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ACRONYMS AND ABBREVIATIONS*

AEC	U.S. Atomic Energy Commission
ALE	Arid Lands Ecology
AMCF	Alkali Metals Cleaning Facility
$BiPO_4$	bismuth phosphate
BNWL	Battelle Northwest Laboratories
BWIP	Basalt Waste Isolation Project
c/m	counts per minute
CCl_4	carbon tetrachloride
CHA	cask handling area
CMM	Core Mechanical Mockup
CPD	Chemical Processing Department
CRCTA	Composite Reactor Components Test Activity
CWS	Chemical Warfare Service
D&D	decontamination and decommissioning
d/m	disintegrations per minute
D_2O	heavy water
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DST	double-shell tank
DUN	Douglas United Nuclear, Inc.
du Pont	E. I. du Pont de Nemours and Company
EBR	Experimental Breeder Reactor
EDL	Engineering Development Laboratory
ELS	Experimental Lithium System
ERA	Expedited Response Action
ERDA	Energy Research and Development Administration
FERTF	Fuel Element Rupture Test Facility
FFTF	Fast Flux Test Facility
FMEF	Fuels and Materials Examination Facility
FMIT	Fusion Materials Irradiation Test
FMPC	Feed Materials Production Center
FPTL	Fission Product Transport Loop
FRG	Federal Republic of Germany
FRPP	Fuel Recycle Pilot Plant
ft	foot
gal	gallon
GE	General Electric Corporation
GEH	GE-Hanford Company
gpm	gallons per minute
HCRL	Hanford Cultural Resources Laboratory
HCVF	Hot Cell Verification Facility
HEDL	Hanford Engineering Development Laboratory
HEPA	high-efficiency particulate air
HEW	Hanford Engineer Works
HGLF	Hanford Grout Lysimeter Facility
H.I.	Health Instruments

*Units of measure: Throughout this document, units of measure are given as they were found in historical source documents. No conversions have been made.

ACRONYMS AND ABBREVIATIONS (continued)

HLO	Hanford Laboratories Operation
hr	hour
HTLTR	High-Temperature Lattice Test Reactor
HTSF	High Temperature Sodium Facility
HW	Hanford Works
HWVP	Hanford Waste Vitrification Plant
I&E	internally and externally cooled
IAX	extracting solution the strength of 5 mol nitric acid/Kilogram of hexone
I.E.	ion exchange
IEM	Interim Examination and Maintenance
in.	inch
INEL	Idaho National Engineering Laboratory
IPD	Irradiation Processing Department
ISV	in situ vitrification
IVHM	In-Vessel Handling Machine
L	liter
lb	pound
LMFBR	Liquid Metal Fast Breeder Reactor
M&M	maintenance and mockup
MED	Manhattan Engineer District
mi	mile
MOTA	materials open test assembly
MPC	maximum permissible concentration
mrep	millirep
MTR	Materials Test Reactor
NASA	National Aeronautics and Space Administration
NDE	nondestructive examination
NHPA	National Historic Preservation Act of 1966
NO_x	nitrous oxide
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NWVP	Nuclear Waste Vitrification Project
PCB	polychlorinated biphenyl
PCLDI	Prototype Closed Loop Development Installation
PCTR	Physical Constants Test Reactor
PFMP	PUREX Facility Modification Program
PFPP	Plutonium Fabrication Pilot Plant
PIOTA	Postirradiation Open Test Assembly
PNL	Pacific Northwest Laboratory
PRCF	Plutonium Recycle Critical Facility
PRF	Plutonium Recovery Facility
PRTR	Plutonium Recycle Test Reactor
psig	pounds per square inch gauge
PUREX	Plutonium-Uranium Extraction (Facility at Hanford Site)
PVC	polyvinyl chloride
QA	quality assurance
r/h	rads per hour
RECUPLEX	reclamation of uranium and plutonium by extraction
REDOX	reduction oxidation
PITL	Postirradiation Testing Laboratory

ACRONYMS AND ABBREVIATIONS (continued)

RL	DOE Richland Field Office
RLFCM	Radioactive Liquid-Fed Ceramic Melter
RLWS	Radioactive Liquid Waste System
Rockwell	Rockwell Hanford Operations
RPS	Retention Process Sewer
SAF	Secured Automated Fabrication
SECS	Sodium Ethanol Cleaning System
SERF	Special Environmental Radiometallurgical Facility
SMF	Shielded Materials Facility
SRDA	Sodium Removal and Decontamination Apparatus
SRP	Savannah River Plant
SST	single-shell tank
Supply System	Washington Public Power Supply System
SWP	Special Work Permit
T&G	tongue and groove
TDS	total danger sum
TIG	tungsten inert gas
TRIGA	Training Research and Isotope Production, General Atomics
TRU	transuranic
TTR	Thermal Test Reactor
TTUS	Tank Truck Unloading Station
UO_2	uranium oxide
UNI	United Nuclear Industries
WATS	Waste Acid Treatment System
Westinghouse Hanford	Westinghouse Hanford Company
WSEP	Waste Solidification Engineering Project

This document is a compilation of historical information of the 300 Area activities and facilities since the beginning. Figure 1 shows the 300 Area as it looked in 1945. Figure 2 is a more recent (1985) look at the 300 Area Facilities.

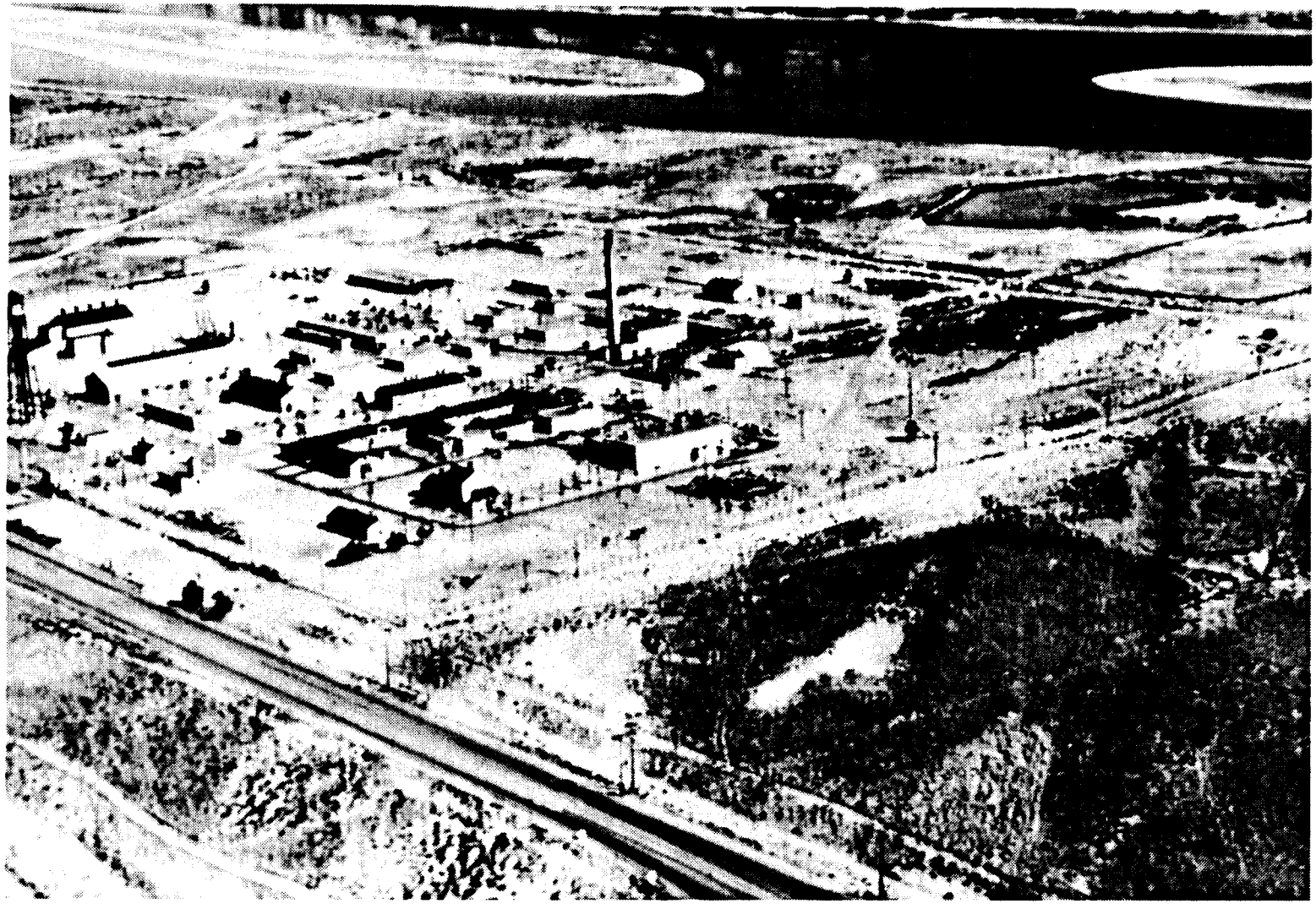

Figure 1. The 300 Area as it stood in 1945, looking toward the northeast.

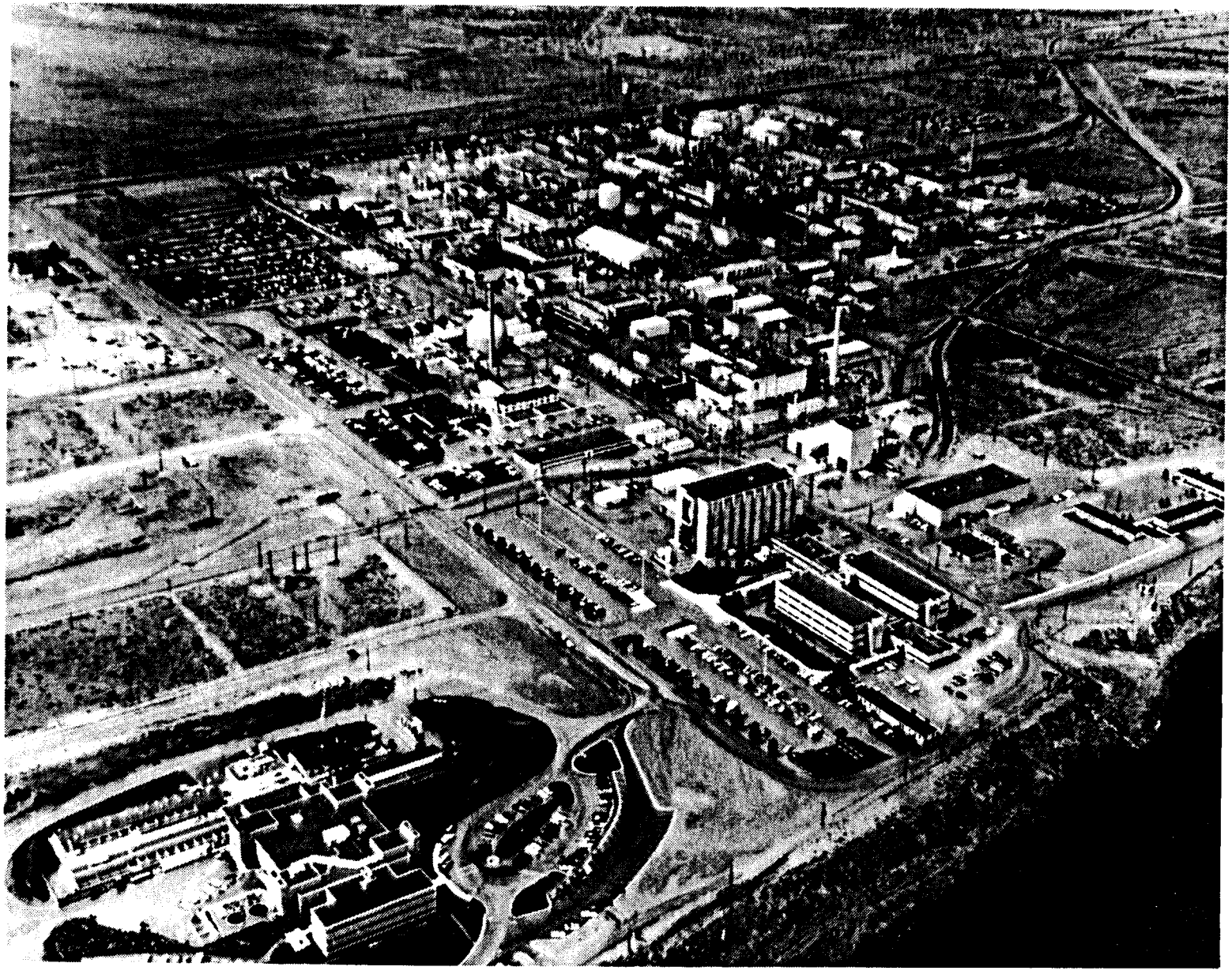

Figure 2. The 300 Area as it stood in 1985. This northwest facing view features the 331 Life Sciences complex in the lower left corner and the 337 Building in the lower center.

1.0 THE 313 AND 314 BUILDINGS

1.1 FACILITIES MISSION AND DESCRIPTION

The original 313 Metal Fabrication Building was a World War II structure built by the Manhattan Engineer District (MED) and E.I. du Pont de Nemours and Company (du Pont), with original overall dimensions of 199.5 ft by 182.5 ft by 20 ft (high) (Figure 3). Its original area was 33,020 ft^2, containing numerous electrical furnaces and metal presses; three fuel jacketing (canning) areas; a welding area; a can cleaning area; a control room; various supply tanks; a tool room and shop; and various offices, storerooms, and sanitary restrooms. The building had a reinforced concrete foundation that stood on a 4-in. reinforced concrete slab floor. The building consisted of structural steel framing, concrete block walls, a precast concrete slab roof with tar and gravel surface, and interior partitions made of concrete block and concrete brick.

In the 313 Building, uranium fuel rods were machined into "slugs" or cores 1.3 in. in diameter and 4 in. and 8 in. in length, which were canned or jacketed using first a "triple-dip" and later a lead-dip process. The finished elements were then tested and inspected in this building.

The 314 Press Building (known as the Metal Extrusion Building) also was a World War II, MED/du Pont structure (Figure 5). Its original overall dimensions were 199.5 ft by 90.5 ft by 40 ft (high) with an area of 14,842 ft^2. It contained a 1,000-ton extrusion press, electric furnaces, a rod-straightening machine, a 7.5-ton overhead crane, an autoclave area, a control room, a shop and repair area, pumping units for the press, and various offices and sanitary restrooms. The building consisted of a reinforced concrete floor supported on reinforced concrete foundation walls and piers. It had a structural steel framework, concrete block walls, a concrete ceiling, and a corrugated asbestos roof with a 36-in. continuous roof ventilator extending nearly the entire length of the building. Interior walls consisted of concrete block with 3/16-in. asbestos board on some interior partitions. Outside, there was a 12-ft by 18-ft concrete and steel platform north of the building. Gas cylinders were located outside along the north wall.

In the 314 Building, uranium that arrived at Hanford Engineer Works (HEW) as billets was heated in a muffle-type furnace with an interior, inert gas atmosphere. (The helium or argon atmosphere was used to reduce the oxidation of metal during heating.) The uranium was then transferred through a closed passageway to the extrusion press, which also operated in an inert atmosphere. After being extruded, the rods were outgassed, straightened, and sent to the 313 Building for machining and jacketing. Later, the extrusion method was replaced by rolled uranium rods, and 314 Building equipment and functions changed (see Section 1.6).[1]

1.2 EARLIEST FUEL FABRICATION METHODS

The earliest uranium for the fabrication of reactor fuel arrived at the HEW in October 1943 as extruded rods. The rods were delivered to the Riverland Yards. The Riverland Yards were an official part of HEW and were

located just east of the Midway power substation (just southwest of the present-day State Route 240 Vernita Bridge). Because railroad track had not yet been completed to the 300 Area, the rods were taken by rail to the Hanford Construction Camp about 20 mi north of Richland, and then by truck to the 300 Area. Once railroad service to the 300 Area was connected in January 1944, uranium was delivered to the fabrication area by rail.

Beginning in December 1943, the first uranium fabrication operation at HEW was machining, in which bare uranium rods were lathed down to specific core dimensions in the 313 Building. The following month, operators began degreasing the machined cores before inspection, using a commercial product that contained primarily trichloroethylene, Detrex*, a solvent degreaser. Core canning operations actually began in the 313 Facility in March 1944. In the 314 Building, autoclaves for fuel element testing started to operate in July 1944. A scrap recovery process began the following month (see Section 1.9). Outgassing and straightening operations started in the 314 Building in September 1944, but HEW's uranium rods still were being extruded offsite. Beginning in November 1944, uranium was transported to HEW as billets, which were stored until the extrusion process began to operate in the 314 Building in January 1945. The press testing phase lasted into mid-spring, and then fuel operations commenced. Greater confidence in personnel performance ended shift work in the metal preparation buildings in June 1945, and work proceeded on a straight, 6-day-per-week schedule. 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]

1.3 THE CANNING PROCESS

The original fuel canning process tried at HEW involved the use of an electric heater press, known by workers as the "whiz-bang," to heat and bond the uranium fuel cores to their aluminum jackets. However, the heaters burned out frequently, did not heat the elements and cans to consistent temperatures, and did not produce a uniform bonding. This problem was serious because nonuniform bonding caused thin places in the jacketing that, under irradiation, heated up more than other places. These "hot spots" could cause fuel element ruptures in the reactors. By August 1944, the uranium fuel cores were being jacketed in a triple-dip method that consisted of bathing them 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

*Detrex is a trademark of Detrex Chemical Industries.

