CHARACTERIZATION OF MIXED WASTES RESULTING FROM FUEL FABRICATION AT THE HANFORD SITE: USE OF HISTORICAL RESEARCH

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ABSTRACT

Fuel fabrication activities took place in the 300 Area of the Hanford Site in eastern Washington State continuously between 1943 and 1987. Methods and techniques of fuel manufacture changed over the years, thus changing the components of the waste streams associated with the processes. Additionally, the national imperatives of World War II and the Cold War caused waste volumes to grow enormously, and disposal practices and policies shifted many times. The result today is an extremely complex mixture of waste forms, locations, composition and potential migration pathways. Because the Hanford Site is large, and waste characterization and cleanup must move quickly under schedules set in the Hanford Federal Facility Order and Consent Agreement ("Tri-Party Agreement"), there was a need to understand the fuel fabrication wastes without undertaking exhaustive physical characterization.

Also, the Columbia River, the greatest single natural resource of the Pacific Northwest, flows past the Hanford Site's 300 Area in close proximity to old fuel fabrication and waste disposal sites. Therefore, Westinghouse Hanford Company employed historical research as a key, initial technique in identifying and quantifying known and unknown waste locations, components and source terms.

EARLIEST FUEL FABRICATION FACILITIES AND CYCLES

The original fuel fabrication activities at the Hanford Engineer Works (HEW - World War II name for the Hanford Site) took place primarily in two, large key buildings located at the north end of the 300 Area: the 313 Metal Fabrication Building and the 314 Press Building (known as the Metal Extrusion Building).(1) As early as December 1943, bare uranium rods that arrived from offsite were lathed down to specific core dimensions in the 313 Building. Core canning operations actually began in that facility in March 1944. In the 314 Building, autoclaves for fuel element testing, as well as outgassing and straightening operations, started in mid-1944, but HEW's uranium rods still were being extruded offsite. Beginning in January 1945, an extrusion process began to operate in the 314 Building, and from that time until 1948, a complete cycle of metal preparation occurred at HEW. The uranium billets went to the 314 Building for extrusion, outgassing, and straightening, then to the 313 Building for machining, canning, and initial inspection, and then back to the 314 Building for autoclave and radiograph testing.(2)

EARLIEST CANNING PROCESSES

The earliest successful fuel canning process used at HEW was a triple-dip method that consisted of bathing the fuel cores in molten bronze, tin, and then a molten aluminum-silicon mixture. The bronze used in this process at HEW was relatively high in tin content (53% tin and 47% copper), and the bronze bath itself had a flux cover composed of barium chloride, potassium chloride, and sodium chloride. As fuel cores were dipped into this mixture, they acquired trace coverings of all of these substances.

Initially, the bare uranium cores were cleaned by passing them through a trichloroethylene vapor degreaser, then through a nitric acid tank, two rinse tanks, and a hot air dryer. The nitric acid rinse was known as "pickling" the slugs. Meanwhile, a steel "sleeve" that would surround each can during the dipping process was cleaned in sodium hydroxide, and aluminum end caps and cans were cleaned in a sodium dichromate solution followed by a methanol rinse. The bare uranium cores were dipped in a bronze bath to heat them to a uniform temperature within the uranium beta phase (660°C to 770°C), and then placed in a tin bath to cool them into the uranium alpha phase (less than 660°C) and to remove excess bronze. Next they were centrifuged to throw off excess tin. Then the cores were immersed quickly in an aluminum-silicon brazing bath (also in the uranium alpha phase), and water quenched. The various heating and cooling procedures were done to randomize the uranium grains, thus inhibiting the uranium "growth" (expansion under irradiation) problem. After water quenching, the steel sleeve was pulled away and cleaned with sodium hydroxide and soap to remove any remaining aluminum-silicon. The sleeve then could be reused many times. The thickness of the residual end cap on the element was then measured with a fluoroscope and marked with a punch to indicate the amount that needed to be removed in subsequent end machining. Identification numbers were stamped on the can base end, and the brazeline on the end cap was tungsten inert gas (TIG) welded to seal the porous braze to the end cap and can. A final etching in nitric acid completed the procedures.

