranium scrap on this site.

The Redox Solvent Extraction Process was investigated very thoroughly and appeared very feasible, particularly with the use of substitutes for diethyl ether, such as hexone (methyl isobutyl ketone). In August 1946 a group was formed for further study, to be assisted by the erection of a four-glass-column demonstration unit, which, if successful, would lead to design and construction of a hot semi-works on the Hanford site.

A development of recent months, as an aid to other Manhattan installations for study of medical applications, was the arrangement whereby many radioactive isotopes were made available. These samples were supplied on the basis of Hanford Request Numbers and included neptunium-237, thorium, uranium-233, uranium-238, beryllium oxide, samarium oxide, gadolinium, radium, lithium fluoride, thallium nitrate, calcium, and phosphorous.

5. Operations Record. - The initial start-up procedures for the individual units followed the same general pattern. After construction was complete, the construction forces were assisted by operations supervision and personnel in testing, run-in, calibration, and identification of all process equipment and instruments. Then the unit was turned over to the Operations Division and processing was begun gradually. In the Pile Areas there was a great deal of preliminary work done in preparation for start-up, including production forecasting, nuclear physical and heat transfer studies, and preparation of Operating Standards and Operating Procedures. Actual start-up operations began with the charging of dummy slugs into the cooling tubes of the Pile. Uranium slugs were then charged, with no water circulating, to the point where the chain reaction began (dry critical) and charging continued, with water flowing, until the chain reaction was re-established (wet critical). After charging to the wet critical point, the control mechanisms were carefully checked, and the Pile power was gradually increased, over a period of time, to full rated capacity. In the start-up of the first Pile, the phenomenon of xenon poisoning was first noticed, and it became a significant delaying factor. In the Separation Areas, operation was begun in fixed

steps: (1) water runs were made through the processing equipment; (2) process chemicals were added for a second series of runs; (3) trial runs were made through the entire process, using metal that had not been subjected to the Pile process ("dead" metal); (4) dead metal runs were made using tracer quantities of radioactive materials; and (5) normal operations were begun, using Pile metal at increasingly higher levels of enrichment.

The significant developments in plant operation are listed below:

a. <u>1944</u>

1. — Charging of 100-B Pile started.
   — 100-B Pile placed in operation; xenon poisoning discovered.
   — First discharge of enriched uranium slugs from 100-B Pile completed.
   — First enriched slugs received in Lag Storage (200-N) Area.
2. — Charging of 100-D Pile started.
   — 100-D Pile placed in operation.
3. — First Hanford enriched slugs dissolved in Separation (221-T) Building.
4. — By close of year, all Separation (200) Areas and Buildings turned over to Operations forces.

b. <u>1945</u>

1. — Isolation of first Hanford plutonium started in Isolation (231) Building.
2. — First plutonium resulting from Hanford operations

transferred to the Area Engineer, thus establishing Hanford process from raw material to finished product.

3. -- 100-B Pile reached rated power level of 250 megawatts; test purge on process tubes to combat film formation was successful.

4. -- First Hanford plutonium transferred to representative of Consumer; assay proved results satisfactory.

5. -- 100-D Pile reached rated power level of 250 megawatts.

6. -- Charging of 100-F Pile started; Pile placed in operation and power level reached at rating of 250 megawatts, reduced to 240 megawatts after 24 hours.

7. -- First discharge of enriched uranium slugs from 100-D Pile.

8. -- On 31 March 1945, construction of Hanford Engineer Works declared completed.

9. -- Plutonium specifications set at two conferences.

10. -- Metal Fabrication and Testing Area began extrusion of uranium rods; stripping and recanning of unbonded slugs started on small scale.

11. -- Manufacture of polonium started with charging of bismuth slugs in 100-B Pile.

12. -- Construction of fish laboratory completed, to permit observation of the effects effluent water has on fish life.

13. -- Plutonium shipped to Metallurgical Laboratory for analysis of heavy isotopes.

14. — Blistered slugs discovered.

15. — Increase in decay period set from 35 to 60 days.

16. — Determination made of critical mass of plutonium for separation processing.

c. 1946

1. — 100-B Pile shut down and readied in stand-by condition, 19 March - 6 May.

2. — Expansion of Pile graphite measured.

3. — General Electric Company assumed operation 1 September 1946.

4. — New waste storage facilities decided necessary, invitations to bid sent out.

5. — Experiments started on blistered slugs.

6. — General Electric Company submitted estimate on expected life of Piles (See "Top Secret" Appendix).

6. Procurement of Materials. - Procurement of materials was complicated early in the operating period by the fact that the manufacturing process was not well enough established to permit definite procedure, and throughout the operating period by the remoteness of the Hanford Engineer Works from the centers of chemical industry. Standard procurement procedures were soon evolved, however, making use of the Contractor's Wilmington Office for procurement on a yearly requirement basis, and of the Area Engineer's and Contractor's agencies on the Project for field procurement. These agencies operated through vendors normally, and, when a special action was necessary, through the Washington Liaison Office or the War Production Board. Classified

materials, such as uranium metal, were procured by the Madison Square Area of the Manhattan District.

7. Plant Safety. - The plant safety program was operated by the Contractor, under the over-all supervision of the Area Engineer. The methods used were designed to place safety on an individual basis, whereby safety suggestions originated from the operating personnel and were routed to the Central Safety Committee through sectional committees. The Contractor's Safety Division consisted of the Industrial Section, which operated in conjunction with the Central Committee in an advisory capacity; the Community Safety Section, which kept a careful check on community health and sanitation; and the Statistical Section, which kept all records and distributed reports of accidents. Special medical facilities and methods were used in keeping careful check on all employees who were liable to exposure to radioactive emanations or dusts. The success of the safety program and precautions is indicated by the excellent safety record of the plant.

8. Transportation. - The transportation system of the Hanford Engineer Works, consisting of both rail and bus systems for the movement of freight and passengers, was operated by the Contractor under the control and direction of the Area Engineer's Transportation Department. Railroad track and roadbed maintenance was handled by a subcontractor, Morrison-Knudsen Company of Boise, Idaho. In addition, the Area Engineer operated an air patrol for security patrols and special transportation problems, while six-day service was available from a water patrol at Hanford Ferry.

9. Richland Village. - The Village of Richland was constructed

to provide housing and living facilities for the plant-operating personnel. During the period of overlap of Construction and Operation, a portion of the construction force was also accommodated. The Village is operated by the Contractor, under the supervision of the Area Engineer's Community Management Branch, and all normal operating and maintenance services are provided.

Housing was provided in the form of conventional type (permanent) houses and prefabricated houses, which were occupied as rapidly as completed, until by 1946 the peak population of 15,401 was reached. However, as construction was completed, personnel were released and a drop in population resulted until it was possible to surplus many prefabricated houses. Several Pacific Northwest colleges and universities were furnished approximately 200 houses, with approximately 168 more shipped to Los Alamos and Sandia. Dormitory needs declined also, and some buildings were adapted to such needs as Youth Centers, emergency hospital buildings, administration offices, and nursery school. Since the shipment of surplus houses was made, the housing picture has changed due to a forecast of increased employment and, by the end of 1946, additional housing was being planned.

Housing rentals were set at roughly 10% of the cost of the houses, excluding value of the land and cost of roads and utilities serving the project.

Medical, hospital and dental services were made available at the hospital in the Village, while services comparable to those of a city department of sanitation were performed with respect to inspections of schools and business houses. Mosquito control was recognized as a medical problem because of the presence of anopheles mosquitoes, coupled with the fact that some residents were veterans with service in the malarial areas of the tropics.

School facilities were provided from the pre-school (nursery) level through high school, although rapid growth of the population outstripped the physical plants and forced use of emergency buildings. Lanham Act funds were added to state and county funds for the years of 1944-45 and 1945-46 to aid school administration, which was under the laws of the State of Washington and supervised by the County Superintendent of Schools.

Nearly all religious denominations were represented in Richland and accomodations of some sort were made available to all. Two churches were constructed, existing buildings were remodeled for church use, and school facilities were utilized, particularly for Sunday School groups. Requests have been received from some groups relative to private construction of churches and a parochial school.

Village transit problems were minimized by establishment of a regular government-owned bus transportation system, at a five cent fare and with transfer privileges to connecting buses. Police and fire protection was provided and the Village record with regard to crime, juvenile delinquency and fires is excellent.

Basic requirements for commercial facilities were provided, wherein operators were appointed on strength of competitive bids, business background, and current source of supply. Each concessionaire provided his own mobile equipment, while the government supplied all stationary equipment.

10. Real Estate. - At the end of 1945, 280 tracts of land, some of which were unimproved desert land owned by the State of Washington were still in condemnation and several cases were pending in both fed eral and state courts. One state highway was condemned and litigatio is under way concerning compensation for relocation; county roads, al condemned, had less justification for compensation but the cases were also brought to court.

The Bureau of Reclamation requested authority to survey a canal right-of-way on government-leased land (the Wahluke Slope) at the northern end of the project. This area is planned by the bureau as a important portion of the Columbia Basin Irrigation Project and an ear decision has been requested as to disposition of the Wahluke Slope.

The Richland Cemetery was acquired by condemnation and title re-vested in the new town of Richland, to be run by a cemetery associati financed by monies from the treasury of the legally dissolved old tow of Richland.

11. Military Intelligence. - Activities of the Military Intelli gence Division continued, during operations, along the same lines as during construction, although post-bomb publicity made necessary cer-tain tightening of security. The responsibility for protection again espionage and sabotage and for safeguarding of classified information rested with the Contractor, and the Military Intelligence Division maintained constant liaison with Contractor Security Division. Close coordination was necessary with the Federal Bureau of Investigation a other agencies, in some cases, calling for joint action.

Safeguarding of Military Information was a responsibility of the

Contractor's Security Division but, as in other phases, was handled a a divided function, the Military Intelligence operating on problems a procedures for government activities and personnel. The program was handled by application of AR 380-5, use of signboards, posters, lectures, and films, and corrective action against violations of the Security Regulations.

Personnel clearances were necessary on all contractor, facility, and government personnel, with the Contractor's Security Division and the Military Intelligence Division handling respective shares of the cases. Further investigation in the event of disclosure of subversive activity became the responsibility of the Military Intelligence Division.

Shipment of the product was handled, from a security standpoint, with an escort of Military Police, heavily armed, travelling without layover by government automobiles from Hanford to destination. Later revision of this procedure substituted a special railroad car for automobile convoy.

12. Communications. - The telephone system for Hanford Engineer Works was built by the Signal Corps with Pacific Telephone and Telegraph Company aid, designed jointly by the Prime Contractor and the Signal Corps. Operation and maintenance of the system was a responsibility of the Contractor, who supplied services to residents and business houses, as well as facilities for long distance outlets. Manufacturing area telephone service is now by means of dial type operation, while plans for conversion to dial type for the Richland Exchange were under discussion at the end of 1946. The telegraphic system was

comprised of a teletype printer in connection with the Army Network, a TWX with code equipment, and a printer circuit for Western Union messages between the local office and the Richland Message Center.

13. Public and Labor Relations. - The Public Relations Office w concerned, prior to the atomic bombings, with virtually complete suppression of Project news, but a switch was made to an "all out" campaign of aid to news outlets which developed their own stories based upon open community affairs, award events, and anniversary celebratic Direct releases from the office were items of general interest, such Manhattan District activities, changeover of contractual arrangements from du Pont to General Electric, and the Atomic Energy Commission.

Labor relations activities were very limited during the operatic phase. Attempts to organize for collective bargaining came to a halt when the unions acceded to the War Department's request that such org isational attempts be withheld until security permitted.

14. Property Accountability and Disposal. - The Area Engineer's Property Branch was set up to dispose of excess construction property and to handle the functions of procurement, inventory, storage, issuance, and record maintenance of operation's property.

Excesses at Hanford Engineer Works were shipped to Little Pasco Engineer Distribution Depot for disposition to War Assets Administration. In August 1946, Little Pasco was transferred to the Pacific Division, U. S. Engineer Department, and excesses shipped after that date were handled through the War Assets Office in Helena, Montana, and later through WAA at Pasco Army Service Forces Depot.

Following a property audit by District Office representatives, t

Property Branch was reorganised as an independent unit under the direction of Captain W. J. Morrell as Accountable Property Officer. Sections were activated to handle records, audit and inventory, excess disposal, and stock issue control, while warehouses previously operated by the Property Branch were closed and stocks turned over to the Contractor, to be issued on requisition only.

15. Demolition of Hanford Camp. - Following the abandonment of Hanford Camp in February 1945, no further need was felt to exist for the facilities in the camp and a contract to demolish the greater part was awarded, the successful bidder being the Mohawk Wrecking and Lumber Co. of Detroit. The work was to be completed in twelve months and was substantially completed by the end of 1946 with the employment of a crew, ranging from 88 to 363 men. Injuries on the job were held to a minimum, the majority being puncture wounds, contusions, and abrasions. The principal items salvaged by the Contractor were lumber, plasterboard, pipe, and fittings, all of which found a ready sale.

16. Legal Aspects of the Management and Contractual Changeover. - The new contract, written for the General Electric Company to replace the du Pont Company, was essentially the same type of cost-plus-fixed-fee contract, and other agreements such as insurance and workmen's compensation, were written with substantially the same provisions as with du Pont. The General Electric Company will handle its own compensation claims, as well as any arising for the period when du Pont was the Contractor. Since the Atomic Energy Commission, upon accepting the transfer of all property under the jurisdiction of the Manhattan District, announced a policy of continuing existing policies and

procedures, there were no apparent results of both changeovers.

17. Costs. - Cost accounting methods were standardized along th lines followed by the Contractor, with certain modifications to confo with general cost accounting methods in use by the Corps of Engineers Cost tabulations and graphs have been prepared which indicate a futur monthly operating cost of approximately $2,800,000.

18. Organization and Personnel. - The operation of the Hanford Engineer Works is performed by the Contractor's Organization under th supervision of the Area Engineer. Plant operating personnel were pro cured principally through the efforts of the Contractor. Training of key personnel was accomplished at the Metallurgical Laboratory, at th University of Chicago, and Clinton Laboratories prior to the construc tion of the Hanford Plant, and on the Project during construction and Plant start-up. The Area Engineer's organization, directed until Feb ruary 1946 by Colonel F. T. Mathias as Area Engineer and Lt. Colonel R. T. Rogers as Deputy Area Engineer, was headed subsequent to that d by Lt. Colonel Frederick J. Clarke as Area Engineer and composed of Engineering & Maintenance, Administrative, and Production Divisions. Prior to 31 August 1946, the du Pont organization, under W. O. Simon, Works Manager, and R. K. Mackey, Assistant Works Manager, contained s main branches--the Production, Technical, Service, Engineering, Medic and Accounting Departments. On 1 September 1946, the General Electri Company took over as operating contractor, with the organization, und direction of D. E. Lauder, Works Manager, and G. G. Lail, Assistant Works Manager, containing such departments as Production, Technical, Service, Engineering, Medical, and Accounting, as well as a Design &

Construction Department.

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 6 - OPERATION

SECTION 1 - INTRODUCTION

1-1. Objectives. - The objectives of Hanford operations are the manufacture and delivery to the Los Alamos Project of sufficient quantities of plutonium and secondary products in time to meet military requirements adequately, at the lowest cost of manpower, money, and materials commensurate with the maximum degree of certainty of successful operations.

1-2. Scope. - The large-scale manufacture of plutonium entailed the following specific functions:

1. Fabrication and preparation of uranium metal for processing.
2. Production of plutonium from the uranium by controlled nuclear processes in chain reacting Piles.
3. Separation of plutonium from the parent metal and fission products resulting from Pile processing.
4. Isolation, final purification, and delivery of the plutonium.
5. Maintenance and operation of all service functions incident to plant operation, including living and housing facilities.

1-3. Authorization.

a. All action in connection with the institution and

and prosecution of this Project was taken under authority granted by Congress in the Acts which are described in another book (Book I); the funds used were likewise appropriated by Acts therein described.

b. Under the authority vested in him by those Acts, the President of the United States issued orders and authorizations which are described in the same book (Book I).

c. Major General L. R. Groves directed or authorized the general policies and directives under which the Manhattan Engineer District carried out the work. The S-1 Committee of the OSRD and the Military Policy Committee registered their general approval of the basic decisions involved, as recorded in the minutes of meetings or in other documents in the Project files (Book III, Appendix D 1; see also Section 6, Organization and Personnel).

1-4. Elementary Facts of Plant Processes. - The processes developed to produce plutonium, and practiced at Hanford, are described in Vol. 2. However, the following summary is included here to make available the elementary facts which apply specifically to Plant operations.

a. Hanford Process. - Briefly, and very generally, the facts of the Hanford process for the manufacture of plutonium-239 are as follows:

1. Metallic uranium is surrounded by graphite in the Pile.
2. Present at random in the system, and emitted continually from the uranium, are sub-atomic particles called neutrons.
3. The structure of the Pile is such that these neutrons

must pass through the graphite, which reduces them to a velocity which permits their absorption by both the uranium-238 and uranium-235, resulting in:

a. The formation of the new chemical element plutonium-239;

b. The destruction of the uranium-235, accompanied by the formation of a number of highly radio-active by-product chemical elements;

c. The emission of neutrons slightly greater in quantity than those absorbed; and

d. The evolution of large quantities of heat approximately equivalent to the burning of 3,000,000 pounds (1500 tons) of coal for each pound of plutonium formed.

4. The uranium is stored to permit decay of highly radioactive fission products and complete formation of plutonium.

5. The plutonium is separated from associated uranium and fission products, and isolated from impurities.

b. Chain Reaction. - The slight gain, or multiplication, in neutrons which accompanies the destruction of uranium-235 is the primary factor which makes the Hanford process possible. This process of neutron multiplication and use is what is commonly called a chain reaction. The quantity of neutrons present in the graphite-uranium structure at any instant must be controlled. If an excess of neutrons is absorbed other than in the uranium-235 (in the formation of an excess of plutonium, is very great. The energy of radiation within each Pile at rated capacity is roughly equivalent to that which would emanate from 3,000,000 pounds of radium. The total amount of radium isolated prior to the outbreak of the war was less than one-millionth of this amount. It is of the utmost importance that these very penetrating radiations be confined adequately so that operating personnel may work in safety. Thus the Piles and all other processing apparatus in which these radiations are present are provided with massive shielding of various materials such as special masonite, iron, steel, concrete, water, and lead, depending upon the specific requirements to be met.

f. Detection of Radioactivity. - The magnitude of these radiations, and the serious consequences with respect to persons exposed to them, make it also of the utmost importance that adequate precautions ~~are~~ be taken to determine their presence, and to maintain records of stray radiations and the degree to which persons have been exposed to them. This is necessary for the protection of all personnel in the manufacturing areas, as well as all inhabitants within a radius of some fifty miles. Monitoring stations have been situated at appropriate locations within the required area to provide records of such stray radiations. These records can be produced as evidence in any possible future legal actions against the Government. The precautions taken require a staff of highly trained technicians, equipped with special instruments for detecting, measuring, and recording the intensities of the various radiations.

g. Secondary Products. - In addition to plutonium, a quantity of radioactive polonium is manufactured. This is accomplished by exposing metallic bismuth to the Pile reactions. The polonium resulting from this exposure possesses properties which are required for other Manhattan District work (See Book VIII). After the required period of irradiation, the bismuth slugs enriched with polonium are discharged from the Pile and prepared for delivery to the Los Alamos site.

SECTION 2 - DESCRIPTION OF PLANT OPERATIONS AND FACILITIES

2-1. General. - The operating plant of the Hanford Engineer Works is composed of the Metal Fabrication and Testing (300) Area; the three Pile (100) Areas; and the two Separation (200) Areas, containing three Separation Plants; and the service and housing facilities necessary to plant operations and personnel (See Vol. 3). The manufacturing areas are described in this section in the order given, to agree with the flow of process materials through the plant. Description of the service and housing facilities will be found in Volumes 3 and 5 of this history.

2-2. Metal Fabrication and Testing (300) Area. - Metallic uranium, in the form of billets about 4½ inches in diameter and 12 to 20 inches long, is received from suppliers under the jurisdiction of the Madison Square Area of the Manhattan Engineer District (See Book VII). In the Metal Fabrication and Testing Area (See App. A 20-22), this metal is prepared for use in the Pile units.

a. Extrusion (See App. A 1). - The billets are heated in a furnace, in an inert gas (argon) atmosphere, to a working temperature of about 1700 degrees Fahrenheit. They are then extruded through a die, by means of a high power hydraulic press, into rods about 1½ inches in diameter and an average of about 12 feet in length.

b. Outgassing. - The rods receive a preliminary straightening manually, are quenched in water, and are then outgassed by heating the rods in an argon atmosphere. The outgassing is performed to remove hydrogen from the metal, to prevent formation of gas pockets or a bulky

[redacted]

chemical compound of uranium and hydrogen, either of which might result in serious difficulties in Pile operations.

c. Straightening. - After outgassing, the rods receive a final straightening in a mechanical device and are then ready for machining.

d. Machining (See App. A 2). - The rods are machined in turret lathes into pieces, called slugs, each 1.359 inches in diameter and 8 inches long. After inspection to assure that there are no serious defects which would adversely affect Pile operations and to make certain that the slugs are within the dimensional limits of tolerance, they are given an acid bath for removal of scale and a treatment for the removal of any grease which may be on the surfaces.

e. Canning Requirements. - The next operation is the vital one of coating and "canning" each slug. The "canned" slugs must meet the most rigid requirements with respect to materials and tightness. The materials of which the "can" is made must have a very low absorptive capacity for neutrons; they must possess a high resistance to corrosion by the action of water; and they must be able to transmit the tremendous amount of heat generated in the uranium slug to the surrounding cooling water. The only materials, now known, which meet these requirements satisfactorily are aluminum and an aluminum-silicon alloy. Because the uranium is very reactive with water, the can must be perfectly tight and bonded. A burst can could readily stop the flow of cooling water and require that the Pile be taken out of service immediately; it is conceivable that the failure of a single canned slug would necessitate the complete abandonment of an entire Pile Area.

[redacted]

j. Autoclave Testing. - One final, drastic test is appli to each slug. This consists of exposure to steam at a pressure of about 100 pounds per square inch for forty hours (See Par. 4-2). Ca ning quality has been such that less than one failure occurs for eac 2000 slugs surviving previous inspections and tests.

k. Quantity Requirements. - The magnitude of the uranium fabrication and canning processes is indicated by the following requi ments: (1) approximately 20,000 billets were required to produce th canned slugs required for the initial charging of the three Piles (Se Par. 4-2); (2) approximately 2100 billets are required in producing canned slugs required for normal replacement each month after equilib rium conditions have been reached in Pile operation.

l. Slug Recovery. - Canned slugs rejected from the cannin process are sent to the Recovery Operation for reclamation of the ura nium. In this process the can and bonding layers are removed from th slug by dissolving them in a mixture of caustic soda and sodium nitr followed by immersion in hydrofluoric acid and a final wash with nit acid.

m. Other 300 Area Facilities (See App. A 25-28). - The Metal Fabrication and Testing Area also includes the following facili ties: (1) office, library, and laboratories for scientific and tech- nical personnel engaged in furnishing necessary assistance to all phases of Hanford operations; (2) a Test Pile for determining the neu tron absorption or emission properties of all materials, such as grap ite and uranium, used in the construction or operation of the manufac turing Piles; (3) semi-works for investigating problems arising in th separation and isolation of plutonium from the uranium and fission by product elements; (4) special shops and facilities for manufacturing, repairing, modifying, and calibrating the many types of electronic an other instruments required in the manufacturing processes and safety surveys; (5) a Standards Building for storage and use of the radium a radium-beryllium sources required for calibration of the special instruments, which also houses a small, special Pile for calibration pu poses; (6) miscellaneous service facilities, such as steam and water supply.

2-3. Pile (100) Areas.

a. General. - There are three Pile Areas for manufacturin plutonium, designated as 100-B, 100-D, and 100-F Areas (See App. A 29 and Vol. 3). Each of the Pile Areas occupies about 685 acres of land Within each of these areas, the Pile is the focal point toward which activities and auxiliary processes within that area are directed. Th auxiliary manufacturing facilities of these areas include several mai features, the most important of which is an unfailing supply of large quantities of extremely pure and precisely treated water. The three areas are identical in design except for differences in the water pur fication and refrigeration systems. In each Pile Area, a river pump house supplies water from the Columbia River to two storage reservoir totalling 25,000,000 gallons capacity. The water is then treated to meet th rigid requirements of the process, which demand almost complete freed from corrosion and film formation, on the surfaces of the water cooli tubes and the canned uranium slugs in the Pile. The facilities for water treatment include equipment for filtration, demineralization (f

100-D Area only), deaeration, and chemical addition. Refrigeration facilities for a part of the water are provided in the 100-D and 100- Areas to increase the power capacity of the Pile during the warm mon when the river temperature rises. After passing through the Pile, th water is held in retention basins to allow decay of short-lived radi activity before the water is discharged back into the river. In addition to the water, helium is circulated through the Pile. A helium storage, purification, and circulation system is provided for each Pi Steam power, high-voltage electrical power, shops, storerooms, labora tories, and offices are also included in the facilities for each Pile Area.

b. Pile Operations. - With emphasis on operations, these facilities are described in somewhat greater detail as follows:

(1) Pile Structures. - Each Pile is a heat-producing unit (See Par. 1-4) designed to liberate the heat equivalent of 250 megawatts or approximately that which would be released from the burn of 850 tons of coal per day. Within the Piles, the uranium slugs are subjected to the bombardment of neutrons originating from the fission of uranium-235, which results in the transmutation of a small portion of the uranium-238 to the product, plutonium-239. The Pile consists essentially of a block of exceptionally pure graphite about 36 feet w by 36 feet high by 28 feet long. From front to rear this block is pierced by 2004 holes in which are located aluminum tubes (See App. A 32, 33). The canned uranium slugs are charged into the aluminum tube and rest upon two ribs located at the bottom of the tubes (See Vol. 3) This design permits the cooling water to pass through the annular spa

between the slugs and the tubes. The graphite block rests upon a massive concrete foundation and is surrounded on the four sides and the top by shielding approximately five feet in thickness, comprising about one foot of water-cooled cast iron and four feet of steel and special masonite arranged in alternate layers. The shielding at the front and rear faces is pierced by holes, matching those in the graphite, for the cooling tubes which protrude through the shields and are connected to an intricate system of piping which, in turn, is connected to the water supply and discharge systems (See App. A 4, 5). The connections are such that refrigerated water can be passed through the central, or hot-test, zone and unrefrigerated water through the outer zone of the Pile. The sides and top of the graphite and shielding contain additional holes for insertion or withdrawal of the neutron-absorbing control and safety rods and for special test purposes.