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 (1) cool them into the uranium alpha phase (less than 660 °C) and (2) 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.

1.4 CANNING TESTS

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 (see Section 1.9). 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]

1.5 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

*Duponol-M-3 is a trademark of the E.I. du Pont de Nemours & Company.

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.

1.6 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. It was also a less expensive process. From 1950 to 1951, a rolling mill was procured and installed in the 314 Building, to save the costs of shipment to offsite mills. However, this mill was relatively small, and the rolling operation was transferred to a large facility constructed at the Feed Materials Production Center (FMPC), an Atomic Energy Commission (AEC) site in Fernald, Ohio, in 1952. Thereafter, no extruding or rolling operations were conducted at the Hanford Works (HW) (the peacetime name given to HEW in 1947 by the 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 (see Section 1.9).[5]

In 1954, the 313 Building underwent a major remodeling and expansion, reaching a total size of 182.5 ft by 486 ft, with a total area of 76,633 ft^2 (Figure 4). At that time, much contaminated equipment and other solid wastes from this building and its immediate surrounding area and from the 303 warehouses were placed in 300 Area Burial Ground 618-3. 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)

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

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 a lower temperature (lower than 660 °C) because the uranium cores already had been beta heat treated in a molten salt bath at the FMPC. 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 and 3732 Buildings in the late 1960's (see Sections 15.1 and 15.2).

In the early 1960's, just before the eight single-pass reactors at HW began to close, experiments were under way in the 304, 3716, and 313 Buildings 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]

1.7 CORED AND INTERNALLY AND EXTERNALLY COOLED FUEL ELEMENTS

In the 313 Building, additional fuel fabrication process changes during the 1950's and early 1960's included the manufacture of cored fuel rods beginning in 1954, internally and externally cooled (I&E) fuel rods beginning in 1957, and projection fuel rods in the early 1960's. The cored rods, hollow elements with an aluminum plug at either end, bonded to the uranium with an aluminum-silicon braze, were designed to give the uranium an inner space in which to expand during irradiation. The early, solid fuel elements were experiencing a troublesome level of distortion, and subsequent rupture, in HW's production reactors. However, the cored fuel elements frequently developed cracks in both the uranium and the aluminum plug areas, and they were discontinued in 1957. The I&E fuel elements, tried next, had a tubular hole down the middle, allowing cooling water to run both around and through them in the reactors. Projection fuel elements, with small fins protruding from their sides, were of two types: the bumper type had six short projections for use in ribbed process tubes, and the self-supporting type had eight projections for use in ribless process tubes.

1.8 PROJECTION FUEL ELEMENTS

The switch to projection fuel rods represented yet another attempt to solve the fuel element rupture problem then plaguing Hanford's eight single-pass reactors. Power and fuel exposure level increases throughout the late 1950's and early 1960's had brought reactor operating temperatures to a point that seriously augmented fuel rod ruptures, with resultant increases in contamination released to the Columbia River. Post-irradiation examinations of failed I&E fuel elements showed that only about 20% of the failures resulted from fuel element "quality deficiency," while 80% resulted from longitudinal corrosion attack caused by warp. Known as "side hot-spot" ruptures, these failures were caused by positioning of the fuel rods in the process tubes. The new projection fuel elements, first tested in 1961 in reactors at HW, were manufactured in the 313 Building through the use of ultrasonic welding. Canned fuel elements first were dipped in a tank to deposit an Ivory* soap film, useful in achieving a good weld. After the projections were welded, the soap film would be rinsed off in a three-compartment rinse using standard fuel fabrication chemicals and degreasers.[7]

1.9 URANIUM SCRAP RECOVERY PROCEDURES

From its earliest days, the MED's concern over the adequacy of uranium supplies brought strict policies that mandated the reclamation of all possible uranium scraps at federal atomic sites. During the earliest fuel fabrication operations at HEW, uranium scraps consisted of lathe turnings, rod ends, and many rejected cores from the machining and canning operations in the 313 Building. Difficulties with early fuel canning techniques produced thousands of rejected cores by mid-1944. These 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 Buildings. By late June 1944, according to 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 Building 303-J 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

*Ivory is a trademark of the Proctor and Gamble Co., Cincinnati, Ohio.

(Figures 6 and 7). Beginning in March 1944, shipments of the various types of scrap to offsite reclamation processing centers became a regular HEW practice.[8]

1.10 CHIP RECOVERY AND MELT PLANT OPERATIONS

By 1946, however, the volume of uranium scraps accumulating and the expense and fire and security hazards of shipment brought a change in policy. A "chip recovery" operation began in the 314 Building. It operated only a few days a month and involved collecting all chips and turnings from machining operations, sorting them, breaking them into small pieces, washing, drying, and then pressing them into briquettes. At first the briquettes themselves were shipped offsite. In May, however, the MED ordered briquetting to be discontinued, due to a number of uranium chip fires within the centrifuging step at other sites. A "melt plant" was established in the 314 Building in late 1947. 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.

1.11 OXIDE BURNER OPERATION

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.[9]

1.12 HEALTH PHYSICS CONSIDERATIONS IN SCRAP RECOVERY

From the outset of chip recovery operations in early 1946, HW's Health Instruments (H.I.) Division detected serious radiological problems with this process. Within one month of startup, 300 Area H.I. Division monitors reported that "considerable overexposure is received when an operator works a full 8-h day at the mezzanine sorting table; where the 'chips' are first sorted when brought from storage." The H.I. Division monitors recommended rotating operators every half-shift, using long rakes, and wearing protective clothing such as heavy aprons and gloves. In July 1946 monitors reported that oxide burner operations were really spreading metal dust and oxide around the 314 Building, producing airborne contamination samples over tolerance. Similar reports continued throughout 1946 and 1947, as H.I. Division monitors tried to persuade operators to wear respirators for these jobs.[10]

In December 1947, the oxide burner operation moved to a separate building north of the 314 Building, and operators were required to wear assault masks "because of the maximum concentrations [airborne] obtained during burning." Additionally, 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. Chip recovery operations continued to produce radiological problems as H.I. Division monitors discovered that the protective gloves could themselves become so contaminated that they became a skin dose source. That December, five operators each received over 100 mrep* to the backs of their hands after only 4 h at the first sorting table.[11]

1.13 MELT PLANT DIFFICULTIES

The startup of melt plant operations in the 314 Building in December 1947 brought the greatest H.I. Division concern expressed to that date. In April 1948, one respirator filter from this plant read 8,000 disintegrations per minute (d/m) alpha after 8 h of use, and one such filter read 28,000 d/m after only 10 h of use. Five Special Hazards Incidents Investigations (predecessors to Radiation Incidents Reports and Unusual Occurrence Reports) took place in connection with the melt plant in the summer of 1948, and H.I. Division monitors reported that airborne "contamination is very prevalent." That September, monitors recommended more frequent rotation of operating personnel and health physics education to make "all operators keenly aware of the radiation hazards associated with Uranium." Melt plant and oxide burner operations were phased out at HW between 1952 and 1954. The burnout of slag from used melt crucibles was completed, and the furnace was excessed to the 300 Area Burial Grounds by late summer 1954. 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 FMPC. 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.[12]

1.14 OTHER WASTES AND CONTAMINATION FROM 313/314 BUILDINGS OPERATIONS

In addition to the airborne and soilborne particulate wastes created by the chip recovery, oxide burner, and melt plant operations, other wastes have been produced by other 313 and 314 Building processes. Bismuth fuel targets welded into nonbonded aluminum cans, irradiated to make polonium-210 in 100 Areas production reactors, were fabricated in the 313 Building from 1944 through the early 1950's. Polonium-210 was the initiator in atomic (pre-hydrogen) weapons explosions. An even larger number of lead-cadmium fuel rods, also welded into nonbonded aluminum cans, were produced for use as "poison" elements in the 100 Areas reactors and in the 305 Test Pile (see Section 17.1). The term "poison" refers to the ability of these neutron

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*Millirep--an early measurement of absorbed dose very similar to a millirem.

absorbing metals to slow down or even kill (control) nuclear chain reactions. The production of lead-cadmium fuel rods continued throughout the years of single-pass reactor operations (through 1971). Additionally, lithium-aluminum alloy fuel targets, manufactured for the P-10 project at Hanford's 100-B Area to produce tritium for the world's first hydrogen weapons tests, were canned in nonbonded aluminum cans in the 313 Building from 1949 to 1952. Also, highly 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 the N Reactor, were manufactured and canned in nonbonded aluminum cans 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. H.I. Division monitors often reported "metal dust" in building and vicinity air as being "over tolerance," with ventilation "not adequate." Although additional ventilation equipment was added to both structures in 1949, pervasive metal dust continued to spread and settle in building rafters, crevices, and in soils in and around the 313 and 314 Buildings. 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.

In general, work with uranium was treated as ordinary foundry work in the 1940's, and special precautions for radiological work were added slowly. The maximum permissible contact dose for bare uranium at HW in 1947 was 12.5 mrep/h for 8 h. A special H.I. Division educational lecture that year illustrates the incomplete information of that era with regard to 300 Area fuel fabrication work with uranium: "The hazard of chemical toxicity sets the levels for the maximum permissible amounts deposited and fixed in the body before an amount is reached which would be intolerable as the result of radiations given off."[13] Exposure and environmental depositions increased when uranium fuel at HW was enriched to the 0.95% uranium-235 level in the late 1940's. The X-ray exposure to personnel sometimes occurred in the fuel element inspection process, but no environmental contamination resulted from this test procedure.

Additional contamination in and around the 313 and 314 Buildings resulted from the pervasive use of hazardous chemicals previously described. Beginning in 1954, waste acids containing recoverable amounts of uranium from the 313

and 333 Buildings were routed to Tanks 3 and 4 in the 313 Building, neutralized in Tank 7, routed to Tank 5 (Figure 6), and passed through a press-and-frame filter press. The precipitate remaining on the filter press was known as "C-6" sludge, and was collected and placed in barrels for shipment to the FMPC (Figure 7). The centrifuging operation, along with waste acid storage tanks, anodizing tanks, and the filter press used to separate sodium diuranate from uranium-bearing, neutralized wastes, was located in the south end of the 313 Building. A process to recover uranium cores from rejected, lead-dip canned fuel elements also began in the south end of the 313 Building in 1954. 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, the south end of the 313 Building 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 from the 313 Building's role in the Waste Acid Treatment System (WATS) process (see Chapter 5.0) were taken to the 183-H Solar Basins for evaporation. Between 1975 and 1985, degreaser solvents were placed in dumpsters and barrels 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 the Central Waste Complex for eventual disposal began.

1.15 MODERN USES

No fuel element preparation activities for the single-pass reactors have taken place in the 313 and 314 Buildings since 1971, when the last of these reactors closed. The 314 Building was modified in the 1970's and was used by Pacific Northwest Laboratory (PNL) for a variety of research projects and crafts services. The remodeling efforts uncovered asbestos and residual uranium contamination. For example, the removal of two doors and frames in 1979 spread local contamination reading up to 60,000 c/m (counts per minute--a measurement of radioactive decay). Outside the building, wind and snow melt exposed soil contamination to a level of 7,000 c/m in January 1991. The report of that finding stated: "The contamination appears to be a result of contamination ... many years ago ... there are many areas outside this building with fixed contamination." Today, the 314 Building meets the criteria for a historic structure in the *National Historic Preservation Act* (NHPA) *of 1966* and will need a full cultural resources review before it is remodeled or demolished.[14]

The majority of the fabrication equipment for single-pass reactor fuel elements was removed from the 313 Building between the mid-1970's and the mid-1980's. However, 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 (see Section 1.5), 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 (see

Sections 5.1 and 5.2). 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, and an Engineering Development Laboratory, including facilities for working with uranium, was established in the structure in the 1970's.

Between 1983 to 1984, a Sutton* extrusion press was purchased and placed in the 313 Building as a backup for the extrusion press operating in the 333 Building performing N Reactor fabrication work. Between 1987 and 1989, the north end of the 313 Building received major upgrades in preparation for use as the Metalworking Facility for N Reactor pressure tube fabrication. The concrete floor in this section of the building was removed, along with several feet of contaminated soil beneath it. Clean fill dirt and a new concrete floor were emplaced. However, the shutdown of N Reactor ended the Metalworking Facility's planned mission before it became fully operational. The Sutton extrusion press already in place and newer metalworking equipment purchased for this program are now being marketed in a pioneer Hanford Site privatization program. The 313 Building and its vicinity contain asbestos and spotty residual contamination (mostly uranium) from past operations. Readings of 40,000 d/m (beta) were found in routine 1990 and 1991 surveys. The 313 Building also meets the criteria for an historic structure in the NHPA and will need a full cultural resources review before it is remodeled or demolished.[15]

*Sutton is a trademark of the Sutton Engineering Corporation, Pittsburgh, PA.

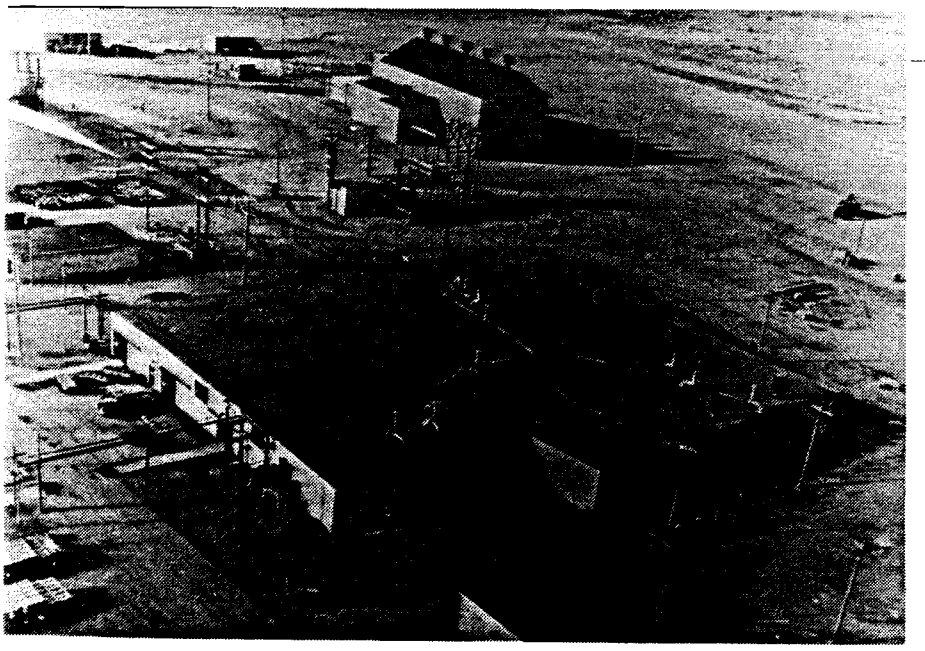

Figure 3. The 313 Metal Fabrication Building as it stood in 1945. The 305 Test Pile, the first operating reactor at the Hanford Engineer Works, casts a mid-afternoon shadow near the top of the photo.

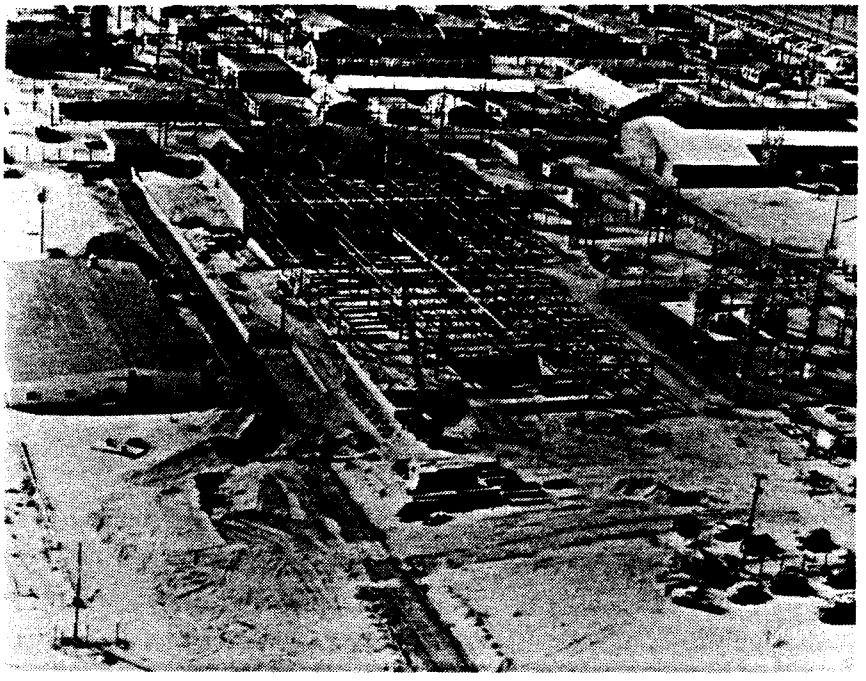

Figure 4. The 313 Building during its 1954 addition. The new construction, on the north end, extended the structure from 200 ft in length to 490 ft.