Three tests followed the canning process. The first, the frost test, consisted of spraying the can with acenaphthene mixed with carbon tetrachloride (CCl_4). The canned element was then placed into an induction coil to heat its surface. If there was a gas bubble or a nonbonded spot, this spot would become shiny, and the element then would be rejected and sent back through a recycling process. If the bond was good, the acenaphthene was removed with trichloroethylene, and the element was inspected in one of several autoclaves located in the 314 Building. In that inspection, the canned element was placed into a steam autoclave, which operated at about 100 lb/in^2 gauge (psig) at 175°C for more than 20 h, to reveal any pinholes or incomplete welds. Water from the steam would be conducted through any such openings, and the uranium core would expand rapidly, resulting from the formation of a uranium oxide (UO_2) compound known as U_3O_8, and split the aluminum can. If an element passed the autoclave test it then underwent a final radiograph (X-ray) test in the 314 Building, to detect porosity in the end weld bead. Any porosity could

have become a pathway for water to contact the uranium fuel and cause the element to rupture.(3)

ADDITIONAL CHEMICAL AND HAZARDOUS COMPONENTS

In addition to the above-mentioned chemicals, other hazardous substances were used routinely in early HEW fuel fabrication processes. Aluminum cans and caps were cleaned using first trichloroethylene, then Duponol-M-3* (an industrial soap), phosphoric acid, and various rinses including methanol. Steel sleeves were cleaned in sodium hydroxide and soap. Caustic cleaners popular at HEW included Aluminux and Diversey-415**, both containing primarily sodium dichromate. Sodium hydroxide and sodium nitrate were used to strip aluminum and braze off the rejected uranium cores. An intermetallic compound layer of uranium and copper (specifically UCu_5) on the rejected cores was removed by using hydrofluosilicic acid. Acetone and methyl alcohol (methanol) were used as all-purpose cleaning and drying agents. Beginning in the late 1950s and continuing until 1971, a process to electrolytically anodize the aluminum spacers used in the single-pass reactors (to create a protective aluminum oxide [Al_2O_3] coating) was added in the 313 Building. This process brought oxalic acid into the 313 Building waste stream. The passivation of N Reactor steel spacers to reduce rust formation also took place in the 313 Building from the mid-1960s through the mid-1980s. This process added 1,3-dimethyl-2-thiourea and increased amounts of oxalic acid, sodium hydroxide, and sodium nitrate to the chemical wastes emanating from the 313 and 314 Buildings.(4) Halogenated hydrocarbons have also been used extensively in the 313 Building.

PROCESS CHANGES

In 1948, the extrusion press in the 314 Building was excessed, and HEW began receiving rolled uranium rods from an offsite commercial mill. The rolling process seemed to offer metallurgical advantages, because the uranium could be processed at lower temperatures, which induced less oxidization and produced smaller and more random grains within the metal. This type of grain within the uranium avoided the "pimpling and dimpling" of fuel rods, a persistent problem in early fabrication efforts. Thereafter, no extruding or rolling operations were conducted at the Hanford Works (HW) (the peacetime name given to HEW in 1947 by the Atomic Energy Commission - AEC) in connection with the fabrication of fuel elements for single-pass reactors. The 314 Building process continued to operate for the purposes of straightening uranium rods, providing autoclave and radiograph testing of canned elements, and providing uranium scrap processing operations.(5)

In 1954, in the midst of the Eisenhower Expansion at HW, the 313 Building underwent a major remodeling and expansion that more than doubled its size. At that time, much contaminated equipment and other solid wastes from this building and its immediate surrounding area and from the 303 Fresh Fuel Warehouses were placed in 300 Area Burial Grounds. The remodeling occurred at the time that fuel canning technology in the 313 Building switched from the triple-dip process to the new lead-dip process. Lead-dip consisted of immersing the uranium fuel cores in a duplex bath (molten lead covered with molten aluminum-silicon) to preheat the cores in the uranium alpha phase. This step formed an intermetallic compound of uranium and lead (UPb or UPb_3) on the core. It was followed by a molten aluminum-silicon bath (also in the uranium alpha phase) to braze and bond the cores to the aluminum cans and caps. This process allowed the first canning bath to occur at temperature lower than 660°C, because the uranium cores already had been beta heat treated in a molten salt bath offsite. However, the new method introduced a great deal more lead and other heavy metals into 313 Building waste streams, because approximately 12,000 fuel elements were canned per day during the years of peak single-pass reactor operations at HW (1955-1964). At about the same time that the lead-dip process replaced the triple-dip method, an ultrasonic test replaced the frost test, which eliminated the use of acenaphthene and CCl_4. Concurrently, the majority of testing autoclaves were removed from the 314 Building and placed in the north end of the 313 Building.

