Cover Illustration: Recent Aerial View of T Plant and Surrounding Facilities.

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Dramatic Change at T Plant

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CONTENTS

LIST OF TERMS

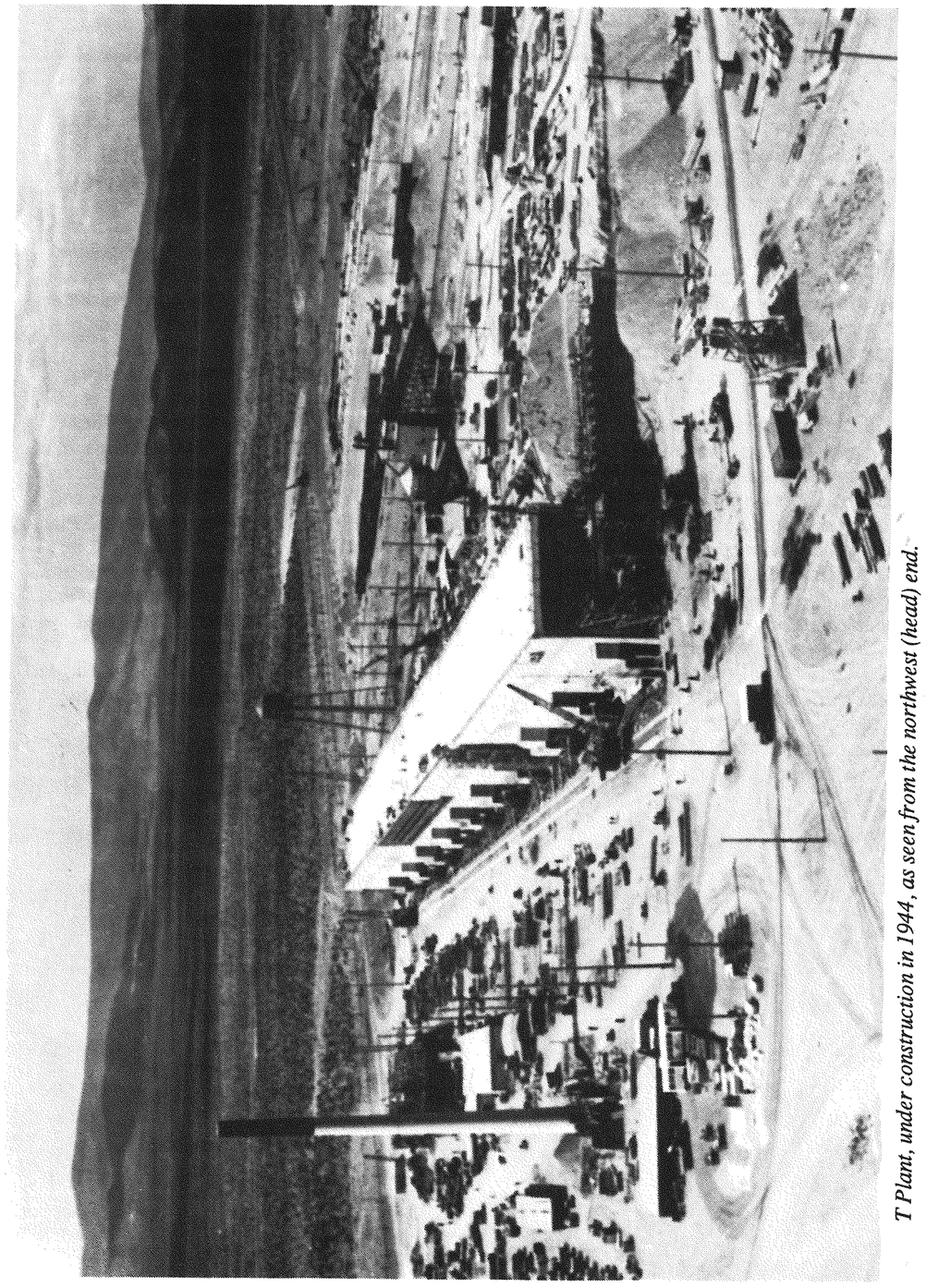
AEC	Atomic Energy Commission
CAM	continuous air monitor
DOE	U.S. Department of Energy
duPont	E. I. duPont de Nemours and Company
ECN	engineering change notice
Ecology	Washington State Department of Ecology
G.E.	General Electric
HEPA	high-efficiency particulate air (filter)
HEW	Hanford Engineer Works
H.I.	Health Instruments
HW	Hanford Works
MED	Manhattan Engineer District
OSD	Operations Specifications Document
P	Production
PUREX	Plutonium-Uranium Extraction (Plant)
REDOX	Reduction-Oxidation (Plant)
S	Separations
SAR	Safety Analysis Report
SDS	Submerged Demineralized System
SST	single-shell tank
TC	temporary construction
WHC	Westinghouse Hanford Company

Introduction

T Plant (221-T) was the first and largest of the early chemical separations plants at the Hanford Engineer Works (HEW), the name for the Hanford Site during World War II. Officially designated as a Cell Building by the Manhattan Engineer District (MED) of the Army Corps of Engineers (agency responsible for HEW), T Plant served as the headquarters of chemical processing operations at Hanford from its construction until the opening of the Reduction-Oxidation (REDOX) Plant in January 1952.

T Plant performed the third step in plutonium production operations, following the steps of uranium fuel manufacture and then irradiation in defense production reactors. The fissionable core (plutonium) used in the world's first atomic explosion, the Trinity bomb test held at Alamogordo, New Mexico, on July 16, 1945, was processed in T Plant. Likewise, the fissionable core of the weapon dropped over Nagasaki, Japan, on August 9, 1945, was processed in T Plant. Because it formed a crucial link in the first full-scale plutonium production operations in world history, T Plant meets criteria established in the *National Historic Preservation Act of 1966*[1] as a Historic Place.

T Plant's radiochemical processing mission ended on March 1956, when other, more efficient processing methods and plants had been developed at Hanford. Within two years, the plant was functioning as the central decontamination facility for the Site. As such, failed and contaminated equipment was assessed and either repaired or discarded there for over three decades. In 1991, the T Plant was placed on limited operations for major upgrades of policies, procedures, and main and ancillary facilities. Currently, the 2706-T Facility (a decontamination "annex" built in 1959) has restarted, with a focus on low-level radioactive decontamination and on repackaging waste from Hanford's Tank Farms. Efforts to process and dispose of wastes and equipment within T Plant itself are under way. Further, the Hanford Site Solid Waste Forecast is being studied to identify new decontamination technologies needed in both the low-level (2706-T) and high-level (T Plant) facilities to offer a full range of modern decontamination, waste assessment, and repackaging services for the Hanford waste remediation mission.



T Plant, under construction in 1944, as seen from the northwest (head) end.

Construction and Startup

Early Construction Was Difficult

Ground was broken for T Plant on June 22, 1943, and the first temporary construction (TC) support structure to be completed was a 24-ft by 40-ft wooden frame structure that housed the offices of the Division Engineer. Finished on October 23, 1943, this small facility held the essential construction offices until a larger office building was completed midway between the T Plant and U Plant sites. Field communication services (temporary telephone facilities) were not connected until December 12, 1943. Water for construction purposes was obtained from the preSite McGee Artesian Well, located in the northwest corner of Hanford, beginning on November 8, 1943. However, only 200 gallons per minute at 20 pounds per square inch was available until November 22, when a booster station and a 100,000-gallon reservoir tank were installed.

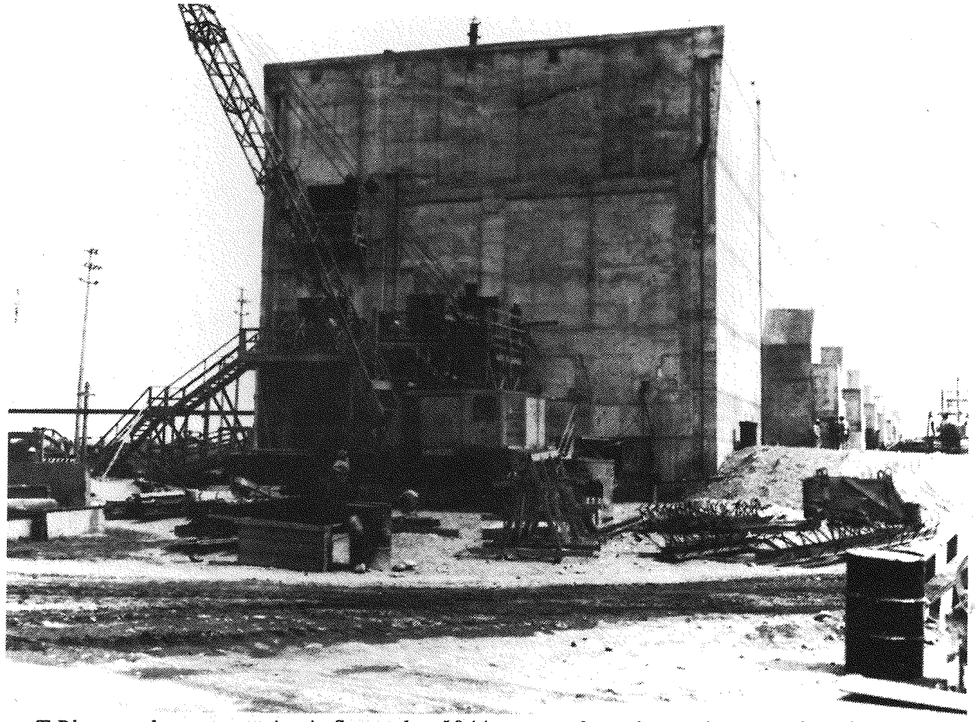
T Plant was built almost entirely of reinforced concrete. Aggregate for the concrete was supplied from the Haven Barrow Pit, located approximately one-half mile west of the 100-B Area; from the Hanford Barrow Pit, located about one mile west of the old Hanford town site; from a "barrow" pit dug in the 200 West Area on the site of the future 288-W Ash Disposal Basin, near the eastern center of the 200 West Area; and from the excavations for the 221-T and 221-U Buildings themselves. Aggregate from the Haven and Hanford pits was brought to the 200 West Area on temporary, standard-gauge rail tracks that terminated at the 200-T Building, a temporary batch plant for the mixing and pouring of concrete used in the construction of the 221-T Building. This batch plant, which stood near T Plant, was disassembled and moved to the 200 East Area after 90% of the concrete had been poured for T Plant in early June 1944. The remainder of the concrete for T Plant was supplied from the nearby 200-U Batch Plant. Additionally, a special Slab Yard was constructed in the 200 West Area for the fabrication of precast concrete cell block covers.

The original construction schedule for T Plant, established by the prime HEW contractor, the E. I. duPont de Nemours and Company (duPont) of Wilmington, Delaware, placed completion at "30 days after the completion of 100-B [Area]."[2] Early construction progressed very slowly because of a shortage of manpower. During the first six months of construction (June through December 1943), only 3% of the work was completed. This portion of the work consisted of excavation for the canyon and the erection of TC support structures and facilities. T Plant was laid out to run from northeast to southwest, with the head end facing northeast.

Manpower Was Key

In September, a two-month "hold" was placed on permanent construction in the 200 West Area to free workers to build additional living quarters in the Hanford Construction Camp. (By 1944, this camp, located at the old Hanford town site, housed 51,000 people.) During this two-month period, less than 300 workers were available to work on the entire 200 West Area. Normal work forces returned to 200 West Area construction on November 28, 1943.

The 75-ton overhead crane, which was to be used to transfer irradiated slugs from their water-filled railcars to the dissolvers in Sections 3 and 4 of T Plant, was installed early so that it could be used in construction operations. Likewise, the 291-T Stack was completed by early 1944 and was used to conduct special meteorological tests using oil fog (SO_2) until the HEW Meteorology Tower became complete enough for use on December 7, 1944.

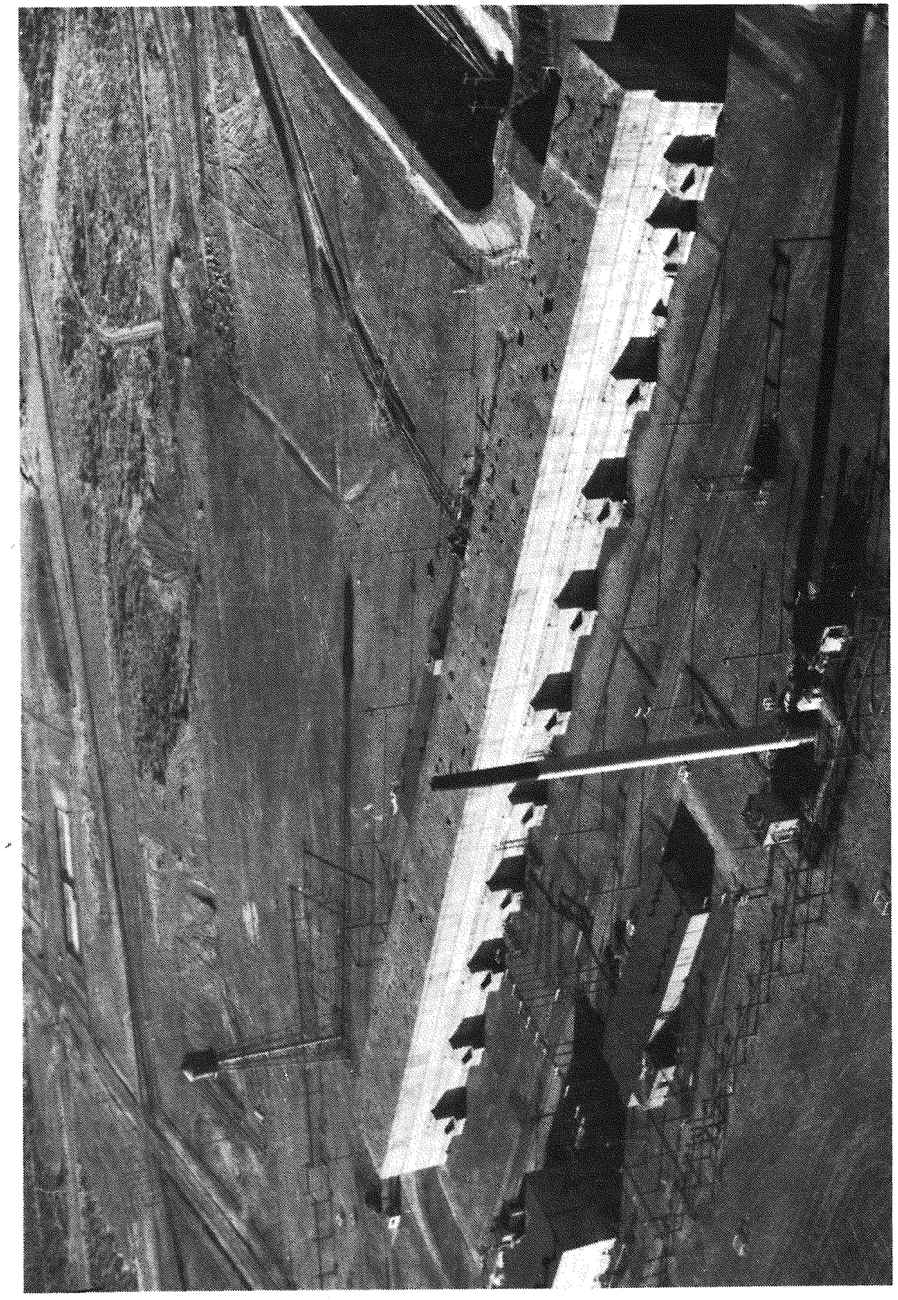


T Plant, under construction in September 1944, as seen from the southwest (tail) end.

In December 1943, a special 65-foot-long, "Head-End Addition," to house laboratory equipment for radiochemical process improvement tests for the bismuth phosphate separations process used at HEW, was authorized for T Plant. The design of this test laboratory section corresponded to two standard sections of T Plant, except that it contained equipment with a smaller capacity.

In March 1944, duPont ordered a sharp increase in the work forces dedicated to the 200 West Area. These forces peaked in May 1944 at 4,960 workers. Employment in the 200 West Area remained at 90% of this peak through July 1944 and declined gradually after that as more skilled crafts were required for equipment and instrument installations in T Plant and other structures. From July 5 through August 25, 1944, all skilled pipefitters and welders were diverted from work on U Plant, B Plant, and other structures and dedicated to completion of key portions of B Reactor and T Plant (the two key structures that would allow plutonium production to begin).

The first group of 60 T Plant operations personnel arrived in the autumn of 1944 from the fuel manufacturing sector of the "P" (Production) Department. A second group of 150 men was chosen in early 1945 from interviews with approximately 400 people from both onsite and offsite who were seeking work as war construction jobs decreased. During late 1944, a training program for T Plant operators was prepared, consisting of general and job-specific material. Familiarity with a new "S" (Separations) Department training manual was required, as was completion of a list of Sitewide training classes in safety, security, transportation, company policies and regulations, and other subjects.