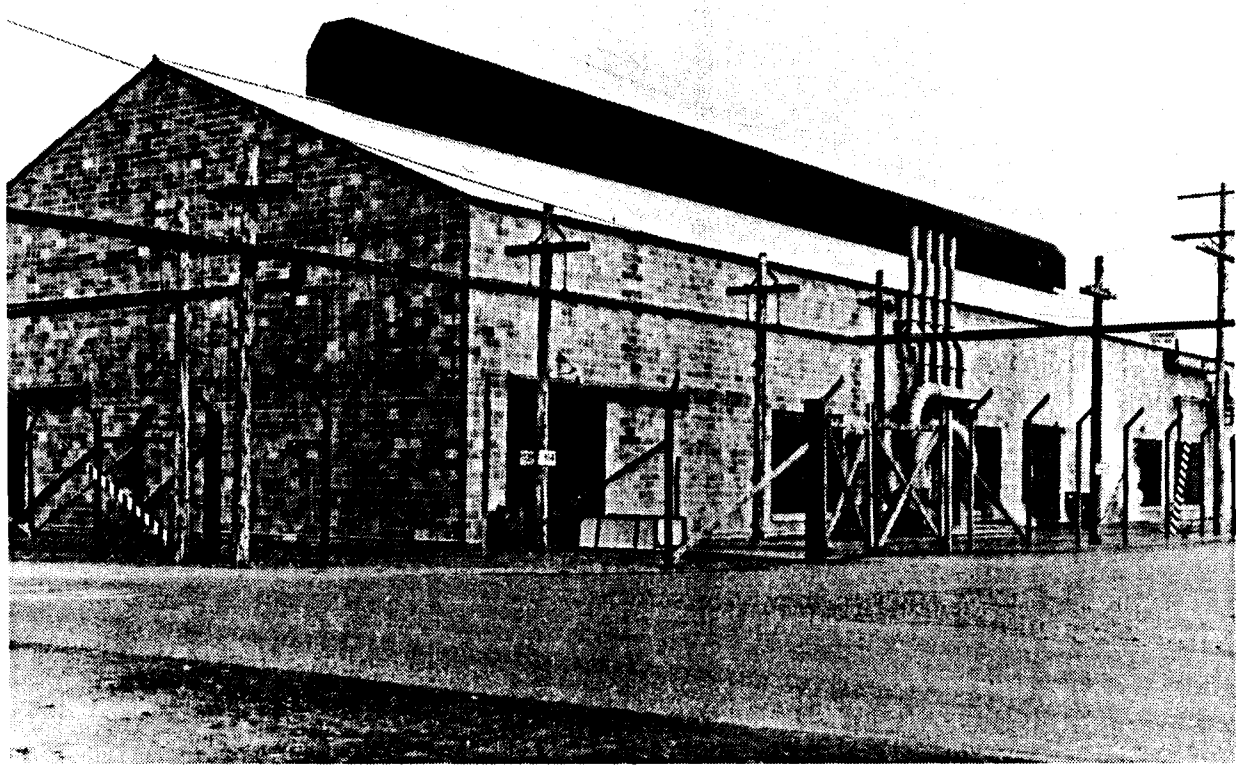

Figure 5. The 314 Metal Extrusion Building, better known as the Press Building, as it stood in 1945.

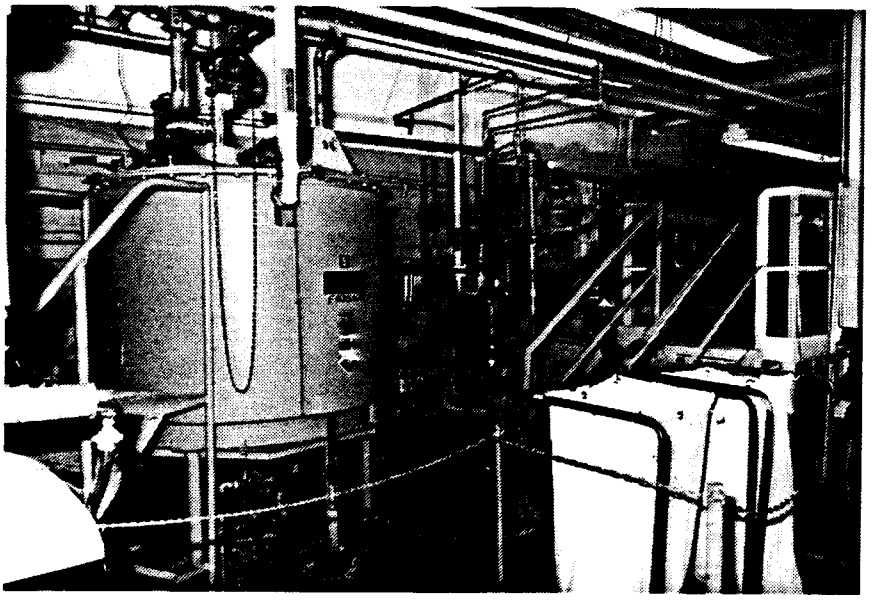

Figure 6. Tank 5 in the south end of the 313 Building. Installed in the major 1954 building expansion, this tank held the feed material (waste solutions containing recoverable amounts of uranium salts) for the filter press shown in the upper right corner.

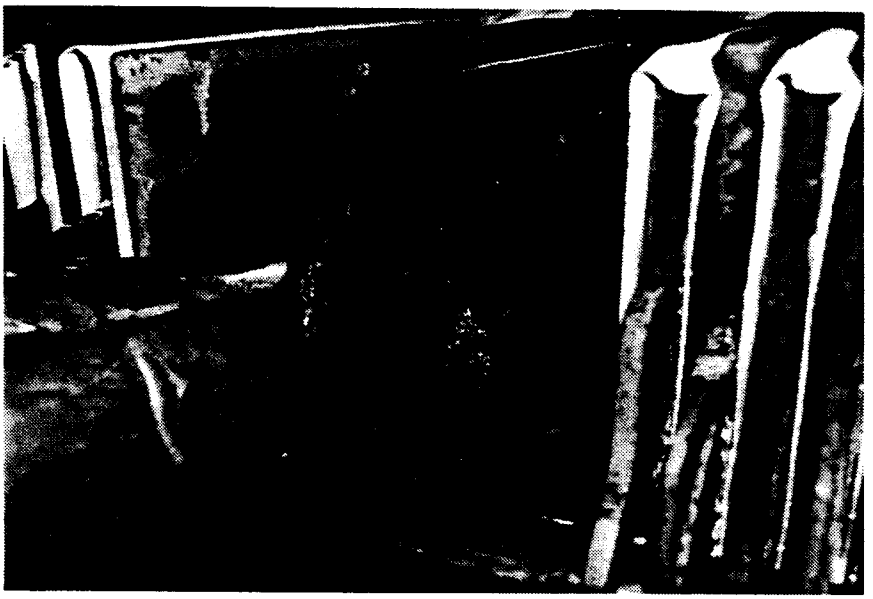

Figure 7. Uranium-bearing precipitate known as "C-6" sludge is removed from the press-and-frame filter press in the 313 Building before it is shipped to the Feed Materials Production Center at Fernald, Ohio.

2.0 THE 306 METAL FABRICATION DEVELOPMENT BUILDING

2.1 FACILITY DESCRIPTION AND MISSIONS

The 306 Building, also known as the "Met Semi-Works," was built in two phases. Originally, it was completed in 1956 as the Fuel Element Pilot Plant or the Fuel Fabrication Pilot Plant. Its initial mission was to support 313 Building operations and to pilot process improvements in single-pass reactor fuel fabrication methods. In 1960 the 306 Building was expanded to approximately double its original size to contain the co-extrusion fabrication process for N Reactor fuel elements. In 1972 the 306 Building was split between Battelle Northwest Laboratories (BNWL) and the Hanford Engineering Development Laboratory (HEDL), which was operated at the Hanford Site by Westinghouse Electric Corporation. At that time, the building was designated as 306-E (the newer portion that was allocated to HEDL) and 306-W (the older portion that was allocated to BNWL).

The original 306 Building encompassed a total area of approximately 40,000 ft^2 (Figure 8). The 1960 addition brought the building to overall dimensions of 160 ft by 380 ft by 25 ft (high), with a total area of 80,160 ft^2. The building is two stories high, with no basement, and has a framework of bolted steel. The first floor consists of reinforced concrete, while the second floor is steel deck topped with concrete. The exterior siding is fluted steel insulated panels, while interior partitions are moveable metal panels with some concrete shielding walls. The roof on the original building was metal deck, but a Class I built-up roof was installed in 1963. The 1960 addition has a concrete roof with a Class I tar and gravel built-up finish. The building was never connected to the 300 Area Radioactive Liquid Waste System (RLWS) but is connected to the sanitary and the process sewer systems. The building was not designed for work with plutonium or fission products, so it does not include negative air pressure barriers for radioactive containment. A series of roof vents, bag filters, fume exhausters, individual laboratory hoods with both wet and dry filters and individual exhausters, and a 40-ft-high, 3.5-ft-diameter stainless steel stack provide for ventilation and the removal of airborne dusts and particulates.[16]

Throughout the history of the 306 Building, its missions have centered on various alloy and fabrication test and development work. During the period 1973 to 1977, the building received much new equipment and many upgrades for work in support of the Liquid Metal Fast Breeder Reactor (LMFBR) program at the Hanford Site (components fabrication and testing for the Fast Flux Test Facility [FFTF]). During these years, the old 1713-H Building was relocated and became the 306 Building storage shed. A small office addition was placed on the west portion of the 306 Building in 1983. From 1988 to 1989, much new equipment was added for fabricating components for the Fusion materials open test assembly (MOTA) I Test and the Multiple Isotope Program tests to be run in the FFTF. The 306 Building continues to operate today, performing a variety of fabrication tasks under joint Westinghouse Hanford Company (Westinghouse Hanford)-PNL (successor to BNWL) occupancy.

2.2 THE 306 BUILDING WASTES AND CONTAMINATION

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 yr 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, tools and fabrication work areas within the building often displayed contamination levels of 20,000 to 80,000 c/m during the 1950's and 1960's. The highest radiation levels generally were found in the "specialty shop" for uranium machining in the west end, also called the Regulated Shop or the Hot Shop (Figure 9). One furnace pot read 40 r/h when surveyed in 1971. As recently as 1987, contaminated equipment entered the building from off the Hanford Site, spreading spotty contamination up to 100,000 d/m.

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. In 1976, this pit was inspected, along with the process waste sump, sewer manholes, and the inlet box to the process sewer leaching trenches, after several hundred gallons of slightly enriched uranyl nitrate hexahydrate solution was spilled into the sump. The investigation found that much uranium and thorium contamination lies in and beneath the 306 Building floor, slab, pipe trenches, and sewer lines. Specifically, two large deposits (8 ft by 2 ft by 6 in. [thick]) of uranium-bearing particulate matter were found in the inlet box, but the accumulated radioactivity levels were determined to be nondangerous (3.6 g of uranium per liter of sludge). No significant accumulation was found in the lime pit and sewer manholes. In 1975, piping that had been installed to transfer fresh nitric acid from the 333 Building to the 306 Building, and to route used acids in the reverse direction, were partially removed in 1975. However, several feet of pipe "spurs" nearest the 306 Building remain in place. These and other pipes, along with pipe trenches, sumps, sewers, and drains can be expected to hold hazardous chemical residues as well as the metal residues listed previously.[17]

Another radiological safety survey in 1977 found significant accumulated uranium contamination in a tailings pile just west of the 306 Building leaching into the 300 Area East Process Trench. The West Process Trench was found to be covered with a mat-like material that screened and diverted the

uranium. In 1979, a HEDL 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 PNL survey performed after a windstorm found hot 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."[18]

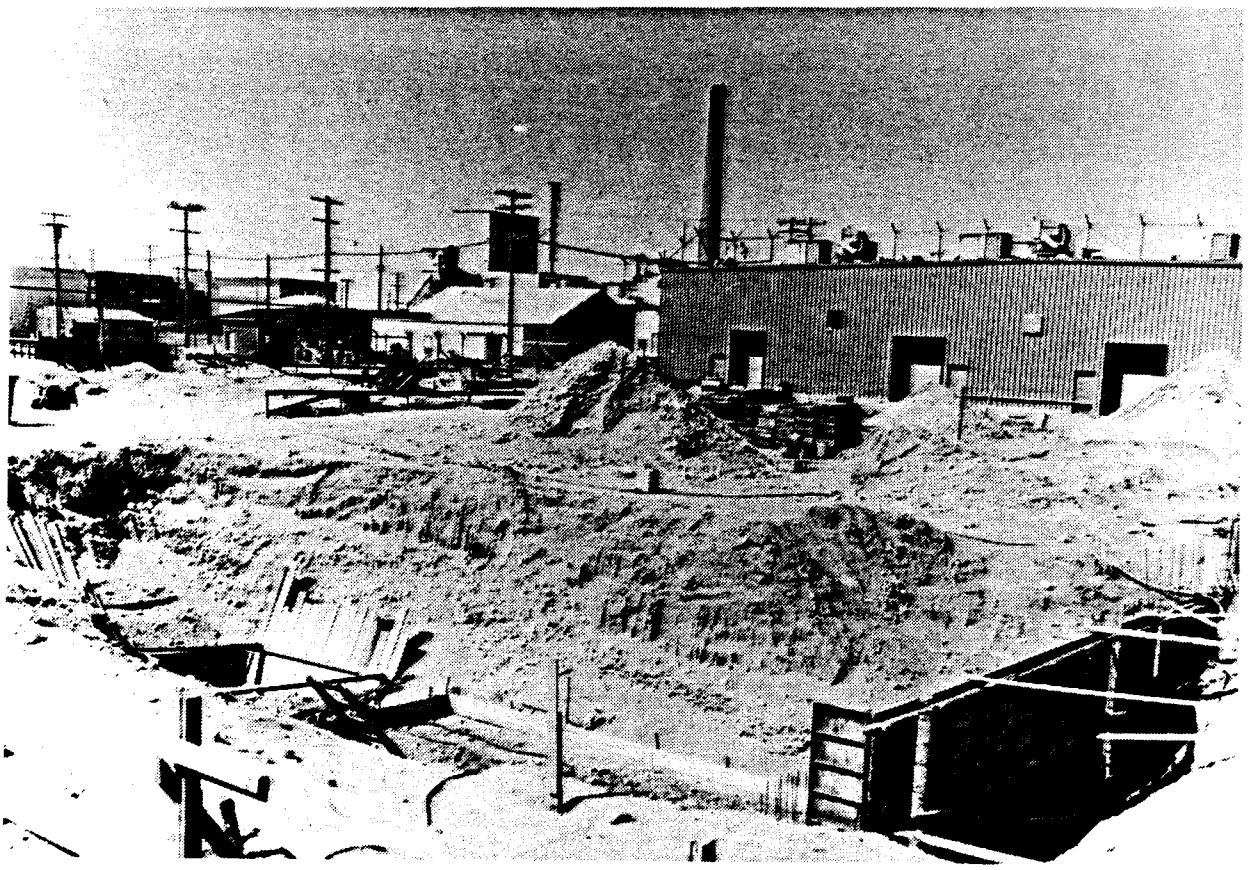

Figure 8. The 306 Metal Fabrication Development Building, known as the "Met Semi-Works," during its 1960 addition. This enlargement doubled the original size of the structure.

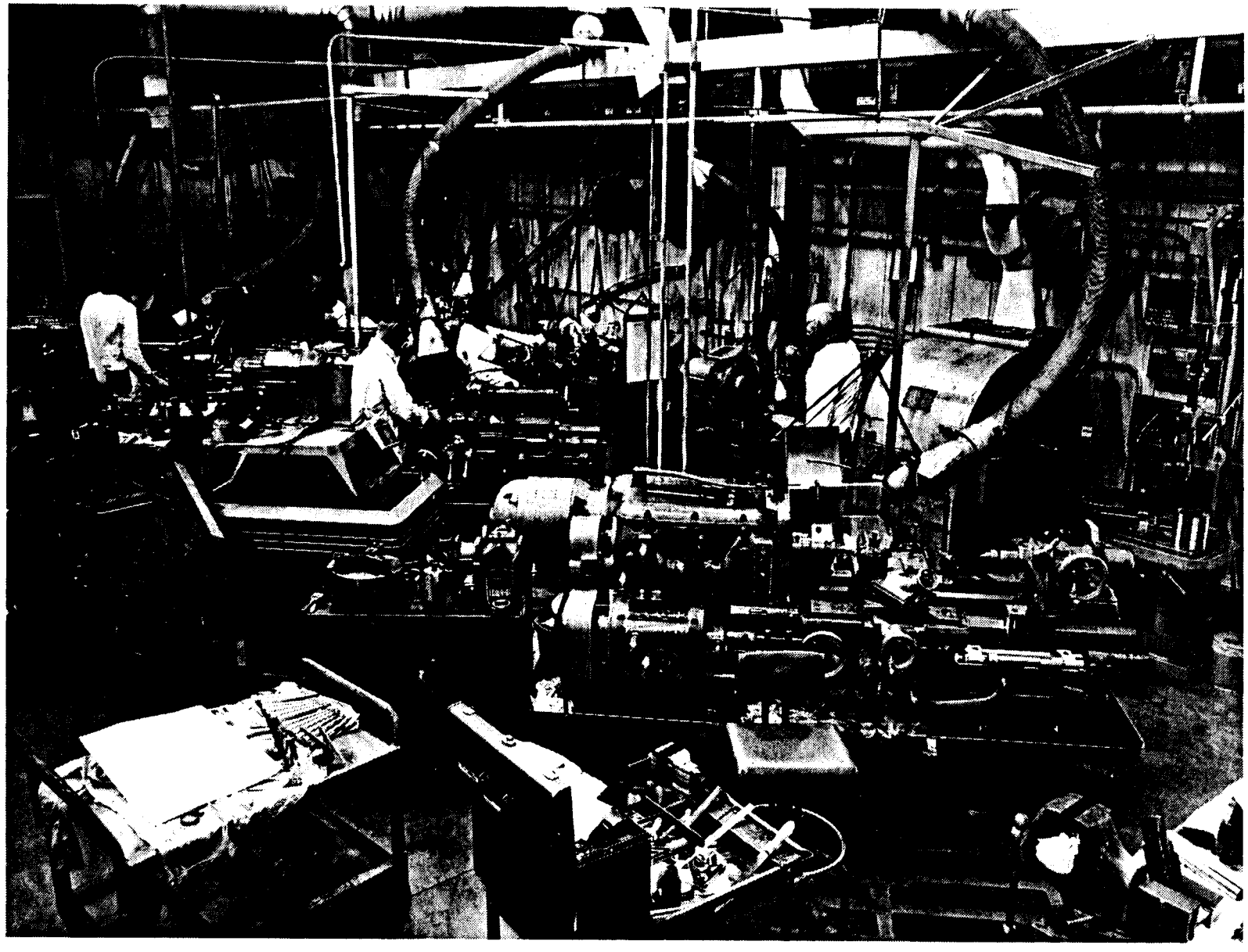

Figure 9. Specialty Shop or "Hot Shop" for the fabrication of new metal designs in the 306 Building, during the late 1950's. The many large vacuum hoses were used to remove metal dusts from the atmosphere.