Large-scale thorium contamination was introduced into the 313 Building and surrounding fuel warehouses in the early 1950's, when a number of attempts were made to fabricate and jacket metallic thorium fuel targets to produce uranium-233. Many problems connected with the rapid formation of a thick coat of oxide on the thorium metal targets led to experiments with a variety of bonding methods and coatings. Eventually, thorium oxide (ThO_2) powder and wafer fabrication was carried out in the 3722 Area Shop and the 3732 Process Equipment Development Laboratory in the late 1960's.

In the early 1960's, just before the eight single-pass reactors at HW began to close, experiments were under way in the 304 Concretion Facility, the 3716 Metallurgical Development Laboratory, and in the 313 Building with a new canning procedure known as the Hot Die Size Process. Also termed the "nickel-plate" procedure, this operation plated uranium fuel cores with nickel, using nickel sulfate, nickel chloride, and boric acid. It included standard fuel fabrication cleaning, degreasing, etching, and testing chemicals and processes. Although the Hot Die Size method was tested successfully, it was not implemented on a large scale, because of the impending closures of HW's eight original reactors.(6)

URANIUM SCRAP RECOVERY OPERATIONS

From its earliest days, the Manhattan Engineer District's (MED's) concern over the adequacy of uranium supplies brought strict policies that mandated the reclamation of all possible uranium scraps, including lathe turnings, rod ends, and rejected cores from the machining and canning operations at federal atomic sites. At World War II HEW, such scraps were washed in nitric acid (later nitric/hydrofluoric acid), and reused. The acid sludges were collected in a dumpster just north of the 314 Building and allowed to evaporate and/or overflow into surrounding soils. Small pieces of solid uranium scraps were collected in 5-gal cans, washed to remove cutting oils, and stored around and among the nine 303 Fresh Fuel Warehouses. By late June 1944, according to

* Duponol-M-# is a trademark of the E.I. DuPont de Nemours and Company.

** Aluminux and Diversey-415 both were trademark products of the Diversey Chemical Corporation

du Pont, "all available space" around these buildings was filled with such cans of scrap, and the fabrication area fence had to be moved about 30 ft east of the 303-J Building to allow for more storage space.

Several can fires occurred, usually because chemical residues from the metal washings reacted with the uranium to form a combustible gas. In those cases, oxidation of can contents, with resultant airborne contamination, took place. Beginning in July 1944, metal oxides that formed when canned slugs failed in autoclave tests accumulated in the autoclave drains. The metal oxide was collected and stored in 30-gal drums. Beginning with the startup of extrusion press tests in January 1945, extrusion butt ends, oxides, and container residues were collected and placed in 5-gal cans. Acids from the slug pickling process and from the slug recovery process were collected and neutralized to cause the uranium metal to precipitate as sodium diuranate. The precipitate was settled and filter-pressed, with the resultant uranium sludge stored in 30-gal drums. Beginning in March 1944, shipments of the various types of scrap to offsite reclamation processing centers became a regular HEW practice.(7)

CHIP RECOVERY AND MELT PLANT OPERATIONS

By 1946, the volume of uranium scraps accumulating and the expense and fire and security hazards of shipment brought a "chip recovery" operation to the 314 Building. It involved collecting all chips and turnings from machining operations, sorting them, and breaking them into small pieces. The following year, a "melt plant" was established in the 314 Building. In that process, "new" uranium could be made by combining uranium tetrafluoride (UF_4 or "green salt") and either calcium chips or magnesium chips. This mixture was placed in a dolomite-coated steel vessel, heated until free molten uranium separated from magnesium fluoride or calcium fluoride, and then allowed to cool. The molten uranium settled into large buttons shaped like Derby hats (called "Derbies" by HW workers). Slag was jackhammered off the Derbies, which were mixed with the recycled uranium scraps and briquettes, melted in a vacuum furnace, and cast into ingots. These ingots were then rolled into new uranium rods, either offsite or at HW, and used to make additional fuel rods.