T Plant, as it stood new during World War II. The rail tracks and tunnel coming in from the northwest are visible in the upper right.

The job-specific courses emphasized hands-on training. According to duPont records, the "primary task was to familiarize them (plant operators) with the operating equipment and processes required for the proper execution of assigned jobs and to provide them with the actual practice necessary to develop proper technique in operating the equipment."[3] Shift supervisors were made responsible for training the men assigned to them. When training classes had been completed, operators were allowed to assist in "water runs" (tests with water instead of process solutions) and then chemical runs through the plant. Only after completing those practice runs were they allowed to participate in processing active uranium.

Calibration Tests and "Cold" Runs Begin

Beginning in early September 1944, portions of the T Plant building and equipment were completed and turned over to the Operating Department. Equipment calibrations and water runs were started gradually, and some last-minute design changes were made as a result of these trials.

At midnight on October 8, all construction forces, including standby personnel, were removed from T Plant. Chemical runs and then practice runs using "cold" (unirradiated) fuel elements having defective aluminum jackets (covers) were made during November and early December. These operations were carried out using remote control techniques, "and in every way possible they represented standard procedure."[3] Flushing and calibration tests were essentially complete by November 20, and Operating Department personnel began preparations for a preliminary startup. Actual runs using process solutions began on December 6, with "tracer" (low-product level) runs. According to duPont, "processing these low-activity runs served as a valuable aid in the training of operating personnel, and in working out minor operating changes."[3]

The first batch of fully irradiated fuel rods, which had been pushed from B Reactor in late November, was processed through T Plant during the night of December 26 and 27, 1944. After further processing in the 224-T Bulk Reduction Building and the 231-W Isolation Building, the miniscule amount of plutonium product that resulted from this first "hot" (radioactive) run was stored in special vaults and then transferred to the Los Alamos Laboratory in New Mexico for use in critical experiments.

Original T Plant Structure and Process

Cell Design Was Conservative

T Plant contained 42 concrete process cells, which were arranged in 21 pairs (called sections) along the length of the building. As with the Hanford production reactors, overall design was conservative, in that three pairs of spare cells were incorporated in T Plant just to accommodate future process improvements that might be discovered. One such improvement, discovered in the MED's Chicago Metallurgical Laboratory in June 1943, required the use of two cells instead of the one. With T Plant's design already in place, the duPont builders decided that, "in order to retain the desirable feature of a spare cell near the middle of the building, the oxidation step was assigned to Cells 11 and 12, and all subsequent steps in the process were moved down two cell numbers to compensate."[4]

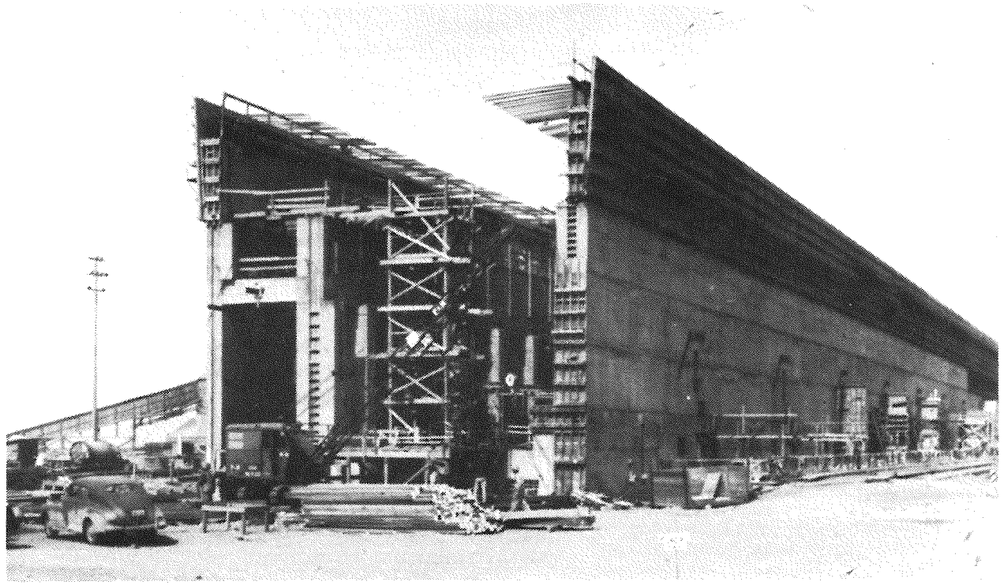
Still later that year, when the head-end semiworks addition was authorized, the decision was made not to number the two cells that constituted it. These areas became known as Cells A and B. Cells 1 and 2 (Section 1) came after the semiworks in terms of physical plant layout, and the last section at the southwest end was numbered 20 (Cells 39 and 40).

Within the main body of T Plant, each standard section was 40 feet long, and each individual cell was approximately 13 feet by 17 feet, 8 inches, by 22 feet high, with 7-foot-thick concrete walls and 6-foot-thick coverblocks. One exception to this size limitation was Cell 3, which was designed to provide a 23-foot cell with adequate shielding to house the railroad tunnel into the building. Another exception was Cell 5R, the collection area for miscellaneous inplant process wastes. This cell extended an extra 20 feet below grade.

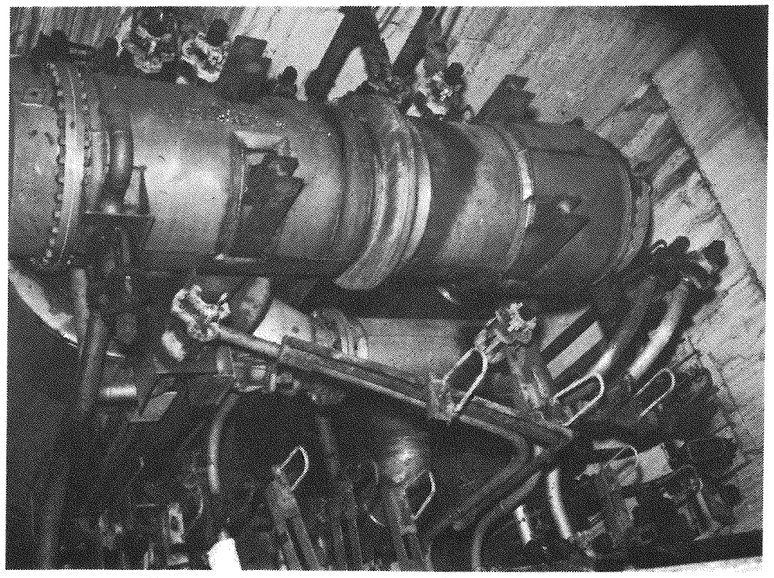
The cover of each cell in T Plant consisted of removable sections with stepped, interlocked edges to prevent the escape of radiation. Twelve of the 20 sections in T Plant each contained a standard grouping of process equipment that consisted of four pieces: a precipitator, a catch tank, a centrifuge, and a solution tank. (These were Sections 6 through 10 and 13 through 19.) All pipe, instrument, sampling, and control lines into the cells were buried in the concrete and terminated in standardized connector flanges on the cell walls. Each of the electrical lines contained six leads. The other instrument, hydraulic, and lubrication lines contained four small pipes. The chemical feed, steam, and water lines consisted of single 2- or 3-inch pipe. To minimize the escape of radiation into the pipe gallery, an S curve was built into the piping as it ran from the cells to the gallery. Within each section of T Plant, process lines between cells were run directly through cell walls. However, because of "difficulties created by the expansion joint which separates adjacent sections,"[5] no piping pierced the walls between sections.

The Bismuth Phosphate Process

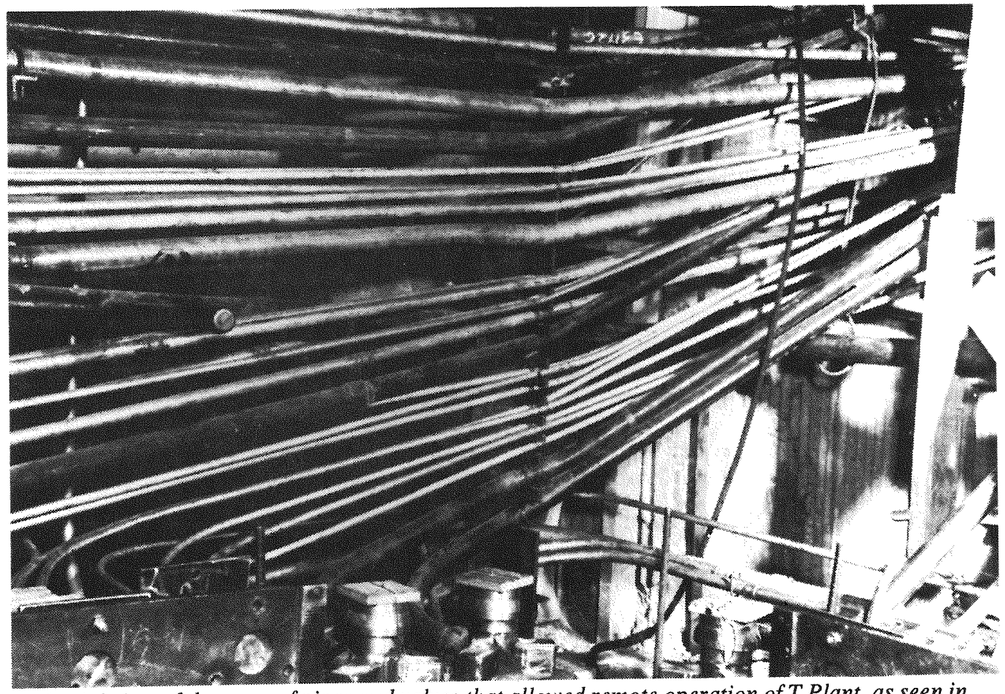
The original T Plant sections and cells functioned in a sequential manner to carry out the steps of the bismuth phosphate separations process used at the facility. This batch precipitation process achieved separation by varying the valent state of the plutonium-239 and then by repeatedly dissolving and centrifuging plutonium-bearing solutions. It was based on the principle that bismuth phosphate is similar in crystal structure to plutonium phosphate. By precipitating bismuth phosphate, the plutonium-239 in the +4 (tetravalent) state could be carried with it in a "product precipitation."



The basic internal structure of T Plant is visible in this 1944 construction photo. The Pipe, Operating, and Electrical Galleries are stacked along the west side (to the left in this photo). The cells, with the crane cabway running along them, also can be seen in this view from the southwest (tail) end.



Early in-cell processing equipment at T Plant.



Partial view of the maze of pipes and valves that allowed remote operation of T Plant, as seen in World War II.

In the +6 valent state (hexavalent), the plutonium-239 would not carry with the bismuth phosphate, and a by-product (waste) precipitation could be achieved.

The plutonium was reduced (taken to the tetravalent state) by adding oxalic acid or ferrous ions and oxidized (taken to the hexavalent state), usually by adding sodium bismuthate but sometimes by using sodium dichromate or potassium permanganate.

The first step in the separations process carried out in T Plant was dissolving, a process that first used boiling caustic (principally sodium hydroxide) to remove the aluminum fuel jackets from the uranium elements. The bare uranium cores then were dissolved in nitric acid. The second step was extraction, wherein the product (plutonium-239) was separated from most of the uranium. This step also removed about 90% of the fission products into what was called the metal waste solution. The extraction step reduced the gamma radiation activity level by a factor of 10. The third step, decontamination, reduced the gamma radiation activity level by a factor of 10,000, giving an overall process "decontamination factor" of 100,000 below that of the original uranium solution.

The basic steps carried out in T Plant, with the original cell usages, were as follows.

Section 1 (Cells 1 and 2): Storage of contaminated, discarded equipment.

Section 2 (Cell 3): Railroad tunnel for bringing in irradiated metal (also known as fuel elements, slugs, or lags).

Section 2 (Cell 4): Storage of slugs with ruptured jackets. This cell was kept filled with water.

Section 3 (Cells 5 and 6): Coating removal, metal dissolving, and reduction.

Section 4 (Cell 7): Coating removal, metal dissolving, and reduction.

In Cells 5, 6, and 7, the aluminum jackets of the irradiated uranium fuel rods first were dissolved in boiling sodium hydroxide, to which sodium nitrate slowly was added (to reduce the formation of hydrogen). This step produced "coating removal waste." The fuel elements themselves then were dissolved in nitric acid. Three metric tons of metal were charged into a dissolver. Nitric acid was added in three increments, enough to dissolve one ton in each increment. The addition of nitric acid was stopped when measurements showed that a certain density or specific gravity (called "spee-gee" by Hanford workers) had been reached. To keep the time cycle as short as possible, "a substantial metal heel" was left in the dissolver between charges. New material was charged on top of this heel. In June 1945, a second dissolver was placed into operation in T Plant.

Section 4 (Cell 8): Metal Solution storage. The dissolved fuel elements were held in a 3,000-gallon tank.

Section 5 (Cell 9): Sewage disposal, holding tanks.

Section 5 (Cell 10): Sewage disposal, sewer cell.

Section 6 (Cells 11 and 12): Spare. Sometimes was used for a by-product precipitation before extraction.

Section 7 (Cells 13 and 14): Extraction (spare).

Section 8 (Cells 15 and 16): Extraction.

In the first extraction step, plutonium was kept in the +4 (reduced) valent state. Bismuth nitrate and phosphoric acid were added to the solution, causing the formation of bismuth phosphate, which precipitated, carrying the plutonium with it in a product precipitation. Centrifuging then separated the solids from the liquid in the precipitate. The solid portion (precipitate "cake"), which contained the plutonium, was placed in another tank and dissolved with nitric acid. The liquid portion (called "metal waste") was sent to Cells 17 and 18 for treatment.

Section 9 (Cells 17 and 18): Treatment of waste metal solution.

Metal waste was so named because it contained the uranium that had not converted to plutonium in the reactors. This waste initially was jetted through underground piping to high-level waste tanks (single-shell tanks [SSTs]).

Section 10 (Cells 19 and 20): Treatment of waste metal solution (spare).

Section 11 (Cells 21 and 22): Spare (unequipped, since 1945).

Section 12 (Cells 23 and 24): Storage and oxidation of metal solution.

Section 13 (Cells 25 and 26): First Decontamination cycle, by-product precipitation.

Sodium bismuthate, sodium dichromate, or potassium permanganate was added to the plutonium-bearing solution from Cells 15 and 16, to oxidize the plutonium to the +6 state. This step caused the bismuth phosphate to precipitate (by-product precipitation), leaving the plutonium in solution.

Section 14 (Cells 27 and 28): First decontamination cycle, product precipitation.

The plutonium-bearing solution from Cells 25 and 26 was reduced (usually with the addition of ferrous ammonium sulfamate) and sent to Cells 31 and 32.

Section 15 (Cells 29 and 30): Treatment of decontamination wastes.

The precipitate material from Cells 25 and 26 was liquified and jetted through underground piping to high-level waste tanks.

Section 16 (Cells 31 and 32): Second decontamination cycle, by-product precipitation.

The plutonium-bearing solution from Cells 27 and 28 was oxidized, and a second waste precipitation was achieved. Through this process, additional product purification (i.e., removal of fission products) could be achieved.

Section 17 (Cells 33 and 34): Second decontamination cycle, product precipitation.

The plutonium-bearing solution from Cells 31 and 32 was reduced to the tetravalent state. By the end of this cycle, the plutonium in solution had been decontaminated by a factor of 10 E+5 (100,000).

Section 18 (Cells 35 and 36): Third decontamination cycle (spare).

Section 19 (Cells 37 and 38): Third decontamination cycle (spare).

Section 20 (Cells 39 and 40): Spare (unequipped).

224-T And 231-Z Buildings Continue the Process

At the end of the processing that occurred in T Plant, the plutonium-bearing solution was sent first to the 224-T Bulk Reduction Building and then to the 231-Z Isolation Building. In the 224-T Building, the starting batch size was 330 gallons of plutonium solution. It was oxidized with sodium bismuthate, and then phosphoric acid was added to produce a by-product precipitation. Centrifuging then separated the solution and precipitate, and nitric acid was added to dissolve the by-product cake, which became waste. Next, the plutonium was oxidized with potassium permanganate, and hydrogen fluoride and lanthanum salts were added to the plutonium solution, producing a lanthanum fluoride precipitate and leaving hexavalent plutonium in solution. This step was known as the "crossover," in that plutonium had to cross over into a lanthanum fluoride carrier process because lanthanum is a better carrier than bismuth phosphate. It could carry plutonium with so little bulk or volume of carrier that a great deal of concentration could take place.