3.0 THE 333 FUELS MANUFACTURING BUILDING

3.1 FACILITY DESCRIPTION AND ORIGINAL MISSION

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 a new process known as co-extrusion. The building was steel frame with double metal insulated panel exterior walls and lightweight metal panels for interior partitions. The foundation and floors were concrete. The roof was insulated metal panel covered with felt and roll tarpaper and a tar and gravel surface. The roof was refinished in 1962. Two mezzanines in the building housed equipment and offices. The structure was 300 ft by 140 ft, with a total area of 48,817 ft^2.

Various areas of the 333 Building accommodated the steps of the co-extrusion process. The co-extrusion process steps involved the following:

- The components were inspected and cleaned with nitric, nitric-hydrofluoric, and Chromic-nitric-sulfuric acid (combined in a commercial product called Zinctone*
- The uranium billets were excavated.
- The components were extruded in an extrusion press.
- The components were machined to create fuel sections.
- Nitric acid was used to remove copper-silicon residues.
- Nitric-sulfuric acid was used to chemically mill excess uranium on fuel element ends.
- The element was etched with nitric-hydrofluoric acids and brazed with a specific beryllium-Zircaloy-2 alloy.
- The fuel supports or projections were welded on and the element underwent audioradiography.
- The element received a final etch with nitric-hydrofluoric acid.
- The element then underwent autoclave testing and inspection and was stored as finished fuel.[19]

3.2 OTHER PROCESSES IN 333 BUILDING

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 (see Section 15.1) for the production of tritium (Figures 10, 11, 12, and 13). Highly enriched

*Zinctone is a trademark of the Turco Purex Industrial Corporation.

(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 (see Chapter 5.0). 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. Between 1987 and 1989, this building received upgrades and modifications in preparation for fabrication of tritium driver fuel elements for N Reactor, but the shutdown of N Reactor precluded implementation of this program.

3.3 THE 333 BUILDING WASTES AND CONTAMINATION

Since 1960 wastes and contamination produced in the 333 Building include all of the fuel components and chemicals used in the fabrication processes. Uranium fuel for N Reactor was enriched primarily to 0.95% uranium-235, with about 13% of the uranium enriched to 1.25% uranium-235. A small amount of natural uranium also was used, with other small portions of highly enriched (2.1% uranium-235) used in the fabrication of tritium production driver elements. Dusts, particulates, fines and chips of uranium, as well as beryllium, copper, zirconium, tin, iron, chromium, nickel, and silicon were spread throughout and near the building in the course of fabrication work and scrap removal. 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 chemical supply and cleansing tanks located in the 334, 311, and 303-F Buildings and in the 311 Tank Farm. In one 1982 incident, 1,100 lb of nitric acid and 280 lb of copper in a waste acid solution containing nitric, chromic and hydrofluoric acids, in solution with uranium, copper, and zirconium were spilled in the 333 Building chemical processing area and entered the process sewer. In August 1983, three spills of uranium-bearing nitric acid from facility supply tanks occurred within 15 days.

Before 1973, waste acids from the 333 Building were discharged first to a 3,800-gal underground tank containing limestone, located east of the 333 Building. The waste acids then entered the process sewer and the North and South Process Ponds (see Part III). In 1971, a study of radioactive releases and special materials accounting practices by Douglas United Nuclear, Inc. (DUN), which was the reactor operations and fuels preparation contractor at HW at that time, identified several areas of concern in 333 Building operations. Among these concerns were the amounts of contaminated gaseous, particulate and liquid discharges, the need for expansion of monitoring and sampling systems, a "general tightening" of procedures in materials movement, recordkeeping, labeling and reporting, and process equipment modification to provide for copper stripping, prebraze uranium etch and chemical mill rinsing. Partly in response to these concerns, the WATS process was developed.

Between April 1 and August 1, 1973, as the WATS operation was being designed, the 333 Building's underground limestone tank and Tank 4 in the 334 Tank Farm (see Sections 5.1 and 5.2) collected waste acids that were en route to the 313 Building for neutralization. On August 1, 1973, the 333 Building underground limestone tank was discovered to be leaking and was taken out of service. From that time until January 2, 1975, waste acids from the 333 Building were discharged directly to the 300 Area Process Sewer and Process Ponds. The liquid in these ponds was neutralized with sodium hydroxide stored in the 311 Tank Farm and added to the process sewer from the 303-F Building (see Sections 6.1 and 6.2). Then, during the years of WATS operation from 1975 to 1987, the primary chemical wastes from the 333 Building that continued to be discharged to the process sewer were rinse water, cooling water and steam condensate. Occasional acid spills also occurred, such as one loss of 1,200 gal of fresh sulfuric acid caused by a break in the transfer line between the outdoor sulfuric acid storage tank and Tank 32 in the 333 Building. The 333 Building was never connected to the 300 Area RLWS. Surveys in 1988 and 1989 uncovered low-level uranium and other contamination in soils, pipe trenches, asphalt, and gravel in and near the building. The 1989 report attributed the contamination to an "unknown historical spill." In a 1990 event, old zirconium-uranium fines in the 333 Building ignited during a belt sander removal procedure. No high-activity radiological contamination is expected in or near this facility. Additionally, airborne trichloroethylene and perchloroethylene releases resulting from evaporation occurred in and around this facility over many years.[20]

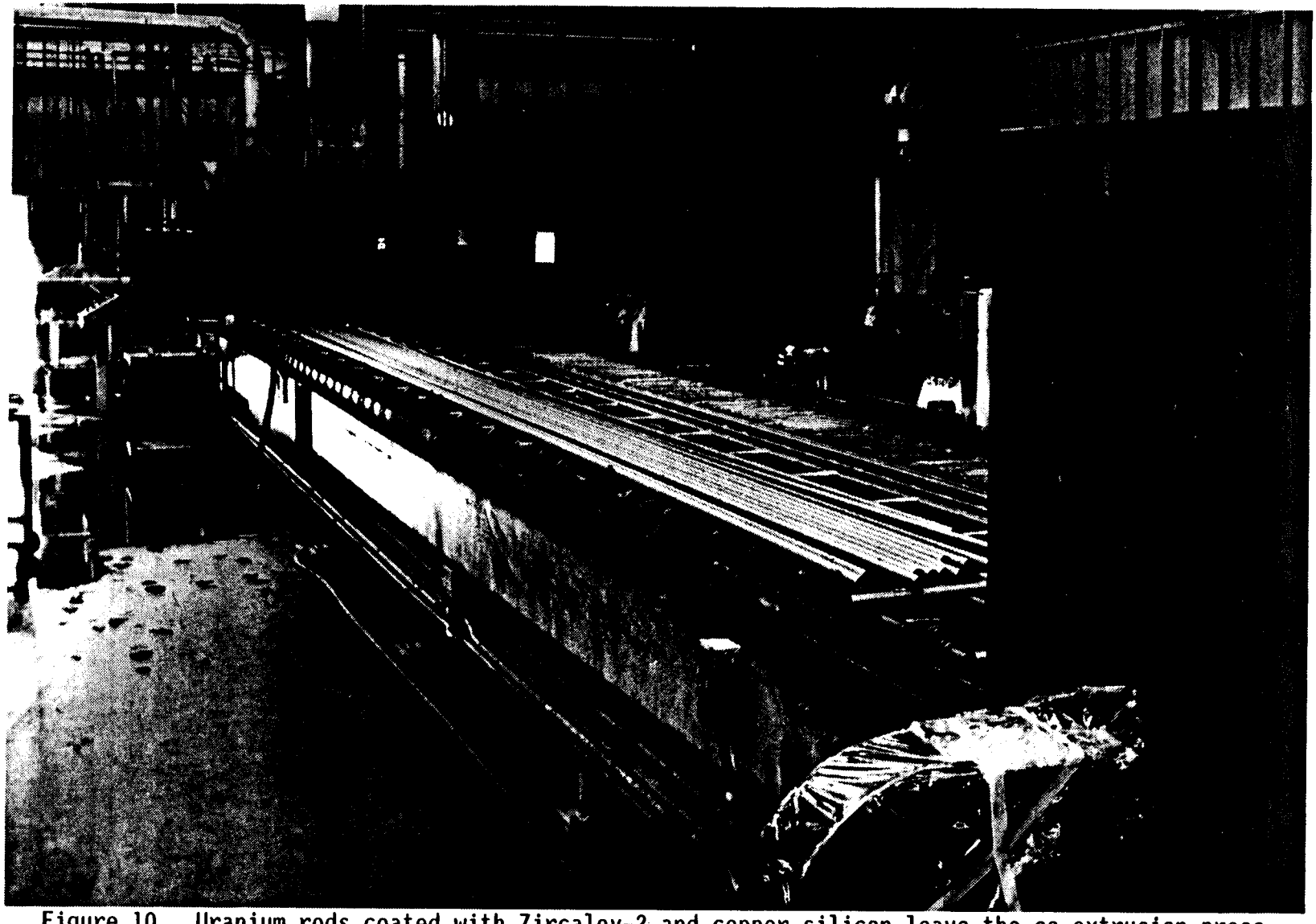

Figure 10. Uranium rods coated with Zircaloy-2 and copper-silicon leave the co-extrusion press on the "runout" table in the 333 Fuels Manufacturing Building during fabrication operations for N Reactor fuel elements in 1973. The cut-off saw is visible at top left.

Figure 11. Autoclave inspection area in the 333 Building, 1984.

Figure 12. Final etch line in the 333 Building, 1981. Following this step, the finished fuel elements for N Reactor underwent autoclave testing and inspection.

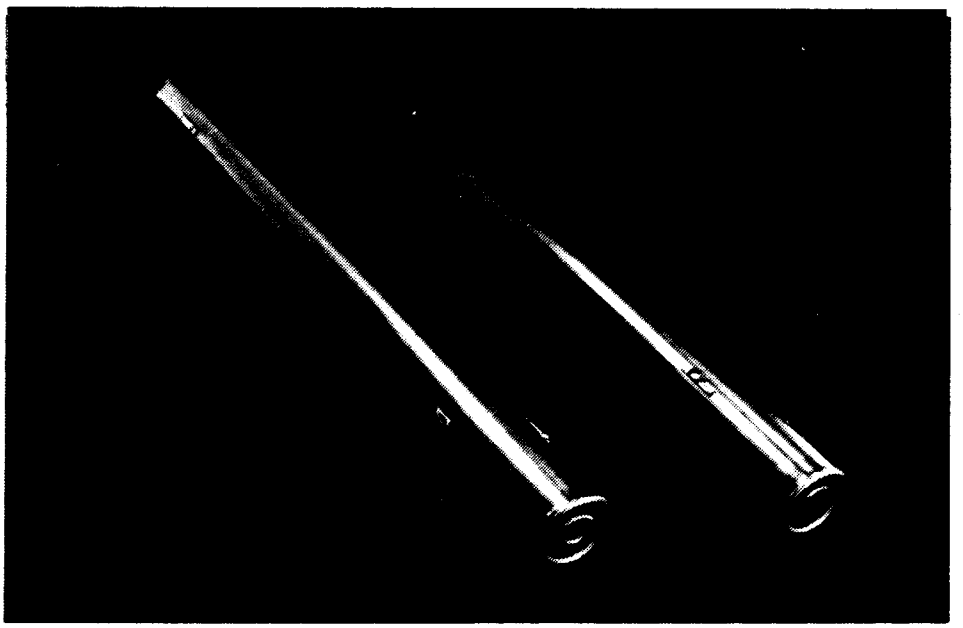

Figure 13. To the left, a normal fuel rod ready for insertion into N Reactor. To the right, an N Reactor fuel element holding a lithium-aluminate target used for making the "co-product" (tritium) in the late 1960's.

4.0 THE 334 CHEMICAL HANDLING FACILITY AND 334 TANK FARM

4.1 FACILITY DESCRIPTION, MISSION, AND WASTES

The small 334 Building was erected at the same time as the 333 Building to house the control instruments for that facility's acid system. The 334 Building, a steel frame structure with a concrete foundation and floor and a roof of insulated metal panel covered with felt and roll tarpaper, also stored minor amounts of chemical supplies such as hydrogen fluorozirconate. It was 20.5 ft by 15.16 ft, with a total area of 300 ft^2. Fuel fabrication acids were stored in four aboveground, 6,000-gal tanks of the 334 Tank Farm, located just west of the 333 Building and partially above Burial Ground 618-1 (Figure 14). Chemical leaks and spills of various amounts occurred over the years. Additionally, a large nitric acid leak from the 334 Tanks into the soil in the mid-1960's dissolved some of the contents of Burial Ground 618-1, allowing them to spread and filter through and beneath the tank farm. The leak also caused the tanks to tilt dangerously. In 1988, Tank 4 in the 334 Tank Farm was removed and buried in the 200 Areas.

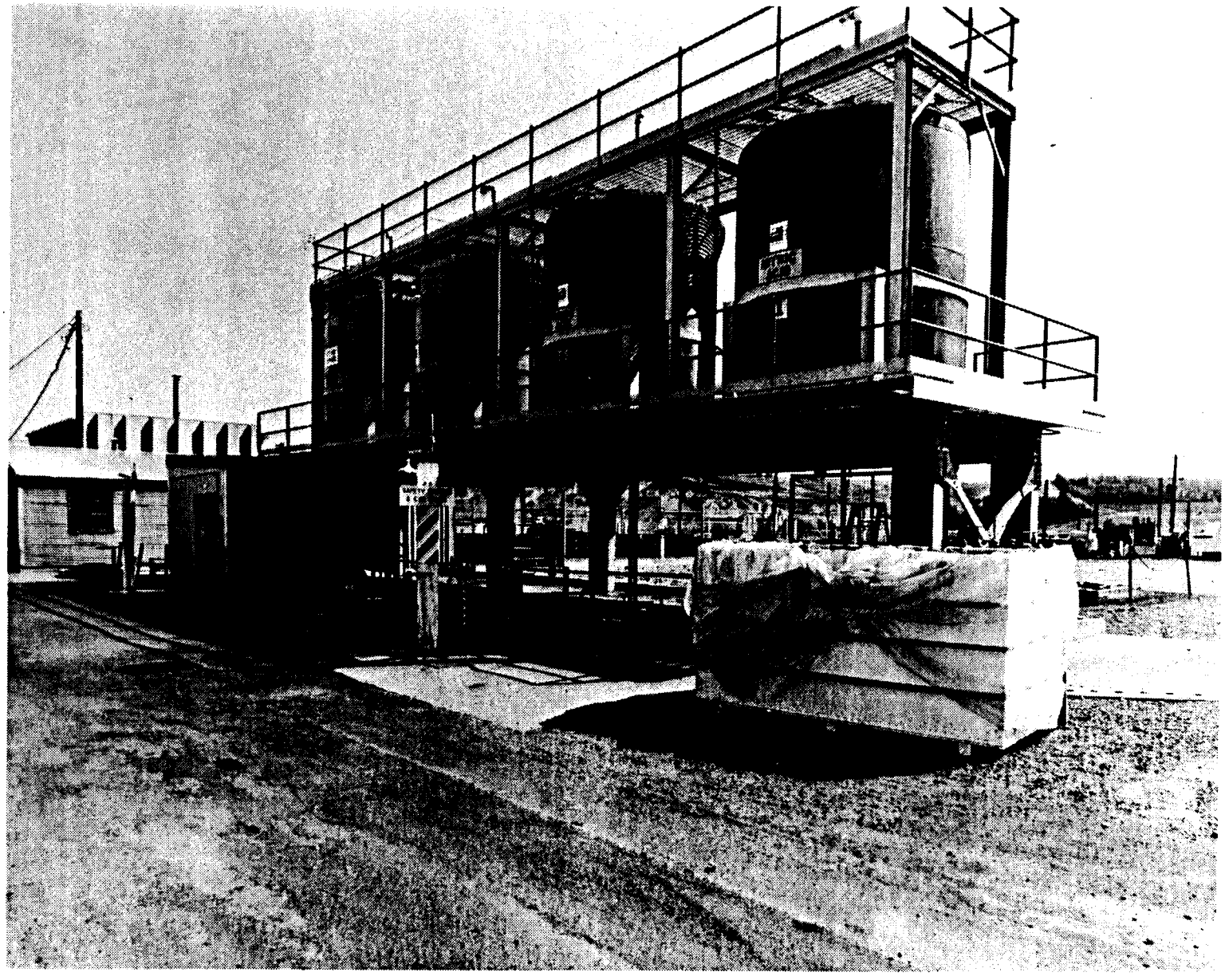

Figure 14. The four 334 chemical holding tanks in 1987. Tank #4, on the far left, had begun to leak near the top and was soon removed and buried.