OXIDE BURNER OPERATIONS

In the spring of 1946, an additional scrap recovery operation known as the "oxide burner" began on the north side of the 314 Building. All uranium-bearing dust and particulate matter that could be collected from the fuel fabrication facilities, as well as the tailings or settlings from washes and quenches, was burned to convert it to oxide (powder) form. The UO_2 was then collected in 5-gal buckets for compact shipment offsite.(8) However, oxide burner operations spread metal dust and oxide around the 314 Building, producing airborne contamination samples over tolerance.(9) In December 1947, the oxide burner operation moved to a separate building north of the 314 Building. While airborne contamination remained a problem at the new site, an additional hazard developed when black powder analyzed to be 93% UO_2 settled on operators' coveralls and shoes and was tracked throughout the area between and north of the 314 and 313 Buildings.(10) Such contamination continued to be spread until melt plant and oxide burner operations were phased out at HW between 1952 and 1954. At that time, the burnout of slag from used melt crucibles was completed, and the furnace was excessed to the 300 Area Burial Grounds.

Thereafter, solid uranium scraps at HW continued to be collected, stored, and combined with solids collected from neutralized, uranium-bearing waste acids and processed through a press-and-frame filter press in the south end of the 313 Building. Together, all of these scraps were slurried into sodium diuranate, stored in the 303 Buildings area, and shipped in barrels to the Fernald Feed Materials Production Center (an AEC site in Ohio). The slurrying process involved the use of hydrofluosilicic acid, sodium hydroxide, and sodium nitrate. Barrels bearing this mixture, along with uranium, sometimes leaked into area soils.(11)

OTHER WASTES AND CONTAMINATION FROM 313/314 BUILDING OPERATIONS

In addition to the airborne and soilborne particulate wastes created by uranium fuel fabrication and recovery operations, other wastes were generated by the production of bismuth fuel targets, lead-cadmium "poison" (neutron absorbing) elements, and lithium-aluminum alloy fuel targets, manufactured to produce tritium for the world's first hydrogen weapons tests. Also, enriched uranium-aluminum fuel cores, used as driver elements in the early tritium production program and in a mid-1960's uranium-233 production program in Hanford's N Reactor, were manufactured in the 313 Building.

Airborne contamination readings within and near the 313 and 314 Buildings were frequently high, resulting from lathe and machining operations, extrusion press work, straightening, outgassing, and other fuel fabrication procedures. Pervasive metal dust spread and settled in building rafters, crevices, and in soils in and around these facilities. It was spread via the clothing, shoes, and hair of personnel into 300 Area sanitary sewers, change houses, and other buildings. Through this pathway, and through the airborne spread of particulates, uranium, thorium, lead, cadmium, bismuth, aluminum, barium, and other heavy metals accumulated in soils and facilities throughout the northern portion of the 300 Area from the years 1944 to 1971.

Beryllium and zirconium were added to the 313 Building's waste stream beginning in 1960, when the facility was used for quality assurance (QA) inspections of the largely beryllium-zirconium alloy from which N Reactor fuel element cladding was made. Also in support of N Reactor production, copper and copper-silicon alloy components used in the exterior jacket required in the co-extrusion process were received and inspected in the 313 Building. Very few large, specific contamination events occurred in the 313 and 314 Buildings, although occasional localized fires around lathes and furnaces, as well as autoclave explosions, took place in both structures. The more serious problems in these two buildings resulted from the ongoing augmentation of wastes over time.

Additional contamination in and around the 313 and 314 Buildings resulted from the pervasive use of hazardous chemicals previously described. Waste acid recovery operations, including filtration, precipitation, centrifugation, anodization, and separation took place in the south end of the 313 Building beginning in 1954. At the same time, a process to recover uranium cores from rejected, lead-dip canned fuel elements also began in the south end of the 313 Building. Boiling sodium hydroxide was used to remove the intermetallic compound layer of lead and uranium from the elements. Although

it was underlain by an acid brick floor coated with an acid-resistant mortar, this area experienced some floor leaks. Combined with routine disposal practices and occasional fresh chemical and liquid waste transfer line breaks, these leaks account for the spread of chemical contamination. After 1975, chemical waste streams and degreaser solvents from the 313 Building's role in the Waste Acid Treatment System (WATS) process (see ahead) were taken to an abandoned reactor area and allowed to evaporate to the atmosphere. Since 1985, such wastes have been placed in drums according to modern regulations. Solids collected from WATS treatment of waste acids containing nonrecoverable amounts of uranium were collected and buried until 1985, when routing to Hanford's Central Waste Complex for eventual disposal began.