(2) <u>Charging and Discharging Operations.</u> - Plutonium is continuously manufactured and the amount present is dependent upon the amount of heat developed (the power level at which the Pile is operated), the length of time the uranium slugs are in the Pile, and, for any specific slug, its location within the Pile. The Pile is taken out of service by insertion of the shim rods when slugs enriched with plutonium are to be discharged. Charging and discharging are performed simultaneously; as the new canned uranium slugs are charged, or pushed, into an aluminum cooling tube, the enriched slugs are forced out the other end, falling freely onto a neoprene mattress and thence into the water of the discharge storage basin. The discharge face of the Pile is evacuated of all personnel during these operations because of the

intense radioactivity. The water in the basin is sufficiently deep t shield the working area above the surface from any radioactivity ema- nating from the discharged slugs. After discharging, the slugs are sorted under water manually by the use of long tongs, placed in spec buckets suspended from an overhead monorail system, and weighed (See Vol. 3). The buckets are then placed, by means of specially designe apparatus, into a lead-lined, water-cooled cask and transferred to th Lag Storage (200-North) Area on a special railroad car (See Vol. 3).

(3) Plutonium Accountability. - It has been stated th the total amount of plutonium manufactured is determined by the powe level, time of irradiation, and location within the Pile. The histo of each of the approximately 70,000 slugs in each Pile relative to those statistics is kept by means of automatic card indexing machine This permits ready selection for discharging of those tubes which con tain the most desirable amount of plutonium.

(4) Helium System. - Helium is circulated through th Piles to provide within them an atmosphere of high thermal conductivi and low neutron absorption. The high thermal conductivity of helium assists in maintaining lower temperature differences between the many energy-absorbing parts in the Pile. In addition, the helium serves t pick up moisture and small amounts of decomposition products which ma be present in the Pile. The main components of the helium system (Se App. A 6, 34, 35) are: the circulation system, which includes the Pi the drying system; the purification units; and the storage facilitie The helium is dried by first cooling and then absorbing entrained moi ture on silica gel, which is reactivated by passing heated helium ove

it (See App. A 7). Three complete drying units are provided, so tha
two units can be placed on alternate drying and regeneration cycles
while the third is available as a spare. Purification of helium is
accomplished by absorbing the impurities from the compressed, cooled
gas on activated charcoal (See App. A 8). The charcoal is regenerat
by passing the gas through it under a vacuum. All helium circulated
through the Pile is filtered and then passed to a duct which enters
Pile through the foundation. The gas is distributed along the face
the Pile by means of a horizontal manifold, passing through the offs
spaces of the front thermal shield blocks and then through channels
the graphite, or around the Pile in contact with the side, top, and
base thermal shielding, and then through the rear thermal shield int
collecting manifold and duct in the foundation (See App. A 9).

(5) Pile Controls. - The three types of controls use
in the Piles are designated as regulating rod, shim rod, and safety
control (See App. A 36-38). All controls are equipped to be operate
either manually or automatically.

a. Regulating Rods (See Vol. 3). - Two water-cooled, boron-coated regulating rods are provided continuously to co
trol the Pile power output. Boron is used because of its high neutr
absorption cross section. Only one of these rods is used in normal
oration, the other being held in reserve.

b. Shim Rods (See Vol. 3). - Seven rods, identi
in construction with the regulating rods, are designated as shim rod
They are used in continuous control of Pile power, although the fine
control is accomplished by means of the regulating rods. They were

[redacted]

designed principally for use in stopping the Pile reaction for chargi and discharging operations.

e. Safety Rods (See Vol. 3). - There are 29 bor steel safety rods provided for additional use in case of emergency. These safety rods are also used in stopping the Pile reaction during charging and discharging operations since it has been found that the shim and regulating rods alone cannot slow the reaction sufficiently. The safety rods, designed to drop by gravity into the Pile when released, are suspended over the Pile during normal operation.

(6) Instrumentation and Control Systems. - The Pile process is of such nature that operation would be impossible without instruments which measure accurately conditions existing at points within the Pile and at other remote and inaccessible locations. All Pile control operations are conducted from a central control room (Se App. A 39-43). The operator is seated in front of the main control panel where he may observe readily these instruments which keep him constantly informed of power level, minute deviations from operating power level, control rod positions, and the identification of any of eight conditions (See App. B 1) which have either automatically inser ed the control or safety rods into the Pile or which require investigation (See Vol. 3). The operator also has immediately at hand the switches for adjustment of control rod positions and for emergency ma ual insertion of the control and safety rods. Four additional instru ment panels are provided in each Pile control room, furnishing import information relative to some 5000 individual conditions of the Pile the contributing auxiliary processes. For example, the water pressur

at the inlet of each of the 2004 Pile cooling tubes is indicated on c panel and these instruments are so constructed and connected that a previously determined deviation above or below the standard pressure causes the nine control rods to be driven instantaneously into the Pi stopping the reaction. The exit water temperature of each of the 200 tubes may be measured automatically at sufficiently frequent interval to assure safe operation. Other panels furnish information relative total water flow, water supply pressures, the functioning of the heli system, radioactivity in various parts of the building, and many othe important conditions. Other important instrument and control centers are located within each Pile Area in the boiler houses, and at variou points in the water supply, distribution, and treatment systems.

(7) Removal of Heat. - More than 90 per cent of the h developed is in the uranium and is transferred through the slug jacke directly into the cooling water, raising its temperature. Most of th remainder of the heat developed is from the bombardment of the graphi by neutrons; a small amount is developed in the shields. Normally, more heat is developed and more plutonium manufactured in the central tube of the Pile than in any other; the central tube is approximately twice as effective in heat and plutonium production as the average tu the outer tubes are less effective. If an abundance of neutrons is available, this distribution of heat can be adjusted somewhat by a pr ess known as "poisoning," in which neutron-absorbing slugs are interspersed within the Pile so as to reduce the heat developed in the central tubes and permit more to be developed in the outer tubes. This i desirable because the exit water temperature of the hottest tube is

limited to approximately 65 degrees Centigrade, or 149 degrees Fahren heit, for a number of reasons, including a factor of safety below the boiling point of water, and because serious corrosion of the aluminum surfaces takes place at higher temperatures. The cooling water syste is so designed and operated that 30,000 gallons per minute are pumped through the tubes and around the uranium slugs of the Pile. This qua tity is more than would be required if each tube of the Pile generate the same amount of heat and if a higher exit water temperature could tolerated. The total amount of water pumped through the three manufa turing Piles (90,000 gallons per minute) is more than would normally required for a city of 1,000,000 population. Because ordinary water sorbs neutrons quite readily, the total amount of water which may be present in the Pile at any instant is limited to that which will perm sufficient neutrons to avoid capture and continue the chain reaction required by the process. This amount of water, in turn, limits the size of the annular passage through which the water must flow in pass ing through the Pile. This fact has resulted in the most severe heat transfer problem ever encountered and demands almost complete freedom from film formation on the cooling surfaces (See Par. 4-4); this is distinct from the requirement of freedom from corrosion to prevent co tact of water with the uranium.

(8) Water Supply (See App. A 10, 11). - The previousl described control and safety rods function to stop the reaction insid the Pile within approximately two and one-half seconds. However, the Pile will continue to generate heat indefinitely at a gradually reduc rate after shutdown because of the radiations emanating from the

fission by-product elements. At the end of the approximate two and one-half second period, the heat developed will have been reduced to about one-fifth of the operating value and this amount will slowly di minish further. Thus, it is vital that the water supply be unfailin Probably the worst condition resulting from stoppage of the water supply would be a steam explosion requiring complete abandonment of t Pile Area, or if the explosion should be of such violence that the radioactive uranium slugs were scattered over a wide area, a much larger amount of territory would become untenable. The design, construction, operation, and maintenance of the water supply system have been predicated upon this requirement of complete dependability. The requirements are reflected in water storage, distribution, pumping, a control systems and in the duplication of electric and steam power (S App. A 12) in many instances. In addition to the primary process requirements, water is required for condensing the steam exhausted from the many steam turbines driving pumps and other equipment; for coolin water for extremely large refrigeration plants; for boiler feeding; f fire and sanitary requirements; and for other purposes. The magnitud of the operations is indicated by the fact that the combined rated ca pacity of the 40 river pumps is 355,000 gallons per minute, or approx mately the amount required for a city of 5,000,000 population. The f lowing tabulation is a partial list of water pumping facilities for t three Pile Areas:

Service	Number of Pumps	Total Capacit Gallons per Mi
River Pumps	40	355,000
Reservoir Pumps	56	360,000

Filter Plant Pumps	46	175,000
Main Process Pumps	72	108,000

The water treating equipment differs slightly in the three areas. On the 100-D Area has a demineralization system. Only the 100-D and 100 Areas are provided with refrigeration equipment. In other respects t facilities in each of the three Pile Areas are identical.

(a) <u>Pumps and Reservoir (See App. A 44-47)</u>. - Water is pumped from the river by means of 10,000 gallon-per-minute motor-driven, vertical pumps. In addition, steam turbine-driven pump are provided for stand-by service. In each area the water is delive from the river pumps to a 15,000,000-gallon reservoir, from which it overflows into an adjacent 10,000,000-gallon reservoir. From this re ervoir it is pumped to a filter plant. The 15,000,000-gallon reserv is called the emergency reservoir and is kept full at all times.

(b) <u>Filter Plant (See App. A 13, 48-50)</u>. - The 35,000 gallon-per-minute filter plant for each Pile Area (39,000 gpm in 183-D) consists of chemical feeding equipment, mechanical mixing a flocculating chambers, subsidence basins, gravity filters, and two 5,000,000-gallon clear wells for storage of filtered water. In the filter plant, the suspended material present in the water is removed treatment with suitable chemicals (See App. A 51), followed by a sedi mentation period and then filtration through a bed of specially treat anthracite coal, sand, and gravel. Provision is also made for chlori ation of water before and after filtration and for separate chlorinat of the sanitary water supply.

(c) <u>Demineralization and Deaeration (See App. A</u>

[redacted]

52-55). - Of the above described facilities, the demineralization and deaeration plants are not being used. These facilities were incorpor ted in design and construction on the basis of the best knowledge and judgment available at the time. Subsequent research and development relative to film formation and corrosion (See Par. 4-4) provided more satisfactory and lower cost methods for limiting these conditions tha do the demineralization facilities. Subsequent knowledge with respec to dissolved oxygen in the Pile cooling water has reversed the earlie beliefs so that deaeration is now considered undesirable. It is poss ble that accumulated operating knowledge will indicate a future need for the demineralization and deaeration facilities.

1. Demineralization (See App. A 14). - A 30,000 gallon-per-minute demineralization plant is provided in the Pi (100-D) Area to assure distilled water purity, if necessary, and spac was left for similar installations in the other areas. The demineral ization plant is designed to remove dissolved calcium, magnesium, and sodium salts by passing the water through "Zeo-Karb H."* In the proc ess, these salts are converted to their corresponding acids. The aci except for the carbonic acid which is formed, are removed by passing the acidic water through a special material, called De-Acidite.

2. Deaeration (See App. A 15). - Deaerating equipment was provided in each Pile Area to remove dissolved gases, principally oxygen and carbon dioxide, from water at the rate of 30,0 gallons per minute. Deaeration (degassification) is obtained by pass ing the water in a finely divided state through towers in which a vac uum is maintained by means of steam jets. Acid feeding equipment is

provided at these units for adjusting the acid content of the exit water in controlling corrosion. Equipment for feeding other chemical such as sodium dichromate and sodium silicate for corrosion control i also provided (See App. A 58).

(d) Refrigeration (See App. A 18, 57). - Provisi has been made in the 100-D and 100-F Areas for supplying chilled wate to the central portion of the Piles. Approximately 18,000 tons of re-frigeration has been provided in the 100-D Area and 10,000 tons in th 100-F Area.

(e) Process Water Storage (See App. A 58). - All process water is stored in specially designed tanks with floating roo to prevent re-absorption of oxygen. There are four such process wate tanks in each Pile Area. Each tank has a capacity of 1,750,000 gallo and two tanks are normally connected to the chilled water system and the other two to the unchilled system.

(f) Process Water Pumps (See App. A 17, 59). - Th process water tanks feed by gravity to the suction of the process wat pumps which force 30,000 gallons of water per minute through the cooli tubes of each Pile. These pumps are arranged in sets of two in serie Each set consists of one 3,000 gallon-per-minute electric pump and one 3,000 gallon-per-minute steam turbine-driven pump. The motor-driven pumps are provided with heavy flywheels so that they will continue to pump for a number of seconds after an electric power failure. The ti element provided by the flywheels assures a positive flow of water through the Pile while the control and safety rods are being inserted stop the Pile reaction and permits the automatic control systems for t

[redacted]

boiler plant and steam turbine-driven process water pumps to act to accelerate steam generation and water pumping by the steam pumps.

(g) Emergency Water Tanks. - Two 300,000-gallon emergency water storage tanks are connected into the water system to the Pile. In the event of failure of both steam and electric power systems, the water pressure to the Pile will be reduced to the extent that water will flow from these emergency tanks through the Pile. This assures an adequate flow of water through the Pile for a short period while steps are being taken to re-establish the normal flow.

(h) Retention Basin (See App. A 60). - Upon leaving the Pile, the process water is neutralized (by pumping a lime slurry into the discharge header at the Pile) to prevent corrosion of the concrete sewer lines and to protect the fish life of the river, and is carried through a 48-inch concrete line to a retention basin. The retention basin, having a total capacity of 7,200,000 gallons, consists essentially of two reservoirs, separated by an overflow flume. Its hold-up is sufficient to permit decay of the radioactivity which the water has acquired in passing through the Pile before its discharge to the Columbia River.

(9) Power Supply.

(a) Electric. - The primary power requirements for water pumping and other services are supplied (See App. A 61) by a 230,000-volt electrical transmission system connected to the Bonneville and Grand Coulee system. The total connected load of the three Pile Areas is 84,850 kilowatts, of which more than 60,000 kilowatts is used by motor-driven water pumps.

[redacted]

[redacted]

(b) Steam. - A boiler plant (See App. A 62) is provided in each Pile Area to furnish an independent source of power (for heating, necessary power plant auxiliaries, emergency lighting, and certain special process demands) in the event of failure of the main electric supply. However, the amount of steam generating capac and number of steam turbines do not duplicate the electric power capa ity; they are limited to those requirements where less than complete dependability would be disastrous. The combined capacity of the ste generating equipment of the three Pile Areas is 1,200,000 pounds per hour or about that required to produce electric power at the rate of 120,000 kilowatts.

2-4. Separation (200) Areas.

a. Decay Storage. - After discharge from the Piles, the u nium slugs, enriched with plutonium, are transferred to an intermedi underwater storage area, the Lag Storage (200-N) Area (See App. A 63) where it was originally intended that metal at rated levels of enric ment would be held for sixty days of underwater storage. This perio was gradually reduced in subsequent processing to approximately 35 days. During the storage period much of the intense radioactivity i reduced through decay, and formation of plutonium is substantially c pleted. The Lag Storage Area contains three separate storage basins (See App. A 64) equipped with mechanical facilities for handling the slugs while under water.

b. Separation Plants. - After the required period of und water storage, the slugs are transferred in their original buckets, using specially constructed and shielded railroad cars, to one of th three Separation Plants of the Separation Areas (See App. A 55, 66). Each of these plants, designated as 200-T, 200-U, and 200-B, was designed to process plutonium-enriched uranium slugs at a normal rate of thirty tons per month, or a total of ninety tons per month for the entire Separation Area. Through intensive study and development, the processing capacity of each plant was later increased to 45 tons per month. The major steps in the separation and concentration of plutonium are accomplished in these plants. Final isolation in the form of pure product is carried out in a separate building, the Isolation (231-W) Building, which serves all three separation plants.

c. <u>Difficulties of Plutonium Separation.</u> - The fact that plutonium is a new and specific chemical element makes it possible to effect a separation from uranium, and from some twenty-five fission by-products of the Pile operation, by the use of a chemical process. Operation of such a process is complicated by (1) the extremely small amounts of product which must be isolated from gross quantities of the parent uranium, and (2) the intense radioactivity of the by-products present. The relative proportion of plutonium is so small that in some steps of the process the amount present in the solutions (of the order of 0.008 per cent) is actually less than the normal hardness of the water used in preparing these solutions. Because of the radioactivity and its hazard to personnel, a major portion of the equipment must be operated and maintained by remote control behind massive concrete shielding. Because of these factors, the separation process, while not especially complex in principle, has presented a number of unique problems which have had to be met by radical departures from the ordinary

[redacted]

standards of chemical plant practice.

d. Possible Separation Processes. - A number of processes were developed for accomplishing plutonium separation; and when the above-mentioned difficulties are realised, together with the fact tha a large portion of the research and development work was conducted wi amounts of plutonium far below the power of the eye to see even when aided by the most powerful microscopes (See Vol. 2), the results have been truly remarkable. The process chosen for the Hanford Engineer Works, as a result of the intensive research and development work carried on at the Metallurgical Laboratory and at Clinton Laboratori is called the Bismuth Phosphate Process.

e. Bismuth Phosphate Process (See App. A 18, C 1). - The Bismuth Phosphate Process is a wet precipitation method in which the insoluble compound, bismuth phosphate, is used as a carrier medium i separating small quantities of plutonium from large amounts of soluti The principle is analogous to that used in the isolation of radium fr its ores, where the amount of key material is likewise so small that cannot be precipitated directly but must be thrown out of solution in combination with much larger amounts of a carrier substance. After t slugs have been dissolved, a single precipitation is sufficient to se arate plutonium cleanly from the uranium, but an extensive series of further steps is needed to eliminate the associated fission by-produ for the required reduction of the radioactivity to one ten-millionth the starting value so that the product can be handled safely without shielding. This series of steps comprises several bismuth phosphate precipitations with the plutonium alternately in its soluble and insoluble forms. The solubility of plutonium is controlled by adjust ing its valence state through appropriate chemical treatment. During this processing, the plutonium formed in a normal charge of 2000 poun of uranium must be handled in as much as 4000 gallons of solution. These large volumes are reduced in the final steps of the process by shifting to a more efficient carrier medium, lanthanum fluoride. The use of this carrier in smaller amounts makes it possible to dissolve the final purified plutonium-carrier residue in about eight gallons o solution. In this form the material is subjected to a final isolatio treatment in which the plutonium is separated from the carrier, preci itated from the solution as an essentially pure (over 98 per cent) pr duct, and prepared for shipment as a concentrated solution.

f. <u>Basic Operations</u>. - From the standpoint of equipment r quirements and operating techniques, the separation process may be co sidered as made up of six basic operations which are performed consec tively.

(1) <u>Slug Dissolving (See App. C 2)</u>. - In this operati the aluminum cans and bonding coatings which envelop the slugs are first dissolved and separated, after which the uranium with its frac- tional per cent of plutonium and fission by-products is dissolved in strong acid.

(2) <u>Extraction (See App. C 3)</u>. - In this operation, t plutonium is precipitated (with bismuth phosphate carrier) from the s lution of uranium slugs and is thus separated from the uranium and al from a large portion of the fission by-product elements.

(3) <u>Decontamination (See App. C 4)</u>. - This is a serie

of steps which is carried out to reduce the fission by-product elemen by a factor of 100,000 and thus permit further processing to be carri on without the use of massive shielding. This is accomplished by fou successive bismuth phosphate precipitations, with the plutonium alter nately in the soluble and insoluble states, and from which the pluton um emerges in combination with approximately one hundred times its weight of bismuth phosphate carrier.

(4) Concentration (See App. C 5). - This operation serves a double purpose of further decontamination (by a factor of 10 and reduction in bulk by substituting an insoluble lanthanum compound for bismuth phosphate as a carrier medium.

(5) Isolation (See App. C 6). - In this step plutoni is separated from lanthanum by precipitation as the insoluble plutoni peroxide. This compound is converted to plutonium nitrate, the solut of this pure salt is dried to a paste, and the concentrate transferr to the Los Alamos site for further processing (See Par. 5-4).

(6) Waste Disposal. - In the several steps above, la volumes of liquid waste are accumulated which, because of the value health hazard of the constituents, cannot be disposed of by ordinary means. During the dissolving of the slugs a large amount of gas is also evolved, which must be vented to the outside air. These waste products are enumerated as follows:

(a) Uranium. - The uranium has been partially depleted of its power-producing isotope of atomic mass 235. However, national security and economy demand that the uranium be stored for future recovery and re-use when time can be devoted to the work.

(b) Fission By-Product Elements. - Many of the radioactive fission by-product elements are so long-lived and so haz- ardous that disposal into the sandy soil of Hanford, or into the Colu bia River, is impracticable because of its possible effect on water supply and fishing industries.

(c) Gaseous By-Products. - Certain of the fissi by-product elements are in the form of gas so radioactive that diluti with atmospheric air of the order of one cubic foot of the gas to one cubic mile of air is required for safety. These gases are partially diluted before release and are then discharged from tall stacks to as sure adequate dispersal.

g. Quantity of Waste Products. - The liquid waste product which amount to about 18,000 gallons per one-half pound of plutonium, are placed in large (550,000-gallon capacity) underground storage tan which will permit appropriate action to be taken at a later date. There is a total of forty-eight of these tanks for the three Separati Plants of the Separation Areas.

h. Separation Plant Facilities. - The six basic operation described above are performed in two of the Separation Plants, namely 200-B and 200-T, and the Isolation Building. When it was proved feas ble to increase the processing capacity of each Separation Plant by [illegible] per cent, it was decided to operate only two plants and to keep the third (200-U) in stand-by condition for emergency usage. This decisi afforded a great saving in manpower. Each of the Separation Plants contains the following process buildings (See App. A 67-70): Separa- tion (221) Building; Concentration (224) Building; Waste (241) Dispos

[redacted]

Tanks; and Ventilation (291) Building and Stack. The following proce service buildings are also provided for each Separation Area (See App A 71-74): Tank (211) Farm; Chemical (271) Preparation and Services; Control (222) Laboratories. In addition, the Isolation (231) Buildi (See App. A 75) is provided to handle the output from the three Separ tion Plants. Auxiliary facilities (See App. A 76-81) are provided f the Separation Areas and include area shops, laundry, boiler houses, water reservoirs, filter plants, first aid, administration building, Fire Department, large-scale heat treating facilities and a meteorol ical station. The most important of these are described:

(1) <u>Separation (221) Building (See App. A 82-88)</u>. - T operations of coating removal, dissolving, extraction, and two decon tamination cycles are carried out in the Separation (221) Building, frequently called the "Canyon" because the process cells and piping a located below the ground surface. This building is a concrete struc ture approximately 800 feet long by 60 feet wide by 80 feet high. Fo essential operating considerations are incorporated in its design: (adequate protection of operating personnel from intense radioactivity (2) remote operation of the process equipment; (3) maintenance of pro ess equipment in the presence of intense radioactivity; and (4) flexi bility of arrangement to permit a wide range of process operations wi out major alterations.

(2) <u>Concentration (224) Building (See App. A 89-91)</u>. As soon as the decontamination steps have reduced the radioactivity t reasonably safe level, it is advantageous to transfer operations from the massive shielding of the Separation Building into a more normal t

of structure. There are six working areas, or cells, in the Concentr tion Building. Four of the cells are identical and contain the same standard units as in the Separation Building. No provisions are made for remote maintenance although operation and control of process ste is accomplished from the central operating panels. Three of these ce are used normally for the operations of a third bismuth phosphate pre cipitation in an oxidized solution, and the crossover from bismuth phosphate carrier to lanthanum fluoride carrier. The fourth is equi to be used as an alternate for any of the other three. A fifth cell contains equipment and vessels for transferring process solutions between the Separation and Concentration Buildings. The sixth cell con tains the equipment for the final plutonium concentration before tran fer to the Isolation Building, which entails the metathesis of the la thanum fluoride to lanthanum hydroxide and the dissolution of the lat precipitate in nitric acid.

(3) Isolation (231) Building (See App. A 92-94). - Up on arrival at the Isolation Building, the plutonium, which was originally associated with a ton of uranium in the form of slugs, is contained in approximately eight gallons of solution weighing 79 pounds. Consequently, the equipment for final preparation is greatly reduced size from that required in earlier processing. Vaults are provided i the Isolation Building for receiving the process solutions from the C centration Building and for storing finished plutonium until it is transferred for removal to the Magazine Storage (213) Building (See A A 95). Five cells are provided in which the processing steps of plut nium peroxide precipitation, elutriation, dissolution in nitric acid,

[redacted]

concentration, and drying are performed in stainless steel vessels un der glass hoods. The remainder of the building houses laboratories, offices, ventilation equipment, stockrooms, and other necessary facil ties. Throughout the Isolation Building cleanliness and safety are e phasised because of the extreme toxicity of plutonium. Every conceiv ble precaution is taken to avoid personal contact with the product.