At this point, impurities in the hexavalent plutonium were precipitated in a by-product cake, with the fission products carried out along with all of the lanthanides (e.g., cerium, strontium, lanthanum) that the bismuth phosphate could not carry out of the stream. The by-product cake was dissolved in nitric acid, neutralized with sodium hydroxide, and sent to waste holding tanks for settling. The plutonium solution then was reduced to the tetravalent state by adding oxalic acid. Lanthanum salts and hydrogen fluoride again were added, thus precipitating lanthanum fluoride that contained the plutonium. The plutonium was separated by centrifugation, and potassium hydroxide was added to metathesize the plutonium lanthanum fluoride, forming a solid plutonium lanthanum oxide. Any liquid was removed by centrifugation, and the solid plutonium lanthanum oxide was then dissolved in nitric acid, making plutonium nitrate. By this time, the original 330-gallon batch that had entered the 224 Building had been concentrated to a volume of 8 gallons.

Finally, the plutonium nitrate liquid was sent to the 231-Z Building, where a final product precipitation using sulfates and peroxide took place. The precipitate cake was dissolved with nitric acid, placed in small (10-inch-high) shipping cans, and boiled right in the cans using hot air. It was reduced to a wet nitrate paste (the HEW product). In this form, the plutonium was shipped to Los Alamos. Each shipping can held about 1 kilogram of plutonium.

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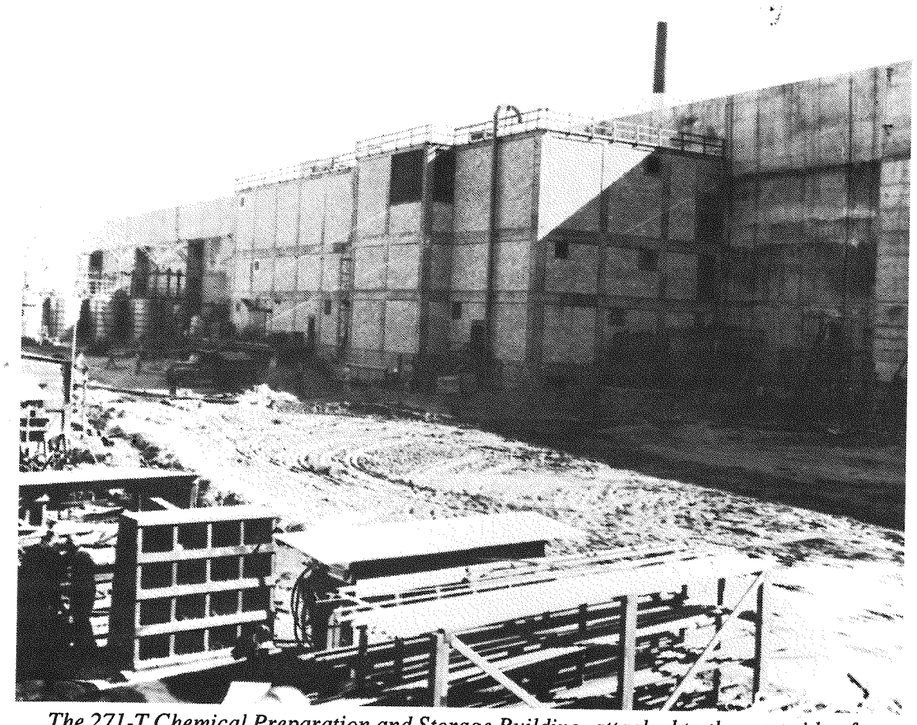
Support and Ancillary Structures Associated With T Plant

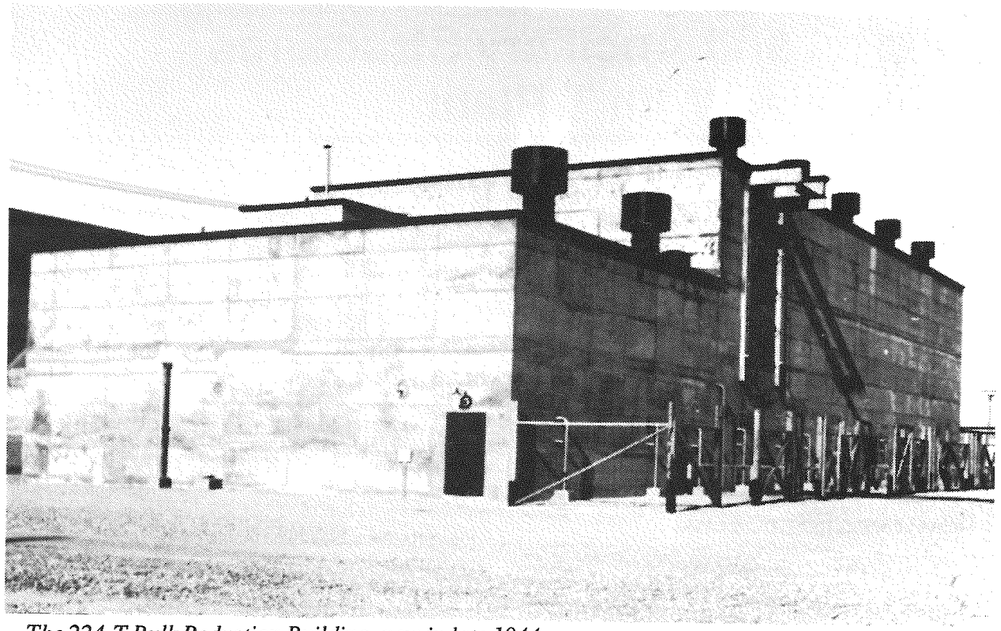
222-T, 224-T, and 271-T Facilities Crucial to T Process Group

A key cluster of buildings that allowed the bismuth phosphate process to operate, including T Plant itself, was known as the T Process Group. These structures included the 222-T, 224-T, and 271-T Buildings.

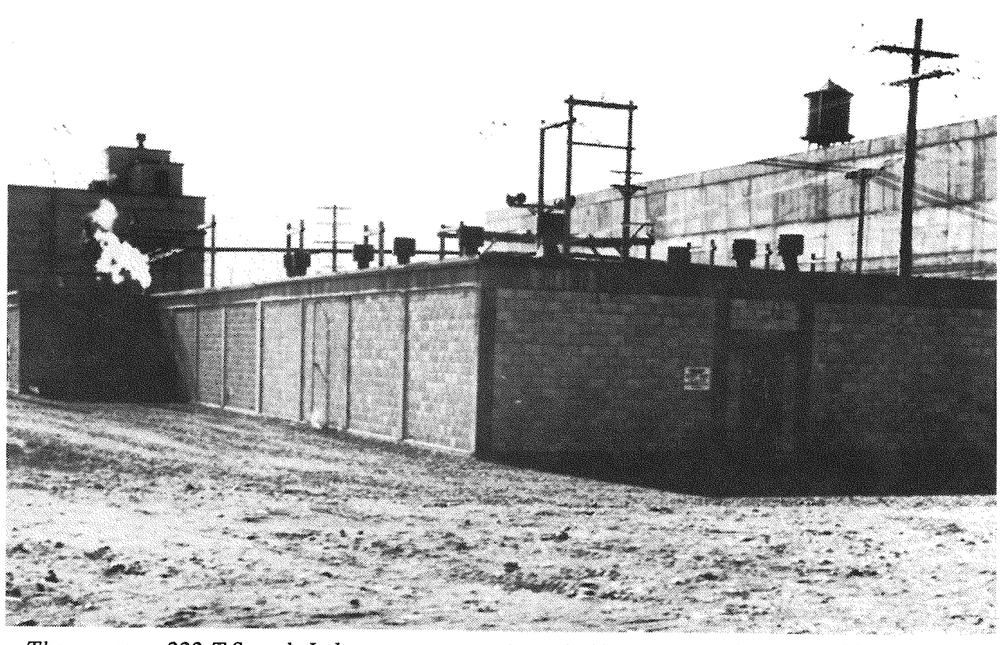
The 222-T Sample Preparation Laboratory, also known as the Control Laboratory, functioned to test the 221-T and 224-T process solutions at various stages in the processes to determine the product concentration and the rate of product decontamination. Because the entire separations process was conducted remotely, verification that the process was working correctly could be obtained only by drawing samples and conducting radioassay. Product concentration was measured by the alpha disintegration rate, and product decontamination (i.e., separation from unwanted fission products) was measured by beta and gamma ray disintegration rates.



The 271-T Chemical Preparation and Storage Building, attached to the west side of T Plant, under construction in 1944. The 211-T Tank Farm is visible to the north of the 271-T Facility.



The 224-T Bulk Reduction Building, new in late 1944.



The one-story 222-T Sample Laboratory, as seen in early 1945, with the three-story 224-T Facility visible to the left and the tall T Plant visible above the laboratory.

The laboratory building was located between the 224-T and the 292-T Buildings. It contained 22 rooms, including chemical and sample preparation laboratories, the sample measurement (counting) room, balance room, instrument repair room, equipment and machinery rooms, receiving room, and others. The counting room in this structure was shielded by 2 feet of concrete.

Samples were removed from T Plant via riser pipes that led into small, lead-shielded sampler pits located approximately 2 feet below the canyon deck level in the cell walls. A long, thin "trombone" apparatus was inserted into the riser pipe to withdraw a sample, which then was transferred into a stainless steel "door-stop" carrier. Less active samples (or those predicted to be less active) were transported to the laboratory in "bayonet" pipette carriers. In the 222-T Building, active samples then were stored on shelves behind an additional 1 inch of lead shielding. In late 1950, additional shielding and ventilation equipment was added to reduce radioactivity levels around the waste sample disposal and equipment decontamination bench in the building. Further upgrades to the building added new acid dispensing equipment and piping in 1951.

The operations of the 224-T Bulk Reduction Building previously have been described in terms of the bismuth phosphate process. This three-story building contained 21 rooms and five reinforced concrete cells with the large Operating Gallery located on the third floor. In 1950, equipment in F Cell was rearranged to allow parallel operation of two centrifuges, thus boosting production. Five years later, when plans were being formulated for the shutdown of T Plant, consideration was given to installing the 231-W Isolation Building process in the 224-T Building. However, this change did not take place. In 1975, the 224-T Building was modified to become a storage facility for plutonium-bearing scrap and liquids. In 1985, it became known as the Transuranic Waste Storage and Assay Facility. Drums containing wastes contaminated with transuranic substances were stored here.

The 271-T Chemical Preparation and Service Building functioned to receive, store, mix, and deliver the chemicals used in the bismuth phosphate process into T Plant. Attached to the back (northwest) wall of the 221-T Building at the midpoint (adjacent to Sections 10 through 13), the large 271-T Building also provided the supervisory office space for T Plant. The basement and first floors contained chemical storage facilities, instrument and maintenance shops, ventilating equipment, and change rooms. The second floor contained offices while nearly the entire third floor housed a large chemical preparation room with a smaller chemical control laboratory to sample the chemical mixtures before they were delivered into T Plant. Although this reagent control laboratory was deactivated in the late 1940s, it was refitted with new equipment during the production increases of the early 1950s. Two labyrinth accessways were provided into the T Plant crane cabway.

Many Other Structures Supported T Plant Operations

Among other key structures that allowed T Plant to operate were the 211-T Tank Farms. Located aboveground, at the rear of 221-T, in the angle between the 271-T Building and the railroad tunnel that entered T Plant to deliver irradiated fuel rods ready for processing, the 211-T Tanks functioned to store and supply fresh chemicals. Nine vertical stainless steel storage tanks held dilute acids (five for 60% nitric acid, three for 75% phosphoric acid, and one for 90% formic acid). Six horizontal stainless steel tanks held the full-strength, concentrated nitric acid that was received in rail shipments, as well as the capacity to dilute this acid to the 60% strength that actually was used at the plant. Additionally, three steel tanks held 50% caustic solution (sodium hydroxide), one steel tank held sulfuric acid, another tank on scales held anhydrous hydrofluoric acid, and a small expansion tank was provided as a spare to

provide for overflow and prevent the rupture of other tanks. Transfer and circulation pumps, as well as drum-filling facilities, completed the 211-Tank Farms.

The 291-T Exhauster Building and Stack functioned to exhaust process gases from the 221-T Building and to provide additional "diluting air" deemed essential to the safe dispersion of process gases in the atmosphere. The stack itself was 200 feet high and was located 252 feet from the head-end face of the 221-T Building. It was connected to T Plant at the center of Section 3 via underground inlet and outlet air ducts. This connection point was chosen because the dissolver offgases, located in the first Sections of T Plant, were the emissions of concern to HEW officials. The operation of the three fans in the 291-T Building was sufficient to add an average of 20,000 cubic feet per minute to the process gases exiting T Plant during normal, World War II dissolving operations. Further discussion of the 291-T facilities can be found in the chapters entitled "Atmospheric Emissions and Hazards Control," Parts I and II.

The 292-T Exhaust Gas Laboratory functioned to sample and test the 291-T Stack gases for levels of chemical and radioactive contaminants. This small (336 square foot) building was located approximately 40 feet from the centerline of the 291-T Stack, in the direction of the 222-T Sample Laboratory. The 292-T Building contained no windows but had roof ventilators and gas refrigeration and testing equipment. It was connected to the 291-T Stack via a two-inch overhead sampling line. The gases were drawn into the 292-T Building and passed through a small water scrubber (containing 5% soda ash solution), dried via refrigeration, and then counted in a chamber to measure the xenon-133 activity. The scrubbing water then was counted in a separate apparatus to determine the iodine-131 activity. Further discussion of the 292-T Facility can be found in the chapters entitled "Atmospheric Emissions and Hazards Control," Parts I and II.

Several other buildings and facilities were constructed to support the entire 200 West Area. As such, they functioned in support of T Plant. These facilities included electrical substations, shops and garages, storehouses, a water filtration and reservoir system, a coal-fired powerhouse, security structures and guardhouses, a fire station and alarm system, office buildings, rail tracks and vehicle roads, lights, telephones, sanitary systems, process sewers, and waste disposal systems. The 241-T Process Waste Disposal System will be described and discussed in the chapter entitled "Waste Management (Nongaseous) and Contamination Events."

Semiworks Had Special Missions

The special semiworks addition to T Plant consisted of "two double-size equipment cells and continuations of the three galleries and crane rails," was authorized for the building. The addition was deemed necessary by duPont, to have a "hot semi-works laboratory...to study and evaluate the various steps in the process and for process 'trouble-shooting'."[3] The criteria for this semiworks was that it be able to handle small-scale batches of full-strength plant solutions and irradiated metal, that it not interfere with the normal operation of T Plant, and that it would be possible to access and clean test equipment so thoroughly that manual inspection and changeouts would be feasible. As finally constructed and equipped, the semiworks was separated from the main portion of T Plant by a barrier wall, and it contained 14 process vessels, each scaled down to 5% the size of the main plant equipment.

The semiworks was completed in September 1944, and chemical and tracer runs were undertaken through December 1944. At that time, full-strength experiments were undertaken in the extraction and first-cycle decontamination steps of the bismuth phosphate process. On January 13, 1945, the semiworks was placed on cold standby, and all personnel were transferred to the 321 Separations Buildings, designated for "cold" process

improvement runs. On February 12, it was necessary to reactivate the hot semiworks to conduct high activity tests; but in March, process improvement trials and personnel were transferred to the 321 Building.

The T Plant semiworks facility continued to run on an intermittent but infrequent basis, making research and development trials for the bismuth phosphate process through early 1947. At that time, the newly formed Atomic Energy Commission (AEC) directed Hanford Works (HW), the new Site designation under the AEC, to begin immediate and rapid development of a continuous, solvent extraction chemical separations process. Because the equipment in the head-end addition of T Plant was not suited to such a process, the semiworks was decontaminated and closed. In early 1949, the original equipment was removed to prepare the space for use as a separations facility for radioactive lanthanum (lanthanum-140, known as "RALA"), a tracer gas ordered by the Air Force for tracking nonnuclear explosions. Made from irradiated barium, RALA had a half-life of only 40 hours, so quick, small-scale separation was necessary. Design studies and the construction of some temporary facilities, such as hoists, hand rails, access platforms and fencing, were completed. However, before the major modifications could be emplaced, the AEC decided to place the RALA Program with the newly authorized National Reactor Testing Station (now Idaho National Engineering Laboratory), to be built near Idaho Falls, Idaho.