RESIDUAL CONTAMINATION

No fuel fabrication activities have taken place in the 313 and 314 Buildings since 1971. However, subsequent remodeling efforts have uncovered internal asbestos and residual uranium contamination. Outside the building, wind and snow melt also have exposed residual soil contamination.(12) After 1971, the south end of the 313 Building continued to house major functions in support of N Reactor fuel production. Among these functions were the receiving and inspection of uranium billets and other components used to make N Reactor fuel elements and the chemical passivation of spacers from N Reactor, the casting and machining of copper-silicon preshape components used in N Reactor fuel elements (beginning in 1973), and the neutralization and handling of non-uranium-bearing acid wastes from N Reactor fuel fabrication processes in the 333 Building. Finished N Reactor fuels and fabrication components, tools, and miscellaneous supplies were stored in the north end of the 313 Building from 1971 to 1987. The 313 Building and its vicinity contain asbestos and spotty residual contamination (mostly uranium) from past operations. Today, the both the 313 and 314 Buildings meet the criteria for a historic structure in the *National Historic Preservation Act* (NHPA) *of 1966* and will need full cultural resources reviews before they are remodeled or demolished.(13)

OTHER KEY FUEL FABRICATION FACILITIES: THE 306 BUILDING

The 306 Building, also known as the "Met Semi-Works," was completed in 1956 as the Fuel Element Pilot Plant or the Fuel Fabrication Pilot Plant. Throughout its history, 306 Building missions have centered on various alloy and fabrication test and development work. Airborne dust and particulate contamination in and near this facility included uranium and thorium, as well as all of the components of the new beryllium-Zircaloy-2 brazing material developed for N Reactor fuel elements. Zircaloy-2 was a blend of zirconium alloyed with small amounts of tin, iron, chromium, and nickel. The N Reactor co-extrusion process also required an exterior jacket of copper-silicon alloy. Poor ventilation was a continual problem throughout at least the first 15 years of 306 Building history. Additionally, multiple fires and leaks occurred over the years in and around the 306 Building, in barrels and waste "load luggers" containing uranium, thorium, heavy metals, and other fuel component scraps. Fires also occurred around and in building equipment, such as centerless grinders, lathes, electric saws, and other machinery. These fires oxidized and volatilized uranium and other wastes; long-lived airborne contamination, which can be recirculated today, settled in building sumps, crevices, and nearby soil.

In addition to airborne and machinery contamination, multiple drain and piping leaks and spills have occurred in the 306 Building over the years. These spills have included chemicals, cleansers, solvents, reagents, oils containing polychlorinated biphenyls (PCB), and other substances used in fuel fabrication processes. From 1956 to 1967 (and once after 1967), a lime tank and valve pit just north of the east end of the 306 Building intercepted and neutralized nitric acid-bearing chemical wastes before discharge to the process sewer. Additionally, in 1976 several hundred gallons of slightly enriched uranyl nitrate hexahydrate solution was spilled into the sump.(14) A 1977 Hanford Site radiological safety survey found significant accumulated uranium contamination in a tailings pile just west of the 306 Building, and two years later, another Hanford Radiological Engineering report stated: "All sewer lines leading from this building are suspect. The lime pit...contain[s] Uranium and thorium sludge. Surface and near surface contamination around this building is to be expected." As recently as November 1990, a site survey performed after a windstorm found particulates in the soil surrounding the 306-W Building. The report stated the cause of this residual contamination as "prior years practices in handling and storage of machine shop Uranium chip wastes."(15)

THE 333 BUILDING

The 333 Fuels Manufacturing Building was completed in 1960 as the New Fuel Cladding Facility. Its mission was to manufacture fuel elements for the N Reactor using the co-extrusion process. Wastes and contamination produced in this facility include all of the fuel components and chemicals used in the fabrication processes, including uranium dusts, particulates, fines and chips, as well as beryllium, copper, zirconium, tin, iron, chromium, nickel, and silicon. Occasional fires in furnaces and in collections of fines caused further distribution of contaminated particles and aerosols. Chemical wastes included nitric, sulfuric, hydrofluoric, chromic-nitric-sulfuric and other acids, along with degreasers trichloroethylene in the 1960's and early 1970's, and perchloroethylene and 111-trichloroethane in the 1970's and 1980's. Heat treatment salts included sodium nitrate, sodium and potassium nitrite, and sodium and potassium chloride. Additionally, many alcohol and acetone cleansers were used throughout the building's history. Many leaks and spills occurred over the years in and between the 333 Building and nearby ancillary facilities.(16)