5.0 THE 334-A BUILDING AND WASTE ACID TREATMENT SYSTEM

5.1 FACILITY DESCRIPTION AND MISSION

The 300 Area WATS process began partial operation for 4 months in 1973 and became fully operational in January 1975. It represented a method to prevent 333 Building fuel fabrication bulk waste acids from discharging to the 300 Area process sewer. At that time, the former 200 Areas building that would become the 334-A Building was fully installed. It was located over the site of the former limestone neutralization pit just east of the 333 Building. It is a metal frame structure 38.6 ft by 18.3 ft, with a total area of 706.4 ft^2 (Figure 15). The portion above grade was used for general storage of products and absorbents, and the portion below grade contained three tanks seated in a reinforced concrete pit 18.5 ft by 18.3 ft by 10 ft (deep). The pit or containment basin was coated with a glass-filled polyester, acid-resistant commercial product on its floor and on the lower 2 ft of the walls. The original coating was Carboglas 1601 SG*. A new coating, Semstone 884,** was applied in 1987.

Tank A in the 334-A Building pit had a capacity of 360 gal and was used as an inline settling tank. Wastes were then discharged into Tanks B and C, which were horizontal cylindrical tanks with a capacity of 2,000 gal each for storage. Beginning in August 1984, wastes were routed directly to Tanks B and C, and Tank A was used to store solutions and solids that had settled during earlier waste transfer activities (Figure 16). In 1988, Tank A was taken out of service but not removed. During most of the years of WATS operation (1975 to 1988) the tanks in the 334-A Building received approximately 210,000 gal of waste acids per year. From 1975 to 1986, Tank 4 in the 334 Tank Farm was designated as an overflow tank for the 334-A tanks, but it was seldom used. In 1986, equipment problems in the 313 Building caused waste acid solutions from that facility to be transferred to 334 Tank 4 for storage. Shortly thereafter, Tank 4 failed near the top and was removed and buried in 1988.[21]

5.2 THE WASTE ACID TREATMENT SYSTEM PROCESS

The waste acids treated in the WATS operation included nitric, sulfuric, hydrofluoric, and chromic-nitric-sulfuric acids bearing uranium, Zircaloy-2 components, copper, beryllium, and other fuel fabrication materials. Waste acids were collected in the 334-A Building tanks and then pumped to the 313 Building for neutralization with sodium hydroxide. The target pH after neutralization was between 10 and 12. Wastes containing recoverable amounts of uranium were routed directly from the 333 Building to the 313 Building and were not treated as part of the WATS process. Waste acids containing nonrecoverable amounts of uranium were pumped to Tank 2 in the 313 Building for neutralization and, beginning in 1985, were centrifuged to remove solids (see Section 1.14). Solids from the centrifuge were placed in drums and

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*Carboglas 1601 SG is a trademark of the Carboline Company.

**The trademark registration for Semstone 884 has been canceled.

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 the 311 Tank Farm for storage and transported by tanker truck to the 183-H solar basins for evaporation. In 1985, Tank 50 was added to the 311 Tank Farm, and waste effluents were shipped from there to the 340-B Building, part of the 340 Retention and Neutralization Complex (see Part III), for transshipment to the 200 Areas or offsite for disposal. The 303-F Building served as the pumping station for the various liquid and slurry waste transfers in the WATS operation.[22]

5.3 THE 334-A BUILDING AND WASTE ACID TREATMENT SYSTEM WASTES AND CONTAMINATION

Wastes and contamination in and beneath the area of the 334-A Building and the various stations 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, including an overflow of about 1,300 gal of waste-etch acids containing copper, uranium and zirconium in solution, on the site of the 334-A Building in 1973, before the emplacement of this structure. The largest spill occurred in June 1978, when a process water fill line to a 333 Building process tank was left on for 2 days. Nearly 19,000 gal of process water containing waste-etch acids with metals in solution overflowed the 334-A tanks containment basin at that time and entered the process sewer. In 1983, about 1,500 gal of similar material were spilled at the same location. Other, smaller leaks have occurred in and between the 334-A, 333, 313, 311, and 303 Buildings throughout the years of WATS operation.

Additionally, when waste acids from various 333 Building processes were combined, copper fluorozirconate crystals formed and settled within the 334-A tanks. Crystals also entered the polyvinyl chloride (PVC) pipes interconnecting the various WATS facilities and sometimes had to be removed by backflushing. Beginning in the early 1980's, in an effort to reduce crystal formation, the waste acid stream was separated into Zircaloy-2-bearing wastes (Tank C) and copper-bearing wastes (Tank B). The PVC transfer pipes of the WATS network are contained in covered concrete pipe trenches, and no significant, known leaks have occurred from the pipes. A closure plan for the WATS facilities has been developed by the U.S. Department of Energy Richland Field Office (RL).[23]

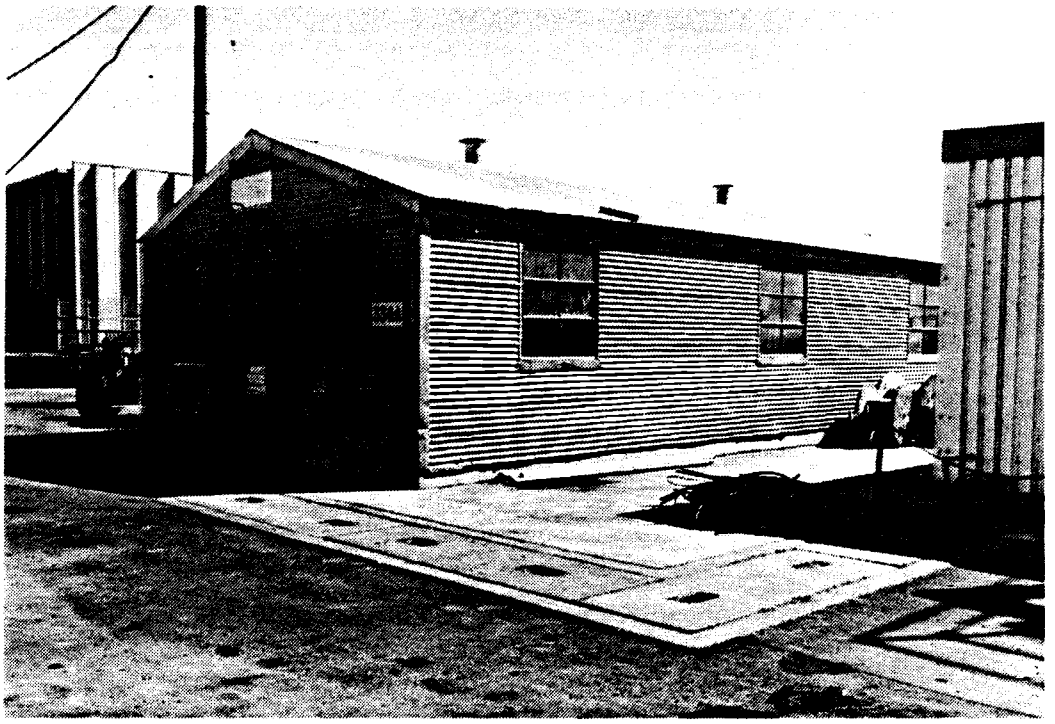

Figure 15. The 334-A Building in 1987.

Figure 16. Tanks A, B, and C, key components of the Waste Acid Treatment System, located below the 334-A Building.

6.0 THE 303 FRESH METAL STORAGE BUILDINGS

6.1 FACILITIES DESCRIPTIONS AND MISSIONS

Nine such buildings were built during World War II by the MED and du Pont. Eight of these buildings (A, B, C, D, E, F, G, and K) were 48 ft by 27 ft by 13.5 ft (high), each having a total area of 1,296 ft^2. They were located in an east-west line near the 313 Building and were constructed of reinforced concrete and concrete block. The ninth, the 303-J Building, was constructed of wood and was 64 ft by 41.5 ft by 27 ft (high), and had a total area of 2,656 ft^2. They were used for fresh metal (unirradiated uranium) and chemical storage and for uranium scrap storage (both in and around the structures).

In 1954, the 303-F and 303-K Buildings were upgraded as part of the project in which the 313 Building was expanded and the 311 Tank Farm was constructed (see Section 8.1) (Figures 17 and 18). After that time, the 303-F Building served as a chemical makeup facility for the solutions (mostly acids) used in the aluminum cleaning, stripping, and anodizing processes performed in the 313 Building. Beginning in 1973, it became the pumping facility for the 300 Area WATS operation (see Section 5.2). The 303-K Building became a decontamination facility for fuel fabrication equipment, where many acids and other chemicals were used. Since 1970, it has been used for the purpose its name implies: a Radioactive and Mixed Waste Storage Facility.

The small sheet metal 303-L Oxide Burner Building, 16 ft by 24 ft, was emplaced on a concrete slab in 1961 over the 618-1 Burial Ground (see Part III). In the 303-L Building, pyrophoric uranium scraps were burned down to an oxide state that would be safe for shipment to the FMPC. However, unconventional burning vessels (two cement mixers lined with concrete) and poor ventilation soon combined to produce airborne contamination readings that frequently exceeded the then-current HW maximum permissible concentrations (MPC) of 2×10^{-12} μCi/mL for unrestricted areas and 6×10^{-11} μCi/mL for restricted areas. Burning was stopped in 1971, and the building was removed in 1976. In 1983, the 303-M Uranium Oxide Facility was constructed on the same site. This high bay, 51 ft by 35 ft by 25 ft (high), a concrete structure with a one-story extension 20 ft by 13.5 ft on the north side, converted more than 115 metric tons of uranium scraps to oxide form during its brief period of operation from 1984 to 1987 (Figure 19).

6.2 THE 303 BUILDINGS WASTES AND CONTAMINATION

The original nine 303 Buildings were called "igloos" by early HEW workers. Soon after the end of World War II, H.I. Division monitors reported contamination problems in and around these buildings similar to those encountered in and near the 313 and 314 Buildings. For example, the unloading of bare uranium billets and rods produced air contamination readings of 4.8×10^{-4} $\mu g/cm^3$ (more than three times the HW "tolerance" value) in January 1947. Additionally, trucks and tools moved into, out of, and near these buildings often displayed surface contamination levels of 50,000 c/m throughout the 1950's and 1960's. Many spontaneous fires occurred in

uranium scrap barrels and in concreted uranium scrap "billets," with one particularly serious fire occurring in the 303-K Building in 1982. These autoignition events, along with oxide conversion activities, produced much particulate contamination that settled in soils. Some of this contamination was flushed deeper into soils and sanitary and process sewers by rain and fire-suppressant chemicals. Also, a plutonium oxide storage container ruptured in the 303-C Building in March 1979, releasing 1.2 to 1.3 mCi of contamination to the atmosphere. Many chemical spills occurred in the 303 Area during the 1940s-1960s. For example, one large spill of uranium-bearing nitric and sulfuric acid occurred from a pipe trench running between the 311 Tank Farm and 303-F Building in 1963. A smaller loss of perchloroethylene degreasing solvent occurred in 1981.[24]

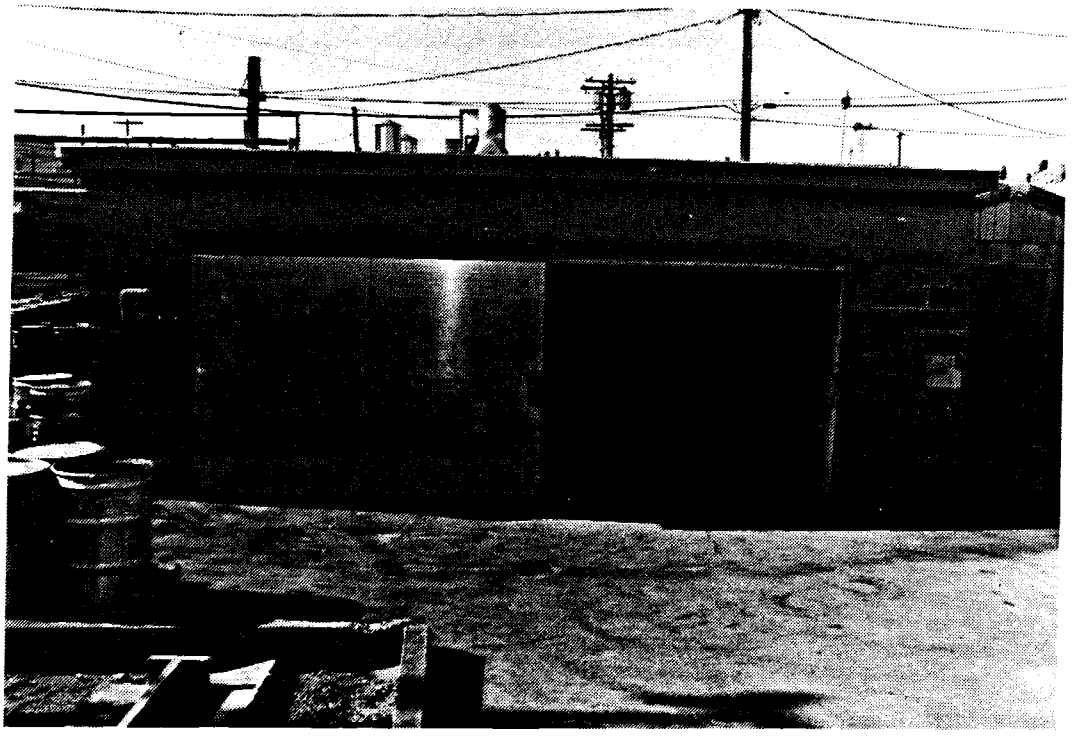

Figure 17. The 303-K Building, north (front) end.

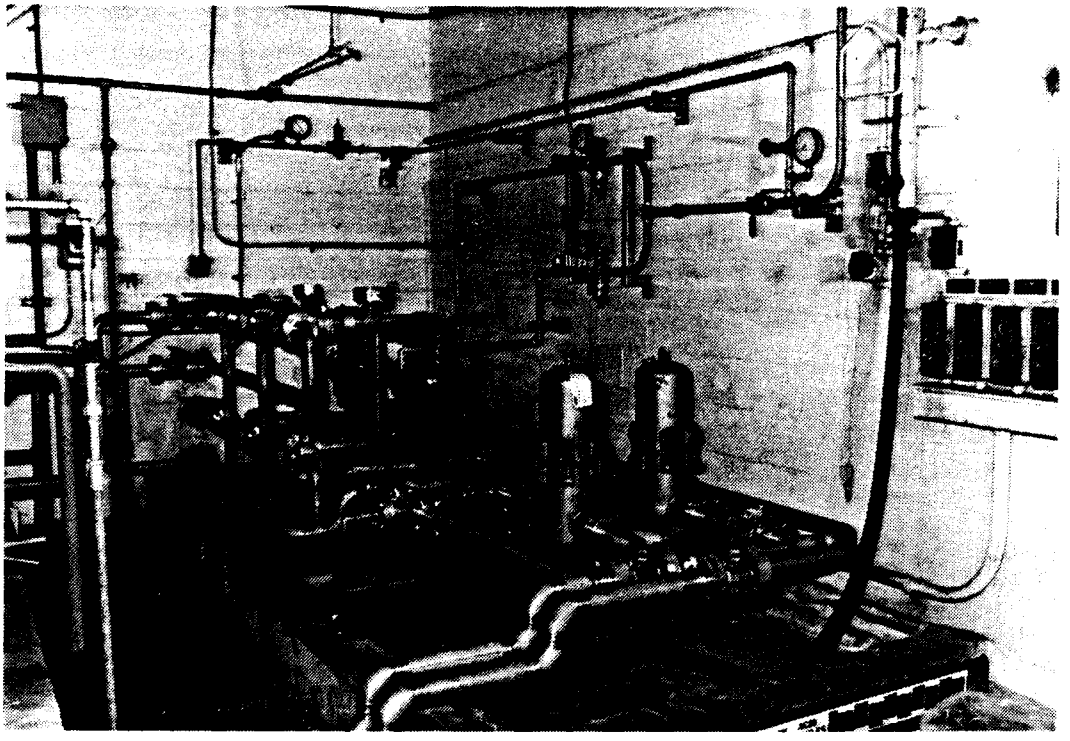

Figure 18. Pumping facilities within 303-F Building. The tall cylinders in the center are in-line filters installed in the late 1980's.