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Early Operations Experiences and Process Improvements

Earliest Operating Experience

Experiences during the first few months of T Plant operations were described by duPont as "unusually satisfactory."[3] No serious mechanical problems developed, except that the bowl of the centrifuge in Section 16 jammed against some dip tubes when it was run backwards on January 5, 1945. The centrifuge was replaced via remote operations, partially decontaminated in a spare cell, and then buried in 1954 when it was determined that it could not be repaired. This and other miscellaneous remote tasks gave operators confidence that "the Canyon Buildings can be operated remotely as planned and with somewhat less loss of fabricated equipment than originally anticipated."[3,6]

During the next six months of T Plant operations, procedures were standardized. Technical efforts were directed toward reduced time cycles, as production sped for the special nuclear materials needed to win World War II.

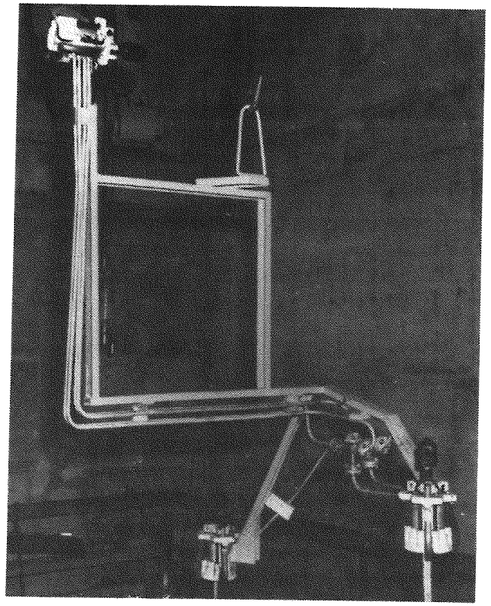
By mid-1945, emphasis had shifted to "a review of process technology and operating technique in an effort to improve efficiency and reduce waste losses."[3] Free nitric acid concentration was reduced to obtain an increase in the specific gravity of dissolver solutions.

The most significant improvement, however, came in the late summer, with the installation of piping to allow for intermediate solution transfer from storage to the precipitator in Section 6 (Cells 11 and 12). This was a safety measure, as metal solution slightly in excess of charge requirements then could be taken from storage, agitated, and sampled so that the correct amount, based on critical mass limitations, could be transferred to the extraction sections of the plant. Further safety improvements included more rigorous efforts to empty and decontaminate the precipitators used in the extraction and decontamination cycles. These measures ensured the prevention of plutonium-239 buildup on equipment.

Chemical Reductions Important

Other very early changes included the elimination of potassium carbonate from the separations process in February 1945; and one month later, the relaxation of iron impurity standards in potassium hydroxide. Overall, the first full-scale separations experiences at T Plant and at the 224-T and 231-Z Buildings led to large reductions in many essential materials, per unit of production. For example, the strength of the key dissolving agent, nitric acid, was decreased from an average of 95% to an average of 69% (reduced by approximately one-third). By September 1, 1945, other key chemical requirements had been reduced by an average of 44%.

During 1946, much experimentation was done in T Plant to further lower the quantities and molarity of phosphoric acid required in the product precipitation steps of extraction and decontamination. Reductions in sodium hydroxide and calcium carbonate also were achieved successfully. Additionally, the "problem of batch size control and prevention of product accumulation received attention throughout the period."[3] New connector assemblies were installed to bypass certain process vessels where the headroom was insufficient to allow for in-tank agitation and where, consequently, product-bearing precipitates might settle. Acid washings of catch tanks in the precipitation cells also were increased



Pipe assembly equipment that was state-of-the-art in remote technology for its era, used in T Plant in the 1940s.

One-Ton-Per-Day Standard Quickly Surpassed

T Plant and the other Hanford separations canyons were designed on the basis that one plant would have the capacity to process the output from one pile (reactor). With each HEW reactor originally planned to produce one metric ton of metal (containing approximately 250 grams of product [plutonium-239]) per day, the earliest standard procedure for T Plant involved starting a one-metric-ton charge of metal into the dissolvers about every 26 hours. However, by the summer of 1945, production tests had shown that charge size could safely be increased to 1.5 metric tons of metal, "without noticeable effect of yield or equipment performance."[3] By September 1, process modifications enabled the plant to complete the processing of a charge in just 20 hours, with only a 10% allowance added onto the average process cycle for equipment repairs.

Additional and ongoing process improvement studies carried out during the 1945 to 1946 period were directed at: simplification of operations to achieve reductions in process time, modification of the process to increase canyon capacity per batch, reduction in waste volumes, recovery of additional product from wastes, the establishment of better understandings of process safety and safety limits, decontamination improvement, and basic studies in the chemistry of plutonium.

to prevent plutonium-239 accumulation, and sampling of standpipes and other transfer lines was increased. As a result of the vigorous acid washes, higher than normal material balances occurred at T Plant during the summer.

At the same time, according to duPont, the "process equipment began to show the effects of one and one-half years of operation." The failure of centrifuges, skimmers, and dip tubes accounted for "a fair portion of the maintenance load." Transfer jets gave "regular though minor troubles," and asbestos gasket failures became common. Piping lines began to fail because of corrosion and/or metal fatigue, and piping jacket leaks increased. However, the 75-ton, remotely operated crane "gave performance bordering on perfection."[3]

Safety was emphasized as an important part of work practices throughout T Plant operations.

T Plant Process Surpassed by New Solvent Extraction Chemistry

Throughout the 1940s, the efficiency of the bismuth phosphate process continued to improve at T Plant and at B Plant (the other active World War II chemical separations canyon at Hanford). By 1950, the Hanford plutonium-239 production rate had increased by 299% over the 1946 rate; and research and development had cut the processing time cycle by 45%. Additionally, process improvements had decreased the amount of fresh chemical materials needed so that, despite higher material costs, expenses for fresh chemicals were reduced by 25%.

Plutonium production at Hanford continued to increase in 1951; and in 1952, with the completion of C Reactor, it rose another 44% over 1951. By that time, the production rate stood at five times that of 1947! During the early 1950s, underwater repair facilities for failed cell connectors and other equipment pieces were installed in Cell 4 of T Plant to avoid unnecessary shutdowns. The separations process was adapted to handle metals irradiated to many different goal exposures, at the same time that batch sizes were optimized and time cycles were minimized. In early 1952, the new REDOX chemical processing plant started up, and B Plant shut down. Despite the improvements in the bismuth phosphate process, the REDOX process was vastly more efficient in that it operated with a continuous action, solvent-extraction chemistry and it salvaged most of the uranium that was not converted to plutonium. With the startup of the REDOX facility, the importance of T Plant diminished somewhat, and by 1953 it was producing only about 12% of the plutonium at HW.

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Waste Management (Nongaseous) and Contamination Events

Underground Tanks System, Basins, and Earth Ditches Handled Liquid Wastes

The earliest practices for handling bismuth phosphate wastes were based around the 241-T Process Waste Disposal Systems. This system consisted of 16 underground SSTs for the storage of high-level wastes, a gunite catch tank (or "sump" tank), a settling tank, four reinforced concrete diversion boxes, two retention basins, and eight observation wells.

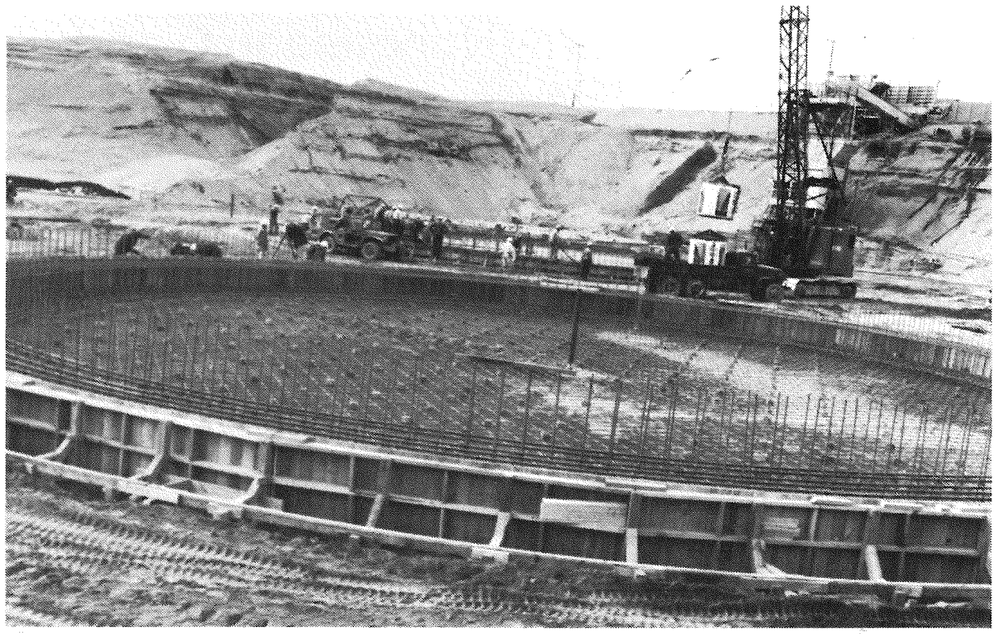
The underground high-level waste storage tanks were constructed of reinforced concrete with a 0.25-inch welded steel plate lining. Twelve of these tanks were 75 feet each in diameter and were numbered in series from 241-T-101 to 241-T-112. Four of the high-level waste tanks were only 20 feet each in diameter and were designated with numbers from 241-T-201 to 241-T-204. Additionally, a 20-foot-diameter catch tank, numbered 241-T-301, was located underground approximately 112 feet away from Tank 241-T-112. Another 20-foot-diameter settling tank, numbered 241-T-361, also was located underground to hold the process wastes from the 224-T Building on a short-term basis. After a settling period, the contents of this tank (except for an accumulated sludge or heel) were discharged into a pipe that carried used process cooling water.

Together, these two liquid streams were discharged into one of the two 500,000-gallon retention basins. These basins, numbered 241-T-352 and 241-T-353, then overflowed into open earthen drainage ditches that ran far out into the desert to the northwest of the basins. Additionally, four underground diversion boxes containing piping, pipe connectors, and water spray nozzles were a part of the process waste disposal system. They functioned to direct the flow of process wastes to the various tanks. Seven of the observation wells were 150 feet deep, and one was 300 feet deep.

The earliest HEW policies divided T Plant wastes into four types: coating removal waste (that generated in Cells 5-7, specifically produced by the dissolving of the aluminum fuel coatings), first decontamination cycle waste (that containing approximately 90% of the fission products and virtually all of the uranium that did not convert to plutonium), second decontamination cycle waste (that containing approximately 10% of the fission products), and cell drainage waste (that collected from floor drains in the dissolver Cells 5-6). The first three types of wastes all were neutralized with sodium hydroxide and placed in the underground SSTs for storage in perpetuity (or until another final disposal alternative is developed). The cell drainage waste was settled with the supernate, then discharged to the ground.

Scarce Tank Space Brings Changes

As production increased at T Plant in response to Cold War imperatives, tank space became scarce and the TX Tank Farm (18 SSTs, holding 750,000 gallons each) was constructed during 1947 and 1948. At that time, "cribs" (also known as earth reservoirs) were first constructed to drain additional low-level wastes through covered void spaces and into the subsoil. The TY Tank Farm, containing six SSTs of similar capacity to the TX tanks, was built during 1951 and 1952. The first two waste evaporators at Hanford, 242-T and 242-B, also started up in 1951 in an effort to conserve tank



Early stages of construction in the 241-TX Tank Farm, February 1948.

The 18 single-shell tanks of the 241-TX Tank Farm take shape, July 1948.

space. First-cycle bismuth phosphate wastes were sent to these facilities for concentration by steam heat, with the condensate discharged to the ground, and the concentrated high-level wastes were sent to SSTs.

At the same time, other efforts to optimize tank space for only the highest level wastes resulted in the decision to combine coating removal waste and second-cycle decontamination waste with cell drainage waste and 224 Building waste, and to send all of this mixture to holding tanks. After settling, the supernate from this waste was discharged to cribs. Additionally, older second-cycle wastes were taken out of SSTs and so discharged.

In some cases in the early 1950s, waste disposal tests resulted in the discharge of mid- and high-level wastes to the soil. In 1953 and 1954, supernatant from some of the older T Plant and B Plant first-cycle wastes were discharged to the ground through "specific retention" trenches. Specific retention practices were based on the theory that liquid waste would be "held against the force of gravity by the molecular attraction between soil particles and the surface tension of water."[7] However, by 1957, the practice had been shown to work poorly, at least with Hanford soils and wastes, and its use was recommended at the Site only in "emergency"[8] situations. In one trial campaign each in 1954, the bottoms of the 242-T and 242-B Evaporators, containing concentrated high-level wastes, were discharged to the ground. Additionally, in a test in 1955 and 1956, newly-generated, first-cycle T Plant wastes were settled with chemical additives and the supernatant was discharged to the 216-T-26 crib.

By the time T Plant shut down as a processing facility in early 1956, approximately 87,285 curies of beta emitters and 7,840.83 grams of plutonium had been discharged in liquid wastes sent to the ground in the various T Plant trenches, cribs, swamps, and reverse wells. Unknown amounts of radionuclides had been disposed to the T, TX, and TY Tank Farms.

Contamination Events

The first recorded contamination event in the history of T Plant occurred on March 11, 1945, when a "suckback" in the steam jetting lines caused higher than normal radiation levels in the Pipe Gallery and in the Operating Gallery. That same year, several maintenance operations in the 224-T Building resulted in the contamination spreads in that facility. In February 1946, a "trombone" containing a high-level product sample was being carried from T Plant to the 222-T Laboratory when it fell to the ground and "spilled highly active solution." At nearly the same time, according to duPont, a leak in an E Cell spray line in the 224-T Building "disseminated several milligrams of plutonium over the floor...[and] onto the pipe gallery floor." The following month, a leak in a 224-T waste line again "released milligrams of product." At nearly the same time, the most serious contamination event at T Plant up to that date occurred when a maintenance man, the ground, a crane, and a diversion box were sprayed with first-cycle waste solution during an attempt to open and free a plugged tie-line from Section 15 of T Plant. One month later, a faulty vent valve on a the 3-5 Right gang valve assembly allowed fumes containing radioiodine and nitrous oxide from dissolver Cell 5 to back up into the Operating Gallery.[3]

In the autumn of 1945, radiation levels in the T Plant exhaust fans located in the 291-T Exhauster Building, reached 8,000 millirad per hour. As a result, the fences around the fans were moved outward, and an earth barricade was placed inside the fence to shield personnel walking near the north boundary. Additionally, locked gates and fenced lanes were erected leading to both the 291-T Exhauster Building and to the 292-T Exhaust Gas Laboratory. The following spring, lead shielding was installed around the emergency steam fan in the 291-T Exhauster Building, and improvements were made in the techniques for remote oiling of the fans.

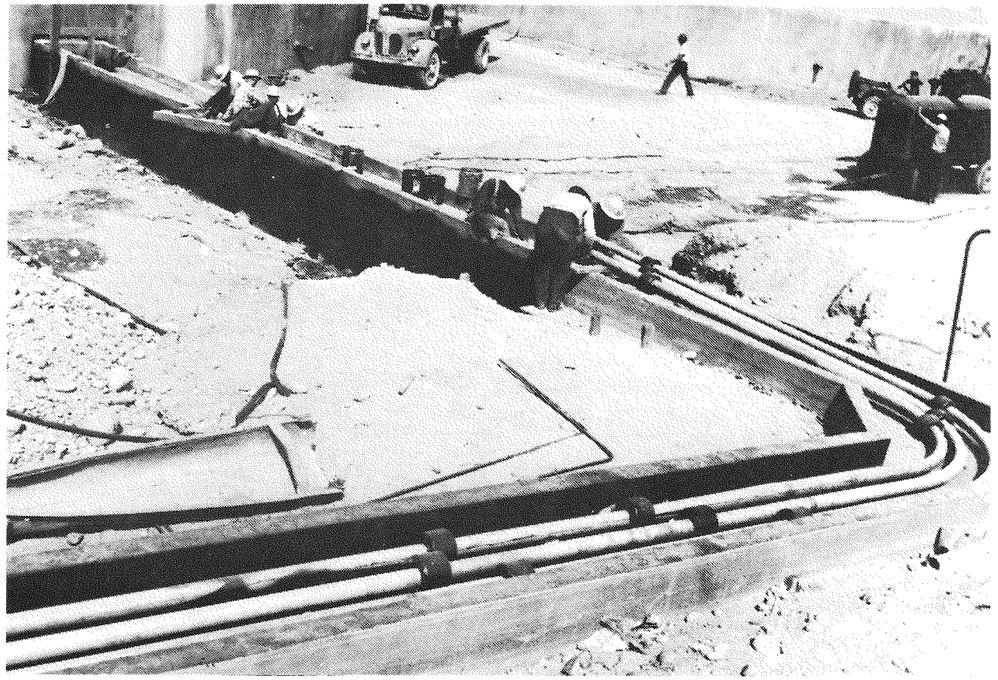
Over the next five years, very few contamination events occurred in the T Process Group. Incidents that did take place usually involved dust blow-backs from improperly conducted burial operations at contaminated equipment burial grounds outside T Plant or the repair, cleanout or transfer of liquids at waste diversion box catch tanks and pipelines. In February 1953, a chemical trainee at the 222-S Laboratory became contaminated when he used improper procedures to transfer samples from T Plant to that laboratory. Three months later, two other chemical trainees using improper procedures dropped and spilled a supernate sample from the 241-TX Tank Farm on the 200 West Area railroad crossing on 22nd Street between Bridgeport and Camden Streets.