From 1965 to 1967, the 333 Building performed autoclave testing, final etching with nitric-hydrofluoric acid, and inspection of special lithium aluminate fuel targets made in the 3722 Building for the production of tritium. Enriched (2.1% uranium-235) uranium driver fuel elements for tritium programs also were made in the 333 Building from 1965 to 1970. In 1973, the WATS began operating to treat waste acids from 333 Building operations. Fabrication of standard Zircaloy-2 clad, uranium fuel elements for N Reactor, along with standard inspections of such elements before irradiation, continued in the 333 Building until 1987. Surveys in 1988 and 1989 uncovered low-level uranium and other contamination in soils, pipe trenches, asphalt, and gravel in and near the building.(17)

EARLY PROCESS WASTE DISPOSAL FACILITIES

The original 300 Area process sewer system, built by MED and du Pont during World War II received all non-sanitary wastes through clay pipes that ran eastward to a single Process Pond located along the Columbia River just north of the coordinates of the 313 and 314 Buildings. The original Process Pond was about 490,000 ft^2 and approximately 5 ft deep. Some additional, temporary cribs and French drains were built to receive some process wastes at miscellaneous (as-needed) locations throughout the 300 Area.(18) Throughout the early years of 300 Area operations, radioactivity levels in the main Process Pond rose precipitously. On October 25, 1948, the dike broke on the northwest side, releasing the bulk of Pond contents, including 12 to 61 lb of uranium contained in 14.5 million gal of waste, to the Columbia River. An increase in the liquid level in the Pond resulting from the plugging of the earthen bottom with a clay-like uranium/aluminum hydroxide mixture (sodium aluminate), was blamed for the break.(19)

Following this dike break, a new and larger Process Pond was built north of the older Pond, and the first Pond was soon dredged and returned to service. Thereafter, the two facilities were known as the North Process Pond (newer) and the South Process Pond (older). Periodic dredgings of the bottoms of both Ponds then were conducted over the years, with the dredged material piled on the dikes to strengthen them. Fuel fabrication wastes continued to go to these Ponds until 1975. During 1974 to 1975, two 300 Area Process Trenches (the West Process Trench and the East Process Trench) were constructed on a north-south axis just north and west of the old Process Ponds. Since then, some fuel fabrication process wastes have gone to these 1,500-ft facilities for slow percolation into the ground, but most waste acids began to be treated in the new WATS facilities (see ahead).(20)

Liquids and particulates in solution disposed to the 300 Area Process Ponds and Process Trenches over the years included all of the metallic and chemical components of the fuel fabrication process. Historical data are not adequate to provide exact volumes of wastes disposed to the Process Ponds and Process Trenches. However, reasonable extrapolations from some existing data have identified approximate totals disposed to the Process Ponds as 124 tons uranium; 9,800 tons (combined) sodium, sodium hydroxide, sodium aluminate, and sodium silicate; 4,100 tons (combined) nitrates and nitric acid; 18,000 tons nickel; 6,700 tons zinc; 2,200 tons trichloroethylene; 2,000 tons silver; and unknown quantities of aluminum, beryllium, zirconium, tin, iron, chromium, silicon, and other substances. Lesser amounts of the above materials were disposed to the Process Trenches resulting from policies that diverted many fuel fabrication wastes to the WATS facilities. During the years that the 300 Area Process Ponds and Process Trenches have operated, soils, groundwater, and the Columbia River shore in, beneath, and near them have become contaminated with the above substances. Additionally, pronounced uranium-bearing liquid waste plumes were tracked in the Columbia River flowing past Richland in 1957 and 1962. Some settled solids from that waste stream may still be encountered in the riverbed along the west shore. Every process drain, pipe, pipe trench, and sewer manhole in the fuel fabrication portion of the 300 Area also must be expected to contain some degree of process waste buildup.