(4) Meteorological Studies. - The radioactive gaseous by-products released during the uranium-dissolving operations were re ognized during early research and development as a potentially seriou operating hazard. Minute quantities of these gases in inhabited buil ings or areas would be sufficient to require cessation of operations and evacuation of personnel. The same conditions, with respect to no mal radioactive impurities from the Pile helium and ventilation sys- tems, exist to a lesser extent in the Pile Areas. These potentially serious conditions demanded that all such radioactive by-products of plant operations be disposed in a safe manner. The method chosen is the medium of high ventilation stacks and fans which discharge the ga eous by-products to the atmosphere 200 feet above ground level. It i essential that adequate dilution be obtained by mixing with the atmos phere above the top of the stacks. Each cubic foot of radioactive ga must be diluted with a cubic mile (over 100 billion cubic feet) of at mospheric air to assure safe conditions. This vast dilution requires that existing atmospheric conditions be known constantly and that at- mospheric conditions in the immediate future be predictable with suff cient accuracy to make certain that dissolving operations, once started, may be carried to completion without creating hazardous

conditions. Climatic conditions at the Hanford site were not known adequately but it was believed to be possible this basin, almost entirely surrounded by ranges of mountains, might conceivably present dead calms or slow wind drifts during some seasons, resulting in entirely inadequate dilution. It was believed possible that slow drift following the Columbia River could create hazardous conditions along its course. Meteorological research was started early in 1943 to provide information relative to atmospheric conditions at the Hanford si The preliminary work consisted of inspections of the site and careful analysis of existing Weather Bureau statistics from those stations closest to Hanford. This work indicated that an elaborate research program was required. Such a program was undertaken, resulting in th collection of a vast amount of data for analysis by a force of expert meteorologists. By November 1944, statistics had been prepared for a full year, which indicated that no complications were to be expected from dead calms or wind drifts. Subsequent work has been devoted largely to verification of information obtained up to that time and t routine forecasting of atmospheric conditions for control of plant op ations. The entire meteorological personnel was required only for a limited time. Routine weather observations are made by regular operating personnel and the scheduling of plant operations is accomplished from these observations.

SECTION 3 - SPECIFICATIONS FOR FINAL PRODUCT

3-1. Contract Requirements. - The Prime Contract (See Vol. 1), signed on 6 November 1943, states that the Contractor shall use all reasonable efforts to produce plutonium which conforms to specifications mutually agreed upon by the District Engineer (as representative of the Consumer) and the Contractor. This stipulation in the Prime Contract was required because the extreme difficulties and uncertainties relating to the manufacture and use of plutonium, at the time the contract was signed, prohibited the incorporation of a rigid specification in the contract or a guarantee that a specification, after being established, could be met explicitly.

3-2. Tentative Specification. - The first tentative specification was furnished by the District Engineer in a letter dated 28 December 1944. This was done as a guide to establish, generally, the requirements of plutonium for the processing steps of the Consumer and to provide early information directed toward elimination of delays which might result from the need for altering processes or equipment.

3-3. First Specification Conference. - The first conference relative to plutonium specifications was held at Hanford during the period 18 to 20 February 1945. The following offices were represented: the Consumer at Los Alamos, the Hanford Contractor, the Metallurgical Laboratory, the District Engineer, and the Hanford Area Engineer. It was reported that the first plutonium received at Los Alamos had redissolved readily and had been assayed at about 99 per cent purity. All impurities were well within the tentatively established limits except for chromium, nickel, and suspended solids. Since it was determined that the amount of chromium and nickel present were not harmful, the tentative limits for these elements were increased. It was suspected that the suspended solids were largely silica which would normally be expected to decrease as Hanford operations became established. It was agreed that a second conference would be held in April 1945, at which time accumulated knowledge should permit a more firmly established appraisal to be made.

3-4. Second Specification Conference. - A second conference was held in Chicago on 27 April 1945. Briefly, the following points were established:

a. Quality. - It was reported by representatives of the Consumer that plutonium quality to this time had been excellent except for the presence of suspended solids.

b. Suspended Solids. - The suspended solids have created filtering difficulties in initial processing and also in subsequent chemical operations at Los Alamos. It was agreed that a research study would be conducted at Hanford, directed toward a determination of the origin of the suspended solids and elimination of these objectionable impurities or their effects. The process step in which the most difficulty has been experienced at Los Alamos was that primarily established to remove zirconium and columbium. Since these elements, together with uranium, are almost completely removed at Hanford, it was suggested that this step might possibly be eliminated at Los Alamos without affecting the final processing and use of the plutonium.

c. Batch Size for Shipment. - It was agreed that the batch size for shipment from Hanford would be doubled per shipping container. This change was effected early in May.

d. Plutonium Assay. - For accounting purposes, it was agreed that the plutonium assay would be determined by radiation counting methods. It was the consensus, however, that a chemical method offered the most reliable determination ultimately, and work on the development of such a method is being carried on at Hanford and at Los Alamos.

e. Plutonium Purity. - It was agreed that plutonium of purity less than 98 per cent would not be shipped.

f. Specific Impurities. - It was agreed that no formal specifications for specific impurities would be established at present, although a tabulation of the normal expectancy of 27 elements was prepared to serve as a guide. It was also agreed that no changes would be made in Hanford processing which might result in deviation from this tabulation without notifying the Consumer. The tabulation of expected specific impurities will be reviewed from time to time as additional information is obtained.

g. Batch Histories. - It was agreed that the Consumer at Los Alamos would be furnished pertinent historical data relative to each batch of plutonium received. This information includes the time and the amount of radiation to which the uranium was exposed in the Piles, the concentration of plutonium in the uranium discharged from the Piles, and the percentage of distribution of the various Pile discharges in each batch shipped.

h. Analytical Methods. - It was agreed to interchange in- formation between Hanford and Los Alamos on matters of mutual concer particularly spectrographic methods for specific impurities and chem cal and radiochemical assay methods, in order to establish standard methods at the two sites.

3-5. Reduction in Enrichment. - The specifications for plutoni were established as information became available on the product de- livered to Site "Y." In August 1945 the decision was reached to limi enrichment of the uranium metal to about 200 grams of plutonium per metric ton of uranium. This step was necessary because further irrad ation, resulting in higher enrichment, produces undesirable quantitie of plutonium-240. Plutonium-240 is formed in the Pile reaction throu the capture of neutrons by plutonium-239.

3-6. Third Specification Conference. - For accounting purposes, the assay of plutonium is accomplished by chemical titration methods and the results applied to carefully checked and rechecked weights of shipping containers and contents. The chemical titration method of assay was adopted at this site in September 1945 in place of the radi chemical method previously used. Since assays of product at Site "Y" indicated that less product had been received than had been reported shipped by this site, a conference of representatives of both sites w held at Hanford on 17-25 April 1946. At this time analyses of identi cal samples were made by chemists from the two sites, using the metho and apparatus of their respective sites; the average results agreed t within 0.03 per cent with maximum difference of about 0.1 per cent. : was believed the discrepancy had been due to inadequate dissolution techniques and non-representative sampling of the product after rece at Site "Y." After improved dissolution techniques had been adopted at Site "Y," a conference, attended by representatives of both sites was held at Hanford in July 1946. Improved correlation of assays wa reported. A program of duplicate analyses has been adapted to both sites, and a careful check has been kept on can weights, with the result that a satisfactory correlation of results at this site and at Site "Y" has been achieved.

[redacted]

SECTION 4 - OPERATING PROBLEMS AND DEVELOPMENTS

4-1. General. - The problems encountered/ during the periods when each manufacturing area was in operation/ were fewer than would normally have been expected in any large industrial plant. This exceptional degree of success may be attributed almost entirely to the high caliber and close cooperation of those persons representing the several responsible organizations in management, scientific advancements, and engineering. The operating problems have been few because potentially serious possibilities were foreseen and adequate provisions incorporated in the plant design to counteract them. However, several important problems arose and are worthy of mention.

4-2. Canning of Metallic Uranium Slugs. - The early research and development work relative to a jacket, or coating, which would unfailingly withstand the severe conditions of exposure within an operating Pile, is recorded in Volume 2. This work effectively determined the approximate conditions and choice of materials for the Hanford process and for substitute processes. However, only the application of mass production methods could establish precisely the permissible limits to which the numerous conditions must be held to assure the minimum possibility of an operating failure. The Hanford process for canning is described briefly in Paragraph 2-2 of this Volume.

a. Fabrication of the Initial Charge. - The fabrication of the initial charge of canned uranium slugs for each of the three production Piles was the responsibility of the Prime Contractor's Construction Division but was primarily a part of actual plant operations.

[redacted]

Briefly, the requirements for these slugs were:

1. The metal had to have a standard of purity rarely obtained in the laboratory, yet had to be produced and fabricated in large quantities.
2. The fabrication had to produce a dense metal slug, free from voids, foreign inclusions, and physical defects such as cracks, seams, laps, and pipes, with the bare metal piece finished to fine dimensional tolerances.
3. The protective coating applied to the slug had to be non-corroding in a water medium, be hermetically sealed to contain the gaseous fission products within the slug and to prevent attack of the uranium by the water coolant, afford efficient heat transmission between the slug and the coolant, and have a low neutron-absorption coefficient.

(1) Metal Supply. - The Madison Square Area of the Manhattan District was responsible for obtaining the large quantities of uranium (See Book VII) which they supplied to the Prime Contractor in the form of billets of pure metal, approximately 128 pounds each. Close liaison was maintained between the Madison Square and Wilmington Areas, both the Prime Contractor and the Metallurgical Laboratory setting up standards of acceptability, rate of metal supply, and handling of scrap materials.

(2) Off-Area Slug Production. - Because of the low power rating of the Clinton Pile (See Vol. 2), requirements of the heat

[redacted]

conductivity between the slug and its jacket, the accuracy of machining, and the soundness of the metal were not as exacting as those pertaining to the pieces to be used in the high-power Hanford Piles. With the Clinton Laboratories development as a precedent, it was considered expedient to produce Hanford slugs by a method following their procedure as closely as possible. As it had better facilities available, the Revere Copper and Brass Corporation was awarded a contract covering the extrusion, outgassing, and straightening of the 1.50-inch diameter rods at their plant in Detroit, Michigan. These rods were machined into slugs by Baker Brothers at Toledo, Ohio. Both of these contracts were temporary and were to be discontinued as soon as the necessary facilities to perform these functions were installed at Hanford. The production of the larger size rods, for use at Hanford, necessitated additional development work on the extrusion operation and some modification of the specifications of metal purity and billet characteristics. In an attempt to produce sounder metal and to improve the yields of rods from billets, a number of large scale rolling experiments were performed at the Joslyn Manufacturing Company at Fort Wayne, Indiana, during the spring and summer of 1944. Some experimental work along similar lines was also done by the Carpenter Steel Company at Reading, Pennsylvania. However, this method of fabrication was abandoned because of the tendency of uranium to develop an excessive number of deep laps and seams in the surface of the rolled bars.

(3) <u>Extrusion and Machining at Hanford.</u> - Extrusion operations at Revere Copper and Brass Corporation were discontinued in November 1944, and begun at Hanford in January 1945. During

[redacted]

the winter of 1944-45 and the spring of 1945, the principal activitie in the Metal Fabrication and Testing (300) Area at Hanford were the re fining of the various stages in the manufacture of a bonded slug. Uranium is difficult to machine in that it is hard, very tough, and h a tendency to build up on the cutting tools. It compares, approximately, to austenitic steels or aluminum bronze in machinability. The chips and turnings produced on a lathe are highly pyrophoric and glow as they leave the cutting tools. Unless constantly flooded with a coolant (20 parts of water to one part of soluble oil), the small accumulations of chips which collect in the lathe-beds frequently bur into flame. Since the glowing chips leaving the tools give off toxic fumes, all machines are hooded.

(4) Hanford Canning Process. - From the summer of 1943 until the summer of 1944, all available technical personnel at Hanford and those under the jurisdiction of the Metallurgical Laboratory at the University of Chicago were striving to develop a suitable canning process for the Hanford slugs. The problem was extremely com plex and only meager progress was made for many months. Various type of plated, cup, and cementation coatings were investigated, all of wh were rejected because of poor bonding or porosity, and the problem re solved itself, early in the spring of 1944, into one of developing a positive method of bonding the uranium slug to the wall of an aluminu can similar to that used for the Clinton assembly (See Vol. 2). The Grasselli Chemical Company at Cleveland finally developed a procedure involving (1) a series of dip coatings on the slug and (2) its final press fit, at an elevated temperature, into a can partially filled

with a molten alloy of aluminum and silicon. The first step in the process involved dipping the slug into a molten bath of an approximately 50-50 copper-tin alloy which heated the slug and gave it a coating of bronze which adhered well to the uranium surface. The hot slug was then dipped into a molten bath of pure tin, followed immediately by a dip into a molten bath of the eutectic alloy of aluminum and silicon. In the meantime, the aluminum can was chemically cleaned, preheated, placed in a steel protective sleeve, which in turn was placed in a heated die on the bed of a vertical press. A small amount of the molten aluminum-silicon alloy, of the same composition as the final dip bath, was poured into the can, and the hot slug and aluminum cap pressed down into the can. The slug displaced the excess molten metal present, leaving behind only enough to fill all voids between the can and the slug. After facing off the cap end, the cap was welded to the can proper by an arc weld under an argon atmosphere. This procedure was extremely complex and required many thousands of man-hours of laboratory time to develop the necessary process controls to make it feasible for large scale operation.

(5) Development of Arc Weld. - The series of resistance welds combined with a crimp, which was developed for the Clinton assembly, was not satisfactory for use on the Hanford slug assembly. During the fall of 1943, the General Electric Company at Schenectady, New York, developed a process for welding aluminum with an argon-shielded arc. Immediately, a section was established at Chicago for the purpose of modifying the General Electric procedure for use on the Hanford slug, and a usable technique was finally developed by them

late in the spring of 1944.

(8) Production of Alternate Charge. - As of June 1944, the canning process had not been developed to the point where i would be used for the production of slugs for the Hanford Piles. Therefore, to prevent a possible delay of the startup of the first production Pile and since it was not known definitely that the bonded slugs would perform satisfactorily in the Pile under proposed operati conditions, an alternate charge of 152 tons of unbonded slugs, canned by a modification of the method used at Clinton Laboratories (See Vol 2) was obtained. This method called for insulating wafers at the end of the slugs and changes due to the difference in size between Clint and Hanford slugs. To produce this additional charge in the short period of time available, the extrusion schedule at Revere Copper and Brass Corporation was increased, using up all available stocks of bil lets. Additional machining facilities were set up at Baker Brothers at Toledo, Ohio, the Pratt Company at Joliet, Illinois, the C. A. Behmerr Company at Springdale, Pennsylvania, and the McKinney Tool Company at Cleveland, Ohio, and a canning procedure was established a the Quality Hardware Company of Chicago, Illinois. These unbonded slugs were placed in an atmosphere of helium at high pressure for several hours and then checked for leaks by means of a mass spectrograph. A very small fraction of the total were found unsuitable for operation. By August 1944, production of satisfactory bonded slugs a Hanford was realized on a sufficiently large scale to render unnecessary further production of the alternate unbonded assembly. By this time, about two-thirds of the alternate first charge had been produce

[redacted]

The facilities at the Quality Hardware Company were dismantled, moved intact to Hanford, and set up again as a stand-by line capable of finishing the first charge, should it be necessary. The eastern machining facilities were cancelled during the summer of 1944, as by this time Hanford facilities were adequate for the requirements of machined pieces.

(7) Slug Production at Hanford. - Hanford production of bonded slugs started during the early summer of 1944 and was accelerated at a very rapid rate. A sufficient quantity had been produced by the middle of September 1944 to charge the first Pile solely with these slugs. A further modification in the canning process was adopted in September 1944, in which the slug was placed into the can manually while it was held beneath the surface of a molten aluminum-silicon bath. This development eliminated many of the troubles incident to the use of the presses and allowed a more economical production of satisfactory canned pieces at a much higher, more uniform rate. However, there was still a great amount of work to be done on the process before it could be considered an established routine procedure. This work was done during the fall of 1944 by the staff at Hanford, and the production of the initial charges for the other two production Piles was accomplished with no serious difficulties.

b. Developments Since Start of Operations. - Canning yields were improved slightly by maintaining more accurate control of the composition and temperature of the bronze, tin and aluminum-silicon baths. As a result of placing the 100-B Pile in stand-by condition (See Par. 4-7), slug production was reduced and, at the end of 1946, tests were

[redacted]

in progress to determine the feasibility of lengthening the usage of the aluminum-silicon canning bath and various solutions used in slug preparation. Some experimental work was done on the use of a lead dip in place of the bronze and tin dip, but this work remained in the experimental stage. Approximately 124 tons of the 152 tons of unbonded slugs prepared as an alternate charge (See p. 4.6) were stripped and recanned by the regular process.

c. <u>Testing of the Canned Slugs.</u> - All slugs were gauged for outside diameter, out-of-roundness, warp, and length and were inspected visually for surface defects. Each slug was subjected to the "frost test" which determines the soundness of the bond. This test consisted of passing a slug, previously cleaned with carbon tetrachloride and sprayed with a nearly saturated solution of acenaphthene, until a smooth white film of the acenaphthene was obtained on the surface of the aluminum jacket, through an induction coil. This produced surface heating only. If the heat induced into the surface of the aluminum can passed through a good bonding medium to the slug, a temperature above 95 degrees Centigrade, the melting point of acenaphthene, was not reached on the surface, hence the acenaphthene remained crystalline and the bonding was sound. If there was a defect in the bonding, the heat induced on the surface was sufficient to melt the acenaphthene at the point of the defect. It was decided that the importance of eliminating the possibility of any slug failure within an operating Pile required a positive method of testing every slug. The autoclave method of exposing each canned slug to steam pressure of 100 pounds per square inch for 40 hours was chosen. The steam penetrated through the

[redacted]

most minute hole and reacted with the uranium, resulting in a burst can. Comparative tests proved that exposure to the steam was much more severe than exposure to hot water at a much higher pressure. In July 1944, the autoclave equipment was ready and the first tests indicated two per cent slug failures. With the production improvements previously enumerated, autoclave failures are now about two per cent of the earlier amount.

4-8. Formation of Xenon-135 (See App. D 1). - Production operations were started in the 100-B Pile at 2248 hours on 26 September 1944, with 901 of the 2004 tubes of the Pile charged with uranium slugs. After making the necessary preliminary measurements at practically zero power level, the Pile power was increased to nine megawatts or 3.6 per cent of rated power level. Shortly thereafter, it became apparent that neutrons were being absorbed somewhere in the Pile at a rate greater than they were being created by the fission of uranium-235. After about eighteen hours of operation at the nine megawatt power level, the reactions diminished to the extent that operations could not proceed and the Pile was taken out of service. After the Pile had been out of service for six hours, the measurements indicated that neutrons were again beginning to multiply slowly and the Pile power was again raised to nine megawatts, at which point it became apparent again that the neutrons were being absorbed at a greater rate than they were being created and the earlier events were substantially repeated. There were numerous possible causes of the parasitic neutron absorption but there was no immediate concrete evidence which adequately explained any of the possibilities. In order to evaluate the

[redacted]

various possibilities, the Pile was again started and the power held at about 2.5 megawatts for six hours, followed by a longer run at 1.7 megawatts. It was determined that continuous operation could be maintained at a power of about three megawatts while the Pile was charged with 901 tubes. From the data collected at this time, and during operations at 90 megawatts in November, the physicists made substantially the following analysis and predictions which proved to be remarkably accurate:

1. The parasitic neutron absorption resulted from the formation of xenon-135 as a fission by-product element. With the time expressed as half lives (the time required for one-half of the amount present to decay to the next element), this is part of the decay chain of: tellurium (2 minutes) to iodine (6.6 hours) to xenon (9.4 hours) to cesium (25 years) to stable barium. In this chain, only the xenon-absorption cross section is about 70 times greater than that of any previously known element.
2. It was predicted that the Pile would be able to operate at the following power levels when the indicated number of tubes were charged with uranium slugs: 14 megawatts at 1000 tubes; 59 megawatts at 1300 tubes; 94 megawatts at 1500 tubes; and 216 megawatts at 2004 tubes.
3. It was predicted that higher power levels than those above would gradually be attained as boron and other impurities with high neutron-absorption characteristics were gradually transmuted during Pile operation to less

objectionable elements; and as plutonium formed in the Pile and some of it fissioned to produce additional neutrons. This prediction was based on knowledge of some other fission by-product elements which would absorb neutrons and thus retard the Pile reaction.

4. It was also pointed out that additional power could be obtained by placing up to 38, instead of the planned number of 32, uranium slugs in each tube of the Pile; by making certain that a minimum of aluminum was present at the ends of the slugs to be charged into the other two Piles; and by carefully zoning slugs in the Piles so that the heavier slugs were in the central portion.

In the early analyses of the possibilities of the Hanford process for the manufacture of plutonium, it was recognized that serious neutron absorption might occur among the fission by-product elements. In all subsequent studies, effort was concentrated on evaluating the various possibilities to the greatest accuracy permissible with the then undeveloped state of knowledge. Thus, even though the effect of xenon-135 was unknown, the possibility of the formation of some element of similar properties was foreseen. If the neutron-absorption capacity of xenon-135 were greater than it is, it appeared reasonable to believe that it would have been discovered during the operation of the experimental Piles at Argonne and Clinton Laboratories (See Vol. 2). In that event, adequate provisions would have been made in the Hanford Piles to counteract it on the basis of accurate knowledge. Through what proved subsequently to have been good judgment, two very important factors were incorporated in the original design of the Hanford Piles; these permitted charging of sufficient uranium slugs to provide a source of neutrons adequate ~~enough~~ to overcome the effect of the xenon poisoning and operating the Piles at, or above, rated power level. The first was the fact that the Piles were constructed with 2004 cooling tubes, rather than the 1500 which were indicated theoretically as being adequate. The second was the fact that nine control rods were designed into each Pile instead of about three which were indicated as being required. The additional control rod capacity proved essential in absorbing sufficient neutrons to hold the Pile safely when starting for the first time, or after a shutdown, when the xenon had decayed to less absorptive elements. On such occasions, the Piles have a far greater ability to accelerate in power than was ever contemplated and are consequently much more hazardous. However, during normal operation the excess neutron-producing capacity was absorbed by the xenon and operations were much less hazardous than had been predicted.

4-4. Film Formation and Corrosion. - Concurrently with the design and construction of the Hanford Engineer Works, a great deal of work was done in developing a means of limiting film formation and corrosion with respect to the Pile cooling surfaces, and for periodically removing any film which might form. Some investigations were conducted by research personnel at the Metallurgical Project (See Vol. 2) and others by the Technical Division at Hanford. Without the successful attainment of these objectives, the Hanford Piles could not operate. The test laboratory at Hanford, called CMX, was built originally to investigate corrosion only, under simulated Pile operating conditions.

However, the formation of film was discovered promptly and became the dominating condition to be controlled. As a result of this work, practicable operating standards were established, prior to the beginning of operations, for the performance of the various water treatment processes and for the final chemical conditioning of the process water by means of the addition of sodium dichromate and sodium silicate. Positive methods were also established for removing the very thin film which formed on the cooling surfaces, through the addition of a scouring agent, "diatomaceous earth,"* to the process water flowing through the Pile. During the early operations of the 100-B Pile, film formation was kept within the limits which had been established. After four months of operation, film had gradually formed to the extent that the pressure drop through the cooling tubes had increased by about 20 to 25 pounds per square inch. The first operating demonstration of the effectiveness of the diatomaceous earth purge was made on 26 January 1945, at which time film was removed successfully from approximately one-half of the Pile tubes. At that time, the purge was limited to those tubes connected to the chilled water system. Film formation, from that time, was controlled by periodic purges of process tubes, and pressure drops through the cooling tubes were never allowed to rise 25 pounds per square inch. The initial charge of uranium into each Pile included certain slugs which had been subjected to extremely careful examination, measurement, and identification. These slugs were discharged from time to time, having received exposures longer than the normal exposures and, by close observation and weighing of the slugs at discharge, it was determined that the average penetration rate was about 0.00004 inches per month while the maximum was about 0.00008 inches per month. Corrosion of the process tubes was most pronounced at the Van Stone flanges but this was not considered serious as yet.

4-5. Graphite in the Pile. - Preliminary research had indicated, prior to start-up at Hanford, that there was a possibility changes might take place in the physical properties of the graphite matrix of the Pile due to neutron bombardment of the graphite atoms (See Vol. 2); this is known as the Wigner Effect. According to the theory of the Szilard Effect, developed later, a further consequence of neutron action, the distortion of the crystalline lattice structure of the graphite atom, might result in an explosive release of energy. Provision had been made for the study of the former, during Hanford operation, by personnel of the operating and technical staffs in close co-operation with the Metallurgical Laboratory, but the Szilard Effect had not been anticipated in the Hanford Piles. Both of these effects were noted in the early Pile tests, and much concentrated study was devoted to the elimination of danger due to their presence. As it was found that the corrective measures taken for the Szilard Effect also retarded the Wigner Effect, study was concentrated on the former. Results of these investigations illustrated that the effects were counteracted by the annealing properties of a low rate of temperature rise in the graphite. Although the Wigner and Szilard Effects in the irradiated graphite have been studied intensively, the emphasis was shifted in recent months to a more serious problem, expansion of graphite due to these effects. It was determined that graphite expands under neutron irradiation in directions perpendicular to the axis of extrusion but not parallel to the axis of extrusion; however, since the alternate layers of graphite blocks in the Pile were placed at right angles and keyed together, the Piles are expanding in all directions. The expansion was most pronounced on the top and far side, as the near side is braced somewhat by the control and rod room walls, and a gap existed between the thermal and biological shields at the charge and discharge faces.

e. <u>Expansion.</u> - During March 1946, an inspection and review of the problem of expansion of Pile graphite was made by General K. D. Nichols, Colonel E. H. Marsden, and Colonel C. W. Beeler of the Manhattan District, and by R. M. Evans, T. C. Gary; F. W. Pardee, Jr., and C. C. Lockhart of the du Pont Company, with the following decisions resulting.