Production Increases Multiply Contamination Incidents

On July 3 and 4, 1953, perhaps the most serious contamination event in T Plant history, up to that date, occurred when a four-foot diameter hole caved in over the old Cell 5-6 drainage waste line between T Plant and the 222-T Laboratory. Liquid flow about 200 feet long from the ruptured 5-6 line was visible along the ground just north of and over the 154-TX diversion box, located between the two buildings. Gross ground contamination occurred over this wide area. The cause of the pipe rupture was unknown. Contamination events multiplied in late 1953 and into 1954 as production increases strained the capacity of plant and support systems. Diversion box catch tank leaks, as well as leaks from 242-T Evaporator steam coils, caused ground contamination spreads in the summer and autumn of 1953 that continued into the spring of 1954. High winds during solid waste burial operations, complicated by procedural errors, brought contamination spreads in large areas north and west of T Plant in November and December of 1953. In January 1954, two employees and a large area of ground were contaminated during the cleanout of pump and sluice pits in the 241-TX Tank Farm.

A serious personnel contamination incident occurred at the 224-T Building in February 1955, when two employees were grossly contaminated (one up to 290% of the maximum permissible body burden) during the replacement of a dip-tube on the F Cell centrifuge. The next day, in a separate incident, a large section of ground around the stack of the TXR Vault was contaminated with particulate matter consisting of activated rust and paint. The TXR Vault had been built in 1952-53, as the place where T Plant high-level wastes from SSTs would be pretreated with nitric acid to be readied for the U Plant Uranium Metal Recovery Mission.

In late December 1955, several thousand gallons of first-cycle waste accumulated on the ground between T Plant and the 224-T Building, as the result of a ruptured underground line. This event was the last serious contamination incident that occurred during T Plant's years as a chemical processing facility. In subsequent years, other contamination spreads occurred along rail and other areas near T Plant. In the summer of 1973, the largest high-level waste tank leak in Hanford history occurred at Tank 241-T-106. However, the event was unconnected with the ongoing operations of T Plant.



Pipe chases and process lines being laid to transport T Plant's high-level waste to the 241-TX Tank Farm, August 1948.

Pipe chases and process lines being laid to transport T Plant's high-level waste to the 241-TX Tank Farm, August 1948.

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T Plant's Atmospheric Emissions and Hazards Control, Part I

Earliest Manhattan Engineer District Experiments Flagged Potential Atmospheric Problems

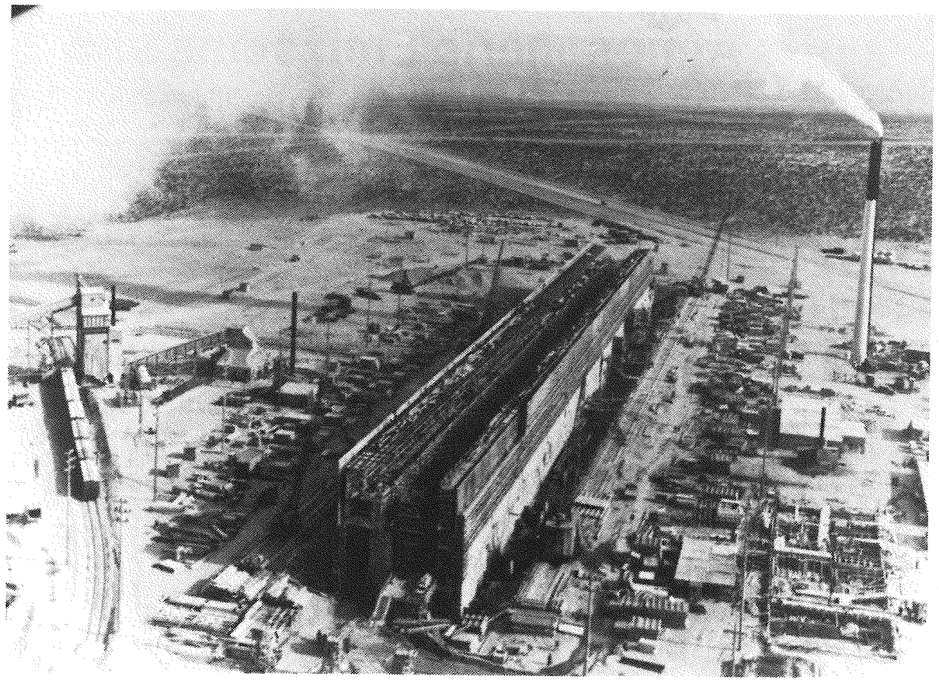
As early as the first MED experiments with processes that would separate plutonium from irradiated uranium, it was known that all of the key processes generated highly toxic fumes in the metal dissolving phase. In fact, this knowledge contributed to the selection of the remote, eastern Washington site for HEW. Further evidence of the generation of radioactive gases containing iodine-131 and many other fission products from the bismuth phosphate separations process was found in the earliest operations of a separations pilot plant that was built at the Clinton Engineer Works (now the Oak Ridge Site). Known as the Clinton Semiworks, this plant began to operate in early 1944 with the same chemistry (albeit on a much smaller scale) that would be used at T Plant.

The knowledge gained in the MED experiments and at the Clinton Semiworks prompted several early decisions at HEW. According to duPont, "these potentially serious conditions demanded that all such...by-products be disposed of safely. The means chosen consist of high [200-foot] ventilation stacks and fans which discharge the gaseous by-products to the atmosphere well above ground level."[9] Each cell within T Plant was connected to a main exhaust duct built into the concrete structure. A separate steam jet was installed for each dissolver to propel the highly contaminated vapors from dissolver operations directly to the base of the concrete stack.

Additionally, a temporary meteorology crew was brought to HEW as early as June 1943. Tasked with determining dominant wind patterns, velocities, and variances, the meteorologists soon found that the prevailing wind directions blew toward the northeast, east, and southeast. However, they also discovered complex micro patterns over HEW, including frequent and pronounced inversions. In early 1944, duPont obtained permanent status for the meteorology group. It's work then expanded to include wind dispersion tests with oil fog (SO_2), beginning in the partially completed T Plant Stack as early as April 1944. In the autumn of 1944, as construction and preoperations activities increased at T Plant, these tests moved to the C Plant Stack, and finally to the 400-foot HEW Meteorology Tower (622-R structure).

Fanning, Coning, and Looping

So extensive was the weather study and forecasting effort that by the end of 1944, over 36,000 individual readings on wind dilution patterns had been recorded in the 200 West Area. The meteorology group evolved key theories that described the offgas trajectories from stacks in the 200 East and West Areas in three possible conditions: "Fanning" denoted a wide, v-shaped path in which the gases followed the wind direction in a relatively straight line; "coning" described a narrow pattern, which also followed a straight line downwind from the stack; and "looping" meant an undesirable condition in which the stack gases bounced from stack height to ground several times in their pathway down the wind stream. The former two cases occurred during "aloft conditions," defined by duPont as circumstances in which "process stack discharge [is/was] not



Oil fog, released from T Plant's 291-T Stack as part of early 1944 meteorological experiments conducted to determine wind patterns, is clearly visible even though the plant itself is far from complete.

expected to reach the ground." Looping, on the other hand, occurred during "unstable" air conditions, primarily inversions, and was seen as the worst possible scenario because it could bring stack gases downward where HEW workers could receive a concentrated dose.[3,10]

Because T Plant (as well as the other 200 East and West Area processing facilities at HEW) would operate without stack filters of any type, wind patterns and dilution factors, as well as the "cooling" (or aging) time that irradiated fuel rods spent between leaving the reactor and being chemically processed, became the chief means of control of the offgases. The duPont scientists calculated the normal flow of air and process gases exiting the T Plant Stack to be 40,000 cubic feet per minute and then augmented this volume with an additional 20,000 cubic feet per minute of "diluting air," giving a total stack flow of 60,000 cubic feet per minute. At the resultant stack flow rate of a 50-foot-per-second velocity, duPont scientists decided that "dilution factors greater than 1000:1 are considered favorable, those from 500:1 to 1000:1 moderately satisfactory, and those less than 500:1 unfavorable."[3]

Using the meteorological calculations for necessary wind dilution factors along with the addition of the fan-driven diluting air in the stack gases, HEW chemists decided in the autumn of 1944 that "if the normal wind dilution factor is 1000...iodine tolerance levels" in the vicinity would "not be exceeded" if the metal was cooled for 30 days. To "schedule dissolver operations when atmospheric conditions are conducive to maximum dispersion," hourly and 12-hour "dissolving forecasts" were phoned to T Plant, beginning with the cold runs in November 1944.[3]

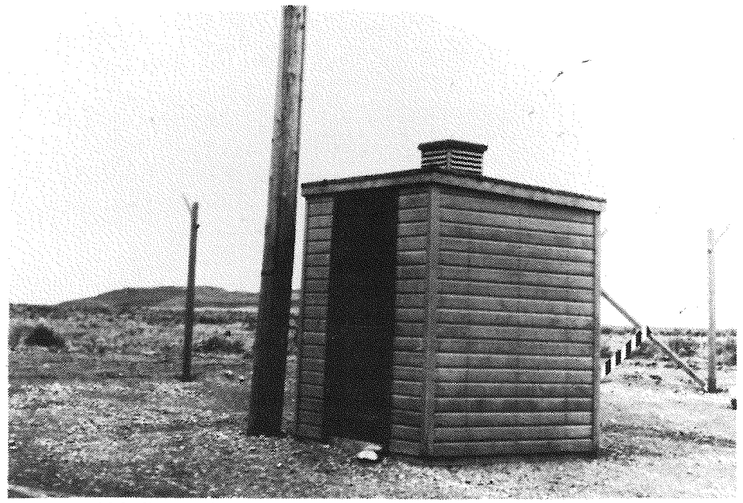
Hot Processing Brings Unexpectedly Large Atmospheric Emissions

With startup conditions thus defined, and the meteorology program in place, T Plant processed its first full, hot charge on December 26 and 27, 1944, with metal aged 32 days. The activity was about 10 times as high as any that had been processed at the Clinton Semiworks. Somewhat surprised at the 1,700 curies of iodine-131 that was evolved, duPont recorded the "first significant plant discharge of radio xenon and radio iodine into the atmosphere at Hanford." Throughout the spring and early summer of 1945, metal cooling times fell, as HEW rushed to produce the plutonium for the Trinity and Nagasaki bombs. Exactly how short the metal decay periods became is unclear, but it is known that they fell below 30 days and to perhaps as low as a few weeks. May 1945 brought a sharp increase in metal activity, increased dissolving frequency, and the change to warmer spring weather. Unstable inversion and lower wind velocities at those times led to a decision in early June to confine dissolving operations to the nights. At the same time, believing that the hourly and 12-hour forecasts had proved "too short for effective scheduling of dissolver operations," the meteorology team switched to a single, daily (24-hour) dissolving forecast.[3]

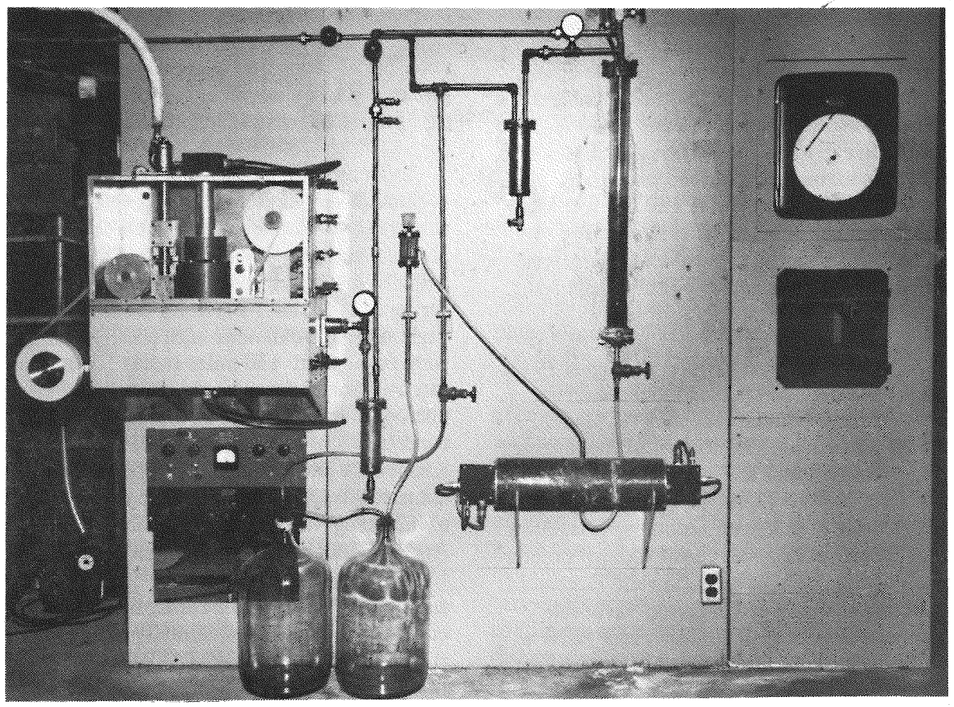
At the end of World War II in August 1945, a large inventory of irradiated fuel rods from HEW's three production reactors (B, D and F) awaited processing. The number of fuel charges being processed rose at T and B Plants from 22 in June 1945 to 77 in December. Beginning in September of that year, according to duPont, chemical processing was carried out in "uninterrupted operation." Between July and December, dissolving was carried out under "favorable" conditions only 60% of the time; and HEW's Health Instruments (H.I.) Section, a part of the Medical Division, reported "an increase in radioactive iodine deposits on vegetation in outlying districts." Concerned, HEW officials increased the metal cooling time from about 35 to about 60 days, beginning in December. During the period from January through August 1946, dissolving was carried out under "favorable" conditions 64% of the time.[3]

As a result of the dissolving practices and quantities of irradiated material processed through T and B Plants, at least 345,000 curies of iodine-131 were released to the atmosphere during 1945, and 76,000 additional curies of iodine-131 were released during 1946. In the meantime, the learning curve continued concerning the deposition and buildup of airborne fission product activity in the HEW plant areas and throughout the surrounding region. In the spring of 1945, H.I. Section studies were extended into the region adjacent to HEW. According to duPont, "detectable quantities of radioactive iodine were found as far afield as Richland." By autumn, "the widespread deposition of iodine-131 on the ground led to a study of its accumulation in terms of micrograms of vegetation."[3]

In December, an "activity increase [on vegetation surrounding HEW] accelerated the already considerable interest in the iodine problem and led to a calculation of the hazard to animals grazing on contaminated plants." In the spring of 1946, the "search for contaminated vegetation was extended until positive samples were found up to 150 miles radius." With the extension of cooling times for irradiated metal that began in December 1945, "radio-iodine concentrations on the ground in Pasco, Kennewick and Benton City fell steadily but did not reach the estimated permanently safe level of 0.2 μc/kg [microcuries per kilogram] until April." Concurrently, throughout the 1945 and 1946 period, studies by Hanford's H.I. personnel and other MED officials continued into the effects of iodine-131 on animals and vegetation at and near HEW.[3]



One of 29 General Monitoring Stations built at the Hanford Engineer Works during World War II to monitor airborne contamination from the various processing buildings. Six such structures were built in the 200 West Area.



Monitoring equipment used to sample the atmosphere for iodine-131 and other radioactive contaminants during T Plant's years as a chemical processing facility.

T Plant's Atmospheric Emissions and Hazards Control, Part II

Postwar Expansions Bring Increases in Production and Airborne Emissions

The early postwar era brought tremendous changes to the HEW. In September 1946, the duPont left the Site as prime contractor and was replaced by the General Electric (G.E.) Hanford Company. On January 1, 1947, the old MED concluded its stewardship of the nation's atomic facilities, as the AEC was created by the *Atomic Energy Act of 1946*[11] (the McMahon Act). As the new civilian-controlled AEC took control, it shortened Hanford's name to the Hanford Works. In the late summer of 1947, a giant expansion of the HW facilities was announced to the public. The G.E. Hanford Company, following urgent orders form the AEC, rushed to build two new production reactors (H and DR), as well as the first continuous action, solvent extraction chemical processing plant in the world (the REDOX Facility), 42 additional underground tanks for the storage of high-level wastes, many ancillary and support facilities, and new housing in Richland. Special nuclear weapons material production goals for HW increased sharply.