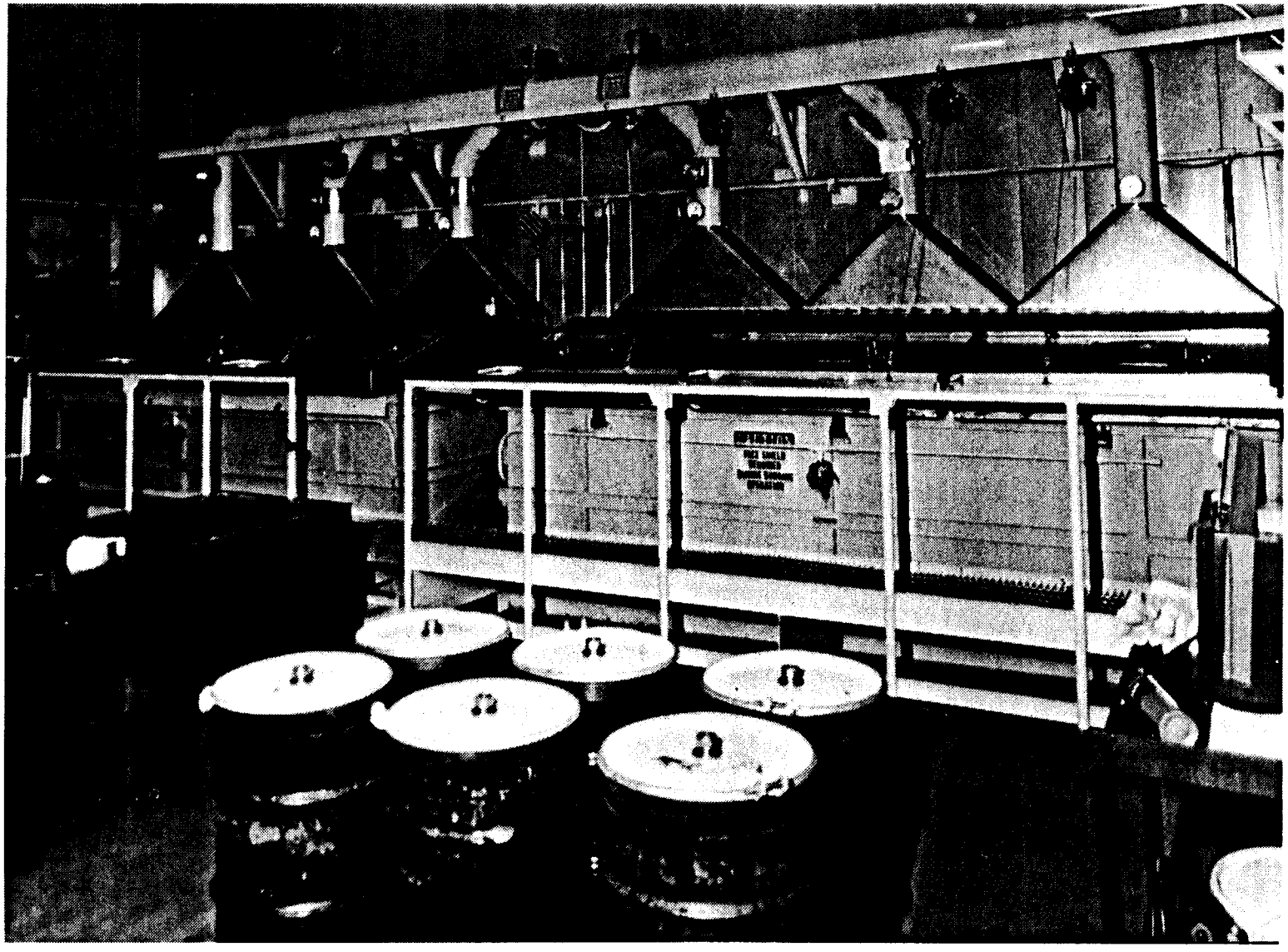

Figure 19. Calcination facilities in the 303-M Oxide Facility, about 1985.

7.0 THE 304 URANIUM SCRAP CONCENTRATION STORAGE FACILITY

7.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

During World War II the 304 Building was built by MED and du Pont as the HEW Sodium Storage Building. It was a concrete block structure approximately 6 ft^2 and 8 ft high. It was dismantled by 1946, and a new (and still existing) 304 Building was constructed in 1952 as a pilot plant for the lead-dip fuel canning process being readied for use in the 313 Building (Figure 20). This new structure is a sheet metal Butler building 26 ft by 48 ft, resting on a concrete pad. In the late 1950's it became the pilot plant for the Hot Die Size (nickel plating) fuel fabrication process, but this operation moved to the 3716 Building in 1962. Soon after, the 304 Building began to be used to store uranium scraps waiting for reclamation. Starting in 1971, a process to solidify pyrophoric uranium scraps in a concrete matrix for disposal or for shipment to the FMPC was emplaced in the structure. Since that time, it has been known as the Concretion Facility. Over the years wastes have consisted of uranium scraps and standard fuel fabrication chemicals. Additionally, a concreted uranium scrap "billet" fire occurred in August 1977, spreading airborne particulate contamination within and near the building. A 1988 survey found residual soil contamination beneath the floor at a level of 20,000 d/m (beta). The report stated that in the past, "water was routinely used to wash down [decontaminate] the loading pads and the floor inside the building... [There was] no way of containing rain water or water used to wash down... The loss of contamination control around the facility has occurred previously."[25]

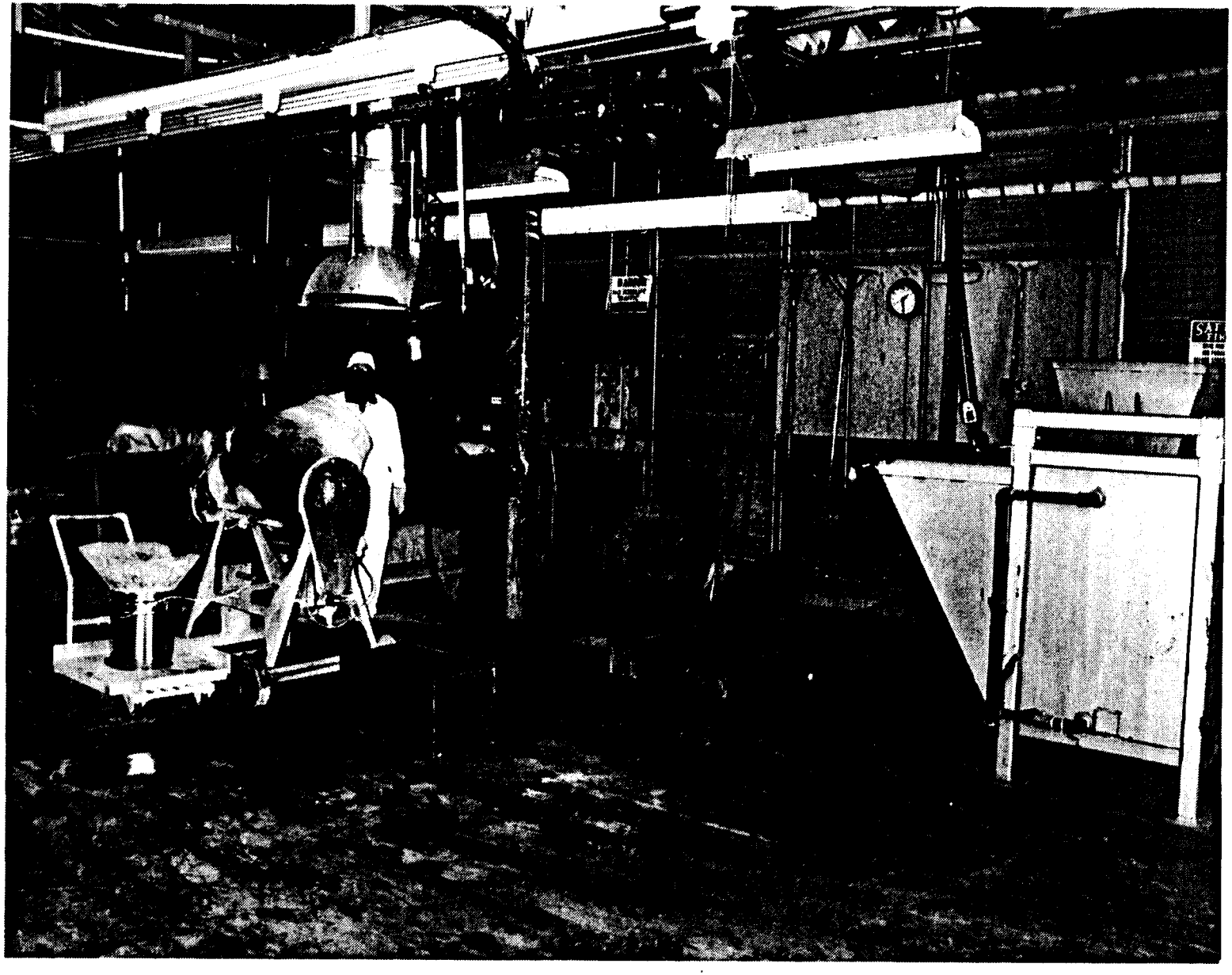

Figure 20. Concreting uranium chips and fines inside the 304 Building, 1979. To the right is the "chip-chopper." Following chopping, uranium chips were mixed with concrete in the cement mixer in front of the operator and poured into 7.5-gal cans for hardening.

8.0 THE 311 TANK FARM AND 311 BUILDING

8.1 FACILITIES DESCRIPTIONS, MISSIONS, AND WASTES

The 311 Tank Farm and 311 Building were built in 1954 and consisted of four aboveground chemical storage tanks, two belowground methanol storage tanks, and the small 311 Methanol Still House (10 ft by 10 ft). Methanol was used as a final rinse in both of the older fuel fabrication processes used at HEW and HW (triple-dip and lead-dip). The 311 Building distilled methanol for re-use and operated until 1971 when the last single-pass reactor closed at the Hanford Site. The 311 Building and 311 Tank Farm wastes consisted of chemical spills and leaks (primarily methanol, trichloroethylene and perchloroethylene). The tanks were located inside a concrete containment curb or catch basin, and many spills from this area and from overhead pipes and pipe trenches occurred over the years (Figures 21 and 22). The most serious single event was a break in an overhead uranium-bearing acid transfer line between the 313 and 333 Buildings in 1963. The line broke, and acids entered the ground near the 311 Building. The 311 Tanks later were used in the WATS operation, and many chemical spills occurred during WATS usage (see Section 5.2). One additional 311 Tank (Tank 50) was built for use in the WATS program in 1985. The 311 Building and the two belowground methanol storage tanks were removed in 1989.[26]

Figure 21. The 311 Tank Farm, 1980's. The upright tanks held fresh caustic, the horizontal tank in the front held waste acids, and the horizontal tank in the middle held fresh nitric acid.

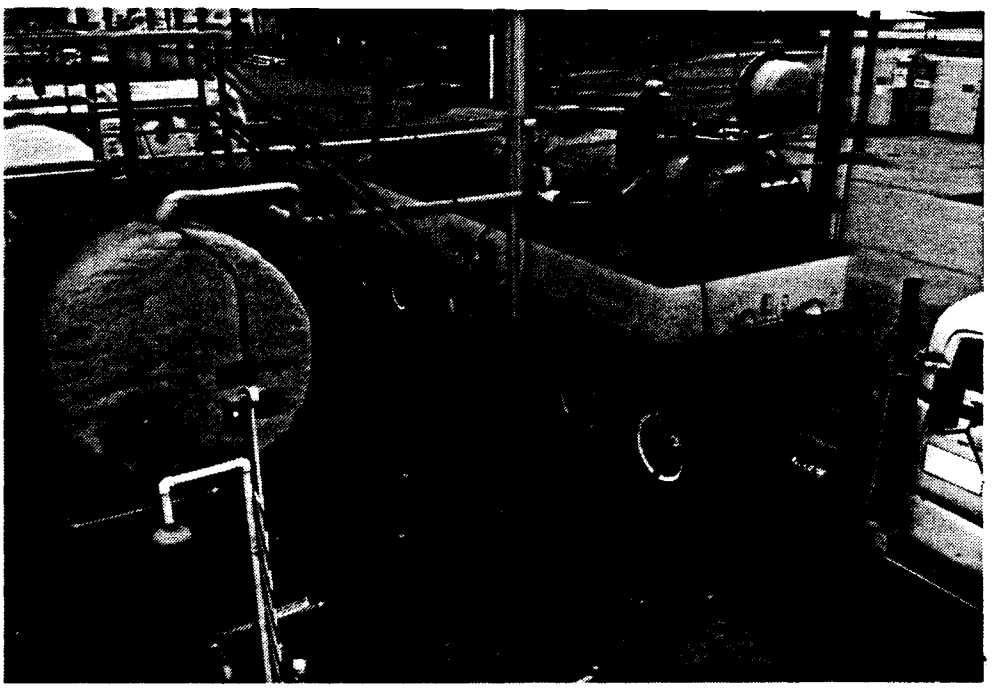

Figure 22. Loading neutralized waste slurry from Tank 40 in the 311 Tank Farm into a tanker truck for transport to the 183-H Solar Evaporation Basins, 1977.

9.0 THE 3707-A AND 3707-B CHANGE HOUSES

9.1 FACILITIES DESCRIPTIONS, MISSIONS, AND WASTES

The 3707-A and 3707-B Change Houses were built by MED and du Pont during World War II. Each was approximately 121 ft by 38 ft by 15.5 ft (high), with an area of 3,750 ft^2. They had 4-in. concrete slab floors supported by concrete block foundation walls. Exterior walls consisted of drop siding over 1-in. sheathing, and interior partitions were a combination of presswood, asbestos board, and gypsum board. The roofs were supported by wooden rafters and sheathing, with tar and gravel surfaces containing several wooden ventilators. Building 3707-A also contained the original 300 Area patrol office. Uranium, thorium, and other metallic contamination from the nearby fuel fabrication and scrap storage buildings was spread into the 3707-A and 3707-B change houses via powders and "fines" (small grindings) on the hands, clothing, shoes, and hair of personnel. Routine surveys of locker and lunchrooms in these buildings often produced low-level contamination readings up to 20,000 c/m. Since the change houses were connected only to the 300 Area sanitary sewer system, radioactive contamination entered the sanitary sewers from this pathway.[27] The 3707-B Change House is shown in Figure 23.

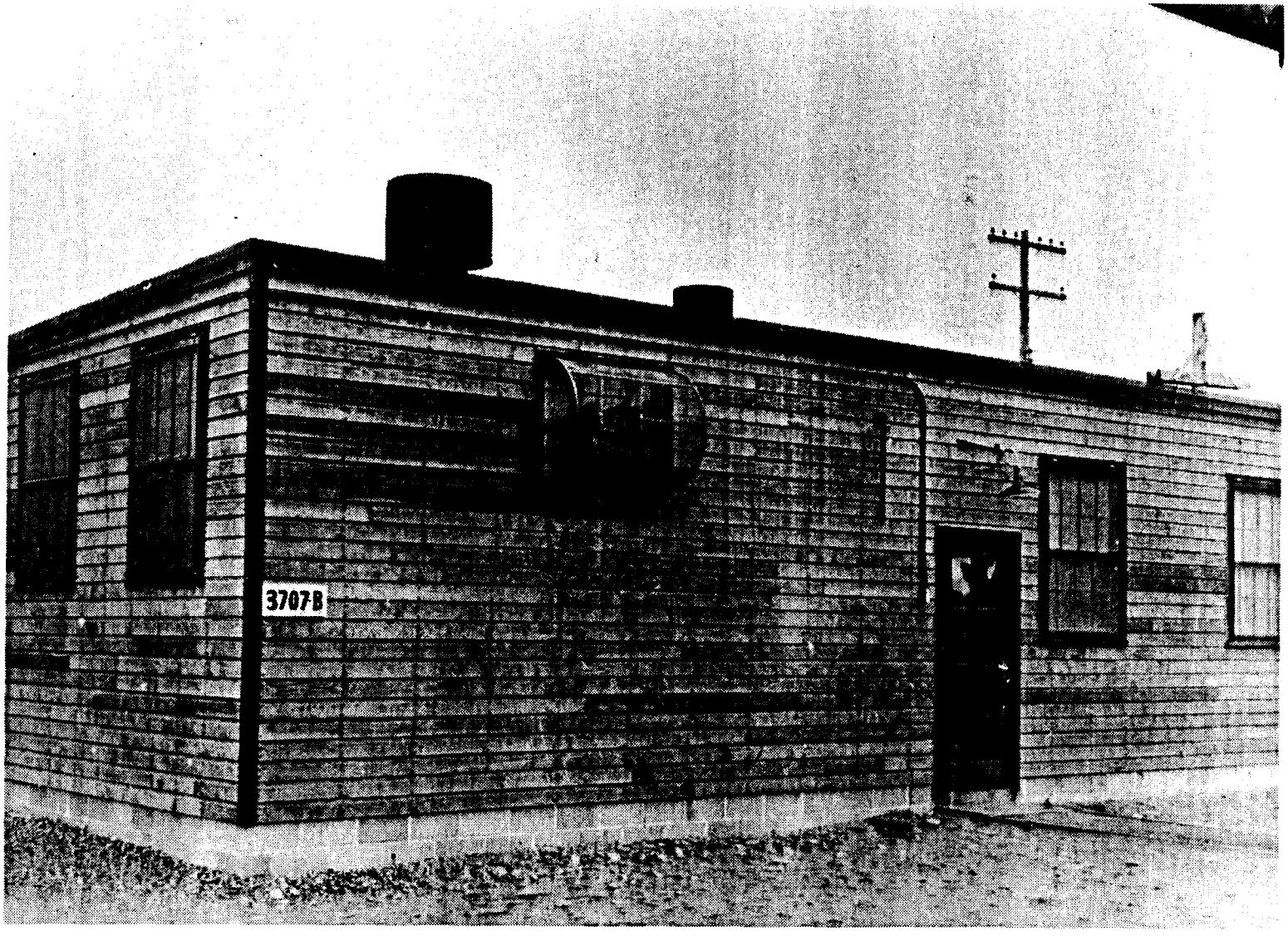

Figure 23. The 3707-B Change House as it stood in 1945.