(1) <u>Stretching of Aluminum Cooling Tubes.</u> - Movement of the graphite from front to rear of the Pile is taking up clearance originally incorporated in the design to allow for thermal expansion. When this clearance is taken up, the aluminum process tubes will be placed in tension between the Van Stone flanges located at inlet and outlet ends. This early effect can be corrected temporarily by performing the extensive work required to install longer process tubes.

(2) <u>Tilting of the Biological Shields.</u> - The helium plenum chambers, located at the front and rear of the internal Pile structure, are formed by the space between the cast iron thermal shields and the biological shields, a space maintained by steel pins located on the cast iron blocks. An early effect of graphite expansion is loss of clearance between the ends of the pins and the

biological shield; this will gradually result in the application of a force against the inside of the biological shield and, since the base of the shield is anchored in the concrete base, may tend to tilt the shield outward.

(3) Bowing of Process Tubes. - Dimensional change in graphite is a function of neutron flux and the magnitude of graphite expansion is greatest at the center of the Pile, resulting in bowing of the process tubes. Since the bottom of the Pile is supported by a rigid foundation and the control rod side by a heavy rigid mass of concrete, the amount of tube deflection increases from bottom to top and from the near to the far side. An early effect of tube bowing is likely to be inability to charge and discharge slugs due to the curvature of the tubes; this effect is expected to appear in about two years under present operating conditions (See "Top Secret" Appendix) and could be alleviated temporarily by substituting shorter slugs for the eight-inch slugs now in use. The fabrication and irradiation of four-inch slugs was done on an experimental basis during the latter part of 1946. Some modifications of the standard canning procedure, such as reducing the thickness of the end caps, were necessary.

(4) Bowing of Vertical and Horizontal Rod Thimbles. - The same phenomenon, resulting in bowing of the process tubes, also causes bowing of the aluminum thimbles for the vertical safety and horizontal control and shim rods. If such deflection became sufficient, several problems could arise.

a. The vertical safety rods could be jammed in dropping, thus becoming partially ineffective.

b. The jamming could rupture the thimbles, permitting radioactive gases to escape from the Pile into the building.

c. The horizontal rods could become inoperative.

(5) Stretching of Neoprene Seals. - The neoprene seals, utilized to prevent leakage of gas through the joints between the top and the front, rear, and side biological shields, are becoming stretched. Since rupture of the seals might be an early effect of graphite expansion, they are being replaced as necessary.

(6) Opening of Biological Shield Joints. - The stepped joints between the top and the front, rear, and side biological shields may begin to open; such openings can reduce the shielding capacity to the extent that neutrons, as well as beta and gamma radiation, may escape to the work areas of the Pile Building.

(7) Corrective Measures. - No methods have been developed for halting expansion or for returning a Pile to its original size. In general, the following possibilities have been considered and indicate that the life of the Piles might be prolonged at least to some extent:

a. Annealing. - It is indicated that annealing at elevated temperatures in an inert helium atmosphere has partially restored irradiated graphite samples to original dimensions: 400 degrees Centigrade - 24%; 600 degrees - 45%; 1000 degrees - 94%. Annealing at the higher temperatures would demand thorough investigation of all possible effects due to heating, to insure that no permanent damage would be done, offsetting the gain in dimensions.

b. Mechanical Alterations. - Some effects of graphite expansion will make the Piles inoperable before the maximum permissible limits affecting other factors have been reached. Stretching and bowing of cooling tubes and rupture of neoprene seals are included in this category. Mechanical alterations can be made which will result in reaching most of the limiting effects at approximately the same time. While this would not be a permanent satisfactory solution to the problem, it offers possible methods of prolonging the life of the Piles.

(8) Status, 31 December 1946. - Periodic measurements were made of the bowing of process tubes and the outward motion of the biological shields. The most accurate data available was on the bowing of the process tubes. In October 1946, the traverse of a tube near the top center of the 100-D Pile showed a difference of 2.31 inches in elevation between the high and low points. This difference increased during the past few months at the rate of 0.08 inches per month.

b. Other Effects of Irradiation. - The total stored energy of graphite was found to increase with exposure. Electrical resistivity increased for the first few months of irradiation but remained constant thereafter. The cross-breaking strength and crushing strength of graphite were found to increase for the first 120 megawatt-days per central ton of irradiation but both decreased slightly with continued irradiation and then reached a constant value at 640 megawatt-days per central ton; likewise, the elastic modulus reached a maximum at about 167 megawatt-days per central ton of exposure, but decreased afterwards. Thermal resistivity increased steadily for the first 640 megawatt-days per central ton of irradiation but the rate of increase decreased with subsequent exposure. X-ray studies indicated that the displacement of carbon atoms under irradiation resulted in an increase in distance between the graphite crystal planes at the rate of about 0.0353 Angstroms per 100 megawatt-days per central ton of exposure.

A technical discussion of the Wigner and Szilard Effects and the graphite problem is included in the Appendix (See App. D 2).

4-6. <u>Gasket Replacement in Separation Plants.</u> - Originally, all process pipe flanges were equipped with gasket material which had been developed for use at Hanford. This plastic material (GX) was indicated by research and development work to be the best available for use in a standard flange, based upon chemical and mechanical considerations. By preliminary testing in the Separation (200-T) Plant, the plastic was found to flow, in some instances, under impact wrench operation on the specially designed flanges in the Separation Building. The Technical, Design, and Operating Departments at Hanford reviewed technical work done in research and development on gasket materials and decided to replace the gaskets in the Separation Buildings with another material (G-9), Blue African Asbestos, which had been used at Clinton Laboratories. The gasket material was not changed in the Concentration Building, as standard flanges were used there.

4-7. <u>100-B Pile.</u> - The limited life of the production Piles, because of expansion of the graphite, resulted in a decision to place one Pile in stand-by condition. This decision was reached during the visit of General K. D. Nichols and Dr. R. M. Evans in March 1946 (See Par. 4-8) in order to avoid the possibility that all Piles attain maximum permissible limits of expansion during the same period. In conformity with this decision, the power of the 100-B Pile was reduced from 225 to 150 megawatts on 14 March for experimental purposes; on 15 March, the power level was reduced to 0.5 megawatts for continuation of the studies. On 19 March, the Pile was taken out of service for an indefinite period but was held in a stand-by condition. Measurements continued to determine as precisely as possible the internal condition of the Pile and to furnish data on which subsequent recommendations might be based. The work necessary to place the Pile in stand-by condition was essentially completed on 6 May 1946. On 16 October 1946, proposed plans for placing the 100-B Pile in operation, whenever operation of this unit might be desired, were submitted by the General Electric Company (See App. D 3).

4-8. <u>Separation Plant Schedules.</u> - As a result of placing 100-B Pile in stand-by condition, the Separation Plants operated on a reduced schedule beginning in the summer of 1946. During the latter part of 1946, the 200-B Separation Plant processed the major portion of irradiated metal and was scheduled to process runs on 18-hour cycle basis. In December 1946, the processing schedules for the two Separation Plants were more nearly equalized. Because of the program to increase separation plant processing capacity, a regular charge was set up as 1.5 tons of irradiated metal slugs and the longest step in the Canyon Process was completed in about 15 hours.

4-9. <u>Separation Plant Waste Storage Facilities.</u> - The Waste Settling (361) Tanks, used for the disposal of waste from the Concentration Buildings, gradually filled up with sludge, and attempts to transfer this sludge to tanks in the Waste Storage (241) Areas were unsuccessful. It was decided to by-pass the Waste Settling Tanks, jetting the waste directly to one of the empty tanks in the 200 Area, and construction on the by-pass and on crib trenches for disposal of effluent was started in August 1946. It is apparent that additional waste storage facilities will be needed by December 1947 on the basis of present operating schedules. As of 31 December 1946, the General Electric Company had begun excavation for lines to the proposed, new waste storage tank farm, 241-BX, and had sent out to contractors invitations to bid on the construction of a tank farm essentially equivalent to one of the existing tank farms. Another plan for providing additional waste storage was under active consideration at the end of 1946. It had been determined that the second cycle wastes contained about the same amount of activity as the wastes from the Concentration Buildings. Therefore, it was planned to determine the feasibility of jetting second cycle wastes through cribs into the ground, thus making tanks previously used for storing second cycle wastes, available for other types of waste. A series of test wells would be required in order to follow the floor of activity and thus to determine the feasibility of continued flow of wastes into the ground.

4-10. Product Content of Irradiated Metal. - In August 1946, the Area Engineer was notified that product obtained from metal irradiated to over 200 grams of plutonium per metric ton of uranium was not acceptable to the Consumer, as product from higher concentration metal contained undesirable quantities of plutonium-240. This change in concentration requirements necessitated rescheduling of discharge operations and uranium billet shipments. Power levels of the

[redacted]

production Piles were reduced to maintain the desired ratio between plutonium and polonium production and to prolong the life of the Piles.

4-11. Blistered Slugs. - The presence of pimples or blisters on some slugs discharged from 100-B Pile was discovered in October 1945 when the high-exposure slugs were examined for corrosion. Since that time, closer examination of discharged slugs in all areas revealed the presence of many blisters. Most of these were found in channels subjected to longer than normal exposure and contained high concentrations of plutonium. At first it was believed that the blister resulted from the formation of a gas bubble between the can and the slug; however, sectioning the slugs showed that this was not a surface phenomenon but that a corresponding pimple appeared on the surface of the uranium metal slug. In December 1946, blistered slugs were measured by means of underwater calipers, with no discovery of significant difference between the diameters of slightly blistered and extensively blistered slugs. Some of the readings were as low as 1.430 inches (standard slug diameter is 1.440 inches), indicating that even slightly blistered slugs were out-of-round through some portions of their lengths. For permanent record purposes, plaster casts were made of some extensively blistered slugs; negatives made under water were split and used in making the positives, which were non-radioactive. These showed very plainly every blister and depression. Tests have been run, using specially-selected extruded slugs and cast slugs; blistering still persists and slugs fabricated from rolled metal are now being tested.

4-12. Uranium Metal Scrap Recovery. - Originally, small pieces

[redacted]

of uranium metal scrap, such as turnings, chips, and floor sweepings, were shipped to Ames, Iowa, for briquetting. The equipment used at Ames was shipped to this site, and installation in Building 313, Metal Fabrication and Testing Area, was begun in January 1946. The initial test run was made in February 1946 and regular briquetting began in March; the briquettes, together with the solid metal scrap, were shipped to Metal Hydrides for recasting into billets. Beginning in April, shipments of scrap uranium metal were received from Site "Y" for briquetting. This material was extremely fine and contained a large amount of foreign material, including other metals and flammable materials. Subsequently, it was found that fire hazards associated with processing this material in the regular manner were too great, and it was decided to roast this material in the furnace, to be shipped as the oxide. A roasting hearth was constructed in Building 314 and was placed in operation in June 1946, burning Site "Y" scrap and floor sweepings, grinder dust, oxides from the extrusion operation, and similar materials from 300 Area operations which might contain finely divided uranium metal. The General Electric Company, upon assuming responsibility for operations, was requested to make a study on the feasibility of installing equipment to melt the solid uranium scrap and cast it into billets at this site. A preliminary cost estimate, submitted by the Contractor in October, indicated that the recasting could be performed on the site at approximately one-half the cost under the current arrangement. Preliminary design work on a completely modern casting plant was underway at the end of 1946.

4-13. <u>Reactivity of Uranium Metal.</u> - Uranium metal is supplied

[redacted]

to this site by suppliers under the jurisdiction of the Madison Square Area. During the spring and summer of 1946, the quality of shipments from one supplier became alarmingly low, as shown by reactivity tests at the Argonne National Laboratory and in the 300 Area Test Pile. Investigation was made and, by the end of 1946, resulted in improvement in the reactivity of metal received from this supplier. Billets cast by Metal Hydrides, from scrap briquetted at Hanford and received at Hanford in July and August 1946, contained an abnormal amount of impurities and exhibited low reactivity; studies were commenced to determine the source of these impurities. In order to meet the requirements for polonium and special irradiations (See Par. 4-17), it was necessary to maintain the amount of excess reactivity of the production Piles at that of 15 October 1946. The amount of excess reactivity is dependent upon the quality of the metal.

4-16. Redox Solvent Extraction Process. - Prior to design of the Separation Plants at the Hanford Engineer Works, many processes for the separation of plutonium from uranium and associated by-products were investigated (See Vols. 2 & 3). Even after the Bismuth Phosphate Process had been selected for use in production operations, research and development work continued on alternate processes. The substitution of other solvents for diethyl ether in the Redox Solvent Extraction Process made this process more feasible. Hexone (methyl isobutyl ketone) was found to be the best solvent yet studied; preliminary development work at the Metallurgical Laboratory showed that better yields of decontaminated plutonium could be obtained than with the present process, and that fission products and uranium were obtained

[redacted]

in more easily recoverable states. In August 1946, a group was formed in the Contractor's organization to study the Redox Solvent Extraction Process and outline a development program to be followed at this site. The development program, as outlined, included the design, construction, and operation of a four-glass-column demonstration unit and pilot plant, using stainless steel columns for tracer runs in the Semi-Works Separation (321) Building (See Vol. 3). If the operation of these units proves the Redox process to be sufficiently superior to the present process, a hot semi-works will be designed for construction, adjacent to one of the Canyon Buildings. It is expected that the glass demonstration columns will be ready for operation about March 1947.

4-15. <u>Transfer for DP Site Operations</u>. - The District Engineer requested that a study be made of the feasibility of transferring to this site the plutonium-processing operations being carried on at the "DP" location at Site "Y." With reference to this request, Site "Y" was visited by representatives of the Hanford Area Engineer during October and November 1946, and by representatives of the General Electric Company in December 1946; so far, no action has been taken.

4-16. <u>Thermocouple Slugs</u>. - To determine internal slug temperature and the changes in thermal conductivity of uranium during irradiation in the production Piles, special uranium slugs containing thermocouples were canned in December 1946. One of these slugs was placed in a tube in the 100-F Area Flow Laboratory in order to develop charging and discharging techniques and to study flow characteristics. It was planned to charge one of these slugs into the 100-F Pile in

January 1947.

4-17. Special Samples. - In addition to plutonium and polonium, many radioactive isotopes were required by other Manhattan District installations in order to study their medical applications and to conduct research in new fields of atomic energy developments, as well as to assist in the solution of operating problems at Hanford. Most of these special samples involved the irradiation of materials in the production Piles. Many special irradiations were made in the Argonne and Clinton Laboratories Piles, but the volume of material to be irradiated or the necessity for irradiation at a high neutron flux made it desirable to irradiate certain materials in the production Piles at Hanford.

Other special samples involved isolation by-products from Separation Plant wastes; included in this category were exposed samples of materials used in normal plant operation. Since these samples were requested by other sites, a system was adopted whereby each request was assigned a Hanford Request Number (See App. B 13 for tabulation showing the status of this program as of 31 December 1946). The materials involved and the purpose of each request are given in the following summary:

HEW Request No.	Description
1.	Neptunium-237 was irradiated at the request of the Metallurgical Laboratory, which desired to investigate the reactions of neutrons with Np-237 and Pu-238, formed by the following reaction:

$$_{93}Np^{237} + {}_{0}n^{1} \longrightarrow {}_{93}Np^{238} \xrightarrow{\beta^-} {}_{94}Pu^{238}$$

[redacted]

Knowledge of the properties of these materials is important in planning new high-intensity Piles.

2. Thorium was irradiated at the request of the Metallurgical Laboratory, such irradiation producing uranium-233:

$$_{90}Th^{232} + {}_{0}n^{1} \longrightarrow {}_{90}Th^{233} \xrightarrow{\beta^-} {}_{91}Pa^{233} \xrightarrow{\beta^-} {}_{92}U^{233}$$

3. Same as 2.

4. The Metallurgical Laboratory requested six standard uranium slugs which had received the highest exposure, in order to isolate the higher isotopes of plutonium and transuranic elements.

5. This request number covered the neptunium-237 recovered from Separation Plant wastes, requested by the Metallurgical Laboratory since 1 January 1946. Two earlier samples were shipped to the Metallurgical Laboratory on 25 April 1945 and 20 August 1945. This material is valuable for studying the properties of neptunium and for obtaining information which may be of use in connection with a possible substitute for polonium.

6. The irradiation of uranium-233 was requested by the Metallurgical Laboratory in order that they might study the neutron-capture cross sections of U-233 and U-234. These properties are important in the planning of new, high-intensity Piles.

7. Same as 1.

[redacted]

[redacted]

8. The irradiation of pure uranium-238 was requested by the Metallurgical Laboratory to provide uranium-240 which may be a source of small quantities of neptunium-240 and plutonium-240. Irradiation of pure uranium-238 should yield less uranium-237 and fission activity, thus simplifying the search for uranium-240.

$${}_{92}U^{238} + {}_{0}n^{1} \longrightarrow {}_{92}U^{239} + {}_{0}n^{1} \longrightarrow {}_{92}U^{240} \xrightarrow{-\beta^-} {}_{93}Np^{240} \xrightarrow{-\beta^-} {}_{94}Pu^{240}$$

A knowledge of the properties of plutonium-240 is of importance in planning high-intensity Piles.

9. The irradiation of pure beryllium oxide and mixtures of beryllium oxide and uranium oxide was requested by the Metallurgical Laboratory, in order to study the effects of intense neutron irradiation on these materials because construction of a beryllium oxide-uranium oxide Pile had been proposed.

10. The irradiation of samarium oxide and gadolinium oxide was requested by the Metallurgical Laboratory because of the necessity of learning more about highly-absorbing fission products in connection with the design of new high-intensity Piles.

11. The irradiation of one gram of radium was requested by the Metallurgical Laboratory because of the desire to study the properties of actinium-227 and its decay products.

$${}_{88}Ra^{226} + {}_{0}n^{1} \longrightarrow {}_{88}Ra^{227} \xrightarrow{-\beta^-} {}_{89}Ac^{227}$$

[redacted]

It is quite likely that actinium and its decay products can be used as substitutes for polonium.

12-A The irradiation of uranium-235 was requested by the Metallurgical Laboratory because of the desire to study the properties of uranium-236. A fraction of uranium-235 reacts with neutrons in the following manner:

$${}_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{92}U^{236}$$

12-B The irradiation of plutonium-239 was requested by the Metallurgical Laboratory because of the desire to study the nuclear properties of the heavier isotopes of elements 94, 95, & 96 and, if possible, of the alpha-emitting isotopes of element 97, which are important in the planning of future Piles. Nuclear reactions similar to those represented in the following equations are expected to take place during irradiation.

$$94^{239} + {}_{0}n^{1} \longrightarrow 94^{240} + {}_{0}n^{1} \longrightarrow 94^{241} \xrightarrow{-\beta^{-}} 95^{241}$$

$$95^{241} + {}_{0}n^{1} \longrightarrow 95^{242} + {}_{0}n^{1} \longrightarrow 95^{243} + {}_{0}n^{1} \longrightarrow 95^{244}$$

$$95^{242} \xrightarrow{-\beta^{-}} 96^{242}$$

$$96^{242} + {}_{0}n^{1} \longrightarrow 96^{243} + {}_{0}n^{1} \longrightarrow 96^{244} + {}_{0}n^{1} \longrightarrow$$

$$96^{245} + {}_{0}n^{1} \longrightarrow 96^{246} + {}_{0}n^{1} \longrightarrow 96^{247}$$

$$96^{245} \xrightarrow{-\beta^{-}} 97^{245}$$

$$96^{247} \xrightarrow{-\beta^{-}} 97^{247}$$

13. The irradiation of beryllium nitride to produce carbon-14 by the following reaction was requested by the

Metallurgical Laboratory:

$${}_7N^{14} + {}_0n^1 \longrightarrow {}_7N^{15} \xrightarrow{-\,H^1} {}_6C^{14}$$

Carbon-14 is desired for use in medical research.

14. The irradiation of aluminum-uranium alloys of different compositions was requested by the Clinton Laboratories. Because it is planned to use these materials in the construction of a new Pile, it is necessary to determine the extent of changes in their physical properties caused by neutron irradiation.

15. The irradiation of lithium fluoride was requested by the Metallurgical Laboratory. Lithium-6 on neutron irradiation produces tritium (hydrogen-3) by the following reaction:

$${}_3Li^6 + {}_0n^1 \longrightarrow {}_1H^3 + {}_2He^4$$

Quantities of tritium were desired in order to study its physical properties and, because of the increased demand for tritium, lithium fluoride was substituted for the regular poison columns in the Piles beginning in September 1946. Therefore, it was necessary to vary exposure time somewhat in order to meet operating requirements.

16. The irradiation of element 95^{241} was requested by the Metallurgical Laboratory for the Radiation Laboratory at the University of California. This irradiation should produce new heavy isotopes and the reactions may follow the courses outlined under 12-B.

[redacted]

17. Samples of irradiated graphite were requested by the Metallurgical Laboratory in order to study changes in graphite during continued exposure to neutron irradiation.

18. The Metallurgical Laboratory requested standard, long exposure, poison slugs to be used in determining the mass of the isotope of cadmium responsible for the high neutron-capture cross section.

19. The irradiation of a sample of mercury sulfide was requested by the Metallurgical Laboratory. The higher isotopes of mercury produced will be used to determine neutron-capture cross sections which would be formed by a series of reactions:

$$_{80}Hg^{200} + {_0}n^1 \longrightarrow {_{80}}Hg^{201} + {_0}n^1 \longrightarrow {_{80}}Hg^{202} + {_0}n^1 \longrightarrow {_{80}}Hg^{203} + {_0}n^1 \longrightarrow {_{80}}Hg^{204}$$

20. The irradiation of thallium nitrate was requested by the Metallurgical Laboratory. It was desired to produce quantities of thallium-204 which may be fissionable.

$$_{81}Tl^{203} + {_0}n^1 \longrightarrow {_{81}}Tl^{204}$$

Higher isotopes and isotopes of lead will also be obtained.

21. No data.

22. No data.

23. No data.

24. The fabrication of approximately 40 tons of small

[redacted]

[redacted]

diameter unbonded slugs for use in the Clinton Pile was requested by the Clinton Laboratories.

25. Same as 13. Irradiation requested by the Radiation Laboratory of the University of California.

26. The irradiation of antimony to produce a source for use in scattering experiments was requested by the General Electric Research Laboratory in Schenectady, New York.

27. The irradiation of calcium in the form of calcium oxide was requested by the Clinton Laboratories to produce high specific activity calcium-45.

$$_{20}Ca^{44} + {_0}n^1 \longrightarrow {_{20}}Ca^{45}$$

This request had not been approved as of 31 December 1946.

28. The irradiation of metallic iron was requested by the Clinton Laboratories to produce high specific activity 44-day iron-59 and 5-year iron-55.

$$_{26}Fe^{58} + {_0}n^1 \longrightarrow {_{26}}Fe^{59}$$

$$_{26}Fe^{54} + {_0}n^1 \longrightarrow {_{26}}Fe^{55}$$

This request had not been approved as of 31 December 1946.

29. The irradiation of phosphorus in the form of phosphorus pentoxide was requested by the Clinton Laboratories to produce phosphorus-32 which is desired for use in medical research.

$$_{15}P^{31} + {_0}n^1 \longrightarrow {_{15}}P^{32}$$

[redacted]

[redacted]

In addition, a few special samples have been handled without Hanford Request Numbers. Many samples of irradiated graphite were sent to other sites for testing in regard to problems encountered in the operation of the Hanford Piles. Samples of plutonium-239 and uranium, enriched in uranium-235, were charged into channel 2874 of the 100-B Pile on 27 September 1944 and discharged on 12 April 1945 (for more information, see Hanford Requests Number 12-A and 12-B). Samples of radioactive iodine have been collected by scrubbing the stack gases in Building 292. These samples were shipped to Clinton Laboratories. Samples of regular irradiated metal solution and extraction waste were shipped to the Metallurgical Laboratory on 22 March 1945. It was expected that more information could be obtained on transuranic elements which could be used in modifications for the Hanford process.

[redacted]

[redacted]

SECTION 5 - OPERATIONS RECORD

5-1. Start-up Procedures. - A brief description of the procedure followed in the initial start-up of the individual units of the operating plant is related below:

a. Metal Fabrication and Testing Area. - Start-up operations in the Metal Fabrication and Testing (300) Area were relatively simple. Operating supervision and personnel were used in conjunction with construction personnel in the fabrication of the initial charge of feed material for the Piles (See Par. 4-2). Prior to this work all equipment in this area was tested and identified by construction personnel. The last buildings in the 300 Area to be completed were accepted by Operations on 19 January 1945 (See Vol. 5).

b. Pile Areas.

(1) 100-B Pile.