As the processing workload on T and B Plants increased in late 1947, so did airborne emissions of iodine-131 and other contaminants. According to HW scientists, increases in vegetation contamination occurred throughout "a rather wide expanse of privately owned agricultural lands of Washington, Idaho and Oregon."[12] During that year, an estimated 24,000 curies of iodine-131 was released from the stacks of T and B Plants.

Another new problem concerned "specks" (particles) that were observed near the stacks beginning in the autumn of 1947. It was estimated that the specks, composed of cerium-144, strontium-90, yttrium, ruthenium-106, cesium-137, and the carbon, iron, silicon, and hydrogen components of the resin paints used in World War II to coat the inner stacks, fans, and duct work were being emitted at the rate of 10 to 100 million per month from each of the two facilities. Beginning in November, the duct work, fans, and fan casings in the 291-T and 291-B Stacks were replaced. Additionally, caustic ("water scrubber") air filters were installed between the fans and stacks and in the individual cell exhaust ducts in T and B Plants.

By early 1948, further examination of the material exiting the stacks showed the presence of "droplets" or "acid mists" from condensed process gases. Like the particles, these mists contained activation products and oxides of nitrogen. Therefore, it was decided in the spring of 1948 to add huge sand filters belowground near the plant stacks and to reroute the process gases through them. Sand filter installation was completed at T Plant on October 15, 1948. Additionally, between April and November 1948, a series of 11 special air monitoring stations were emplaced around the northwest, specifically to monitor for stack particulates. Three of these stations were located at Richland, Pasco, and Benton City, but the remaining eight stretched in a huge trapezoid from Great Falls, Montana, to Boise, Idaho, to Klamath Falls, Oregon, to Stampede Pass, Washington.

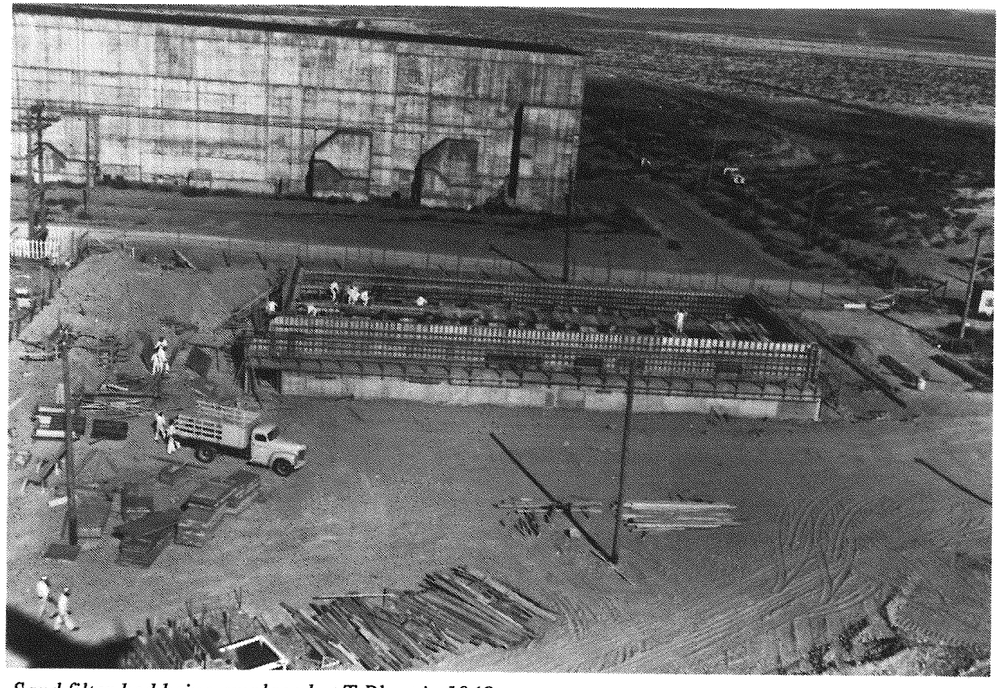
The sand filters themselves consisted of successively finer gradations of sand, placed in a large underground container (110 feet by 48 feet) at T Plant and equipped with air distributors, plenum chambers, and duct work. However, these filters were only marginally successful because the sand beds plugged and the resistance (pressure drop) within the unit

increased rapidly. Soon fiberglass filters, consisting of glass filaments one to two microns in diameter, were added in the dissolver offgas lines themselves. However, according to G.E. Hanford Company, "high radioactive particle content"[13] in the air around the stacks in the 200 East and West Areas and throughout the region remained a problem through at least 1953.

Further Production Increases Stress Sand and Fiberglass Filters

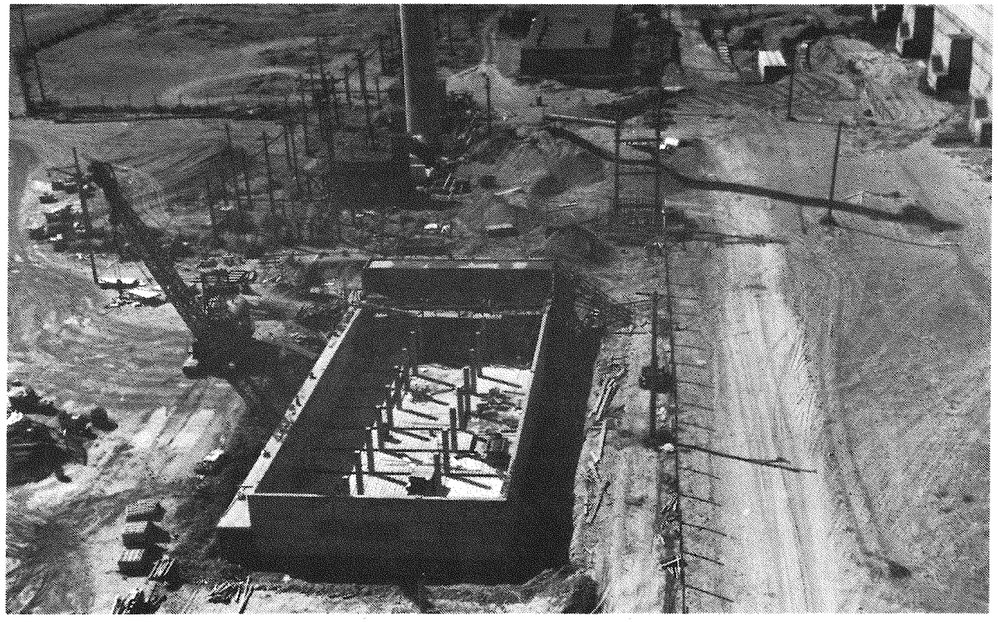
The time frame 1948 to 1950 witnessed a dramatic increase in the output of irradiated metal from the HW production reactors. In July 1948, B Reactor, closed since 1946, was reenergized. In October 1949, the new H Reactor became active, as did the new DR Reactor exactly one year later. The activation of these units brought the total number of operating Hanford reactors to five. Further, in April 1949, experiments began a successful increase in the operating power levels of the oldest HW reactors above their World War II design levels. With the new REDOX processing plant not scheduled to go on line until early 1952, the workload on T and B Plants rose substantially.

In mid-1948, metal cooling times at HW were increased to between 90 and 125 days and remained there for most of 1948, 1949, and early 1950. Additionally, in 1948, the AEC established a Stack Gas Working Group of prominent industrial health specialists from around the nation. While the Group was to address difficulties throughout all AEC installations, it was instructed that "Hanford is to have top priority."[14] In mid-1948, the Group concluded that the water scrubbers and sand filters were the best available and practical means to deal with the huge volumes and high radioactivity levels of the T and B Plant Stack discharges.



Sand filter bed being emplaced at T Plant in 1948.

Sand filter bed being emplaced at T Plant in 1948.



Sand filter bed being emplaced at T Plant in 1948.

Despite the best efforts of the Stack Gas Working Group and HW scientists, no truly effective chemical or physical barriers to control the activity levels in T and B Plant Stack emissions were identified in 1948 or 1949. Additionally, during the summer of 1948, the National Committee on Radiation Protection voted to reduce the permissible limit for iodine-131 to man by a factor of 25. At the same time, Hanford's tolerable level for iodine-131 contamination on vegetation was halved, to 0.1 microcuries per kilogram. In view of these developments, metal cooling times were kept long, and iodine-131 emissions at the Site were held to approximately 1,200 curies for 1948.

Green Run Spikes Emission Levels in Late 1949

Radioiodine discharge levels remained low throughout 1949, until December, when a single event at T Plant allowed the escape of nearly 8,000 curies in a two-day period. This event, known as the Green Run, was so named because it involved the experimental dissolving and processing of irradiated metal that had been aged only a short time (i.e., that was "green" or newly irradiated). The event occurred just three months after the U.S. learned that the Soviet Union had detonated its first nuclear test bomb over Siberia. According to the General Accounting Office, the Green Run was an instrument development test that "was also generally related to research into the safety and health effects of nuclear detonations and nuclear production operations."[15] The event was directed by the U.S. Air Force and involved the dissolving of two tons of fuel elements that had been aged only 16 days.

Effects of the Green Run on contamination levels on regional vegetation, in rainwater and mud, and in other environmental media, were dramatic. Rain and snow moved into the area just a few hours after dissolving began on the 12:00 (midnight) to 8:00 a.m. shift on December 2. Vegetation samples taken in the Tri-Cities and Benton City demonstrated average activity levels from 83 to 617 times the then-tolerable limit of 0.1 microcurie per kilogram, with the highest reading in Kennewick showing over 1,000 times this limit. Overall, an elliptical zone of higher than normal contamination, encompassing the Hanford area as well as areas 70 miles to the northeast and southwest, was produced. Animal thyroid values for beta (iodine-131) activity within 70 miles of HW averaged 14 times higher that December than they had in October. In the years since the Green Run was made public in 1986, the level of public interest in this controversial test has remained high.

Silver Reactor Filters a Major Discovery

Following the Green Run, metal cooling times at Hanford briefly returned to the 90- to 125-day range. However, a major discovery in iodine-131 control was made in 1950. "Silver reactor" filters, so called because they contained a bed of fiberglass material soaked with silver-nitrate that would react with radioiodine to form silver iodide, were developed and tried on an experimental basis. The tests worked so well that such filters were installed at B and T Plants in October and December, 1950, respectively. The equipment was placed in the ducts that led out of the dissolver cells and into the main plant exhaust lines. Hanford officials, anticipating good results from the silver reactor filters and anxious to increase production in view of the onset of the Korean Conflict, began in September 1950 a series of experiments in shortening metal cooling times. That month, the aging period was dropped to 70 days, but a quick rise in iodine-131 emissions drove the period up to 78 days for the remainder of the year.

Initial reports prepared in January and February 1951, placed the efficiency rate of the silver reactor filters for iodine-131 removal at 99.9%. As a result, metal cooling times at HW were dropped to 67 days in mid-February and lowered further to an average of only 44 to 55 days by mid-May. The average fraction of evolved iodine-131 that was released to the atmosphere rose dramatically, from the 2 to 5% range to 25%. In one dissolving, as much as 34% was released. Additionally, with the greater throughput of irradiated metal, more iodine-131 was being generated than ever before at HW. The amount of total released curies soared to an average of 181 each day throughout the spring, with a one-day maximum of 425 curies. By late July, H.I. monitors reported that the silver reactor filters were "easily saturated" and "failing."[16] The filters serving Cells 4-5 Left and 3-5 Right in T Plant were replaced when they overheated and again showed good results. However, in view of the overall performance record of the silver reactor filters, metal cooling periods were lengthened to 80 to 100 days at HW. Atmospheric emissions of iodine-131 then fell to an overall average of five curies per day throughout the fourth quarter of 1951.

In total, the years 1950 and 1951 witnessed the airborne discharge of approximately 2,100 curies (iodine-131) and 18,700 curies (iodine-131), respectively. In 1950 to 1951, the experiments in shortened metal cooling times were clearly reflected in the radioiodine discharge levels and in the vegetation and animal thyroid activity levels in the Hanford region.

Silver Reactor Filters Ultimately Succeed

Throughout the next few years, Hanford scientists learned that the silver reactor filters worked well, as long as they were replaced and/or regenerated (i.e., sprayed with additional silver nitrate) on a frequent basis. Additionally, operating experience showed that the filters worked best when the gas was heated to approximately 375 degrees F (Fahrenheit), instead of at the mid-1951 levels of 400 to 478 degrees F. Silver reactor filters became the standard and best means of control for iodine-131 to be used at T Plant (and other areas at Hanford) throughout its operating history. However, after 1951, T Plant did add mercury, silver, potassium, and/or sodium to the metal dissolving solution to help keep iodine in solution and to provide added means of emission control.

Throughout the remainder of T Plant's years as a chemical processing facility, metal cooling times were maintained between 90 and 110 days. Average total emissions of iodine-131 from HW hovered around 2.8 curies per day and sometimes reached as high as 4.2 curies per day. During early 1955, T Plant experienced a spike in the amount of iodine-131 released from its stack, and subsequent investigation revealed malfunctions in the dissolvers in Cells 3-5 Right. That summer, in the midst of a special nuclear defense materials push undertaken by President Eisenhower, the question of shortening metal cooling times was again debated at HW. A Symposium on the Iodine Problem was held, but none of the speakers could affirm the safety of reducing the decay period to 70 days, as dependable countermeasures were not at hand.

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End of Chemical Processing and Transition to the Decontamination Mission

Process Improvements at T Plant Offset by Newer Plants

The 1950s brought dramatic rises in plutonium production at Hanford. During 1954, a 30% rise in processing capacity was realized at T Plant, with the acquisition of a third metal dissolver in August and a third extraction unit in December. Still, demands for plutonium driven by the Cold War, outstretched the supply, and the 4X Program was initiated. This program planned to use T and B Plants, as well as the REDOX Facility and the new Plutonium-Uranium Extraction (PUREX) Plant, for active chemical separations. Design and proposal work was approved, and construction work for the reactivation of B Plant was begun in December 1954. During the following year, a combined operation of T Plant and U Plant, to be known as the TBX Plant, also was studied. In this plan, metal dissolution and process feed preparation would take place in T Plant, while separation and decontamination would take place in U Plant. While such studies went forward in 1955, T Plant operations were characterized by increased time-cycle efficiency, to the point where the average processing time cycle dropped to 4.5 hours. The overall HW production rate increased by 26% in 1954 and 30% in 1955.

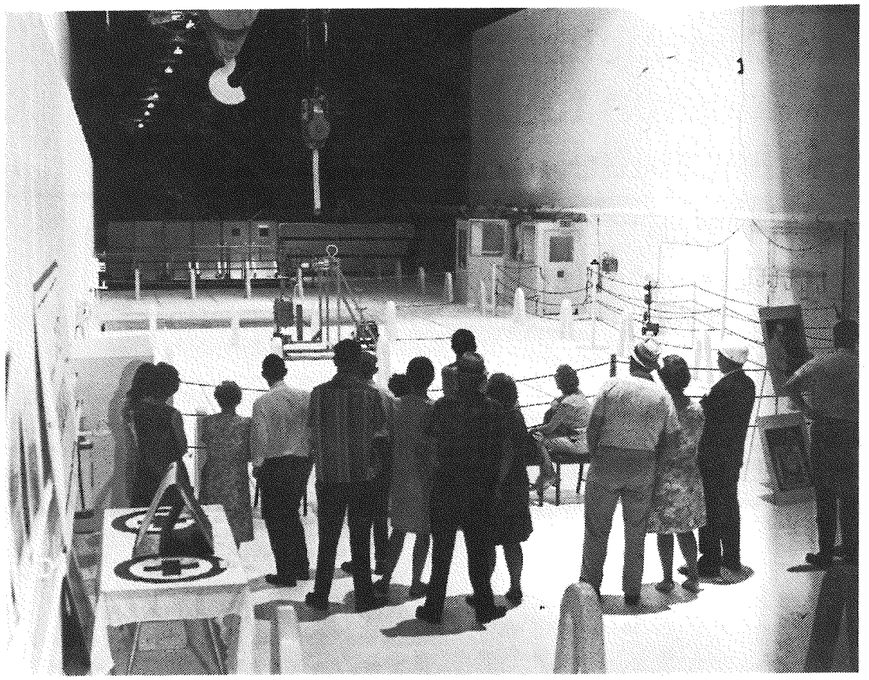
By 1956, however, the overwhelming processing efficiencies being experienced at the REDOX and PUREX plants made the operations of T and B Plants unnecessary. That year, overall chemical processing rates at Hanford jumped by 59%. The decision was made not to reactivate B Plant, and T Plant was retired from active service as a chemical processing facility on March 20, 1956.