10.0 THE 3708 RADIATION MEASUREMENTS BUILDING

10.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3708 Radiation Measurements Building was built in 1948 to process personnel dosimetry badges and meters. It was a one-story concrete block structure with a concrete foundation, concrete slab floor, and a tar and gravel surface on the roof. It was 74.5 ft by 51.16 ft, with a total area of 3,868 ft^2. In the early 1960's, the building was an electrical and optical shop used for storage, maintenance, and development of electrical and optical instruments. From 1967 to 1968, the structure was renovated as a fuel fabrication facility. In 1968, neptunium oxide fuel targets were manufactured in a reduction process, then canned in aluminum for special plutonium-238 production tests in the 100-K Reactors. The following year, another fuel blend that combined neptunium oxide with graphite in pellet form was fabricated in the 3708 Building. These fuel targets also were canned in aluminum and irradiated in the 100-K Reactors. However, graphite expansion under irradiation caused many of the cans to rupture, and this experiment was abandoned. In the early 1970's, the north end of the 3708 Building was used for the experimental canning of americium oxide and curium oxide fuel blends. These pressed powder targets, clad in aluminum, were irradiated in the older HW production reactors to make special isotopes for medical and other scientific uses. During that time period, tools in the building occasionally would display 40,000 c/m of radiation, and other wastes consisted of standard fuel fabrication chemicals. An atmospheric release of plutonium occurred from a waste drum about 1984 to 1985. A belowground chemical storage tank located just northwest of the building was removed in 1989, but some residual hazardous substances may remain near a buried oil storage tank that was removed when the building was excavated.[28]

11.0 THE 3710 SOLVENT AND GREASE STORAGE BUILDING

11.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3710 Solvent and Grease Storage Building was built in 1959 on the south side of the 3720 Building, just north of the 3712 Building (see Chapter 12). It is a one-story, concrete block structure with a reinforced concrete floor and concrete slab roof with built-up roofing and had dimensions of 13.3 ft by 17.3 ft and a total area of 231 ft^2. It has been used to store solvents and greases for fuel fabrication operations in various facilities, including the 313, 306, 333, 3712, 3720, 3722, and 3732 Buildings. There have been many spills and leaks of materials stored in drums in and around this building over the years.[29]

12.0 THE 3712 FUELS WAREHOUSE

12.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3712 Fuels Warehouse was built in 1961 and is a one-story steel frame structure with metal panel siding and roof. It has a concrete floor and foundation, dimensions of 90 ft by 108 ft, and total area of 9,720 ft^2. It was used to store uranium fuel elements, component parts for fuel fabrication, and uranium scraps from fuel manufacturing processes conducted in both the 313 and 333 Buildings. It currently holds fuel elements that had been scheduled for charging into N Reactor, as well as uranium billets that had been ready for fabrication into fuel elements. Wastes and contamination in and around this building consist mostly of fuel scraps and of particulates spread by a severe fire that occurred in improperly cured concreted uranium scrap billets being readied for shipment to the FMPC in July 1979 (Figure 24). That fire resulted in the spread of UO_2 contamination and fire-suppressant chemicals.[30]

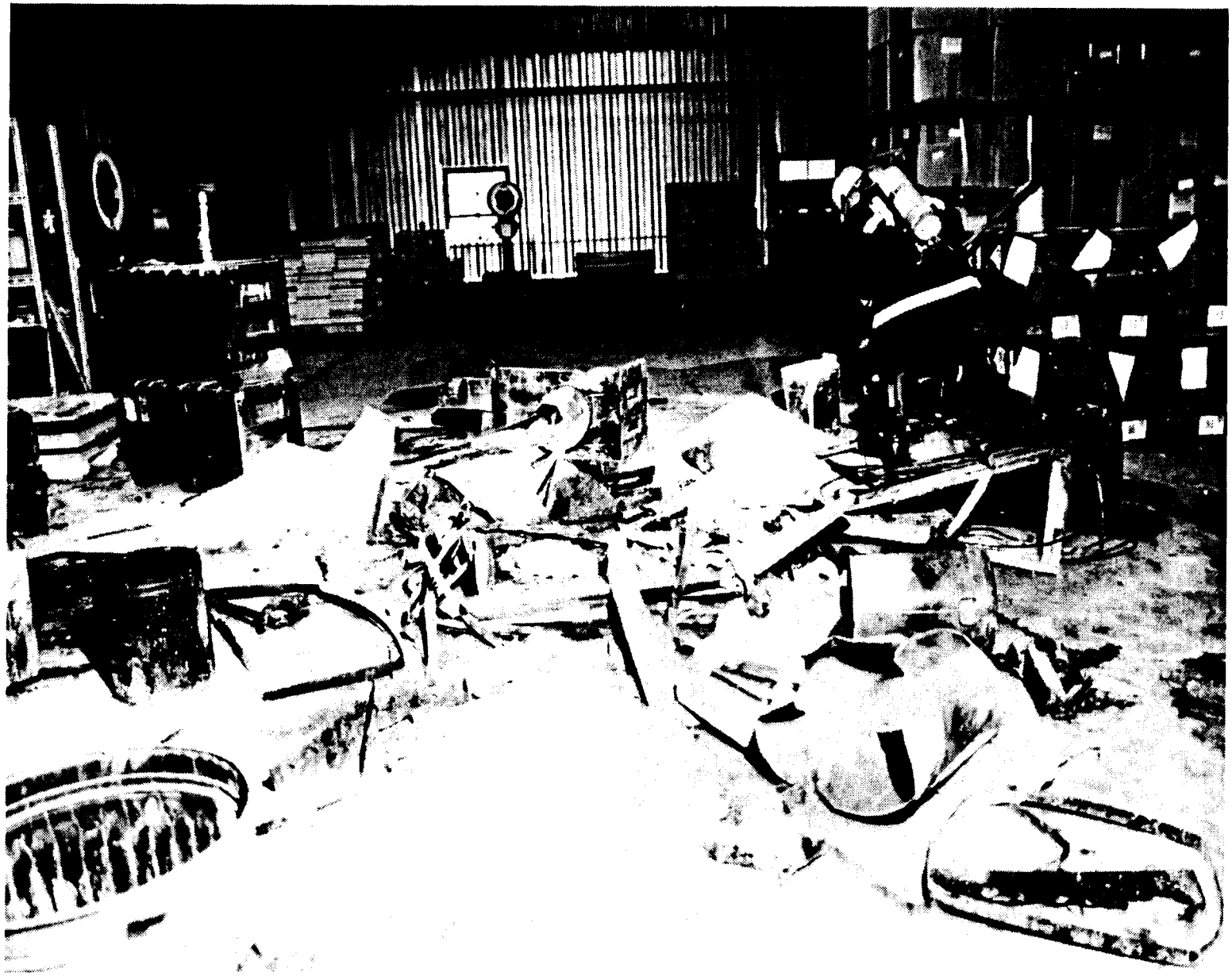

Figure 24. A Hanford firefighter sifts through the remains of an autoignition fire that occurred in concreted uranium scrap billets being cured in the 3712 Warehouse for shipment to scrap recovery operations offsite, July 1979.

13.0 THE 3716 AUTOMOTIVE REPAIR SHOP

13.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3716 Automotive Repair Shop was built by MED and du Pont during World War II. It had no particular association with fuel fabrication activities until 1962, when the building itself was moved to a location just south of the 333 Building and designated the Metallurgical Development Laboratory. As such, it served as an engineering pilot plant to develop alternate fuel fabrication processes, including the Hot Die Size (nickel plating) process. In late 1969, a 500-ton vertical extrusion press was installed to aid several experimental fuel fabrication processes. Among these experiments were the extrusion of titanium billets into rods with subsequent jacketing in copper with copper-silicon end caps, and the extrusion of zirconium-uranium alloy billets jacketed in copper-silicon. The jackets then were removed so the quality of the elements could be examined after they were exposed to the heat and chemicals required by the jacketing processes. Both processes were performed for commercial customers. During the years of piloting operations, fines, sludge, and other uranium-bearing wastes were dissolved in nitric acid and stored in steel drums on an outdoor pad until enough solution accumulated to warrant recovery in large, 313 Building processes. After most fabrication piloting operations were consolidated in the 306 Building, the 3716 Building was used to store uranium fuel supplies and fabrication equipment. Contamination and wastes include fuel fabrication chemicals, some low-level uranium, copper, and copper-silicon alloy residues.[31]

14.0 THE 3720 CENTRAL SERVICES LABORATORY

14.1 FACILITY DESCRIPTION AND MISSIONS

The 3720 Central Services Laboratory was built in 1959 on the site of the old 3722-A Building (see Section 15.1), and was used by General Electric (GE), DUN, and United Nuclear Industries (UNI) for analytical chemistry work in support of HW reactors in the 1960's and early 1970's. It was a two-story metal frame structure with dimensions of 240 ft by 100 ft and erected on a concrete foundation, footings, and floor slab. Additionally, it had a basement 24 ft by 109 ft under the southwest corner. The sloped gable roof with tar and gravel surface sat on a corrugated sheet metal base. In 1971, the 3720 Building was transferred to PNL and used by many departments including craft services, fuels and metallurgy, and atmospheric sciences. In 1980, a one-story concrete block addition, 48 ft by 40 ft, was constructed on the north end, giving the structure a total area of nearly 25,000 ft^2. The addition contained general laboratory and office facilities and was equipped with double high-efficiency particular air (HEPA) filters for low-level radioactive laboratory work. The building was never connected to the 300 Area RLWS; "cold" (nonradioactive) laboratory wastes were disposed to the 300 Area process sewer, and "hot" (radioactive) wastes were disposed via cask containers.

14.2 THE 3720 BUILDING WASTES AND CONTAMINATION

Over the years building wastes have included uranium and beryllium from the 1960's analytical work performed by GE, DUN and UNI. Uranium-bearing sludge (uranium, aluminum, and silicon carbide) from the abrasive cut-off saws accumulated beginning in 1965 and was measured at levels up to 50,000 c/m in a sump pit below the building in 1971. A major beryllium decontamination effort was undertaken by PNL in 1972; contaminated sludge was removed, and concrete was poured into the sump pit at that time. Other wastes have included standard laboratory wastes and craft services oils and solvents. A process waste sump backed up in the building during a power outage in 1981, and anoxic chambers imploded (as a result of excess negative pressure) in building laboratories in 1981 and 1985. The anoxic chambers were being used in studies involving the leach characteristics of basalt and the solubility of radionuclides in groundwater. However, little to no radioactive contamination was spread. The building, now called the Central Services Laboratory, is used by PNL for vitrification and grout developmental experiments, including radioactive laboratory work.[32]

15.0 THE 3722-A AND 3722-B AREA SHOPS

15.1 FACILITIES DESCRIPTIONS, MISSIONS, AND WASTES

The 3722-A and 3722-B Area Shops were built by MED and du Pont during World War II as general construction and fabrication shops. The 3722-A Building was a temporary structure located in the northeast corner of the 300 Area along the railroad spur. In the 1940's, contaminated items scheduled for burial were stockpiled just north of this structure. It was taken down in the late 1950's, and the 3722-B Building then became known as "the Area Shop." It had a wooden frame and a gable roof and was stationed on a 4-in. concrete reinforced slab floor supported by concrete foundation walls. Interior partitions consisted of pressboard and asbestos board. The overall dimensions were 120 ft by 41.5 ft by 29 ft (high), with a total area of 4,980 ft^2.

During 1964-65, the 3722 Building received much new equipment to house production of the lithium-aluminate fuel targets for tritium production in N Reactor. The tritium, produced under strict secrecy during the latter half of the 1960's, was known as N Reactor's "co-product." From 1965 to 1967, the lithium-aluminate arrived at the 3722 Building as powder, was pressed into pellets, sintered, cut, cleaned, and assembled in an argon atmosphere. The lithium-aluminate fuel targets were canned in aluminum, and then the aluminum cans were clad in a Zircaloy-2 jacket. Autoclave testing, final etching and inspection were performed in the 333 Building. See Section 3.2. From 1968 to 1970, pelletized thorium oxide fuel targets for uranium-233 production in Hanford single-pass reactors were fabricated in the 3722 Facility. Additionally, the building housed a furnace for the "recycling" (reduction) of depleted thorium oxide after it was processed in Plutonium-Uranium Extraction (PUREX) (Figures 25, 26, and 27). Currently, the 3722 Building is used as a Kaiser Engineers Hanford (KEH) construction shop.

15.2 THE 3722 BUILDING WASTES AND CONTAMINATION

Chemical wastes included standard machinery and construction oils and cleansers from the 1940's and 1950's shop operation. Fuel fabrication wastes from 1960's operations included fuel fabrication chemicals as well as lithium-aluminate and thorium oxide powders spread by the pressing and sintering processes throughout the ventilation system and onto press and furnace equipment. The most serious contamination consists of ruthenium-103/106), produced in particulate form as a "boil-off" from the thorium oxide sintering furnace in the late 1960's. However, the approximately 1-yr half-lives of ruthenium-103 and ruthenium-106 means that these isotopes have decayed through 22 to 24 half-lives and can be expected to present only minor hazards at this time.[33]

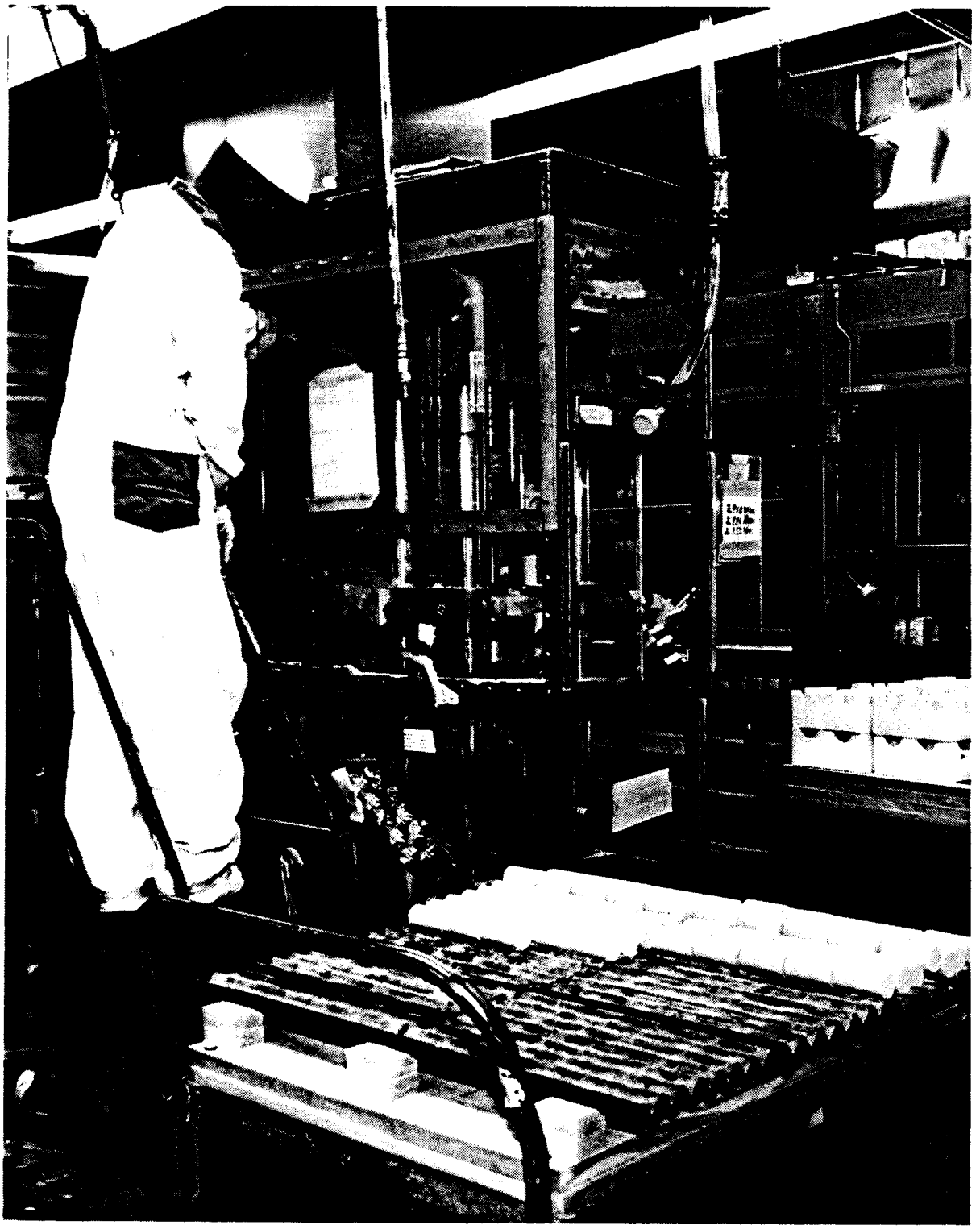

Figure 25. Press forming thoria powder into wafers during thoria wafer target element fabrication in the 3722 Building, 1969.

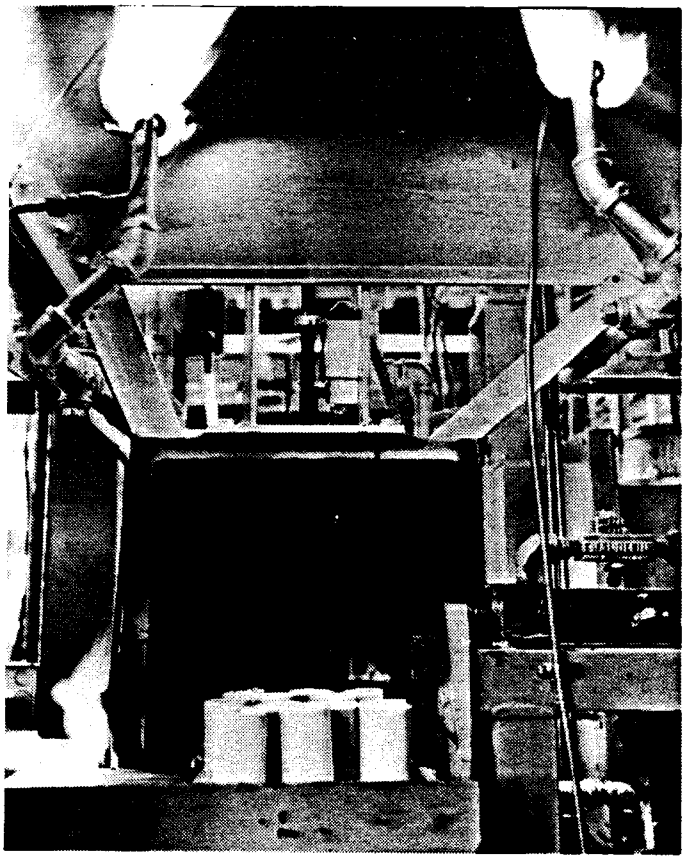

Figure 26. Thoria wafers exiting the 3722 Building sintering furnace after post-processing in the uranium-233 production program that took place at the HW from 1968 to 1970.