(a) Preparation. - By June 1944, test procedures had been completed for such equipment as periscopes for viewing radioactive areas, communication systems, uranium slug charging and discharging equipment, helium purification and circulation, uranium slug storage and transfer equipment, and the horizontal control and shim rod apparatus (See Par. 2-3). The Technical Department had made substantial progress in establishing procedures and tentative standards for charging of uranium slugs, and for calibration of the horizontal control and shim rods of the 100-B Pile. The effects of uranium discharge schedules, uranium charging, Pile power levels, and numerous other considerations had been estimated for forecasting manufacturing

[redacted]

operations. In accordance with the possible necessity for an accelerated program producing two kilograms of plutonium in the shortest possible time, studies relative to the many factors entering into such a program had been substantially completed by July 1944. By August 1944, the accelerated program had been abandoned in favor of the original plan of obtaining the maximum plutonium production over an extended period of time, rather than the earliest possible delivery of the small amount. By July 1944, scientific and specialized personnel had arrived at Hanford from the Metallurgical Laboratory of the University of Chicago and from the Contractor's main office at Wilmington, Delaware. These men were available as consultants in nuclear physics, heat transfer, and other related fields during the remaining preparatory stages of the work and until normal operations were assured.

(b) Operations. - Final preparations for starting the first Pile were in accordance with the comprehensive instructions incorporated in the extensive sets of Operating Standards and Operating Procedures which were prepared at Hanford to cover the full scope of the work. The Operating Standards (See App. C 9) provide the limits of tolerance for each of the hundreds of conditions encountered in Pile operation; the Operating Procedures (See App. C 7) provide specific instructions relating to all phases of Pile operation. During the months of August and September 1944, and concurrently with the similar work conducted on the electric, steam, and water systems of the 100-B Area, final preparations, checking, testing, and calibration of the Pile and all appurtenances were continued. The Operating Department accepted full responsibility for the 100-B Area, including some

[redacted]

relatively minor construction work taken over from the Construction Division, as of 13 September 1944. This construction work included elimination of serious vibration in the process water pump piping system and final alterations to the refrigeration equipment for helium purification. Charging of the 100-B Pile with the necessary dummy slugs was accomplished prior to 13 September 1944. Charging of the uranium slugs was started at 1750 hours on 13 September, using the highest quality slugs from the Metal Fabrication and Testing Area production. A chain reaction was established with no water in the Pile when 400 tubes had been charged at 0230 hours on 15 September (dry critical). Charging was continued and the establishment of a chain reaction with water flowing through the Pile was noticed on 18 September at 1730 hours when 838 tubes had been charged (wet critical). It was calculated that approximately 834 tubes charged in the prevailing pattern was the actual wet critical loading. 903 tubes were charged by 0500 hours on 19 September. Shortly thereafter, excessive loss of pressure of the water flowing through two tubes necessitated discharge of the uranium slugs from these tubes and replacement with dummy slugs, leaving 901 tubes charged with uranium slugs. At intervals during and after the charging of the Pile, the necessary measurements were taken to determine operating characteristics of the Pile and auxiliaries (See Par. 5-2). In general, the results proved that the installations satisfactorily fulfilled the conditions imposed by the rigid operating and safety requirements of the transmutation process. Production operations in the 100-B Pile were started at very low power level at 2248 hours on 26 September. At 0140 hours on 27 September, the power

[redacted]

level was increased to nine megawatts, followed by gradual loss of reactivity due to what was later determined as xenon poisoning (See Par. 4-3). By the end of October 1944, the 100-B Pile had been operated with 901, 1003, 1128, 1300, and 1500 tubes charged with uranium slugs. Under these conditions power levels of approximately 1.6, 17, 30, 60, and 90 megawatts, respectively, had been attained and data collected to permit determination of Pile operating characteristics. The establishment of full-rated flow of water through the Pile, together with the absence of any film formation on the slugs or cooling tubes during operations to that time, indicated that engineering design and construction of all water facilities were adequate (See Par. 4-4). The freedom from slug jacket failures in the Pile was encouraging and was indicative of the soundness of the canning operations and of the policy of rejecting all canned slugs except those of the highest attainable quality. The incorporation of substantially greater uranium and control rod capacity than was originally believed necessary in the Pile structure had proved to be the controlling factors in approaching design power levels. It was believed that only relatively minor alterations, or modifications, to Pile appurtenances, or contributing processes, would be required to attain design operating capacity. This belief has since been proved to be entirely justified. The greater part of the month of November 1944 was devoted to operation of the 100-B Pile, charged with 1500 tubes, at a power level of 90 megawatts. Operations were stabilized during this period to collect complete data relating to all Pile characteristics. This was necessary to establish a sound policy for additional Pile charging and to permit reasonably certain forecasts of plutonium production. Toward the end of November 1944, charging of the 100-B Pile was continued in increments, with power levels increased as rapidly as knowledge of the process permitted. On 28 December 1944, the Pile was charged to the full capacity of 2004 tubes and, on 4 February 1945, the rated power level of 250 megawatts was attained. The charging of the last 500 tubes was delayed purposely until the 100-D Pile had been charged dry to its full 2004 tubes to make certain that the vertical safety rod neutron-absorbing capacity was adequate to hold the Pile reaction in the event of loss of water.

(2) Comparison of the Three Manufacturing Piles. - With minor differences, each of the three manufacturing Piles (100-B, 100-D, and 100-F) was placed in operation in substantially the same manner. The primary difference was in the time required to charge each to its full uranium capacity of 2004 tubes and to attain rated power level. This timing is illustrated in the following tabulation:

Pile	Date Start Charging Uranium Slugs	Date Complete Charging 2004 Tubes	Date Placed in Operation	Date Attained Rated Power Level
100-B	13 Sep 1944	28 Dec 1944	26 Sep 1944	4 Feb 1945
100-D	5 Dec 1944	10 Dec 1944	17 Dec 1944	11 Feb 1945
100-F	15 Feb 1945	19 Feb 1945	25 Feb 1945	8 Mar 1945

The plutonium manufactured in the Piles is related to the power level at which the Piles are operated and the time during which the Piles operate at any given power level. For Hanford operations, this power-time relation is expressed as megawatt-days. One megawatt-day

[redacted]

of Pile operation under all Hanford conditions ultimately will produce approximately 0.91 grams of plutonium ready for delivery to the Los Alamos site, at which final processing and assembly are accomplished.

(3) Pile Discharging. - Discharging operations for the manufacturing Piles were scheduled to make available to the Separation Plants uranium slugs of progressively increasing plutonium content. Although the 100-B Pile was not fully charged until 28 December 1944, the first discharge was completed on 28 November 1944. This consisted of 8.3 short tons of uranium which had been irradiated for a total of 216 megawatt-days. Using the theoretical factors available at that time, the plutonium content of this discharge was calculated as about 195 grams. Cumulative megawatt-days in the uranium discharged from each Pile and the total for the three Piles are plotted separately, together with cumulative tons of uranium discharged (See "Top Secret" Appendix).

c. Separation Areas. - The start-up operations in the Separation Areas are covered in the following steps:

1. Run-in, testing, identification, and calibration of all process equipment and instruments was accomplished by both operation and construction personnel.
2. All process equipment was flushed with water which was run through the equipment, following operational process steps.
3. Chemical runs were made through all process equipment except that used in the coating removal and

[redacted]

metal dissolving steps, using all process chemicals and following operational procedure.

4. Trial runs were made through the entire process using metal that had not been subjected to the Pile process ("dead" metal). These runs included all steps in the process.

5. Trial runs were made, repeating dead metal runs and using tracer amounts of radioactive materials. Radiochemical methods of analysis were used on these runs.

6. Normal process runs were begun, using enriched metal from the Piles.

5-2. Significant Developments. - The following account describes briefly the most important developments in the operations history of the Hanford Engineer Works beginning with the first quarter of 1944 and continuing through 31 December 1946.

a. 1944

(1) Canning of Metallic Uranium Slugs. - By July 1944, a sufficient quantity of acceptable slugs had been canned for charging the 100-B Pile. During August an improvement introduced in the canning procedure resulted in a marked improvement in the quality of canned slugs. The temperatures of the bronze, tin, and aluminum-silicon baths were lowered by about 50 degrees Fahrenheit, e.g., the tin bath temperature was reduced from 1148 degrees to 1100 degrees. During the next month a further improvement, in which the canning process was modified to eliminate the hydraulic presses, resulted in substantial

[redacted]

improvements in the quality of the canned slugs (See Par. 4-2).

(2) Pile Areas.

(a) 100-B. - This area was accepted by the Operations Division in August, except for certain work remaining to be done by the Construction Division and scheduled for the period from 28 August - 4 September and about 15 - 22 September. All testing, inspections, and preparations were completed in the Pile except for those which could be done only after charging the Pile. The actual charging of uranium slugs into the Pile was started at 1750 hours on 13 September. The dry critical condition was obtained with 400 tubes charged with 32 slugs apiece at 0230 hours on 15 September and the wet critical condition was passed when 834 tubes had been charged on 18 September. By 0600 hours on 19 September, 903 tubes had been charged. Subsequently two channels were unloaded because of excessively high water pressure loss. The production of plutonium was realized at 2248 hours on 26 September. The Pile was operated at various power levels between this time and 20 December when it was taken out of service to complete charging to the full 2004 tubes, and a power level of 150 megawatts was obtained on 28 December. The first enriched slugs were discharged from the 100-B Pile on 28 November.

(b) 100-D. - Full responsibility for the Pile Building was assumed by the Manufacturing Division on 27 November and final inspection, testing, and preparation of all facilities for initial charging of the Pile was commenced. The completed area was turned over to the Operations Division on 5 December. All 2004 tubes were charged with 35 slugs per tube by 10 December, and production

[redacted]

operations were started at 1111 hours on 17 December. By 27 December the Pile power had reached 180 megawatts.

(3) Separation Areas.

(a) 200-T. - The Operations Division accepted full responsibility for the Separation Plant on 9 October. Prior to this date, testing of all facilities in the Separation Building under simulated operating conditions had been carried out by the Manufacturing Division assisted by Construction Personnel. 96 irradiated uranium slugs from the Clinton Laboratories Pile were received at Hanford for use in tracer runs in checking the performance of Separation Building processing equipment. The first enriched uranium slugs from the 100-B Pile Area were dissolved in the Separation Building on 26 December.

(b) 200-U. - On 18 December, the entire Separation (200-W) Area, including Separation (200-U) Plant and the Isolation (231) Building, was accepted by the Operations Division.

(c) 200-B. - The Operations Division accepted full responsibility for this area in November, which was made ready for the arrival on 4 December of the first enriched uranium from the Pile Area.

(d) Isolation Building. - This building was taken over by the Operations Division on 18 December.

b. 1945.

(1) Establishment of Entire Process. - By the end of January 1945, the entire process for the manufacture of plutonium had been proved from raw material to finished product. Although a considerable number of improvements and refinements remained to be made in the many process steps and in the sampling and analytical procedures,

the results to this time were noteworthy.

(2) Pile Areas.

(a) 100-B. - The 100-B Pile attained the rated power level of 250 megawatts on 4 February. During January the initial test purge of the process cooling tubes was carried out in an attempt to reduce formation of film which was resulting in excessive pressure drops along the tubes. This purge was successful and established the fact that a satisfactory method of removing film was available. From 11 December to 29 December, the 100-B Pile was shut down for maintenance purposes, inspection of vertical safety rod thimbles, and installation of screens on process water risers.

(b) 100-D. - The Pile reached the rated power level of 250 megawatts on 11 February. In accordance with a proposal from the Contractor, dated 9 April, the power level was raised to a maximum value of 280 megawatts at 0805 hours on 9 June. In August the power level was reduced again to 250 megawatts, and by 30 December had been reduced to 225 megawatts.

(c) 100-F. - The Pile Area was accepted by the Operations Division on 10 February (See Vol. 5). The full 2004 tubes had been charged with 35 slugs each by 19 February and production operations were commenced at 1247 hours on 25 February, with the Pile attaining its rated power level on 8 March 1945. The operating level of this Pile reached a maximum of 280 megawatts at 0915 hours on 11 August but was subsequently reduced to 225 megawatts on 24 August. A further change in power level occurred at 0950 hours on 19 December when the level was raised to 250 megawatts because of the maintenance shutdown at the 100-B Area. [redacted]

(3) Separation Areas.

(a) 200-T. - The processing of the first enriched uranium slugs from the Pile (100-B) Area had established the fact that, with only minor alterations, the production capacity of the Separation (221) and Concentration (224) Buildings was at least equal to the rated capacity. Figures made available during February indicated that the over-all yield through the Separation (200-T) Plant was 74.4%. The measured loss of plutonium through processing was about 13%, the remainder of the discrepancy being due to sample analytical difficulties and hold-up of plutonium in many parts of the system.

(b) 200-U. - The final checking of instruments and equipment was completed during January so that the water, chemical, and other preliminary process runs could begin in February.

(c) Isolation Building. - The first concentrated plutonium was received from the Concentration Building on 16 January, so that isolation processing started on the following day. The first plutonium resulting from Hanford operations was transferred to the Area Engineer by the Contractor on 2 February and then transferred to the Consumer on 5 February. A complete assay of this shipment was received and results indicated that the material was entirely satisfactory.

(d) 200-B. - The Separation Plant was accepted by the Operations Division on 11 February (See Vol. 5). With the acceptance of this plant, all manufacturing facilities at the Hanford Engineer Works were completed by the Construction Division. The Waste Storage Tanks of the abandoned Separation (200-C) Plant, however, were

[redacted]

not yet connected to the 200-B system. Because of the additional waste storage capacity, it was planned to use the 200-B Plant as the second Separation Unit rather than the 200-U Plant. The 200-B plant was placed in production on 10 April 1946.

(4) Plutonium Specifications. - Conferences relative to plutonium specifications were held during the period 18 to 20 February with representatives of the Consumer. It was reported that the first batch of material was satisfactory and within the tentatively established limits for impurities, except for silicon in the form of suspended solids, chromium, and nickel. It was expected that silicon would be materially reduced as Hanford operations proceeded. Since the amounts of chromium and nickel were not harmful, the limits for these impurities were increased. At the end of April a conference was held at the Metallurgical Laboratory to develop plutonium specifications more fully. This conference was attended by representatives of Hanford, the Metallurgical Laboratory, and the Consumer (See Par. 3-4).

(5) Metal Fabrication and Testing Area. - In January, the Operations Division accepted from the Construction Division the facilities for extruding uranium billets into rods. Production operations were on a developmental basis until the latter part of the month, due to difficulties with the furnace, extrusion press, and appurtenances. This work was done by the Revere Copper and Brass Company at Detroit until 26 November, at which time operations at that location were discontinued. The stripping and recanning by the standard process of the 152 tons of unbonded slugs prepared as an alternate charge (See Par. 4-2) was begun on a small scale during the month of July.

[redacted]

(6) Secondary Product Manufacture. - In accordance with a decision made during conferences held from 18 to 20 February relative to the production of polonium, effective manufacture of polonium was started on 9 March when each of 2 tubes was charged with 140 pounds of bismuth slugs in the 100-B Pile. Two additional tubes in the 100-D Pile were charged with 140 pounds of bismuth each on 16 March. Three irradiated bismuth slugs were discharged from the 100-B Pile and sent to the Monsanto Chemical Company at Dayton, Ohio, on 17 March for assay of polonium content for correlation with Pile calculations in estimating future polonium production. The first quantity of irradiated bismuth was discharged from the 100-B Pile on 26 April.

(7) Fish Laboratory. - A fish laboratory was constructed in the Pile (100-F) Area by the Construction Division during the month of March. This laboratory was built, at the request of special consultants at the University of Washington (See Vol. 3) and the Seattle Engineer District, to permit special investigations on the effects of Hanford effluent water on fish life in the Columbia River.

(8) Studies of Heavy Isotopes. - It was agreed during March that 500 milligram samples of plutonium from Hanford production would be shipped to the Metallurgical Laboratory at Chicago for analysis of heavy isotopes formed in the Pile process. During this month, a special run was completed in the Separation (200-B) Plant to concentrate small quantities of neptunium-237 for studies at the Metallurgical Laboratory. This material was shipped on 25 April.

(9) Refrigeration of Pile Cooling Water. - On 20 April the refrigeration plants in the Pile (100-D and 100-F) Areas were

[redacted]

placed in operation. At that time the river temperature had risen to about ten degrees Centigrade. The refrigeration systems were operated to hold the chilled water entering the Piles at about seven degrees Centigrade. This was discontinued on 8 October when the river water temperature had dropped to a point at which refrigeration was unnecessary.

(10) Blistered Slugs. - Blistered slugs were first discovered in a group of high-exposure slugs discharged from the 100-B Pile on 30 October.

(11) Increased Decay Period. - During December it was decided to increase the period of decay storage, prior to separation processing, from 35 to 60 days to permit longer decay of radioactive gases. Radioactive iodine was detected in sagebrush as far away as 80 miles from Hanford. There was no concern in regard to human occupancy of the region but there might be some danger to animals grazing on contaminated foliage.

(12) Waste Storage. - Work was started in December to connect the Waste Storage Tanks in the 200-C and 200-U plants to the waste lines from 200-B and 200-T Separation Plants, respectively.

(13) Critical Mass. - As a result of studies and experiments conducted by the Consumer at Los Alamos, New Mexico, studies at Hanford, and a conference on 27 - 28 April, attended by representatives of Hanford and Los Alamos, the critical mass of plutonium for separation processing had been determined within working limits.

c. 1946

(1) Pile Power. - On 1 January, the power level of the

[redacted]

100-F Pile was lowered from 250 to 225 megawatts, and was lowered from this lower level to 200 megawatts on 15 March. The 100-D Pile, which had been operating at 225 megawatts, was raised in power level to 250 megawatts on 16 March.

(2) <u>100-B Pile.</u> - The 100-B Pile (See Par. 4-7) was shut down on 19 March, as a result of the decision reached a few days earlier, so that all three Piles would not reach the end of their useful lives simultaneously. The work of placing the 100-B Pile in stand-by condition was essentially completed on 6 May.

(3) <u>Expansion of Pile Graphite.</u> - A tube near the top center of the 100-B Pile was traversed during the month of January and the difference in elevation between high and low points was 1.7 inches. The difference in elevation of a corresponding tube in the 100-F Pile was 1.0 inch. By July the difference in elevation between high and low points of the tube near the top center of the 100-D Pile was 2.1 inches. This represented an increase of 0.5 inches since February 1946. By August 6, this increase had become 2.16 inches.

(4) <u>Change of Contractor.</u> - The General Electric Company assumed the responsibility for the operation of the Hanford Engineer Works at 0001 hours on 1 September 1946.

(5) <u>Waste Storage.</u> - Connections were completed for transferring wastes from the 200-B and 200-T Separation Plants to the Waste Storage (241-C and 241-U) Areas, respectively, and the first waste was jetted from the 200-T plant to Area 241-U during the month of February. During March, the first waste was jetted from 200-B Separation Plant to the Waste Storage (241-C) Tanks. Construction of

[redacted]

a by-pass line to jet Concentration Building waste to tanks in the Waste Storage (241) Areas was begun on 28 August (See Par. 4-9). By the end of the year it was apparent that additional waste storage facilities would be necessary in the 200-E Area by about 1 December 1947, and excavation for these waste facilities was begun on 10 December 1946.

(6) Blistering of Uranium Slugs. - Cast uranium slugs were charged into 26 channels of the 100-D and 100-F Piles during the month of April as part of the experimental work on the blistered slug program (See Par. 4-11). Three of these channels were discharged during August and preliminary examination indicated that cast slugs are at least as susceptible to blistering as are extruded slugs. During November, rolled uranium rods were fabricated into slugs for charging into the Piles in hopes that this type of metal would be less susceptible to blistering than extruded slugs.

(7) Redox Solvent Extraction Process. - A group was formed in the Contractor's organization to study the feasibility of the Redox Solvent Extraction Process (See Par. 4-14).

(8) Life of Manufacturing Piles. - The General Electric Company submitted an estimate on the expected life of the Production Piles in October 1946 (See "Top Secret" Appendix).

(9) Four-Inch Slugs. - To obtain information on the feasibility of extending the life of the manufacturing Piles by the use of four-inch slugs (See Par. 4-5), three process tubes in each of the operating Piles were charged with four-inch slugs during the month of October 1946.

[redacted]

(10) Inventory. - An inventory of all uranium, including uranium-235; thorium; and plutonium on the site was made on 31 December 1946. This was a physical inventory with the exception of material in the Piles, decay storage basins, separation plants, and waste storage tanks.

5-3. Production and Delivery of Products. - Production figures for the various stages of the Hanford process are included in the "Top Secret" Appendix, together with an outline of the methods used in delivering product.

[redacted]

[redacted]

SECTION 6 - PROCUREMENT OF MATERIALS

6-1. General. - Production at Hanford was handicapped by the fact that experimentation, in many instances, had not proceeded far enough to decide definitely on the best chemicals for a given purpose. This situation, of necessity, complicated procurement of some of the essential materials. Further difficulty was caused by the huge quantities of many of the items involved and, in some cases, the lack of production was so evident that it was necessary to construct new facilities at vendors' plants to satisfy requirements. Major chemical plants were, for the greater part, located in the East so that transportation and the quantity of containers required for various products was a considerable factor in procurement. Procurement of a number of classified items, such as uranium metal, for delivery to Hanford Engineer Works was arranged by the Manhattan District Office at Madison Square Area, New York (See Book VII). Some of the items were shipped against schedules showing monthly requirements; others were shipped only as definitely requisitioned, though schedules of estimated requirements were furnished by the Project to assist in regulating rate of manufacture.

6-2. Procurement of Classified Materials. - The Production Control Section was responsible for the procurement of classified material, such as uranium metal, from the Madison Square Area of the Manhattan District and the maintenance of control records of classified materials received and shipped off the Project. All shipping documents applicable to classified materials were processed through this section. The Contractor's daily and monthly metal accountability reports and records

[redacted]

have been audited for accuracy, propriety, and form. These reports and records covered a detailed accounting for the uranium used in the conduct of the work and were recorded for the most minute amounts. Only that metal which is finally charged into the manufacturing Piles was considered productive and all other remaining metal in the form of scrap, turnings, sludge, oxides, and cleaning solutions was conserved for shipment to other locations where the material is reworked, to appear again in the form of uranium billets. Control accounts have been maintained for uranium, miscellaneous classified materials, polonium, shipments of plutonium, other special materials, and the radium sources used in the Contractor's Technical and Health Instrument Departments.

6-3. Procurement of Essential Materials. - All normal purchasing was carried on by the Contractor and the Area Engineer's Office in accordance with Government regulations, by requesting necessary bids and by award of orders to the bidder offering most advantageous terms. Records and current files of such purchases were maintained in the various procuring sections with complete interchange of information between them. Expediting was carried on by the individual procurement sections on orders originating therein, and in cases of need for special priority action, the Area Engineer's Material and Equipment Control Section was advised so that appropriate action could be obtained through the Washington Liaison Office (See Vol. 5). Receiving reports for material arriving on each order were incorporated in each order file and, when delivery was completed, the order was removed to completed order files.

a. Agencies.

[redacted]

(1) Wilmington. - Procurement at the Contractor's Wilmington Office was confined largely to contracts for essential chemicals and special needs on a yearly requirement basis, and to spot purchases of chemicals that could not be purchased on the West Coast by the Contractor's Project Production Office. The basis of the contract quantities were estimates of monthly requirements as furnished by the Project operating forces, but contracts let on a yearly requirement basis stipulated that shipments were to be made only on Project orders as requisitioned by the Area Superintendents.

(2) Field. - Procurement for production at the Project involved the Contractor's Purchasing Division, including the Priorities, Excess Materials, and Expediting Section, and the Essential Materials Section; the Government Procurement Section; the Material and Equipment Control Section; and the Production Control Section. The Area Engineer's Engineering Division with the Contracts and Claims Section supervised placing of contracts and subcontracts.

b. Method. - Requisitions for requirements originated in the various areas, approved by the various superintendents, or from the Warehouse and Stock Control Section. This section was established as a clearing house for requirements that were common to several areas, and a minimum stock considered sufficient to take care of plant repairs and replacements for a period of thirty to ninety days was carried. In this way many small requisitions from the field were taken care of from the warehouse on the Project and procurement was relieved of placing numerous small orders. The Stock Control Section also reviewed excess material lists and requisitioned stock requirements, so

[redacted]

far as possible, from excess shown available. The requisitions received by the Contractor's Purchasing Division were reviewed by the Government Procurement Section and the Material and Equipment Control Section. Requisitions containing Treasury Procurement Schedule items were marked for referral to the Government Procurement Section; and requisitions containing items best obtained from Government supplies, or which were to be purchased through Government Central Procurement Agencies, were so designated for referral to the Material and Equipment Control Section. All requisitions were then returned to the Contractor's Purchasing Division for orderly distribution, either to their buyers, the Government Procurement Section, or Control Section for necessary action. The Contractor's purchase orders were known as PHX orders. The Government orders based on Contractor's requisitions were designated as OHEW orders, those based on Government requisitions as HEW orders, and orders placed on Government Depots were designated as Requisition 45-144-1 and up, serially. The 45-144-1 was the station number of this Project and the serial number represented the order number. The Control Section was given a block of these numbers from 1 - 1500 for procurement of materials from Government Agencies and transfers of excess materials. Classified orders used by the Production Control Section were designated as OCT-10,000 orders, numbered serially. When procurement could not be made through vendors by either the Contractor or Government Procurement Section, the requisition was referred to the Control Section for procurement from Government supplies or from a source located through the Washington Liaison Office or the War Production Board. The Control Section, aside from its procurement of materials and equipment from Government Agencies as well as excess materials, was responsible for proper extension of priorities, issuance and authentication of all routine Project ratings, and maintenance of the War Department register of all ratings issued, together with maintenance of official files containing copies of certificates issued. This section advised the Area Engineer of special action needed with regard to requirements for maintenance of civilian morale and, upon approval, requested appropriate action through the Washington Liaison Office. The Control Section set up a system for check, both on procurement and deliveries of supplies of essential materials, to make certain that production would at no time be delayed. Confidential monthly reports were furnished to the Area Engineer's Area Supervisors for their information and guidance, giving the status of materials on hand in each area, the amount on order, and the estimated consumption for the next period. The information was kept current by continuous check of contracts, revisions thereto, requisitions, and receiving reports, and by liaison with the Essential Materials Section of the Contractor.