THE WASTE ACID TREATMENT SYSTEM (WATS)

In 1975, a new waste treatment system, representing a method to prevent 333 Building fuel fabrication bulk waste acids from discharging to the 300 Area process sewer, began operations. Waste acids treated in this WATS operation included nitric, sulfuric, hydrofluoric, and chromic-nitric-sulfuric acids bearing uranium, Zircaloy-2 components, copper, beryllium, and other fuel fabrication materials. Those containing nonrecoverable amounts of uranium were collected, neutralized with sodium hydroxide, and then centrifuged. Wastes containing recoverable amounts of uranium were routed from the 333 Building to the 313 Building and were not treated as part of the WATS process.) Solids from the centrifuge were placed in drums and transferred to the 303-K Radioactive Mixed Waste Storage Facility or to the Central Waste Complex for eventual disposal. Filter press effluent and centrifuge effluent from 313 Building operations then was pumped to tanks for storage, and then transported to an abandoned reactor area for evaporation.(21)

Wastes and contamination in and beneath the various stations and facilities of the WATS process can be expected to contain all of the waste acids and their constituent solids and solutions (including uranium, copper, chromium, Zircaloy-2 components, beryllium, and other fuel fabrication materials). Many leaks and spills occurred over the years. Additionally, when waste acids from various 333 Building processes were combined, copper fluorozirconate crystals formed and settled within tanks and pipes.(22)

SOLID WASTE BURIAL GROUNDS

The earliest MED policies at HEW called for the burial of hazardous and radioactive solid wastes and allowed for the aboveground burning of ordinary or uncontaminated trash. Throughout the years previous to 1970, at least 11 known burial grounds were constructed and used to contain contaminated equipment and other solids from fuel fabrication operations. Additionally, many sites to the northwest of the 300 Area along the railroad tracks leading to the 300 Area received aboveground deposits of uranium-contaminated aluminum and aluminum-silicon turnings. Maintaining waste burial records was a very low priority during the rapid expansion and production years at the Hanford Site, and it is not possible to know with accuracy exactly what these burial grounds contain. However, historical research into fabrication practices, equipment replacements and building renovations has been able to uncover useful information that can lead to estimates of the volumes and components of burial ground contents. For example, it was learned that contaminated trash and construction materials from the major 1954 expansion of the 313 Building virtually filled one 300 Area burial ground. Also, rejected aluminum fuel element "cans" were loaded into rail cars for sale as scrap offsite, with the specification that these scraps not be used in the food canning industry. The loading spot, about one mile northwest of the 313 Building, received the most concentrated deposits. However, spills of uranium-contaminated aluminum and aluminum-silicon occurred along the intervening length of track, as well as along vehicle roads, on the surfaces of burial grounds throughout and north of this region, and especially near the 300 West Quonset Hut, a small station from which rail loadings were recorded and tracked.(23)

In 1970, all of the principal operating contractors of the Hanford Site joined together to conduct a study of solid waste

disposal practices. They recommended segregation and labeling of several waste types, including transuranic (TRU) waste, wastes containing asbestos, PCBs, radioactive animal carcasses, and many other categories. They also recommended strict waste minimization practices (because burial grounds all around HW were filling and engaging more space), the purging of all liquids from solid wastes scheduled for burial (in order to prevent underground leaching of radionuclides) and advised that all future burials take place in the 200 Areas. The implementation of the last recommendation ended solid waste burials in the 300 Area and vicinity from that time on.(24)