T Plant's Role As a Decontamination Facility

The full process of cleanout and transition to a new role as HW's decontamination facility took several years at T Plant, although washes of the processing equipment and cells, using 60% nitric acid, began on April 1, 1956. The acid flush material then was collected and processed for plutonium recovery, and subsequent flushes were performed with a solution of 1% sodium citrate and 5% sodium hydroxide. Between 1956 and 1963, many jet assemblies, jumpers, tanks, tank spargers, dissolvers, centrifuges, heaters, lubricators, pumps, valves, instruments and other equipment, and some piping was removed from T Plant and buried as contaminated waste.

In 1958, the facility replaced U Plant as HW's central decontamination plant. Several control panels and other miscellaneous equipment pieces were moved into the plant's head end and stored there. In 1959, two small shacks associated with T Plant were removed to make room for construction of the 2706-T Decontamination Annex, a facility that handled equipment too large to be moved into T Plant or pieces having lower contamination levels than those decontaminated in T Canyon itself. As late as the 1964 to 1966 period, World War II processing equipment and instruments, as well as chemical, air, steam, and water pipes were being removed from T Plant and buried.

In 1964, a Burst Test Containment Facility was installed in the plant's head end, thus providing a place to conduct trials in the explosive degradation of irradiated fuel elements.



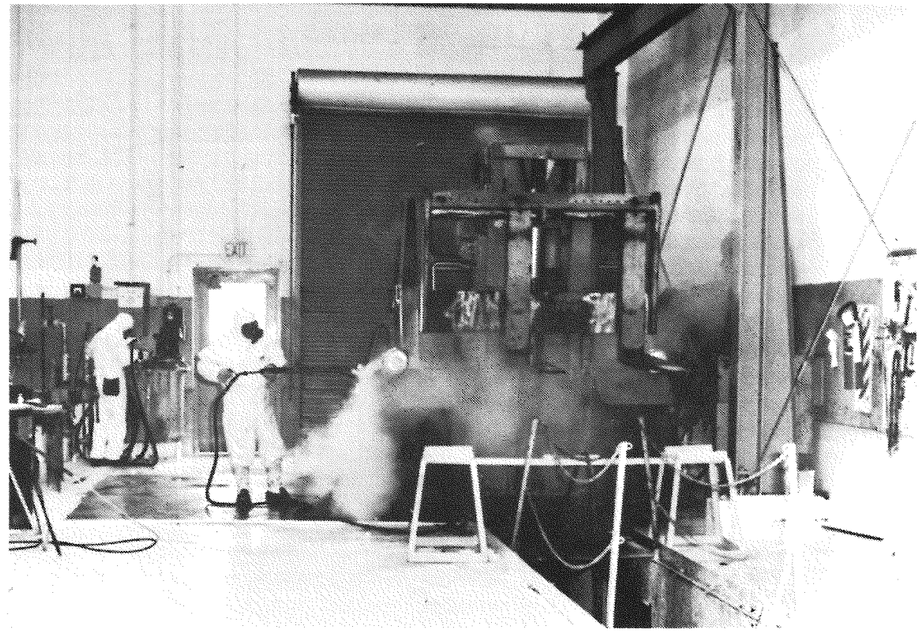
Visitors at T Plant's Silver Anniversary in 1968 watch a demonstration in the partially decontaminated canyon.

At that time, additional dissolvers, condensers, towers, heaters, and silver reactor filters were removed and buried. In 1967, more panel boards and gang valves, as well as miscellaneous stainless steel and black iron pipe and fittings, were removed and buried to make space for other experimental work in the head end. Many additional pieces of equipment, old instruments, as well as much wiring and additional piping, continued to be removed during 1968 and 1969.

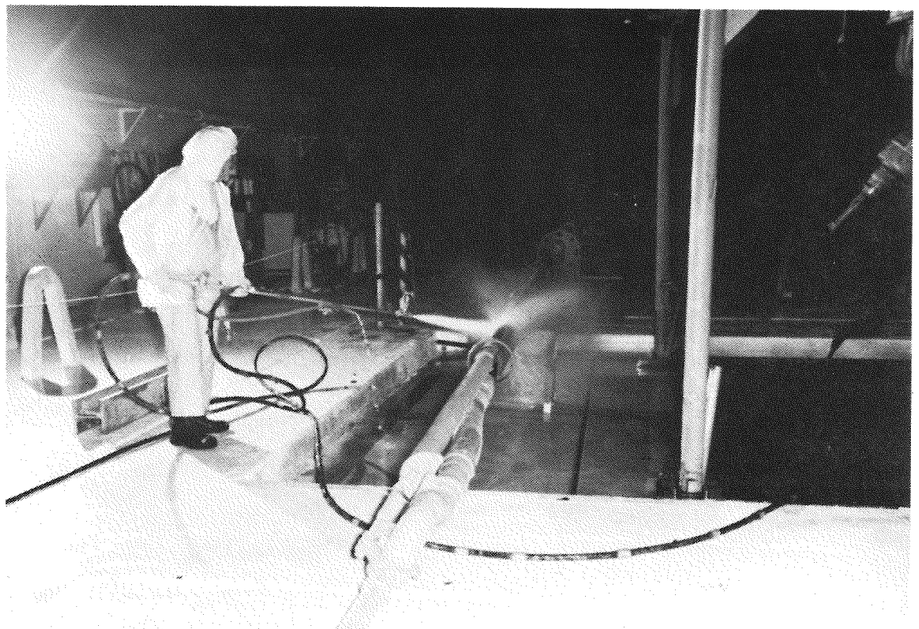
Early Decontamination Operations Used Steam, Sand, Chemicals, and Detergents

Early decontamination operations carried out in T Plant involved several processes. Smaller equipment pieces were immersed in decontamination solutions in "thimble tanks," and larger pieces were flushed with water, chemical solutions, sand-blasted, steam-blasted, high-pressure sprayed (using pressures up to 10,000 pounds per square inch), and/or scrubbed with detergents. During the initial years, a strong nitric acid flush (approximately 60%) usually began the decontamination process, followed by a caustic wash with sodium hydroxide combined with sodium phosphate, boric acid, versene, sodium dichromate, sodium tartrate, or sodium citrate. However, it was learned that versene and tartrate, in particular, adversely affected the ability of soil cribs to adsorb the rinsate materials. High-pressure sprays often used 1,1,1 trichloroethane or perchloroethylene, and detergents generally were chloride-based.

By the mid-1960s, commercially prepared and trademarked chemical mixtures had replaced most of the simpler chemicals used in the early



Spray decontamination activity being carried out in the 2706-T Facility during the 1970s.

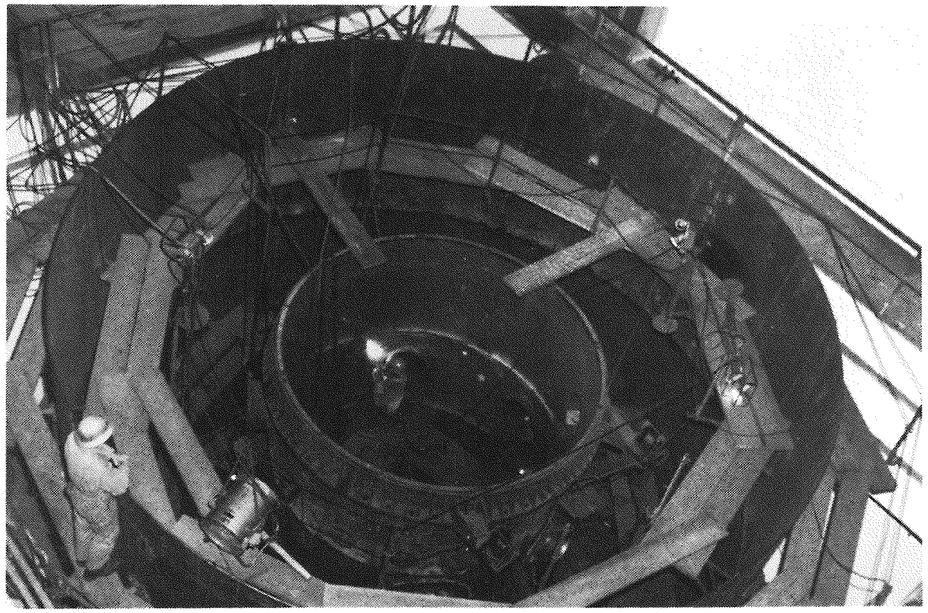


Decontamination activity in the T Plant canyon in 1974.

years. Many of the commercial products were based on oxalic acid, phosphates, nitric acid-ferrous ammonium sulfate combinations, potassium permanganate, and sodium bisulfate, with some unknown additives. Filtration of airborne effluents associated with decontamination activities was accomplished through the sand filters. In this mode, T Plant continued to perform decontamination functions until it was placed on Limited Operation in January 1987. After that time, limited amounts of decontamination and repair of rolling stock and other equipment took place in both the 2706-T and T-canyon facilities until they were shut down for major upgrades in January 1990.

Decontamination operations carried out in T Plant demonstrated their economic value early. In just the first year, savings over nearly $225,000 were shown in plant records, based upon the depreciated value of used equipment cleaned and returned to service. By 1969, monthly savings usually were valued at between $100,000 to $200,000. Most equipment needing decontamination was transferred to T Plant in "multi-purpose transfer boxes." Such containers made of welded stainless and carbon steel and mounted on flat railcars.

Some very special transfers occurred to and through T Plant during its years as a decontamination facility. During the late 1970s, the rail entry tunnel and pool cell were used to receive, unload, and disassemble high-exposure, irradiated fuel from the Shippingport (Pennsylvania) power reactor. In 1983, the T Plant rail entry tunnel again was used to receive and transload (into overpack burial containers) zeolite beds encased in stainless steel liners and loaded with cesium-137 from the Three Mile Island (Pennsylvania) power reactor. Following an accident in that reactor in 1979, the zeolite beds had been used to absorb cesium-137 out of the contaminated water in the reactor coolant system's containment sump. In 1983, the Submerged Demineralized System (SDS) liners came to Hanford for burial as contaminated waste. During 1982 and 1983, several improvements were made to the T Plant crane and cab, filtration system, instrumentation, and rail tunnel in preparation for this project.



The Burst Test Containment Facility, built for experimental purposes in the head-end of T Plant, nearly complete in January 1965.

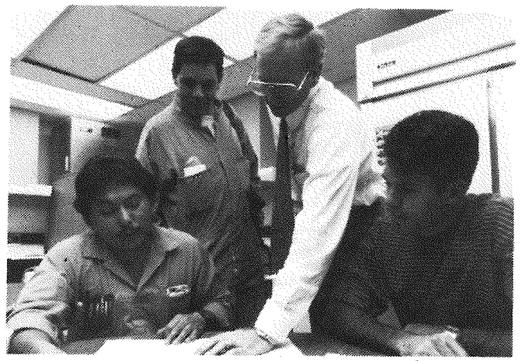
1990s Bring New Challenges to Historic T Plant

T Plant's Deficiencies Manifested

On October 24, 1990, a Continuous Air Monitor (CAM) at T Plant was silenced by the use of a stick and a chair. A subsequent investigation reported the incident as indicative of procedural deficiencies, poor work practices and training, inadequate communications of management expectations, and deteriorating physical conditions in T Plant. Eight other incidents in quick succession that autumn and early winter led to a decision by operating contractor, Westinghouse Hanford Company (WHC), to curtail operations. As of January 9, 1991, T Plant was ordered to accept no new work and to focus its sole efforts on upgrading the facility and the operating practices "to acceptable levels."[17]

An Unusual Occurrence Report entitled "Limited Decontamination Operation," issued later that month reiterated the problems endemic at T Plant: "The facility has been allowed, due to resource limitations, to deteriorate over a period of years...Equipment has not been serviced or replaced with the regularity necessary to provide reliable service. Procedures have not been revised...Personnel training has been insufficient."[18] The award fee from the U.S. Department of Energy (DOE) for the six-month period covering October 1990 through March 1991, likewise pointed to the alarm disabling as a tip-of-the-iceberg event reflecting "systematic neglect by the line organization over a substantial period of time."[19] A DOE Conduct of Operations inspection of T Plant, carried out during this time period, "displayed all areas to be in noncompliance."[19]

At nearly the same time, WHC organized a T Plant Future Assessment Task Team to determine the future decontamination needs of the Hanford Site and to delineate T Plant's role in filling those needs. A facility manager was named, along with a new staff of people dedicated and excited by the immense challenges of rehabilitating the historic plant.



T Plant Manager, G. W. Faulk, examines updated facility drawings with staff members in the refurbished lunchroom located in the 271-T Building, late 1993.

Long Road Back

Thus began the long road back for T Plant. In June 1991, the Task Team concluded that a centralized decontamination facility was essential to the Hanford Site cleanup mission, for reasons of safety and economy. Hazardous and radioactively contaminated objects would face almost insurmountable regulatory barriers if they were to be shipped offsite for decontamination. Further, the costs of onsite decontamination would pay large dividends, in instances where equipment was returned to service and in cases where objects were reduced

in radiation and chemical levels low enough that they could be buried as low-level waste or released as nonregulated scrap. Because the cost of burying low-level waste is approximately one-third that of storing high-level or mixed waste (and there are additional costs for ultimate disposition of high-level and mixed wastes), it quickly became obvious that an upgraded T Plant had an important role to play in Hanford's future.

In the meantime, the T Plant staff was busy evaluating the facility and beginning improvements. The lack of updated, usable, as-built drawings jumped out as an immediate problem. Eventually, 2,600 drawings applicable to T Plant were identified, nearly all of them dating from an original set developed in World War II to cover T, B, and U Plants as a unit. Over the years, engineering change notices (ECNs), applicable to any one of the three plants, had been entered in pencil on the drawings, even though these facilities soon diverged widely in equipment, missions, and modifications. The result was a master set of drawings that described none of the plants as they really existed.

The T Plant staff selected approximately 500 of the most important old drawings, let a subcontract to enter them into a modern, computerized system, and updated them through a series of thorough "walk-downs" of the facility. At the same time, a unique identifier system of coded labels was developed for each component of the steam, water, air, drain, ventilation, process, and instrumentation systems. Entered onto the updated drawings, as well as onto the physical components in the plant, these identifiers completed the process of making the drawings unique to T Plant. They also made it possible to write accurate new procedures for facility activities and to implement a specific and workable Lock and Tag system. Additionally, a "worker-friendly" set of systems drawings was developed, designed to represent various single systems in schematic fashion, thus making it easier to perform maintenance work and other routine inspections.

Another set of problems discovered early by the new T Plant staff were those concerning safety documentation. The facility was operating with a conglomeration of documents that included an old Safety Analysis Report (SAR) with many supplemental ECNs that had not been incorporated into the original, three sets of Operational Safety Requirements (now called Technical Specifications or "tech-specs"), and five Operating Specifications Documents (OSDs). None of these documents had been approved officially by DOE. Studying this maze, the staff began a process of both excising the irrelevant portions contained in the many documents and consolidating duplicate or overlapping material. At the same time, they incorporated the findings of a criticality safety evaluation report completed on the facility in 1989 and 1990. The result was the adoption of a single SAR by mid-1993 (with some chapters still being revised in early 1994), a single, consolidated OSD, and two smaller documents relevant to the 72 irradiated fuel assemblies from the Shippingport reactor that have rested in the T Plant pool cell since 1978. Both documents relative to the fuel assemblies will be incorporated into the consolidated documentation during 1994.

One more early activity flagged with a high priority was the inspection of the pool cell, known as the pressurized water reactor pool because of the presence of the Shippingport fuel elements. The water storing the rods appeared unclear and was covered with floating debris. However, some preliminary cleaning and the addition of new screening and filtration devices showed that the pool itself was basically sound. A waste minimization initiative was made to replace or possibly eliminate antique refrigeration units that had been needed to chill the pool's water and, thus, eliminate some of the secondary cooling water discharges to the 216-T-4 Ditch. Additionally, new liquid-level instrumentation was installed, and firm administrative controls were placed on the water levels required in the pool.

Cleanup and Cleanout of Staff "Living" Areas

At the same time, a complete radiological characterization survey of T Plant was carried out, and physical cleanup was started. Staff "living" areas, such as offices, shower rooms, bathrooms, and change facilities were given first priority. The program that had built the experimental laboratory into T Plant's head end in the 1960s had abandoned the facility, leaving a substantial supply of chemicals. The cleanout of this area revealed a vast array of substances now defined as hazardous, including some shock-sensitive chemicals that had to be detonated under controlled conditions. Existing office space on the second floor of the 271-T Building was repainted, carpeted, and wired to accommodate modern computers and other office machinery. In the same building, an old electroplating shop containing many hazardous substances was cleaned out and fitted as a consolidated lunchroom. The new lunchroom was needed to address safety and radiological concerns associated with five older lunch areas. Two new change trailers were emplaced to serve the 2706-T Building and the rail tunnel to improve radiological controls and to allow radiation zone reductions in these areas.