[redacted]

SECTION 7 - PLANT SAFETY

7-1. General. - The safety program of the Hanford Engineer Works functioned with the Contractor's Safety Department, making all actual corrections and suggestions through the Central Safety Committee. The Area Engineer's Safety Department acted in an advisory capacity and was notified of all activities and happenings. Matters of policy were discussed with the Area Engineer's Safety Department and, if necessary, were referred to the Area Engineer for decisions. Monthly reports of man-hour exposure and accident experience were submitted to the Manhattan District Office (See Book I, Vol. 11).

7-2. Contractor's Safety Organisation and Duties. - The Hanford Engineer Works Operations Safety Program was organised to function not as an individual specialized program, but as a program within each section of the Project, covering all phases of the work. The method used to produce the desired program was to establish a series of committees throughout the entire organisation, each committee consisting of persons working within a certain section. Safety problems were discussed within the committee and routed to the Central Safety Committee for further discussion. The Central Safety Committee consisted of all Department Heads, with the Assistant Plant Manager as Chairman and the Director of Safety as Secretary. The duties of the Central Safety Committee were to discuss all problems and methods of operation and draw proper operating procedures for each phase of plant operation. Problems dealing with specific types of operation were dealt with by the department most closely concerned, then routed to the Central Committee for discussion.

[redacted]

[redacted]

The procedure was drawn up, sanctioned by the committee and routed to all areas concerned. The idea behind this type of program was to have all necessary procedures issued from the group of persons most closely connected with each particular operation. This method did away with the necessity of one group specializing in safety procedures for all types of work. The program functioned in such a manner that each section was conscious of its responsibility for safety and proper operating procedure.

a. <u>Safety Division.</u> - The Contractor's Safety Division consisted of the Director of Safety and Fire Prevention and four safety engineers. An optical inspector functioned in all areas and made periodic checks of all safety glasses and goggles. The various sections of the Safety Division and their duties were as follows:

(1) <u>Industrial Section.</u> - This section operated in conjunction with the Central Safety Committee and its subcommittees in the capacity of technical assistant. The procedures and recommendations issued by the Central Safety Committee were reviewed by the Industrial Safety Section which made applicable suggestions. Safety meetings were held independently by each operating section, but the safety engineer could be called on for assistance in preparing or formulating policies of the meetings. A system of written suggestions was used wherein the working individual submitted a written report on conditions which he felt were not proper. These suggestions were routed through the safety engineer and passed on through supervision. If the suggestion merited further study, it was routed to the Central Safety Committee, acted upon, and returned to the department where it originated, with notation as to any action taken.

[redacted]

[redacted]

(2) Community Safety Section. - The Community Safety Section organized and supervised the School Safety Program which con- sisted of literature, slide films, and sound movies for the children school. The School Safety Patrol was organized and supervised by th Community Safety Section in conjunction with the Richland Patrol Sec

(3) Statistical Section. - This section compiled reco of all man-hours worked on the Project and all accidents and actions taken because of these accidents. The accidents were grouped under subdivisions: (1) major accidents, accidents which caused the injure person to lose time from his work or to become permanently disabled any manner; (2) sub-major accidents, accidents where the person inju was able to return to his regularly assigned work without significan loss of time; (3) minor accidents, accidents of a minor nature such scratches, bruises, and cuts requiring first aid only; and (4) near-serious accidents, accidents in which no person was injured but possi serious injury to personnel or equipment might have occurred. Repor of all accidents, with the exception of minor accidents, were circul throughout all areas for the purpose of future elimination of the sp ic hazard.

b. Area Coverage. - The areas of the Project were covered the following manner: One safety engineer covered the three Pile (1(Areas, maintaining an office and library in each area. Another safe engineer followed the same procedure in the Separation (200) Areas. third covered the Metal Fabrication and Testing (300) Area and con- ducted the training program for new men entering the industrial areas The Administration (700) Area was covered by one safety engineer who

[redacted]

[redacted]

also operated the Community Safety Program.

c. Performance (See App. B 2). - The aim of the safety pr gram of the Hanford Engineer Works under du Pont operation was the pr motion of a work program, free of hazards to personnel and plant equi ment; under operation by the General Electric Company, which assumed responsibility on 1 September 1946, the same aim was pursued and the Pont program was continued in its entirety. At no time before or aft the changeover were the established safety standards relaxed. During the period of December 1943 through December 1946, 25,902,042 man-hou were worked with a frequency (accidents per million man-hours worked) of 0.81 and a severity (days lost per 1000 man-hours worked) of 0.26. These figures were far below the average industrial accident rate and indicated the success of the safety program, further emphasized by th winning in 1946 of a safety award for working 144 days without lost time injury, a record extended by 91 more days to a total of 235 days before the occurrence of a lost time injury.

7-3. Health and Medical Considerations. - Hazards peculiar to the processes, the isolation of the site, and military secrecy combi to create great demands for adequate health and medical facilities and services at the Hanford Engineer Works (See Book I, Vol. 7). Process hazards of an unusual nature were those relating to intense radioactivity. Not only did the over-all intensity of radioactivity associated with Hanford operations exceed by enormous amounts any that had been experienced previously, but the nature and distributio presented new problems. In addition to beta and gamma radiations, previously experienced in relatively small amounts, neutrons were

[redacted]

encountered for the first time, in enormous concentrations. Information concerning the physiological effects of neutrons and their effects on the materials of construction was entirely incomplete, even at the time that the Hanford Engineer Works was placed in operation. To offset the lack of positive knowledge of the physiological effects, the permissible limit of personal exposure to radiations was established at a value far below that which would have noticeable consequences. The health and medical problems arising from this intense radioactivity were concerned with predicting, detecting, measuring, and controlling the radiations encountered in the many process steps and throughout the plant site and neighboring areas; the prevention of overexposure of personnel to such radioactivity; the recording of the degree of exposure to which each individual had been subjected; and the care and treatment of persons who may have become overexposed inadvertently. The outstanding health record at the Hanford Engineer Works is conclusive proof that the extreme precautions taken were entirely adequate. Frequent physical examinations and permanent records were required to assure adequate knowledge at all times of the condition of any persons subject to such exposure. This was demanded for the protection of individuals as well as for the protection of the Government in the defense of possible future lawsuits. In addition to the special hazards at Hanford requiring competent health and medical personnel and facilities, the broad scope of the work introduced almost every other type of hazard encountered in any large industrial plant.

[redacted]

SECTION 8 - TRANSPORTATION

8-1. General. - As completion of the construction period drew near and the operating period gained momentum, considerable re-arrangement of the Transportation Department functions was effected, resulting in consolidation of departments and reduction of personnel. In August 1945, the Labor Department and the Repairs Department were combined into a single unit, Mechanical and Labor Department, while the Traffic Division became part of the Transportation Division, two consolidations which, plus other smaller moves, resulted in a decrease of 108 persons. This approximately 15% reduction was mainly due to releases of (a) bus and truck drivers and foremen, (b) mechanics and equipment inspectors, (c) railway operating personnel (locomotive operators, switchmen, etc.), and (d) Traffic Office employees, but was also due to the change from a 48-hour to 40-hour week for the entire installation.

8-2. Railroads. - The transfer of railroad operation from the Construction to the Operating Department began in October 1944, but not until February 1945 was it completely relinquished by the Construction Department. The operation of the railroads was under the direction of the Transportation Officer in the Office of the Area Engineer, assisted by a Transportation Superintendent who was employed by the Prime Contractor. Between the above dates, two train crews of four men each were transferred from construction to operations for the purpose of handling freight movements in the Pile (100-B) and Separation (200-W) Areas. A yardmaster and a weighmaster were also assigned and performed their duties at the Riverland Yards, which were set up as the point of transfer to direct incoming freight delivered by the railroad company. All materials received here were separated for movement to their respective areas or transferred from one area to another by a dispatcher. Car movements, such as spotting and intra-switching, averaged 6600 per month while railroad personnel averaged 24 persons, including locomotive operators, switchmen, conductors, weighmasters and clerks. As a point of interest, car movements during the period 1944-46 approximated 140,000 with only one minor mishap, a slight derailment without injury to anyone. During 1946, from March to December, a total of 2120 cars were handled for the Mohawk Wrecking Company of Detroit, engaged in a contract to wreck the construction town of Hanford.

a. Maintenance. - The tracks of the reservation railroad system required considerable maintenance work before they could handle safely the heavy volume of traffic required. The railroad subcontractor furnished necessary rolling stock and maintained his own train crew for spreading ballast and laying rail. The maintenance of the tracks was under the jurisdiction of Morrison-Knudsen Company of Boise, Idaho, which was awarded the contract for this work in April 1945.

8-3. Buses. - Operation of buses began in March 1943, when the first rented bus was loaded with employees and dispatched from Pasco to Hanford. From this beginning, the Bus Operations Division grew until, in September 1944, 904 buses were being utilized in the combined activities of the division--operation and maintenance of all buses on the Project. Bus transportation problems rapidly diminished during the transition period from construction to operations and, since operation from the bus centers at Hanford grew less as the construction work neared

[redacted]

completion, all bus activities were transferred to Richland where a bus station and a dispatching office were put in service. By December 1946, plant bus operation had decreased to the point where only 90 buses were operating, transporting 73,933 passengers during the month. Village bus service ran on regular schedules and, as of December 1946, totaled 87 trips daily.

8-4. Air Patrol. - Since the beginning of the Project, the Hanford Engineer Works Air Patrol, equipped with Army planes piloted by civilian pilots, was used for security patrols and as a transportation facility on emergency occasions. In addition, the Project planes, which used Richland Airport as a base, assisted on many searching missions for missing boats and persons, while a regular part of the 1945-46 program was in mosquito control, where Piper Cub trainers were used to spray DDT where other vehicles could not reach. With the exception of major overhauls, all maintenance for the six plane fleet was accomplished at the airport.

8-5. Water Patrol. - During 1946, the water patrol activity, accomplished now with modern equipment as replacements for the antiquated equipment in service when the Hanford Ferry was taken over for security reasons, gave six day service (Monday through Saturday) with 4 operators on duty.

[redacted]

[redacted]

SECTION 9 - RICHLAND VILLAGE

9-1. General. - Richland Village (See App. A 96) was constructed to house the operating personnel of the plant and, in addition, a portion of the construction force during the period when construction and operation of the plant overlapped. Adequate facilities were furnished to provide for the essential requirements, with respect to food, housing, clothing, health, schools, churches, recreation, transportation, and police and fire protection, of a population of approximately 16,000. The Administrative Area (See App. A 97) for the Hanford Engineer Works was located in Richland Village.

9-2. Village Management. - Evaluation of all the factors entering into the management of Richland Village indicated the desirability of placing this responsibility with the Prime Contractor. This proved advantageous to the Government by eliminating duplication of effort, in many instances by combining a considerable number of village operation requirements with existing plant management and services. As with plant operation, Richland Village was under the general administrative and supervisory control of the Area Engineer, who was represented by the Legal Branch and, later, by the Community Management Branch.

9-3. Housing. - Since some of the Operations employees were located on the Project early in the construction period, a small percentage of the first houses constructed was allocated to them. Prior to January 1944, practically all of the houses were allocated to Construction or Government personnel. During January, 10 per cent of the

[redacted]

[redacted]

houses completed were allocated to Operations personnel, 10 per cent to Government personnel, and 80 per cent to Construction personnel. During February, the figures were changed to 30 per cent for Operations, 10 per cent for the Government, and 60 per cent for Construction. They were further revised during March to 50 per cent for Operations, 10 per cent for Government, and 40 per cent for Construction. This last ratio was used until all of the requirements of the Construction Division were met. Originally, it was felt that the reduction of construction forces would take place early enough, and at a rate rapid enough, to enable operations forces to move into the vacant houses with a minimum of delay. Studies during 1944 indicated that there would be a good deal of overlap, however, and the last group of 500 prefabricated houses was erected primarily for Construction personnel, but was assigned to Construction, Operations, Government, and miscellaneous personnel exactly as were the first 1300 prefabricated houses.

All houses in Richland were occupied as rapidly as they were completed. The peak population of 15,401 was reached in the spring of 1945, with a considerable drop in population during the summer resulting from completion of the last phases of construction and from a reduction in operating forces as operations were gradually stabilized. A total of 4304 houses were built, comprising 2500 permanent and 1804 prefabricated temporary dwellings (See Vol. 3 - Design). Of the latter, 500 were included to assure adequate housing of key personnel during the unusually prolonged peak period when both construction and operations forces created extremely heavy demands. Approximately 25 existing houses from the original village of Richland were occupied.

[redacted]

[redacted]

In July 1945, many project employees were living in various Federal Public Housing Authority projects in Pasco, Kennewick, Prosser, Grandview, and Sunnyside. Demands for such housing fell off, however, and in January 1946, FPHA cancelled eligibility of all such employees, other than war veterans, in conformance with the national policy on such projects.

Housing requirements in Richland were somewhat relaxed in late 1945, and permission was given to allow rental of houses by groups of single women. There was a relatively large number of vacant prefabricated houses with little or no demand for them, and it became obvious that the project would have to declare most of this group surplus. Therefore, prefab occupants were encouraged to move into the regular type houses, thus permitting surplus declaration of a maximum number of prefabs. In September 1945, representatives of various universities and colleges in the Northwest met in Richland with representatives of FPHA. They discussed their needs for housing, estimated at about 1000 houses, but were informed that not more than 500 houses would be surplused from Richland.

In October 1945, movement from the project started for 302 prefabricated houses which had been transferred to FPHA for various colleges. Two "test-case" prefabs were shipped by rail to Los Alamos in January 1946, with the Manhattan District subsequently approving the removal of 105 prefabs to Los Alamos and 60 to Sandia. Four three-bedroom prefabricated houses were moved to the Midway Substation, at the Northwest corner of the Hanford Project, as a loan to Bonneville Power Administration; one other prefab had been loaned to the Midway

[redacted]

Substation previously.

Meanwhile, the power, water, and sewer connections were disconnected on vacant prefabricated houses, a policy discontinued in April 1946 when it was decided no more houses would be surplused, even though 100 additional vacant prefabs remained on the project; of these, 87 had the utilities disconnected. In the late summer and early fall of 1946, proposed employment schedules for the Prime Contractor indicated a steady increase in personnel and a consequent severe housing shortage. Between October and December 1946, utilities of the 87 disconnected prefabs were restored to permit renewed Project use.

Plans had been made to surplus 14 tract houses in the Richland area, but the surplusing documents were recalled, pending a study to determine which houses might be rehabilitated for temporary or permanent occupancy.

A General Electric employment forecast showed a shortage of 110 family units by April 1947, but it became apparent that the shortage would be more serious before that time. A study was made to determine which abandoned houses in the White Bluffs-Hanford area could be moved and installed on sites formerly occupied by prefabs in Richland. Twenty-five (25) metal tropic hutments, remodeled into duplex apartments at the Pasco Naval Air Station, were made available to the Project for movement to Richland.

To avoid duplication of functions, all houses held by the Community Management Branch for assignment to government employees were returned to the Prime Contractor, and all subsequent assignments of houses were made by the Contractor Housing Office. Community

Management continued to certify those government employees eligible for housing.

In order to alleviate the anticipated housing shortage, the Prime Contractor ruled against hiring women with dependents, in order to avoid assignment of houses which might be required by male employees with families. In addition, a proposal was submitted for converting one vacant dormitory into 10 apartments, with possibility of similar conversion of four additional units in early 1947.

9-4. Furniture. - Original plans called for furnishing of a great number of houses at Richland, partly due to the fact that the isolation of the Project made it difficult for many people to have their futurniture shipped here, particularly since most of the construction employees would live here only a relatively short time. Practically all houses were provided with basic furnishings, such as electric refrigerator, electric stove, electric water heater, garden hose and garbage can. In addition, all prefabricated houses were purchased furnished, such furniture being of plywood construction similar to the houses, with tables and chairs of the folding type. Furniture for 1175 conventional type houses was procured but at no time during 1944 and the early part of 1945 were more than 900 houses furnished. This furniture was of maple construction, as durable as good taste and economy would allow.

In the late summer of 1945, when occupants of prefabs were being encouraged to move into the regular type houses, it was found that there was insufficient furniture on the project to meet the demand for furnished houses. As early as July 1945, appeals were made to several army storage warehouses on the Coast, to learn whether furniture might be available; however, none was located. In August, it was learned that the Federal Public Housing Authority had a number of warehouses full of furniture, but the Prime Contractor, [redacted], was not in favor of bringing furniture to the Project and assumed that the problem could be solved by hiring only personnel who had their own furniture. It was not until late 1945 that the contractor agreed that it was desirable to get more furniture from whatever source might be available. It was possible to obtain enough beds, chests of drawers, mirrors, dining sets, davenos and occasional chairs to furnish about 120 houses partially.

9-3. Dormitories. - Upon completion of construction, dormitory population fell off materially, with the result that several of them were closed during the period July 1945 to September 1946, leaving 8 men's dormitories and 7 women's dormitories in operation. One of the closed dormitories was taken over by the hospital to use as a "stand-by" for a possible isolation or emergency building, one was taken over and modified as a kindergarten for the Pre-School Parent Teacher's Association, two were remodeled at private expense as Youth Centers, and one was remodeled for the installation of the government's Property Branch office. It was agreed with the Contractor, however, that no dormitory would be made available to private groups, such as clubs and private organizations. One dormitory was rented for a period of three months by the Mohawk Wrecking & Lumber Company, for housing some of its personnel, while Mohawk key employees rented a maximum of 11 houses during 1946. This company held the contract for tearing down Hanford.

9-4. Housing Rentals.

[redacted]

a. Conventional and Prefabricated Houses. - The annual rental of Richland Village homes was set at roughly 10 per cent of the cost of the house (See App. B 5). This did not include the value of the land or the cost of the roads and utilities serving the property. This "rule of thumb" was adhered to in establishing the rental of the conventional type houses. When the prefabricated houses were provided, their rentals were set by comparison with those already applied to the conventional types.

b. Dormitories. - Rentals for rooms were the same in both men's or women's dormitories as follows:

Single:	Inside rooms	$20.00 per month
Single:	Corner rooms	$22.50 per month
Double:	Inside rooms	$30.00 per month or $15.00 per person
Double:	Corner rooms	$35.00 per month or $17.50 per person

9-7. Services (See App. A 98-105). - Normal services for the entire village were performed by the departmental organization of the Contractor. Included in such services were the following: maintenance of buildings, houses, facilities, roads, and walks; furnishing of electricity, water, grass seed, and fuel and heat; collection and disposal of sewage, garbage, and ashes; furnishing of police, fire, and sanitary protection; and billing, collecting, leasing, and accounting relative to rentals for housing and commercial establishments. The cost of all such normal services was included in the rental agreements established.

a. Health. - The Medical Department was organized to provide medical services and to maintain a close check on business

[redacted]

establishments and schools to assure the highest possible sanitary standards.

(1) Medical, Hospital, and Dental Service. - Medical, hospital, and dental services were available to all residents of the village at reasonable cost at the hospital (See App. A 106) located in Richland. While this hospital and medical center was provided to take care of the industrial requirements of the plant, adequate facilities were included to serve the essential needs of the village.

(2) Sanitary Services. - Periodic inspections of all food-dispensing establishments were made in schools and business houses, with reports forwarded to those department heads who were responsible for the maintenance of sanitary facilities. Copies of the reports were also sent to the respective schools and business operators. Rechecks were made to determine that the recommendations of health inspectors were carried out.

(3) Mosquito Control. - In the summer of 1945, some efforts were directed toward the control of mosquitoes. Extensive slough areas to the west of Richland and an extensive well field in the heart of Richland (periodically filled with water from the irrigation system to charge the domestic well system) made ineffectual normal mosquito control efforts, and unbelievable swarms of mosquitoes made life intolerable after sunset during the summer months. Because of the presence of anopheles mosquitoes which transmit malaria, the Medical Department became concerned over the problem, since it was known that war veterans, with service in malarial areas of the tropics, would be moving to Richland.

A Mosquito Control Committee was established in January 1945 to coordinate and direct activities of all departments concerned in the mechanics of controlling the pest. Represented on the committee were the Contractor's Medical Department, Village Office, Power Department, and the Area Engineer's Safety and Community Management heads. As a result of their coordinated efforts, the extent of mosquito control in 1945 was far beyond the most optimistic expectations.

An oil spray truck and crew were constantly available, spray equipment was installed in a Piper Cub plane, and Federal Prison Industries crews were put to work draining the sloughs west of Richland with power equipment. This latter cost $2,500 while the costs of the entire program came to $18,000. It was found that the airplane spraying was the determining factor in mosquito destruction, although no one method of control would have been adequate by itself.

b. Schools (See App. A 107-111). - The schools were operated entirely under the laws of the State of Washington and under the jurisdiction of the County Superintendent of Schools. Because of the great expansion of school population, however, it was necessary to rely heavily on federal funds made available under the Lanham Act (See App. C 12). For the school year 1944-45, state and county funds in the amount of $90,000 were available to the Richland schools. In addition, it was necessary to use $278,292 of Lanham Act funds for school facilities, supplemented by an additional $74,008 in the school year of 1945-46. Representatives of the Area Engineer and the Prime Contractor were appointed advisory members of the School Board to represent the Government's and the Contractor's views on any questions

[redacted]

or problems pending, such as transportation of students, and school physical facilities. These advisory members had no vote and, therefore, had no control over the selection of a school superintendent, teaching personnel, or text books to be used.

In October 1945, all school buildings in Richland were leased to the School District for a total of $1.00 per year, effective 1 July 1945, and property responsibility was placed on the School District.

Reports submitted by the Superintendent of Schools in March 1946 predicted a large increase in school enrollment for the fall term. School population at Richland persistently expanded upward from the lower grades, since there were an unusually large number of small children growing up in the town. To meet the expansion and to reduce the size of classes, 17 hutments were placed on the grounds of various schools for use as classrooms for the 1946-47 term.

The school enrollment in December 1945 was 2,648 in the grade schools and 616 in the high school, a total of 3,264. The enrollment for fall term of 1946 was 670 in the high school and 2,651 in the grades and kindergarten, a total of 3,321.

From the start of the project to 30 June 1946, the School District had received from Lanham Act Funds $58,390 for nursery schools and $324,443 for general school use, a total of $382,833. In August 1946, representatives of the Federal Works Agency, which disbursed Lanham Act Funds, advised this office that, since the Manhattan District funds included necessary money for schools on Manhattan projects, the District would be expected to finance deficiencies in Richland schools. They were advised that the Manhattan District funds were intended for

[redacted]

schools elsewhere which were entirely financed and operated by the District and that such funds would not be available for the Richland schools. No indication was received by the close of the year whether or not Lanham Act Funds would be available to meet the relatively small deficiencies of Richland schools for the year 1946-47.

Studies were begun in the late summer of 1946 regarding the space requirements of a junior high school. The need was based on a census, showing a large number of small children who would enter school within the next few years. Construction of a Junior High School would eliminate the pressure in the grade schools and should care for the anticipated increase in the high school grades. It is probable, however, that additions will be required on various grade schools within the next few years.

e. Churches (See App. A 112, 113). - Nearly all religious denominations were represented in Richland. Fifteen of the Protestant groups were combined in the Council of Churches and Education for Washington and Northern Idaho (See Vol. 3). However, there were eight groups not included in the State Council and for which there were no church buildings. Several of these, in particular the Latter Day Saints, had large congregations, with Sunday School enrollment almost double the size of the church congregations. These groups held their services in various school buildings, but the Latter Day Saints and the Assembly of God requested permission to build churches at their own expense. The Catholic Church requested permission to build a parochial school on the Project. As of 31 December 1946, no permission had been given and there was a probability that policy and regulations would combine to prevent such permission.

d. Transportation. - Government-owned bus transportation, under the direction of the Transportation Officer, was provided throughout the village for the essential requirements of the Project employees. Bus fare was 5¢ per ride, with free transfers to connecting local buses. This fare was established on the basis of the rates charged in other communities of similar size in the State of Washington. Due to the physical size of Richland, the fact that intra-city transportation facilities would have to be provided was recognized from the beginning, and the service was inaugurated in June 1944.

e. Police Protection. - Police protection for Richland was provided by the Plant Patrol, the village, for operational purposes, being considered as a plant area. Headquarters for the Village Patrol originally occupied the existing building later to become an electrical shop. Late in 1944, Patrol moved to another existing residence, with this second headquarters becoming the permanent Village Patrol Headquarters. Normal municipal police protection including traffic regulation was provided, particular attention being given to traffic during the hour preceding and following the daily school period while greatest numbers of children were on the streets. Day and night patrol in radio-equipped cars was maintained. The headquarters for the entire Hanford Engineer Works Operations Plant Patrol was located in the former temporary construction office at the corner of Goethals Drive and Swift Boulevard.

f. Fire Protection. - Special attention was given to fire protection and the record to December 1946 proved excellent, with smoke and odor investigations in connection with faulty stoking of furnaces the principal cause of village fire alarms, while most plant alarms were the result of spontaneous ignition. For 1946, the following comparison on fire record was made:

(1) Richland, Washington - 1.7 fires per 1000 population

(2) Bellingham, Washington - 9.6 fires per 1000 population

(3) Eugene, Oregon - 14.7 fires per 1000 population

Fire protection since February 1944 has been under the supervision of the Operating Department (See Vol. 3).

g. Red Cross (See App. A 114). - Early in the construction of the village, a chapter of the American Red Cross was established in Richland and was originally located in an existing residence. Due to the interest shown by the residents in the Red Cross and the work performed by it in the war effort, the Government directed that a permanent Red Cross Headquarters be established.

h. Children's Nursery (See App. A 115). - Early in the planning of the village, the need for a children's nursery to provide care for children of working mothers was recognized, but the matter was held in abeyance until the summer of 1944 in order to determine the actual requirements for such a unit and to ascertain, at that time, whether or not any of the existing buildings and residences not previously allocated would be suitable for a nursery. For this purpose, an existing residence at the corner of Lee Boulevard and Goethals Drive was selected. The residence itself was converted for use as a nursery and, in addition, two hutments were erected adjacent to the original structure. For the school year 1944-45, $47,224 of Lanham Act funds were provided for the nursery

[redacted]

(See App. B 3).