REFERENCES

1. DuPont, Construction, HAN-10970, Vol. VI, pp. 1017-1022; and De Neal, DUN-6888, pp. 1-6.
2. DuPont, Operation, HAN-73214, Book 10, pp. 19-26; and Simon, IN-03400, p. 1.
3. "HEW Technical Manual," HW-10475, Section A, pp. 1-28; and DuPont, Operation, HAN-73214, Book 10, pp. 2-139; and HW-58115-DEL; and Williams and Williamson, H-#-08393; and Harlan and Williamson, H-3-8391: and Kratzer, HW-21450.
4. KENT, HW-25906, pp. 5-6; and Hochschild, Paulovich and Godwin, HAN-49157 DEL; and Corlett, HW-38332, pp. 1-6; and Yost, HW-39945, pp. 1-4; and Lane, HW-47260, pp. 1-4; and Weakley, HW-24494, pp. 1-4; and Weakley, HW-27321, pp. 1-2; and O'Rorke, HW-27428, pp. 1-6; and Weakley, HW-27734, pp. 2-15; and Brandt and Kraemer, HW-28282, pp. 1-4; and Brandt, HW-29871, pp. 1-3; and DOE/RL-90-11, p. A-10; and Harrington and Reuhle, eds., Uranium Production Technology, p. 352.
5. HARRINGTON and REUHLE, eds., Uranium Product Technology, pp. 5-12, 383-425; and Greninger, HW-14110, pp. 72-73; and HW-07504, pp. 49-50.
6. WEAKLEY, HW-58115 DEL; and DOE/RL-90-11; and AEC-GE Study Group, GEH-26434, pp. 3.18; and GE-Bouillon and Griffith, HW-4955; and HW-76836.
7. DuPont, Operation, HAN-73214, Book 10, pp. 24-26.
8. National Lead of Ohio, Uranium Feed Materials...," pp. 14-15; and Chamberlin, 300 Area Monthly Reports" (March 1946 and June 1946); and HW-7-4049.
9. BIXLER, "300 Area Monthly Reports," 1947.
10. BIXLER, "300 Area Monthly Reports," December 1947 and January 1948, pp. 1-2.
11. Ibid., and April 1948; and Special Hazards Incidents Investigations," Class I, #85 and #86 (1948) and Class II, #9 (1948); and Hervin, "Radiation Monitoring Coverage," July 1954, pp. 1-2; and DOE/RL-90-11, Appendix A.
12. Unusual Occurrence Report, PNL-79-13; and Unusual Occurrence Report, PNL-91-0017-314; and DOE/RL-90-11, pp. A-8 through A-9.
13. Unusual Occurrence Report PNL-79-13; and Unusual Occurrence Report WHC-90-0126-313; and Unusual Occurrence Report WHC-91-0007-300G; and Unusual Occurrence Report PNL-91-0017-314; and DOE/RL-90-11, pp. A-8 through A-9.
14. YESBERGER, Special Hazards Incident Investigation 55-202; and Henle, Radiation Occurrence Report 61-0-34; and Sanders, Radiation Occurrence Report 62-0-27; and Rice, HEDL Incident Report 19-73; and Berry, "Requirements;" and Collin, Occurrence Report 76-BNW-5; and Selby, Occurrence Report 76-BNW-14; and Steger, Occurrence Report 76-BNW-20; and Martin, Occurrence Report 76-BNW-22; and McCarthy, "Investigation;" and Event Fact Sheet SS-86-14.
15. CUMMINGS, "Airborne;" and Jech, "Special Studies;" and Selby, Occurrence Report 76-BNW-14; and Richey, Occurrence Report 76-BNW-15; and McLaughlin, " 306-W...;" and Wald, Occurrence Report PNL-90-044-306W.
16. DRUMHELLER, HWS-6797; and AEC/GE Study Group, GEH-26434, p. 3.36; and DOE/RL-90-11; and Clemans, WHC-CM-5-20; and Gill, HW-69941.
17. CURTISS, "Radioactive Releases...," (1971); and TEW, RL Occurrence Reports 73-27 and 75-1; and Lyttle, Occurrence Report 79-50; and Sather, Occurrence Report 82-16; and Piippo, Occurrence Report 83-12; and DOE/RL-88-31, Appendix A.6; and Greager, 300-DRFS-8703; and Vedder, WHC-UO-87-014-DRD-01; and Clemans, 88-06-DRFS; and Cucchiara, RL Occurrence Report 75-25; and WHC-C-88-086-DRFS-03, pp. 5-10; and Asay, OSS-3A-89-005; and Schumacher, NRFS-90-05.
18. DURUM and CHAMBERLIN, "300 Area Monthly Reports," 1945-1946; and Special Hazards Incident Investigation, NRFS-90-05.
19. SINGLEVICH, HW-11534; and Singlevich and Paas, HW-13743 DEL, pp. 24-32.
20. VANCE, WHC-SP-0137; and Dennison, Sherwood and Young, Draft: PNL-6442; and Loe, DUN-3155; and DOE/RL-90-11.
21. DOE/RL-90-11, Appendix A and pp. 3.1 through 3.9.
22. Ibid., pp. 3.10 - 3.23.
23. STEVENS, "Burial...;" and Backman, HW-84619, pp. 10-11.
24. HILL, Corbit, Voiland and Wilson, ARH-1596.