Installation of fire protection equipment for the new change trailer.

Area just north of the 271-T Building and west of the north Canyon wall littered with unknown wastes and debris in 1991 (above) and after cleanup in 1993 (below).

In 1992, a large "entryway" project, designed to control the then-unregulated access to the 221-T Building, started. Personnel radiation monitoring devices were emplaced to survey each person before leaving the plant, and a visitor identification and check-in office was established by early 1993.

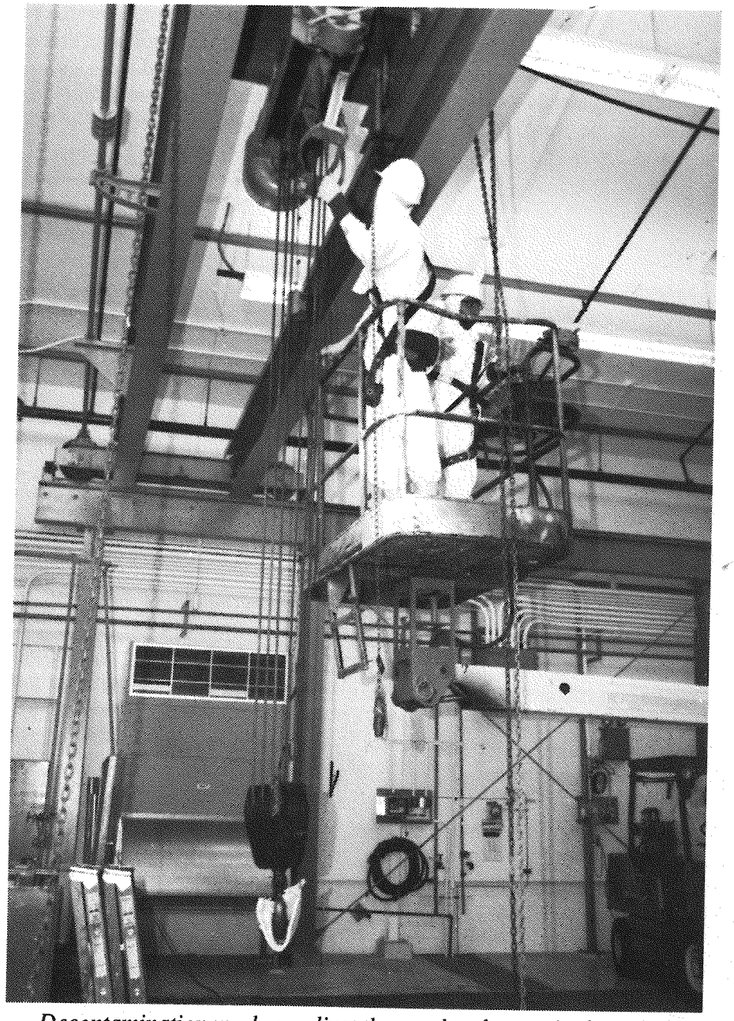
Rehabilitation of the 2706-T Facility

In early 1992, the cleanup and cleanout of the 2706-T Decontamination Annex began. Many boxes and drums containing unknown wastes had been stored in the facility over the years. One such drum, which had been moved outside to await disposition, began to leak, which brought inspectors from the Washington State Department of Ecology (Ecology) in May 1992. Several deficiencies were noted for the yard area outside of the 2706-T Building and the T Plant rail tunnel, all concerning noncompliance with waste accumulation, storage, administrative control, and record-keeping regulations. The T Plant staff began an ambitious program to open, sample, characterize, label, and disposition every box, drum, and equipment piece at the facility. The contaminated items were carried into the T Plant rail tunnel, and much of the sampling was done with the aid of Hanford's Sampling and Mobile Laboratory group. The three most corroded drums were inspected by the Site's Hazardous Materials Team. When highly acidic contents were identified, the contents were treated, and the drums were overpacked and dispositioned as hazardous and radioactive waste. In January 1993, Ecology and WHC conducted a follow-up inspection of the 2706-T yard and confirmed that the noncompliance issues of the previous spring had been "satisfactorily completed."[20]

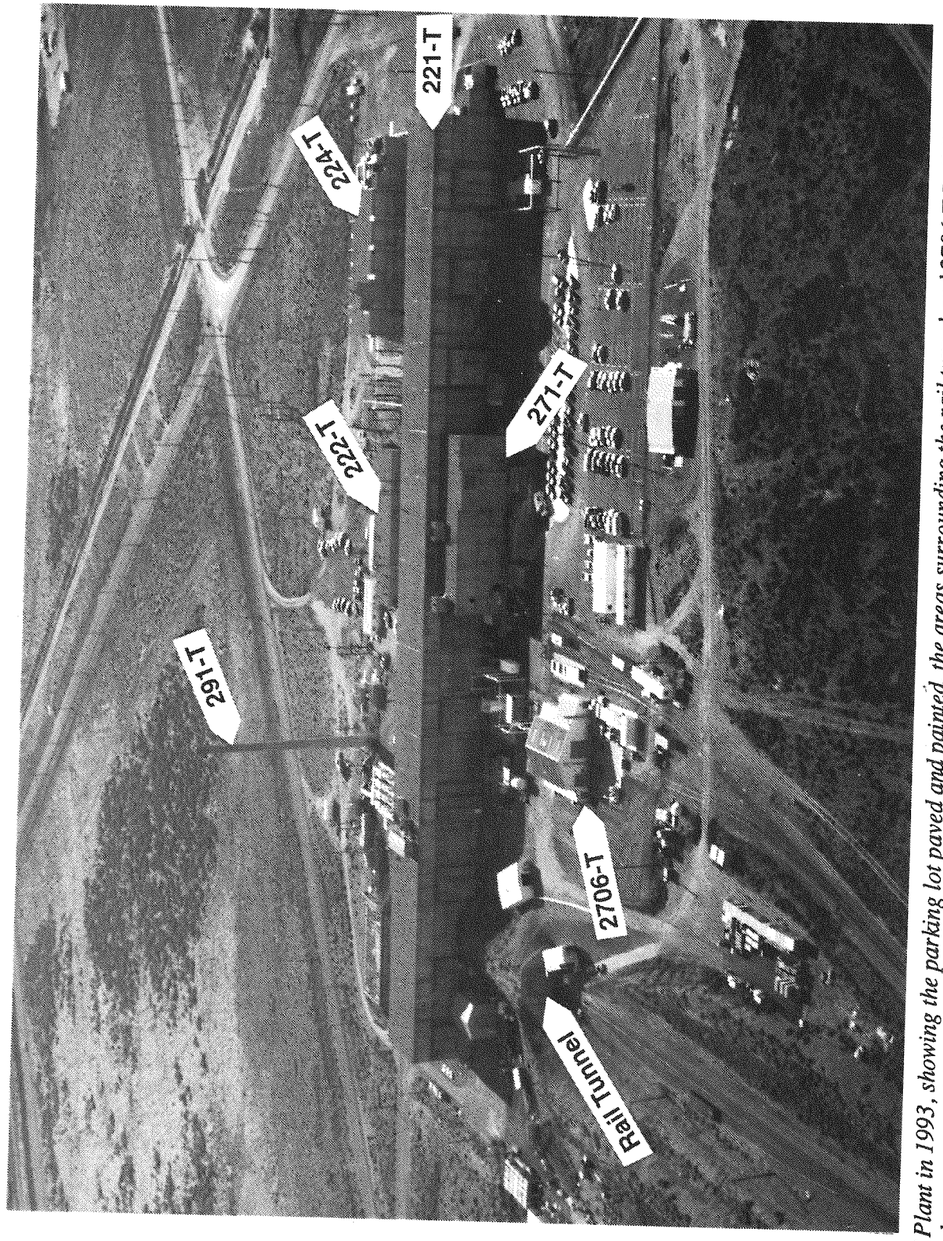
At the same time, T Plant officials had learned from dealing with their own noncompliant waste drums and boxes that they could perform a valuable service for the rest of the Hanford Site. To receive, store, contain, and perform some minimal waste treatments, such as liquid absorption from containers, T Plant applied for and received an expanded Part A Dangerous Waste Permit. This permit also identifies waste management activities supporting the facility's long-term mission in waste storage and treatment, in tanks, containers, and other units.

Waste inspections and repackaging then became an important part of the T Plant mission as the facility stepped up to accept, open, sample, and repackage over 200 drums containing unknown wastes from the Tank Farms in 1993. Work also was completed on an inventory of 58 boxes of unknown Tank Farms waste, and an agreement was reached to help sort, sample, and repackage part of a huge inventory (over 2,000 boxes and drums) of other Tank Farms containers found to be in violation of Washington state codes in 1992. The availability and suitability of T Plant for this work soon became a key factor in the ability of WHC and Ecology to reach agreements on Hanford's backlogged and unpermitted waste containers.

In the meantime, rehabilitation of the 2706-T Facility, where unfiltered, open-air decontamination activities had taken place, continued throughout 1992 and 1993. A high-efficiency particulate air (HEPA) filtration system was installed, along with new doors with tight seals, a fan room to provide for negative air pressure in the facility, air monitoring equipment, new floor grates and drains, an automatic fire sprinkler system, and new lighting. Procedures for the facility were rewritten to meet current standards, and training packages were developed to ensure safe operation of the facility. DOE Readiness Reviews certified the 2706-T Building as capable of limited operations in 1993 and for full-scale operations in early 1994.



Decontamination workers adjust the overhead crane in the refurbished 2706-T Facility in late 1993. With this equipment, they can position spray nozzles and other machinery to access each angle and part of the items being decontaminated.



T Plant in 1993, showing the parking lot paved and painted, the areas surrounding the rail tunnel and 2706-T Building cleared of unknown waste objects and containers, and current wastes labelled and stored on approved pads.

T Plant Canyon and Cells Pose Cleanup Challenges

Once the cleanout and refurbishment of the 2706-T Facility was well underway, the T Plant staff turned its attention to the main canyon, the in-plant tanks, and the galleries. Inspection of the in-plant tanks and piping revealed the inability of these single-walled vessels to meet modern regulatory codes. New piping leading to the rail tunnel was needed. The galleries contained extraneous pipes and process control equipment, much of which was insulated with asbestos, as well as obsolete and underpowered electrical connectors and clutter of various types.

The canyon "deck" itself was littered with old pumps; racks; hoses; and old processing equipment in various states of repair and disrepair, including jumpers, pulsers, motors, transformers, shields, pallets, tanks, and many other items. Most prominent amidst the canyon debris were the components of the "Hot Spares Train," and two large "drag-off" box liners. The latter were the stainless steel shells from inside concrete waste containers approximately 8 feet by 8 feet by 16 feet. The components of the Hot Spares Train (known as the "Circus Train" by Hanford workers) were several used towers and process tanks from the PUREX Facility, brought to T Plant in early 1990 after a series of transportation mishaps that inspired the nickname.

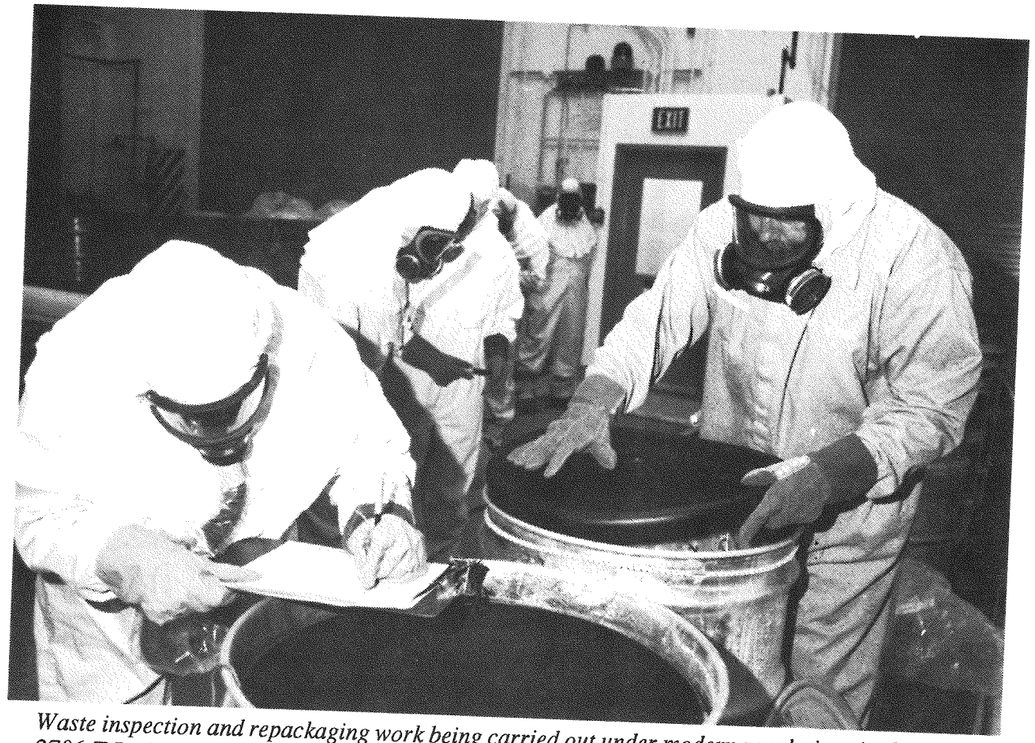
During 1993, the first drag-off box liner was emptied, sorted, and the wastes were segregated, repackaged, and dispositioned according to the appropriate designation. Work to characterize the contents of the second drag-off box liner, known to contain at least one item providing a significant, potential radiation dose, also was initiated in 1993. An initial attempt to remove contaminated equipment from this liner resulted in high local radiation readings, thus providing evidence of the radiological contamination associated with the contents. Complete repackaging of this liner in 1994 is crucial to readying the canyon deck for future operations. The components of the Hot Spares Train, also likely to contain significant radiological contamination, likewise, remain a crucial puzzle that must be tackled in 1994. Radiological and physical characterization, and discussions with the regulators will help to determine whether the parts are cut up and partially decontaminated and buried, or whether they are sealed and transported to the PUREX tunnels or to some other final disposition site.

Future Bright for Historic Facility

Looking to its future, T Plant currently has many upgrades projects under way. Among the largest is a multi-million dollar addition to the 291-T Stack ventilation system, replacing and augmenting the fans that circulate the T Plant canyon air system. Other extensive upgrades will add capacity to the primary power systems and motor control centers of T Plant. An approximately $15-million project will provide modern collection tanks with secondary containment and leak detection capacity for in-plant liquid, mixed waste, as well as two collection tanks in the 2706-T yard and one large tank in the 2706-T rail pit. Additionally, a moveable hoist is planned for use inside of the 2706-T Facility to ensure that decontamination workers and equipment can reach any angle needed to perform work on odd-shaped equipment.

Other plans are being developed to provide low-level decontamination services for a variety of needs, including verification sampling of mixed waste, waste repackaging, disposition of T Plant backlog waste, and refurbishment of well drilling rigs, cranes, trucks, tankers, and other equipment used in the course of the Hanford Site cleanup. Preparations are underway for high-level decontamination operations to process contaminated canyon deck equipment. Additionally, a WesTIP[a] (Westinghouse Technologies to Improve Processes) workshop recently was held to discuss the integration of customer, regulator, servicer, and other needs in decontaminating Tank Farms long-length equipment in T Plant. A transfer port to bring in odd-shaped or oversized contaminated equipment is being designed for the tail (southwest) end of T Plant.

[a]WesTIP is a trademark of Westinghouse Electric Corporation.



Waste inspection and repackaging work being carried out under modern regulations in the 2706-T Building, December 1993.

Once the cleanout and upgrade projects are completed at T Plant, some standard decontamination techniques will be used, including steam and water sprays, vacuum cleaning, chemical and detergent scrubs, electropolishing, various soaks accompanied by ultrasonic agitation, and others. An ice blaster has been procured for decontamination work in the 2706-T Building, and a cutting mechanism may be obtained for the 221-T canyon. Also, innovations, such as steel "greenhouse" enclosures for separate stations within the canyon, are possible. Additionally, thought has been given to cleaning out some of the cells themselves, lining them with steel, and setting up specialized work areas with robotic systems to perform the highest level work. Currently, customers from all over the Hanford Site, especially the Tank Farms, are pressing T Plant to begin performing decontamination work on high-level "debris" and on a wide variety of equipment pieces. As quickly as it can meet regulatory requirements for safe operations, this historic plant will make significant contributions to Hanford's environmental cleanup.

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