9-8. Housing Maintenance. - The Contractor started a painting program in the spring of 1946 for exterior trim on permanent houses and for complete exterior painting on the prefabs; painting of prefab roofs was about 40% completed during the summer of 1946, but the program for exterior trim on regular type houses probably will be spread over a period of about three years.

Furniture equipment and maintenance presented an increasing problem as the furniture became older, and consideration was given to the advisability of setting up a furniture repair and exchange store as a commercial facility in Richland.

9-9. Commercial Facilities (See App. A 130-146). - All normal essential living requirements, such as food, drugs, clothing, miscellaneous supplies, entertainment, and similar needs, were provided by commercial establishments. This arrangement proved to be very satisfactory, as indicated by the lack of complaints from village residents. The commercial operators maintained as complete stocks of quality merchandise as conditions permitted. Prices were checked periodically and maintained at the prevailing levels of those in the nearest towns, with Office of Price Administration regulations as the controlling factor where applicable. The facilities were not operated by the Government or the Contractor but by concessionaires (See App. B 4), who were selected by competitive bids on the basis of maximum monetary return to the Government, as well as maximum service to the village. All mobile equipment used by various commercial facilities throughout the village was provided by the concessionaires, while all stationary equipment was provided as a

[redacted]

part of the building. In evaluating the bids of prospective commercial operators (See App. C 14), consideration was given to past successful experience, financial responsibility, and procurement capacity under existing difficult conditions. Only two of the original Richland business operators were considered as meeting these requirements and both declined to enter bids.

In August 1946 the Veterans Administration made arrangements for a contact office in Richland and rented a tract house at Cullum and Davenport for office use.

a. Commercial Rentals. - Considerable thought was given to the establishment of a basis for rentals of facilities to the various commercial operators. Uncertainties in the volume of business and the duration of operation introduced difficulties in arriving at equitable arrangements. Consequently, it was decided that rental would be determined as a percentage of gross income from the business and that each prospective commercial operator would include his percentage as a part of his bid, to be evaluated in combination with other considerations in selecting the successful bidder (See App. C 16). This method was followed in the great majority of cases.

By July 1946, the Government had taken in a total of $570,155 as rentals on commercial facilities in Richland since the start of the Project. Two service stations had paid in rent more than the cost of their buildings, while several operators, principally food stores and drug stores, had paid in more than 85% of the cost of the buildings they occupied. However, several of the facilities found it necessary to request temporary reductions in rent because business had fallen off, due primarily to inability to get adequate merchandise.

9-11. Community Organizations. - In a town as self-contained as Richland Village, held together by a common bond of employment, it was inevitable that community organizations became the rule, rather than the exception. With a population recruited from all parts of the country, every conceivable interest in communal activities was displayed and, by the latter part of 1946, there were 64 community organizations on the Project, counting all Boy Scout Troops as one organization, all Camp Fire Groups as one, and all Girl Scout Troops as one.

A Civil Air Patrol Squadron was organized in 1945 and, early in 1946, the squadron was authorized to establish, at its own expense, a landing field south of Richland. The squadron leased a tract house for use as headquarters and constructed three gravel-surfaced runways.

The American Legion rented from the Project the old high school building and made it over into a club house, all alteration being done at the expense of the Legion. To finance their operation, the Legion installed two good dance floors and a bar for beer sales.

9-12. Recreational Facilities. - With the completion of the Recreation Hall, and with numerous groups organized for various special activities, facilities for adult recreation in Richland were believed to be adequate. Recreation for teen-age children, however, presented a serious problem, since Federal funds under the Lanham Act were not available for a recreational program. It was necessary, therefore, that various Richland civic organizations and the schools combine and coordinate their efforts to provide essential recreation for the teen-age groups.

Various groups or associations, such as the Coordinate Club, the

Government Engineer's Club, and the Masonic Lodge were established in Richland from time to time, and all facilities, such as the High School auditorium and the Recreation Hall lounges, were made available for use to these and any other groups in the village. In addition, various existing residences in the village were renovated and rented to the various organizations and groups for use as clubhouses.

SECTION 10 - REAL ESTATE

10-1. <u>General</u>. - While proper discussion of real estate, land acquisition, and related problems is made in Volume 4 of this series, some problems existing in the operations phase provided management with slight difficulties. By the end of 1946, there were a number of tracts still in condemnation, on which settlements had not been obtained. (See Volume 4.)

10-2. <u>Road Condemnation</u>. - Two pending cases involved state and county roads and highways, one covering State Highway 11-A (running from Cold Creek to Hanford) which was condemned and $1.00 deposited as compensation. The State claimed sufficient compensation to permit relocation of the highway on one of two sites, north of the Project, construction costs estimated at one and two million dollars.

In the other action, covering proposed road construction along Wahluke Slope to connect Yakima with Connell, Washington, the two relocation sites called for passage through (1) the Cold Creek area of Hanford Engineer Works or (2) the Yakima Artillery Range. Since the U. S. Army planned to retain the firing range as a permanent installation and since Project policy prevented public highway access to any area, court action appeared inevitable.

All county roads were acquired by condemnation, the sum of $1.00 being deposited as compensation. The County claimed about $200,000 but had less of a case than did the State, because the county roads all dead-ended on the Project and no relocation was involved. In an apparent

[redacted]

effort to establish need for a relocation, however, the County asked the Area Engineer if the Manhattan District would construct a highway along the west side of the project, up Cold Creek, connecting the Benton City highway with the state highway at Cold Creek, all mileage located within Area "B" of the Project. The County was advised that no such highway could be constructed.

10-3. Land Actions. - In an effort to obtain higher compensation for their land, approximately 60 land owners petitioned the Federal Court to set aside the deeds given to the government. Hearings were held on three of these petitions, the Court ruling that the deeds could not be set aside since no fraud or misrepresentation was shown; similar ruling should be forthcoming on each of the petitions.

For a period of about eight months, during the interval between the resignation of Federal Judge Lewis Schwellenbach and the appointment of Samuel Driver to the Bench, the Department of Justice was able to accomplish little in the federal courts in connection with the Hanford condemnation cases. Consequently, directors of the Priest Rapids Irrigation District petitioned the dissolution of the District and distribution of its assets. The Department of Justice had hoped to confine such activities entirely to the Federal Court, inasmuch as the District planned to ask large compensation for the physical assets of the Priest Rapids Power Plant and the Coyote Rapids Pump Plant; however, since none of the visiting federal judges would act on this case, the directors were able to get the matter into the state courts as well as the Federal Court.

10-4. Columbia Basin Project. - In November 1946, the Department

[redacted]

[redacted]

of Interior (Bureau of Reclamation) asked authority to survey a canal right-of-way across five miles of government-leased land, on the Wahluke Slope, at the north end of the Hanford project. The Bureau was advised that the Manhattan District could not approve this work, pending decision regarding acquisition of all leased lands in fee. The Reclamation Bureau asked for an early decision, inasmuch as part of its Columbia Basin planning was contingent on the availability of the Wahluke Slope to irrigation. Another factor tied in with future use of the Wahluke Slope was the proposed relocation of State Highway 11-A, as described above.

10-5. Wartime Leaseholds. - In December 1946, the Manhattan District was advised that leaseholds were held on about 60 tracts under condemnation action for the duration of the war only; at the end of the war, or termination of the National Emergency, these leaseholds would lapse and it was essential that new condemnation actions be instituted to continue the leased status. Relating to this problem was the fact that many land owners have capital tied up in lands under lease to the government, and several desired sale to the government in order that their capital would be released.

10-6. Richland Cemetery. - The government acquired the Richland Cemetery by condemnation but, inasmuch as ownership of the cemetery was not essential to the Project and since it was intended to keep the cemetery available to the public for burials, steps were taken toward revesting the tract title (except for its appurtenant water rights) in the town of Richland. This was done on 25 November 1946 by the Federal Court, with the stipulation that the old town of Richland, having about $15,000

[redacted]

cash in the treasury, convey title to a cemetery association and set up funds for permanent administration by the association. Remaining funds would go to the state school funds when the incorporated town of Richland is dissolved by the state courts.

10-7. Federal Prison Industries. - At the initiation of the Project, little was known as to how long many of the leased farm units would be needed to preserve the security of the Project. Apart from the fact that certain farm lands were incorporated into the area of Richland Village and that many nearby houses, as well as others near the town of Hanford, were utilized during construction, it was felt that buildings should be maintained and land kept in cultivation in order to bring better prices at future sale, if the unit were government-owned, or to bring about restoration to owners of leased lands of property that was still in good condition. Therefore, a contract was entered into with the Federal Prison Industries in the summer of 1943, covering care of farms and orchards, whereby prisoners did the work, the resultant crops became the property of Federal Prison Industries, and the food was processed at McNeil Island Prison, on Puget Sound. In addition to cultivating the farm lands and orchards, the prisoners maintained pipe lines, fences, and other farm property.

The prison camp, known as Columbia Camp, had a capacity of 300 inmates and wartime population approximated capacity at all times. In 1946, the population began to drop until, by October, the camp housed 120 inmates, 26 maintenance personnel, and 25 field personnel. During the war years, there was a relatively large prison population of conscientious objectors who were easy to handle in field operations.

[redacted]

After the cessation of hostilities, the number of conscientious objectors decreased and it became difficult to supply the camp with inmates because of custodial problems presented by the more hardened type of offenders.

Originally, the FPI farmed approximately 1300-1500 acres but by 1946, this area had dropped to 800 from which excellent yields were obtained in fruit, produce, and hay while fruit on the remaining portion of orchards inside Richland proper was sold to the village residents on a self-pick or picked basis.

[redacted]

SECTION 11 - INTELLIGENCE & SECURITY

11-1. General. - Activities of the Military Intelligence Division during the operations period followed the same pattern as during the construction period, which was described generally in Section 6, Volume 1. However, following the atomic bomb raids on Japan in August of 1945, some changes in policy were necessary. Up to that time, secrecy served as the basis for the security policy but, as publicity after the bombings revealed the purpose of the Project, it became necessary to strengthen security control from a physical and internal standpoint. This was accomplished gradually, and with a minimum of publicity, by redistribution and augmentation of the exterior guard forces, higher clearance standards for old and new employees, a strict publicity control, and other similar measures based upon the principle of safeguarding that which the Project is known to possess.

11-2. Liaison with Prime Contractor Security Section. - Under the terms of the Prime Contract, the Contractor was charged with the responsibility of protecting the Hanford Engineer Works against espionage and sabotage and for the safeguarding of classified information. In this connection, the Military Intelligence Division maintained constant and close liaison with the Contractor, passing on all matters of policy, procedure, and jurisdiction. Frequent meetings were held to discuss new and/or improved security measures and to promote coordination of the efforts of both houses. It was in this manner that the Manhattan District security policies and regulations, as well as the local security requirements, were effected without noticeable conflict with existing conditions.

11-3. Liaison with Outside Agencies. - The Military Intelligence Division maintained constant liaison with Federal, State, County, and local agencies within the territory assigned by the Manhattan District. The division had an established contact with the Federal Bureau of Investigation, the Office of Naval Intelligence, Army Intelligence and Counter-Intelligence, State Police and, in most cases, local police and sheriff's offices in Washington, Idaho, Oregon, Montana, and Wyoming.

The Seattle Field Office of the FBI assigned a resident agent to the Richland Area. This agent maintained his office in the Military Intelligence Building, concerning himself with all project matters of interest to or falling within the jurisdiction of the FBI.

Since Manhattan District Security Offices throughout the country, each covering its assigned district on all matters pertaining to the Project, had contacts with offices and agencies enumerated above, nation-wide contacts were available to the Military Intelligence Division in short order.

11-4. Safeguarding Military Information. - The responsibility for the Safeguarding of Military Information at Hanford Engineer Works, which was the Contractor's responsibility according to the Prime Contract, was actually handled as a divided function. The Contractor Security Office handled those phases of SMI pertaining to Contractor operation and personnel, while the Military Intelligence Division handled SMI problems and procedures for Government activities and personnel.

Both Security Offices were guided in all phases of SMI activity by

Army Regulation 380-5 and its interpretations, as directed by higher Manhattan District authority. Relationships between the two offices were very cordial, and SMI plans and activities were freely discussed, thus promoting thought along such lines and providing a constant sour of new material.

The SMI program at Hanford Engineer Works was divided into three general phases as follows:

a. Safeguarding Classified Information and Material. - (For the most part, this was accomplished by application of the provisions of AR 380-5.)

b. Security Education of Personnel. - (This was accompli ed by the use of large "Jumbo" signboards, posters, lectures, bulleti security training films, etc. See App. B 14.)

c. Violations and Dispositions. - (This involved the recording of all violations of the Security Regulations and the taking appropriate corrective action.)

11-5. Personnel Clearances. - All Project employees (including those of the Prime Contractor, subcontractors, facility operators, con cessionaires, consultants, and the government, as well as miscellaneou part-time employees) were subjected to clearance investigation, the ex tent of which was predicated upon the position of the employee and the degree of access to classified information. In this function, the gov ernment and contractor security forces operated on a divided basis, ea office handling clearances for the personnel assigned to its own organ sation. The Military Intelligence Division received from the Contract Security Office all data as to final clearance of all personnel to facilitate permanent record maintenance; any personnel clearance investigation that developed into a matter relating to espionage, sabotage, sedition, treason, or any subversive element, was turned over to this division for further action.

11-6. <u>Investigations</u>. - The Division was responsible for the investigation of any incident, person or persons, which ~~of who was~~ might be in any way suspicious or involved in the elements of espionage, sedition, sabotage, treason, or general subversion within the boundaries of the Project. Such investigations outside the boundaries of Hanford Engineer Works were under the jurisdiction of the FBI, yet through close liaison between the FBI and the Military Intelligence Division, such investigations which concerned the Manhattan District were handled on a joint basis.

11-7. <u>Physical Security</u>. - The physical security control of the Project was divided into two sections: the inner or Production Areas, and the outer or Perimeter Control. Inner Security Forces were composed of contractor civilian guards, supervised by the Contractor Security Section; the Outer Security Forces were members of the U. S. Army, Military Police Detachment #2, which unit was permanently assigned to Hanford Engineer Works. While the administration of the Military Police detachment was a command function, responsibility for the protective measures enforced by its members rested with this Division.

Contractor guard force members were deputized by the Sheriff of Benton County and acted in that capacity as occasion demanded. These guards were also sworn in as Auxiliary MP's and, in emergency, would be subject to military control.

[redacted]

11-8. Shipment Security. - Shipment from the Project of all classified items and materials was also a responsibility of the Military Intelligence forces. The utmost secrecy required in transferring the end product from Hanford Engineer Works to the processing agency at Los Alamos, New Mexico, necessitated a policy of classifying as "Top Secret" all records concerning cumulative production figures and inventories. Actual shipping papers were coded and classified as "Secret." This procedure was adopted with the initial shipment and remains in effect at the present time. Records concerning such figures were kept in the office of the Chief of Production, who accepted all end product from the Prime Contractor in the Isolation (231) Building.

Since the product, after such transfer, became the responsibility of the Area Engineer, and since the nature of the shipment demanded it, the responsibility for escorting the product off-site was necessarily given to the Military Police Detachment stationed at Richland. At all times during which these men were on escort duty, they were heavily armed and travelled in vehicles equipped with two-way radios, thus allowing constant contact between vehicles. Furthermore, all convoys were self-supporting and travelled from Richland to destination without layovers, stopping only for refueling purposes. During August 1946, it was found desirable to change the method of transportation from automotive to rail, utilizing for this purpose, a specially equipped railway car.

Further details of shipment security procedures and developments will be found in the "Top Secret" appendix to this volume.

11-9. Security Surveys. - Within the plant area, sabotage and espionage protection, fire protection, the security aspects of Production

[redacted]

Continuity, and miscellaneous items bearing on general security were subjects of continuous surveys. Security Survey personnel covered all operating areas every sixty (60) days and were directed from time to time to perform special surveys in connection with shipments, MP control, and civilian guard force activities.

11-10. Training. - The Military Intelligence objectives called for a continuous training program for intelligence agents and selected personnel. This training was designed to keep investigation personnel informed on latest developments of investigative technique and equipment and acquainted with current activities of known and alleged "subversive groups," and new developments in the field of espionage and sabotage.

SECTION 12 - COMMUNICATIONS

12-1. Telephone. - The permanent telephone system for Hanford Engineer Works was designed jointly by the Prime Contractor and the Signal Corps, being built by the latter with the aid of Pacific Telephone and Telegraph Company crews. As each unit was completed, it was taken over by the Area Engineer for operation through the Prime Contractor who supplied and supervised all switchboard operators. Maintenance was also performed by the Contractor because it was impossible to recruit Government employees for such work while Contractor approved wages were at a much higher level than those approved under Civil Service locality wage surveys. The system, as of 1 January 1944, at which time it was practically completed, consisted of the following:

(a) 139 miles of lead-covered cable (13,794 wire miles);

(b) 439.19 miles of open wire;

(c) 3640 poles;

(d) 2544 cross arms; and

(e) 16 switchboards, approximately 2600 lines.

This network provided full intercommunication between all offices and other activities in the area. It also provided commercial telephone service to residents and business houses of Richland, as well as complete facilities for outlet to Pasco and Kennewick and the long distance lines of the Bell System. Adequate transmission between Pasco and Hanford was provided during the construction period by 24-voice frequency repeaters located at Richland, tied in with an 11-position switchboard at Hanford (900 lines) and a 2-position board at Central Shops (200 lines).

In March 1945, the Central Shops Exchange was closed, as was the Hanford Exchange, at which time the remaining security telephones were connected to a 1-position PBX established at Hanford Fire Station. All Hanford and Central Shop equipment was salvaged, returned to Signal Corps or retained for local re-use, or excessed as in the case of cable, terminals, and telephone repeaters. This move from Hanford increased Richland traffic substantially, requiring re-arrangement of certain portions of the Plant into permanent condition. Cable additions were made to provide facilities needed for offices and residences as movement of construction personnel from the Project and of operations personnel to the Project began.

12-2. Telegraphic. - The local network carried telegraphic services consisting of 1 TWX connection with the Army Administrative Network, another TWX with code equipment, and a printer circuit to handle Western Union messages between the message center and the Richland Western Union Office.

At the peak of operations in Hanford, telegraphic service was provided as follows: 2 TWX teletype printers (one with code equipment) operated by WAC personnel in the message center of the Area Engineer's Office; 2 Western Union printers, 2 Bell System TWX printers, and 1 direct Hanford - Wilmington printer circuit operated by the Contractor; and 2 News Service printers for the receipt of world news. In addition, Western Union maintained a Hanford Office. As operations started, equipment was gradually moved to Richland until, by the spring of 1945, all equipment was consolidated in the Government Message Center at Richland.

In addition to the telegraphic services described above, there was available a railroad dispatching line, 45 miles long with approximately 16 stations, and a power dispatching line, same length but with 8 stations, as well as wires for fire, burglar alarm, remote control and monitor of radio stations.

12-3. Conversion of Telephone System. - By December 1945, telephones in service had increased to 3755, while lines in service were 2260, and maintenance manhours decreased somewhat to 2652 per month. During this increase in telephones and lines, all telephone systems in the manufacturing areas were converted to dial operation, the equipment being installed by the manufacturer, Automatic Electric Sales Company of Chicago, Illinois. The rebalancing and retermination of trunk cables at the control office (and Tandem Office known as "BY") was handled by Ninth Service Command Signal Corps, while Communications Branch personnel installed the dials, total service being cut in by the middle of November 1945.

This installation speeded up service and eliminated expense and transportation of operators, yet the unattended lines were liable to sudden failure and thus safeguards were made necessary, such as 24-hour coverage, test desk for remote testing of all offices, cable-carrying trunks to be under constant gas pressure, and emergency manual switchboards. The latter--manual switchboards for emergency--were completed at "BY" in October 1946, while work is still in progress toward gas pressurising the trunk cable.

Studies were under way at the end of 1946 to provide a basis for possible dial conversion of the Richland Exchange, while many other modifications were completed at this time, such as a switchboard at the MP Detachment Area to service all outpost guard telephones, Cossack Post extension north of the Columbia River, re-grouping of party line stations to provide additional vacant jacks, and change of the hospital switchboard from "through" to "local" supervision.

[redacted]

SECTION 13 - PUBLIC AND LABOR RELATIONS

PART I - PUBLIC RELATIONS

13-1. General. - Prior to June 1945, duties of the public relations staff involved the "suppression" of Project news, all efforts being concentrated on maintaining the Hanford Engineer Works security program through the medium of support from outside organizations, near-by community and state governing bodies, and news outlets. To this end, news outlets were encouraged to handle the "normal community angle" of Richland news in lieu of technical information.

During July of 1945, preparations were made for anticipated "bomb-drop" press demands, while the remaining activity in 1945, following the atomic bombings, was characterized by the release of news concerning Hanford and general Manhattan District war activities, with a constant flow of press and radio visitors to the Project.

In 1946, the major releases concerned activities of Richland Village, although many rewrites of past publicised Project information were in demand by news outlets. Significant articles covered reviews of developments during the first post-bomb year; the changeover of contractual arrangements from du Pont to the General Electric Company; and the appointment of a civilian Atomic Energy Commission. Public relations for both Contractors' and the Government offices were handled by the Public Relations Office of the Government forces.

13-2. Functional Changes. - Release of atomic bomb news allowed certain freedom in Project talk and permitted release of news covering the building and physical make-up of Hanford, general activity and

[redacted]

personalities, but did not relax responsibility for the control of news. Curiosity and probing followed publicity about Hanford, and the need for alertness in suppression of news and speculation remained as important as in the early development, in order that national security might not be endangered. To offset such curiosity, censorship was lifted sufficiently to publicize open community enterprises, and the Public Relations Office guided programs for Richland Day celebrations, "E" Award events, and Atomic Anniversary affairs.

13-3. New Policy. - An obligation was felt toward the press, radio, and certain community organizations for their splendid support of the Hanford Engineer Works security program. To meet this obligation, a new public relations policy was established, allowing "all out" cooperation with these bodies up to security limits. No attempt was made for stunt publicity or "built-up" handout releases but the Public Relations Office cooperated to the fullest extent possible in aiding news outlets which developed stories on their own initiative. General releases from the Office concerned only policy changes, Contractor changes, or items of general public interest, which were widely distributed without favoritism.

Further efforts to foster good public relations resulted in acceptance of outside speaking engagements throughout the Pacific Northwest and along the Pacific Coast. For the most part, these engagements were filled by the Area Engineers and the policy developed excellent relations in the area, to the extent that there has been a continued voluntary support of the security program, even with abolishment of wartime censorship measures.

PART II - LABOR RELATIONS

13-4. General. - Labor trouble in the sense of differences between labor and management presented practically no problem to Hanford Engineer Works during the operations phases. Minor problems existed as during construction but were settled promptly and satisfactorily to all concerned.

Attempts were made to organize operations workers for the purpose of collective bargaining, but friendly discussions between the interested groups and the Area Engineer's representatives resulted in a discontinuance of such attempts. Existing unions appealed to the War Department and obtained permission to hold elections at Oak Ridge but were requested to withhold such Hanford attempts until security permitted. This request was honored completely by the union bodies, all organizational efforts for the purpose of collective bargaining being held in abeyance. However, a small group of Hanford workers, members of AFL unions, attempted to recruit new members but these efforts were unorganized and, as a result, ineffective.

Portal-to-portal claims appeared possible at the close of 1946 when the Metal Trades Union threatened to file such a suit against the Contractor, covering construction. So far, no indication exists that this threat will materialize.

[redacted]

SECTION 14 - PROPERTY ACCOUNTABILITY & DISPOSAL

14-1. General. - During the period of transition from the construction phase to full-swing operations, the Area Engineer's Propert Branch was divided into two organizations, one to continue with the d posal of whatever construction property and equipment remained on the Project, the other to set up and organize for the functions of purcha inventory, storage, issuance, salvage, disposal of excess and surplus record maintenance under the operations phase, as required by existin regulations. At this time, the Area Engineer released the du Pont Co pany from responsibility for Hanford Camp and the stocks of remaining excess, transferring such accountability to his representative, the Accountable Property Officer.

14-2. Duties & Responsibilities. - The Accountable Property Off: cer decided, at this time, to establish his own accountable records a separate and distinct from those of the Prime Contractor, so that a m rigid control of property might be maintained and that equipment and supplies being purchased or secured from excess stocks might be supervised. For this purpose, three sections (Accounts & Records, Equipme and Field Audit, Receiving and Warehousing) were set up, located in th Administration Building, Richland. To establish the desired accountability control, records were to be built up from contractor inventori for clearance against construction records, which had to be brought to zero balance; however, progress was slow due to lack of personnel and confusion in methods of closing the construction period and transferri property on hand to the proper organization. Nevertheless, during thi

[redacted]

period, the Accountable Officer picked up on record all items purchased and received by the contractor. In addition, real property records were started in November 1945 and information necessary to initiate the records on all property acquired by purchase, lease, easement, etc., was received from the Pacific Division of the U. S. Engineer Department; records covering the original acquisition of land were completed about 15 July 1946, and for the 100 and 700 Areas during October.

14-3. Handling of Excesses. - Between July 1945 and February 1946, this office transferred all excesses from this Project to Little Pasco Engineer Redistribution Depot, a depot of the Pacific Engineer Division, under procedures which allowed physical movement from this installation, which was not possible if this office dealt with the War Assets Administration directly. In January 1946, upon notice of the prospective closing of Little Pasco as a redistribution center, this office found that the Pacific Engineer Division refused responsibility for handling of excesses through the nearby Pasco ASF Depot; therefore, immediate steps were taken for the transfer of Little Pasco to the Hanford Engineer Works as an off-project installation (for handling excesses only). As a result, this office continued to ship excesses to Little Pasco for further transfer to War Assets Administration on War Department Shipping Document, a system continued until August 1946, when, due to the freeze on shipment of excesses, Little Pasco was transferred to the North Pacific Division. In this move, the officer-in-charge at Little Pasco was relieved of that duty and given charge of redistribution and salvage at Hanford Engineer Works. When the freeze on shipping excess was lifted, arrangements were made with WAA at Seattle to ship to

[redacted]

[redacted]

Auburn, Washington, but these arrangements were soon changed to cover shipment to Spokane on War Department Shipping Document and later, to Helena, Montana, under the same conditions. The latter change slowed the program of excess disposal since it was necessary to forward exce lists through Spokane WAA office to the Helena office. Preparation of SPB-1 and SPB-1.1 (surplus declaration) forms was not required in thi arrangement. Late in 1946, authority was received from WAA to start shipment into Pasco ASF Depot under similar arrangements.

14-4. Audit of Records. - In April 1946, at the request of this office, a representative of the Manhattan District Property Audit Off was sent to perform a pre-audit of records and to suggest possible co rection of construction records. His report stated:

(1) The accounts were in such a condition that a complete audit would require a team of 5 men for a period of three months.

(2) Military Intelligence property was not accounted for.

(3) Military Police property should be on record.

(4) The ten-dollar limit was being correctly used on construction only.

(5) Real property records were only 15% completed.

(6) An estimated 75% of Class B property was not on record.

(7) Expendable property from construction was not on record.

(8) No written evidence existed of governmental check

[redacted]

[redacted]

on contractor records.

(9) Decalcomanias in use to identify property were not suitable.

(10) Survey Board should be appointed to clarify the situation.

A request by the Area Engineer that the latter board be set up resulted in another pre-audit by representatives from the District Office, following which discussions decided that an audit team was necessary, that Capt. W. J. Morrell be appointed Accountable Property Officer, and that corrective action be taken on points brought up by the District representatives. The major correction effected in records was to create a different account for contractor and military property.

14-5. Reorganization. - In line with the above suggestions, in May 1946, Capt. W. J. Morrell was appointed Accountable Property Officer. He took immediate steps to reorganize, submitting a new organization chart which was approved in June 1946, with recruitment starting in July. From a section of 24 people, an organization of 89 civilians and 2 officers was built, although by the end of 1946, it was possible to reduce this personnel by 8 civilians. This new arrangement set up the Property Branch directly under the Administrative Officer, with the following sections:

(1) Accounts and Records Section.

(2) Field Audit and Perpetual Inventory Section.

(3) Excess Disposal and Transfer Section.

(4) Stock Issue Control Section.

To take care of the expanded size of this Branch, offices were moved

[redacted]

[redacted]

from the Administration Building to Dormitory W-8 which had been remodeled to make suitable space. In September 1946, the procurement functions were transferred to the Property Branch and incorporated with stock issue functions to create a Procurement and Stock Issue Control Section, responsible for procurement, issuance, and control of materials and services. All warehouses operated by the Property Branch were closed in order to permit drawing all material from the Prime Contractor by requisition; all property in government warehouses was turned over to the contractor as excess for assimilation into regular stock or for declaration on monthly excess reports. This arrangement, plus separation of the military property account from the contractor property account (completed in September 1946), made possible continuing audits to verify correctness of records.

14-6. Hanford Demolition. - During February 1946, the Mohawk Wrecking Company was awarded a contract to dismantle a part of Hanford Construction Camp, for which work the Property Branch furnished checkers to inspect each load shipped. In May 1946, this procedure was superseded by one initiated by the Military Intelligence Division whereby security patrols around the residual area were given the responsibility of checking the Contractor's shipments. Following the completion of the Mohawk Contract, it was planned to retain the balance of Hanford Camp as a residual camp, with equipment and furnishings stored in Mess Hall #1.

14-7. Change of Contractors. - Effective 1 September 1946, the General Electric Company signed an acceptance of responsibility for all property located on this project and charged previously to the E. I. du Pont de Nemours and Company. The Area Engineer relieved the du Pont

[redacted]

Company by letter of responsibility for all property charged to it in performance of its contract with the Manhattan District.

14-8. <u>Trail Project</u>. - In September 1946, the District Office at Oak Ridge, Tennessee, forwarded to this office the account of the Trail, B. C., Area. The Trail records covered only Class B property purchased or transferred to Trail from the beginning of operations since the contractor maintained the Class C records, while the records for Class A property were non-existent. An inventory, taken in November and December, resulted in assignment of property identification numbers to all Class B property at the Trail Project.

SECTION 15 - DEMOLITION OF HANFORD CAMP

15-1. General. - Following the completion of construction in February 1945, all administrative and service offices were moved to Richland. Hanford Camp was abandoned, since its proximity to the operating areas made very likely a disaster of catastrophic proportions, should an explosion of any consequence occur in the plants. Further, it was believed easier to maintain security if the non-operating population (facilities employees and families of workers) was outside the restricted area.

This abandonment resulted in a decision to demolish most of Hanford Camp, leaving only a residual camp capable of housing 1000 men, in the event some emergency construction became necessary. Bids for demolition and clean-up of the portion to be wrecked were called for and the successful bidder was the Mohawk Wrecking & Lumber Company of Detroit, Michigan. The successful bid was $103,003.30.

15-2. Progress. - The wrecking program was commenced in January 1946 and completion was planned in twelve months (approximately 26 January 1947). Demolition progress was as follows:

	31 August 1946	31 December 1946
Structures	64.5%	99.0%
Trailer Camp Areas	80.0%	100.0%
Water Distribution	8.2%	93.0%
Steam Distribution	90.0%	100.0%
Electrical Distribution	90.0%	100.0%
Miscellaneous Fences, Etc.	55.0%	90.0%

[redacted]

15-3. Personnel. - This rate of progress was accomplished by a relatively small wrecking crew, the peak being about 363. The employment figures were as follows:

January	88	July	338
February	143	August	251
March	318	September	248
April	352	October	275
May	363	November	238
June	316	December	207

15-4. Main Salvage Items. - Main salvage items included lumber and plasterboard, for which the Mohawk Company found a ready sale, with lumber selling at prevailing new lumber prices. Some of the approximate quantities recovered by 31 December 1946 were:

Lumber	23,000,000 board feet
Water Pipe, wood stave	157,000 linear feet
Water Pipe, steel	9,000 linear feet
Overhead steam pipe	55,000 linear feet
C. I. Soil pipe	58,800 linear feet
Plasterboard	6,500,000 square feet
Cast Iron fittings	33,500 items

Salvage of lumber was estimated to be about 95% suitable for re-use, with 80% of the total salvage being sold in the Pacific Northwest. Fire hazards were held to a minimum, with one fire partially destroying one wing of the convalescent hospital. All fire losses were absorbed by the Contractor.

15-5. Injuries. - Despite the nature of the work, injury cases

[redacted]

were not unusually high, with 509 cases recorded as follows:

(1)	Puncture wounds, contusions and abrasions	320
(2)	Lacerations	61
(3)	Splinters	45
(4)	Strains and sprains	32
(5)	Eye injuries	31
(6)	Fractures	7
(7)	Burns	6
(8)	Inguinal hernias and strains	4
(9)	Tooth injuries	2
(10)	Amputations (partial - finger)	1

15-6. Equipment. - During the wrecking program, the Mohawk Company utilized 13 trucks, 6 trailers, 4 tractors, 4 motor scooters, 3 cranes, 6 buses, 3 bus trailers, 4 bulldozers, 3 backhoe trenchers, and 2 A-frames.

15-7. Government Salvage Activities. - Prior to the letting of any Contract to a commercial salvage company, it was decided that a crew under the direction of O. S. Clark, Chief of the Area Engineer's Engineering & Maintenance Division, would operate in the Hanford Camp to recover and rehabilitate all electrical and mechanical equipment, to be later redistributed to other portions of the Project for re-use. Much of the salvage in this operation, however, was declared excess to Project needs and shipped to other parts of the Manhattan District or placed for disposal by proper excess disposal agencies.

SECTION 16 - LEGAL ASPECTS OF THE MANAGEMENT AND CONTRACTUAL CHANGEOVER

16-1. General. - No substantial changes were apparent with respect to the basic legal status of the Project and the legal relationships between the Government and the operating Contractor, other than those involved in the operating changeover from the du Pont Company to the General Electric Company, effective 1 September 1946, and from the Manhattan District to the Atomic Energy Commission, effective midnight 31 December 1946. Contract No. W-7412 eng-1 with the du Pont Company was terminated formally by letter dated 25 July 1946. The new Contract with the General Electric Company, No. W-31-109 eng-52, is essentially the same type of cost-plus-fixed-fee Contract as that which existed between the Government and du Pont.

16-2. Insurance and Compensation. - The changeovers were effected with a view to retaining, insofar as possible, all existing legal arrangements. Thus, a new insurance agreement between the General Electric Company and the Travellers Insurance Company, dated 30 October 1946, contained substantially the same provisions as the previous agreement to which du Pont was a party. Similarly, the name of the General Electric Company was substituted for that of the du Pont Company in the tri-partite agreement with the State of Washington, covering the administration of workman's compensation and occupational disease, by Modification #1, dated 1 September 1946. Under the terms of this modification, General Electric will handle not only its own compensation claims, but also those arising during the term of the du Pont Contract. In view of the fact that this arrangement with the State is based upon emergency wartime legislation (Chapter 85, Session Laws 1943, State of Washington), arrangements will be necessary in the near future to extend the existing State Legislation or to adopt some substitute arrangement.

16-3. Executive Order No. 9816. - By Section 9 of the Atomic Energy Act, approved 1 August 1946, the President was authorized to direct and did, by means of Executive Order No. 9816, the transfer to the Atomic Energy Commission of all property under the jurisdiction of the Manhattan District, effective 31 December 1946. The announced policy of the Commission was to continue existing practices and procedures insofar as they are compatible with the Atomic Energy Act.

16-4. Establishment of Hanford Military Area. - By Public Proclamation No. 26, dated 12 November 1946, the Commanding General of the Sixth Army designated the Hanford Engineer Works reservation as "Hanford Military Area." The reservation had been established as a Military Exclusion Area by Public Proclamation No. 18, dated 14 July 1943, with the new proclamation, effective 2 December 1946 and containing substantially identical provisions other than boundary revisions, superseding the old order.

16-5. Litigation. - At this writing, no law suits had been entered against the General Electric Company by reason of its operation of the Hanford Engineer Works. Most of the lawsuits pending against the du Pont Company involved personal injuries, workmen's compensation claims, and Fair Labor Standards Act claims. One case, pending in the United States District Court for the Eastern District of Washington (Gordon et al. vs. du Pont), may decide whether du Pont, in performing under its Contract

[redacted]

at Hanford Engineer Works, was engaged in interstate commerce or in the production of goods for interstate commerce within the meaning of the Fair Labor Standards Act.

[redacted]

[redacted]

SECTION 17 - COSTS

17-1. General. - It was necessary to give considerable time and study to the type of cost accounting to be used in connection with the operation of the plant. Because of the policy of security, that records of classified materials be kept separately (See Par. 6-2), it was determined that no effort would be made to maintain unit costs, but that a system of expenditure costs would be used with breakdowns according to processing areas. A system was established in accordance with the Prime Contractor's cost system being used in ordnance plants, with certain modifications to conform with general cost accounting methods in use by the Corps of Engineers. A detailed account of costs was maintained by the Prime Contractor, and the Cost Section in the Office of the Area Engineer maintained a control account of Contractor's costs plus detailed records of Government maintenance and overhead costs.

17-2. Cost Tabulation. - A cost tabulation (See App. B 6) gives the breakdown on the major phases of plant operation in each processing area. This breakdown covers all operating costs (exclusive of classified material costs) during the period 1 January 1944 through 31 December 1946, although the operating period did not begin until 1 April 1945, at the official close of the construction period. Contractor and Government overhead and indirect distributive costs have been added to this tabulation to reflect total plant operation costs. However, in arriving at total expenditures by the Government, it will be necessary to add approximately $4,900,000.00 to cover the cost of inventories which, although an actual expenditure by the Government, do not appear as an

[redacted]

operating cost until the materials covered are used in the operation of the plant. Distributive and overhead costs as shown on the cost tabulation are comprised of both Contractor and Government expenditures and include the following: General Superintendence; Maintenance General; Patrol; Employment; Safety; Fire Protection; Transportation General; Automotive; Railroads; Administrative Functions; Warehousing; Vacation Salaries; Taxes; Medical Expense (Less Revenue); Village Maintenance Expense (Less Revenue); Contractor's Home Office Expense; Government Maintenance Expense (Including Patrol by Military Police, Maintenance of Farm Lands, and Telephone Maintenance); Government Overhead; and Miscellaneous Contractor and Government Overhead and Indirect Cost.

17-3. Cost Graph. - It should be noted that the average monthly operating cost, as shown by the cost tabulation, does not give a fair basis for future determinations because it covers a period when only a portion of the plant was in operation and an additional period of start-up and experimental work, when a large force of technical and maintenance employees was necessary to cope with unexpected developments. In order to allow for a more comprehensive study of actual operating costs, a cost graph (See App. B 7) is enclosed, with actual costs indicated through 31 December 1946. High costs as shown during December 1944 through February 1945 were due, to a large extent, to the inclusion of estimated value of classified materials as a portion of Project costs, in accordance with policy at that time. This estimated value was deducted from that of March 1945, at the time when the present policy of separate accounting was adopted, which accounts for the low cost for that month. It is recommended that future monthly

[redacted]

operating costs be based on the November estimate of $2,850,000.00, which amount represents total expected expenditures, including both Government and Contractor overhead and normal additions and betterments. Approximately $2,210,000.00 of this amount represents direct plant operations.

17-4. Insurance. - For a complete discussion of insurance deposits and cost, see Book I, Volume 6 of the Manhattan District History.

[redacted]

[redacted]

SECTION 18 - ORGANIZATION & PERSONNEL

18-1. General. - Operation of the Plant was handled by the Contractor's Organization (E. I. du Pont de Nemours & Co., Inc., until 31 August 1946, and the General Electric Company subsequent to that date) under the supervision and jurisdiction of the Area Engineer. Procurement of operating personnel, except for some laborers and special craftsmen transferred from the Construction to the Operations Division, was carried on entirely by the Contractor. This procurement was accomplished by drawing operators and supervisors from other projects in which the Contractor was engaged. As the Project opened, all key supervision and some operators were first trained at the Metallurgical Laboratory and at Clinton Laboratories; these men were, for the greater part, transferred to the site of the Hanford Engineer Works prior to Plant start-up in order to allow them to familiarize themselves with the buildings and equipment with which they were to work. The operators were also brought to the Project as early as possible, and were instructed in the particular phases of the work with which they were concerned, during the construction period. Further training was acquired during the start-up operations of the Plants (See Par. 5-1) by actually operating the equipment. The high quality of operating personnel procured and the success of the training program is indicated by the excellent record of Plant production.

18-2. Area Engineer's Organization (See App. B 8). - The Area Engineer's operating organization was formed principally from the construction organization (See Vol. 5), through a period when construction and

[redacted]

operation overlapped. As of 31 December 1946, the Area Engineer's Office listed 26 officers, 276 enlisted men, and 341 civilians under Lieutenant Colonel F. J. Clarke, Area Engineer, who replaced Colonel F.T. Matthias. The Area Engineer's Staff consisted of Major J. E. Travis, who had replaced Major W. L. Sapper as Executive Officer; Major J. W. Van Hoy as Administrative Officer; Captain P. B. Mountjoy, Intelligence & Security; Lt. Colonel H. E. Skinner, Operations (Production) Officer; R. I. Harris, Legal Advisor; O. S. Clark, Engineering & Maintenance Division; and M. R. Cydell, Public Relations.

a. Engineering & Maintenance Division. - This division, under O. S. Clark, was responsible for the planning and directing of work in all the engineering sections and offices and for the coordination of policies and plans with the various sections and with the Prime Contractor. This division consisted of a Communications Branch, headed by Lieutenant Fred Coulson; a Safety Branch, headed by V. R. Holmquist; a Community Management Branch, headed by N. G. Fuller; and an Engineering Branch, headed by J. M. Musser.

b. Administrative Division. - This division, under Major J. W. Van Hoy who had replaced Major H. D. Riley, was responsible for directing the work in all administrative sections and offices. The Administrative Division consisted of a Fiscal Branch, headed by A. Linares; a Control Branch, headed by H. D. Sturgis; a Property and Supply Branch, headed by Captain W. J. Morrell; a Transportation Branch, headed by J. L. Dickson; a Civilian Personnel Branch, headed by J. M. De Mille; and an Office Service Branch, headed by A. George.

c. Production Division. - This division, under Lt. Col. H. E.

[redacted]

Skinner with the technical assistance of R. C. Hageman, was responsible for all aspects of Plant production, the technical phases of Plant processes, and that part of works engineering dealing with Plant maintenance, steam power, water, and industrial and health instruments. The Pile and Separation Areas were supervised by Major F. A. Valente, and the Metal Fabrication and Testing Area by R. E. L. Stanford. Major O. H. Greager, who supervised the Separation Area activities during the early production period, was replaced by Major Valente on 1 June 1945.

18-3. Contractor's (du Pont) Organization (See B 9). - From the start-up of operations until 31 August 1946, the Hanford Engineer Works was operated by the TNX Division, Explosives Department of E. I. du Pont de Nemours & Company, Incorporated. R. Williams was Assistant General Manager of the Explosives Department in charge of the TNX Division. R. M. Evans was Manager and J. N. Tilley Assistant Manager of the Manufacturing Division. As of 31 August 1946, the Contractor's operating organization at the Hanford Engineer Works employed 5,469 persons under the direction of D. A. Miller, Plant Manager, who had replaced the earlier manager, W. O. Simon. T. N. Stapleton was Assistant Plant Manager, having replaced B. H. Mackey, who in turn had succeeded D. O. Notman when the latter was transferred back to the Wilmington Office in early 1945 upon completion of the initial organizational work. The Production, Technical, Protection, Service, Engineering, Medical, and Accounting Departments (the latter five originally reporting to the General Superintendent, J. A. Grady, who had been succeeded in June 1945 by the later Assistant Manager, J. N. Stapleton) had been established to perform the operating functions of the Hanford Engineer Works.

[redacted]

a. Production Department. - The Production Department was responsible for all primary manufacturing operations and for the coordination of all technical, auxiliary, and service functions relating to production operations. This department was under the direction of a Production Superintendent, which position was held by E. E. Swenson during the work of organization until 31 October 1944; by F. Otto until 1 June 1945; and by M. H. Smith subsequent to that time. There were two primary departments under the Production Superintendent: the P (Pile) Department was responsible for the fabrication, canning, inspection, and testing of uranium, for Pile operations, and for the delivery of the enriched uranium slugs to the Lag Storage Areas; the S (Separation) Department was responsible for the Lag Storage Areas, for all separation processing, and for the delivery of plutonium to the Area Engineer. M. H. Smith was P Department Superintendent until 1 June 1945 when he was succeeded by C. N. Gross. F. Otto was S Department Superintendent until 1 June 1945 when he was succeeded by W. C. Kay, who later was assigned as Technical Superintendent and replaced by F. B. Vaughan.

b. Technical Department. - The Technical Department was responsible for all Plant process technology, analytical control of all production processes, and development work and technical assistance to other departments in connection with process and equipment problems. The department operated the Plant control and development laboratories, maintained the Hanford Technical Manual and the Hanford Operating Standards, and issued regular reports of technical progress. This department was under the direction of the Technical Department Superintendent, which position was held by S. J. Bugbee until December 1944 when he was

[redacted]

succeeded by P. W. Crane and later K. O. Kay.

c. <u>Protection Department</u>. - The Protection Department under F. W. Stapleton and later H. L. Richmond, combined the three protective activities which had special importance at the Hanford Engineer Works: investigation, security, and patrol.

d. <u>Service Department</u>. - The Service Department, under W. T. Cloud, was responsible for the administration of the employment, industrial relations and training, selective service, safety and fire protection programs, and the management of Richland Village, as well as for the maintenance of central files. The Assistant Superintendent in charge of the Plant was H. V. Albrechtson and the Assistant Superintendent in charge of the Village was C. A. Sullivan until 8 November 1944, when he was succeeded by W. O. Rhodes who was replaced by E. V. Henningsen on 1 April 1945. At the time the du Pont Contract was terminated, G. C. Houston had become Assistant Superintendent in charge of the Village, while Albrechtson still remained in charge of the Plant.

e. <u>Engineering Departments</u>. - The five engineering departments of the Hanford Engineer Works were under the supervision of the Works Engineer, L. A. Darling, who was succeeded by R. Hare. The Power Department, headed by F. M. Acker, was responsible for all steam and water facilities on the Project. The Maintenance Department, first under R. Hare and then under A. J. Schwertfeger when Hare became Works Engineer, handled the maintenance of the greater number of Plant and Village facilities. The Electrical Department, headed by P. S. Skaff until 1 June 1945 and subsequently by H. A. Carlberg, was responsible for the operation and maintenance of all electrical distribution facilities as

[redacted]

[redacted]

well as the maintenance of all Plant electrical equipment. The Instrument Department, under V. F. Hanson prior to 1 May 1945 and then under W. P. Overbeck, was responsible for the maintenance of instruments and process control equipment. The Transportation Department, under R. T. Cooke, operated and maintained all automotive and railroad equipment on the Project.

f. Medical Department. - The Medical Department, headed by the Medical Superintendent, W. D. Norwood, M. D., operated all facilities provided for meeting the normal and special needs for the Plant and Village.

g. Accounting Department. - The Accounting Department, headed by the Chief Accountant, T. W. Brown, who was succeeded by S. D. Ewing, was responsible for all accounting and related activities essential to the operation of the Hanford Engineer Works under the terms of the Prime Contract.

18-4. Contractor's (General Electric) Organization (See App. B-10). - Subsequent to 31 August 1946, the Hanford Engineer Works was operated by the General Electric Company, which assumed operating responsibility for the production, research, and related activities under a Contract identical to that awarded the du Pont organization. Arrangements were made at the contractual changeover to transfer all employees at the Hanford Engineer Works from the du Pont to the General Electric payroll, if each employee wished to continue at HEW. The transfer was practically 100% complete, other than in the case of key employees transferred with the du Pont organization or lesser employees with long seniority rights with du Pont.

[redacted]

[redacted]

D. H. Lauder assumed control as Plant Manager, with G. G. Lail as Assistant Manager. The Production, Technical, Service (now including Protection), Engineering, Medical, and Accounting Departments were continued with the same functional responsibilities as under du Pont, while a Design and Construction Department was created to prepare for an expansion program projected for the 1947-1950 period.

a. Heads of Departments:

(1) Production	C. N. Gross
(a) P. Department	J. E. Maider
(b) S Department	W. K. MacCready
(2) Technical	A. B. Greninger
(3) Service	E. L. Richmond
(4) Works Engineer	W. P. Overbeck
(a) Power	H. A. Miller
(b) Maintenance	W. W. Pleasants
(c) Electrical	H. A. Carlberg
(d) Instrument	(open)
(e) Transportation	R. T. Cooke
(5) Medical	W. D. Norwood, M. D.
(6) Works Accountant	F. E. Baker
(7) Design and Construction	F. W. Wilson

18-5. Acknowledgments. - In addition to the individuals mentioned above, many others deserve special mention for their contributions to the successful operation of the Hanford Engineer Works. The Technical Division of the du Pont Explosives Department TNX Division furnished consultant services during the start-up of the Hanford Engineer Works.

[redacted]

[redacted]

C. H. Greenewalt, Manager of the Technical Division, J. A. Wheeler, H. Worthington, D. F. Babcock, T. B. Drew, C. W. J. Wende, W. K. Woods, and P. F. Gast served as consultants. In addition, N. Hilberry, J. P. Howe, and I. Perlman of the Metallurgical Laboratory served as consultants. Special mention should be made of the services rendered by the Bonneville Power Administration; Headquarters, Ninth Service Command; the Federal Agencies concerned with housing, rationin , allocations, and price ceilings; and other Federal Agencies that contributed to the operation of the Hanford Engineer Works.

[redacted]

INDEX

[redacted]

[redacted]

[redacted]

[redacted]

SECRET

SECRET