Figure 27. Molybdenum trays hold thoria wafers after sintering in the 3722 Building furnace, 1969.

16.0 THE 3732 PROCESS EQUIPMENT DEVELOPMENT LABORATORY

16.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3732 Process Equipment Development Laboratory was constructed in 1949 as an engineering pilot plant for the triple-dip and lead-dip fuel canning processes. It is a one-story, metal frame structure seated on a concrete foundation, with a concrete floor and a corrugated metal roof. Overall dimensions are 28.5 ft by 48.16 ft, with a total area of 1,365 ft^2. Powdered thorium oxide fuel targets for uranium-233 production were fabricated in the 3732 Building from 1965 to 1967. The process of handling these powder targets spread fines and particulate contamination throughout the building. After the thorium oxide program switched to pelletized targets in the 3722 Building in 1968, these new fuel targets were canned in the 3732 Building through 1970. As a result, the 3732 Building contains standard fuel fabrication chemical wastes, as well as residual thorium oxide contamination in crevices and areas throughout and near the building. The facility is now empty.[34]

ENDNOTES - PART I

1. DuPont, *Construction*, HAN-10970, Vol. IV, pp. 1017-1022; and DeNeal, 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; Williams and Williamson, H-3-08393; Harlan and Williamson, H-3-8391; and Kratzer, HW-21450.

4. Kent, HW-25906, pp. 5-6; Hochschild, Paulovich and Godwin, HAN-49157-DEL; Corlett, HW-38332, pp. 1-6; Yost, HW-39945, pp. 1-4; Lane, HW-47260, pp. 1-4; Weakley, HW-24494, pp. 1-4; Weakley, HW-27321, pp. 1-2; O'Rorke, HW-27428, pp. 1-6; Weakley, HW-27734, pp. 2-15, Brandt and Kraemer, HW-28282, pp. 1-4; and Brandt, HW-29871, pp. 1-3; and p. 352; and DOE/RL-90-11, p. A-10; and Harrington and Reuhle, eds., *Uranium Production Technology*, p. 352.

5. Harrington and Reuhle, eds., *Uranium Production Technology*, pp. 5-12, 383-425; and Greninger, HW-14110, pp. 72-73; and HW-7504 pp. 49-50.

6. Weakley, HW-58115-DEL; DOE/RL-90-11; AEC-GE Study Group, GEH-26434, p. 3.18; GE-Bouillon and Griffith, HW-4955; HW-776836.

7. Drumheller, HW-47887; and Bell, HW-68662, pp. 3-8.

8. DuPont, *Operation*, HAN-73214, Book 10, pp. 24-26.

9. 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.

10. Bixler "300 Area Monthly Reports," 1947.

11. Bixler, "300 Area Monthly Reports," December 1947 and January 1948, pp. 1-2.

12. Ibid, and April 1948; and Special Hazards Incident 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.

13. Durum and Chamberlin, "300 Area Monthly Reports," 1945-46; and Mickelson, HW-21699, pp. 53-55; and Hervin, "Radiation Monitoring Coverage," 1954; and Parker, HW-7184, Lecture 20, pp. 6-7.

14. 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.

15. Unusual Occurrence Report WHC-90-0126-313; and Unusual Occurrence Report WHC-91-0007-300G.

16. AEC/GE Study Group, GEH-26434, p. 3.8; and Karnie, HW-56892; and Hall, HW-56747.

17. Yesberger, Special Hazards Incident Investigation 56-202; 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.

18. 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-90-0044-306W.

19. 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.

20. 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 Greagor, 300-DRFS-8703; and Vedder, WHC-UO-87-014-DRD-01; and Clemans, 88-06-DRFS; and Cucchiara, RL Occurrence Report 75-25; WHC-C-88-086-DRFS-03, pp. 5-10; and Asay, OSS/3A-89-005; and Schumacher, NRFS-90-05.

21. Remaize, Unusual Occurrence Report 86-01; and DOE/RL-90-11, Section 3 and Appendix A.

22. Ibid, Appendix A and pp. 3.1 through 3.9.

23. Ibid, pp. 3.10-3.23.

24. DuPont, *Construction*, Vol. IV, pp. 1011-1013, and Bixler; "300 Area Monthly Reports," 1947-48; and Dabrowski, "Radiological Status...," (1969); and Curtiss, "Radioactive Releases...," (1971); and Lawrence and Jacobi, DOE/RL 88-21; and Galioto, Unusual Occurrence Report 82-005; and Fuquay, BNWI-1017-Del; and DOE/RL-88-31, p. A-21; and DOE/RL-90-04, p. 3-1 and Appendix A; and Geier, DRAFT: "Request for Variance...," (1992); and Bloom, Occurrence Report 81-1.

25. DuPont, *Construction*, HAN-10970, Vol. IV, p. 988 and 997; and Weakley, UNI-1454; and Kirk, Unusual Occurrence Event 77-02; and Critique #WHC-C-88-086-DRFS-03, with attachment; and DOE/RL-90-03, p. 3-1.

26. GE-Bouillon and Griffith, HWS-4955; and DOE/RL-90-11, pp. 3.17-3.24.

27. DuPont, *Construction*, HAN-10970, Vol. IV, pp. 1040-41.

28. AEC/GE Study Group, GEH-26434, p. 3.53.

29. "HEDL Facilities Catalog," (1971), p. 3710 (1 p.); and Asay, HEDL-MG-17, Rev. 6, pp. 121-122.

30. AEC/GE Study Group, GEH-26434, P. 3.56; and Lyttle, Unusual Occurrence Report 79-027.

31. DuPont, *Construction*, HAN-10970, Vol. IV, p. 989; and Scanlon, DUN Monthly Reports, January, February, and March 1970.

32. Schultz, "Adequacy...;" and Scanlon, DUN Monthly Report, March 1970, p. 3; and Jones, "Project BAP-306;" and Unusual Occurrence Reports PNL-81-14, and PNL-85-2.

33. DuPont, *Construction*, HAN-10970, Vol. IV, pp. 1047-1049; and Bixler, "300 Area Monthly Report," September 1946; and Tabb, HW-19985; and Tew, RL-REA-2177; and Roedel and Stevenson, RL-REA-2240, Rev. 1; and Denton, "Operating History...," (1969); and Shaw, RL-GEN-1773.

34. AEC/GE Study Group, GEH-26434, p. 3.68; and RL-REA-2177.

PART II MANHATTAN PROJECT FACILITIES NOT CONNECTED WITH FUEL FABRICATION

17.0 THE 305 TEST PILE, BUILDINGS 305-A AND 305-B

17.1 THE 305 FACILITY DESCRIPTION AND MISSIONS

The 305 Test Pile (reactor), located in the then northwesternmost corner of the 300 Area, was the first operating reactor at the Hanford Site. It was built during World War II by MED and du Pont as a quality assurance tool to house testing of "the application of new information or developments if any happen to appear." On a more routine basis, the 305 Test Pile tested samples of each lot of graphite, uranium, aluminum tubes, aluminum canning material (for fuel rod jackets), and other materials used in the large HEW production reactors (B, D, and F Reactors). Measurements of material purity using instrumentation and calculations were too time consuming for wartime schedules. Therefore, actual performance tests of material samples in a reactor were deemed necessary. Also, according to du Pont, the long distance between the MED's Metallurgical Laboratory (Met Lab) at the University of Chicago and HEW "dictated the necessity of a test pile at Hanford." Trials conducted in the 305 Test Pile compared the performance of material samples under irradiation with samples of known quality and graded each lot. According to du Pont, the reactor also served as "a radiation source for technical and instrument development work."[35]

The 305 Building was an oblong, steel-framed, gable-roofed structure approximately 163 ft by 87 ft by 51 ft (high), with a total area of 7,000 ft^2 (Figure 28). The concrete block walls were 8 in. thick, and the roof consisted of two layers of felt applied with hot asphalt on a pre-cast tile deck. Eight ventilators on the roof washed and circulated building air. There were no outside windows in the building, and all doors, except those for pedestrians, were metal-sheathed sliding doors. Building floors were of 8-in. reinforced concrete throughout, set on concrete wall foundations and concrete piers with spread footings. The 305 Test Pile operated at a very low critical level usually less than 50 W. The average operating thermal level was 20 °C to 22 °C. It sat above ground inside a 5-ft-thick concrete shielding barrier that was 28.25 ft by 28.25 ft by 24.5 ft (high). The barrier in the south side could be opened for charging and discharging operations and for maintenance. After each assembly (or charging), a south barricade and a roof barricade made from concrete blocks were emplaced.

The pile itself consisted of 51 layers of graphite block. The core was a 16-ft graphite cube with 1-ft graphite reflectors on all sides, giving the core the overall dimensions of an 18-ft cube. The core was pierced by 519 circular holes and 20 rectangular holes (for "stringers"; see Section 17.2) running from the charging face to the discharge (east) face (Figure 29). There were 292 metal-bearing channels, with an 8.5-in. lattice spacing. One solid vertical, boron steel safety rod hung above the pile that could be dropped in to "poison" or tamp down reactivity. Additionally, a smaller metal safety rod on top of the pile could lower small boron steel pellets, or shot, down another hole in the reactor. Three solid boron steel horizontal control rods also could be inserted into the pile from the south side. These rods operated as emergency safety controls. However, the normal operating control rods, used to adjust reactivity in the pile, consisted of one mild steel shim rod and one cadmium-mild steel strip control rod, each 200 in. long.

Automatic Beckman* meters could be set to release the safety rods and drive the control rod into the pile at any desired power level. The reactor was natural uranium fueled, and air cooled.[36]

17.2 TEST PILE OPERATIONS

Sample materials were loaded and unloaded from the 305 Test Pile via metal stringers. There were 10 uranium-bearing stringers (known as metal stringers) and 20 graphite stringers, of which one each, metal and graphite, were used routinely. Because the stringers ran from east to west through the reactor, materials were said to rest in the east stringers or the west stringers. Each stringer totalled about 500 in. in length, including the central test bed portions, end portions, and maple "pushers" that moved the stringers in and out of each side of the reactor. Graphite used in the production reactors had to be very pure, or it would capture too many neutrons and "poison" (slow down or stop) the reactivity. During the most hectic months of reactor construction at wartime HEW, so much graphite testing was needed that the 305 Test Pile was placed on a two-shift schedule almost as soon as it began to operate in March 1944. Two months later, the facility began to operate three shifts around the clock. Graphite testing slowed considerably after August 1944. From that time until the war's end, the 305 Test Pile operated only 3 to 4 days a week, on a day-shift basis only. During 1946, it operated only 1 to 2 days per week.

Graphite testing consisted of comparing one to four graphite bars of unknown purity with two standard bars in the central sections of stringers 11 and 12. The purity of the test bars was reported as the difference in reactivity between the test and the standard bars, corrected to the density of the standard bars. The secondary standards of the test bars were then measured by "poisoning" the graphite with known amounts of neutron absorbers (in this case, copper wires).

Samples of newly arrived uranium billets were termed "billet eggs" or simply "eggs." They were taken from the end of every fifth or sixth uranium ingot and submitted for pile testing to determine the level of impurities (especially rare earths) in the uranium. Egg testing consisted of comparing 8 eggs of unknown quality (spaced along the centers of stringers) with 16 test eggs. The difference in reactivity between test and standard eggs was reported as the total danger sum (TDS), or the change in reactivity multiplication that would result if a production reactor were loaded with the test uranium instead of with the uranium containing no impurities.

Machined slug testing consisted of comparing 11 test slugs with 11 standard slugs in the central portion of metal test stringers. Slugs were tested both before and after canning, first to determine the quality of metal going into the canning process and afterward to detect any accidental inclusion of high cross section elements (i.e., elements having a high ability to absorb neutrons). The latter test, an impurity calibration, was performed by artificially poisoning each of the 11 test slugs with copper foils. First

*Beckman is a trademark of Beckman Instrument, Inc.

one, then two, then three, and then four copper foils were added per slug, to act as neutron absorbers on the surface of the slug. Changes in reactivity values were then measured and compared.

Various other metal foils, including aluminum, gold, indium, and others, were also placed in the 305 Test Pile to vary reactions and to obtain different measurements. Indium foils were used to measure neutron intensity. Under irradiation, this short half-lived element would reach a point where its rates of neutron absorption and beta decay were nearly equal. Therefore, measurements of its decay rate could give a good indication of neutron intensity at any point in the pile. Samples of iron, aluminum welding rods, lubricant oil, and boron used in the construction of the large HEW production reactors also were tested in the 305 Test Pile. Instrumentation for the 100 Areas reactors, including counter tubes, gas chambers, thermopiles, shim-stock chambers, and neutron and gamma chambers also were calibrated in the 305 Test Pile.[37]

17.3 OTHER 305 BUILDING FUNCTIONS

The 305 Test Pile continued to operate as such through the late 1960's. It performed quality assurance trials on much of the graphite used to build N Reactor in the early 1960's, and tested the Li^6 (depleted lithium) values in special lithium-aluminate fuel targets used to make tritium in N Reactor in the late 1960's (see Part IV). Although the 305 reactor was primarily a "workhorse" testing machine, a few critical experiments also were performed there in the early postwar years. In one case, a device was placed in the side of the reactor to extract fission gas samples. In this angular correlation experiment, the gases then were run through both beta and gamma ray spectrometers to see if decay products were emitted in certain angles from the radioactive source. Soon, however, HW scientists recognized the need for a separate experimental reactor, and the 305-B Building was built for this purpose during 1952 to 1954 (see Section 19.1).

From 1968 to 1973, copper-silicon pre-shapes used in the N Reactor co-extrusion process billet assemblies were cast and machined in the west end of the 305 Building. Thereafter, this function was moved to the 313 Building (see Part I). In 1974 and 1975, UNI (the reactor operations contractor at the Hanford Site at that time) removed the 27 tons of natural uranium fuel from the 305 Test Pile; the reactor itself was dismantled and buried in 1977 to 1978. At that time, 474,000 tons of graphite were removed and sold as excess. In the late 1970's, a large addition (approximately 5,000 ft^2 including a high bay) was placed on the south/southeast side of the 305 Building, and the majority of the facility was converted to the Hot Cell Verification Facility (HCVF) (Figure 30), a cold prototype for the 427 Fuels and Materials and Examination Facility (FMEF). In 1985, the 305 Building was converted again to support mechanical development, mock-up, and testing for the Rockwell Hanford Operations (Rockwell) which was the Hanford Site waste management and chemical processing contractor at that time, Process Facility Modifications Program. Currently, the facility operates to test shipment cylinders, casks, and capsules in the DOE 7A testing program. It has potential historic status according to the criteria of the NHPA, but the fact

that the reactor has been removed and the building has already been substantially modified decreases likelihood that it will be named to the National Register of Historic Places.[38]

17.4 THE 305 BUILDING WASTES AND CONTAMINATION

The 305 Test Pile operations produced no significant environmental contamination. The natural uranium fuel was irradiated neither long enough nor at a high enough power level to achieve a significant burn-up, so the fission product yield was low. The irradiated uranium samples (eggs and slugs) were returned to the fuel fabrication process in the 313 and 314 Buildings if their quality was satisfactory. The primary environmental hazards came from the spread of uranium fines (both before and after irradiation) as samples were transported and manipulated. A 1954 ground contamination survey taken between the 305 and 313/314 Buildings read 80,000 c/m. More serious environmental contamination resulted from personnel handling and examining irradiated graphite samples (see Section 28.2). There were no known operating accidents or significant contamination events associated with the 305 Test Pile.

However, reactor loading and unloading operations did produce some undesirable levels of personnel exposure throughout the facility's history. Finger ring dosimeters worn by operators demonstrated average exposures of 60 to 90 mrep per day, with some maximum readings as high as 150 mrep received in three to six hours of work. "Rep" (radiation equivalent physical) is an obsolete term quite similar to the current "rem," meaning radiation equivalent man. Like the rem, it was a measure of biologically absorbed dose, or of the ability to generate a biologically absorbed dose of radiation. Contact readings from bare uranium removed from the pile demonstrated 1,700 mrep/h and 250 millirads per hour (mr/h) with occasional experimental readings as high as 2,500 mrep/h. In May 1947, a special H.I. Division survey of 305 Test Pile operations took place, with the result that personnel were required to wear heavy aprons and shoe covers. The production expansions and increases in uranium enrichment levels that took place at HW in the years after 1947 brought sharp increases in radioactivity levels in the test samples. "Poison wires" (foils) read up to 5,500 mrep/h at contact in the early 1950's, while bomb-grade uranium slugs read up to 9,500 mrep/h, and uranium eggs read up to 6,000 mrep/h. In the early 1960's, irradiated material removed from a 305 Test Pile stringer read 5 r/h.[39]

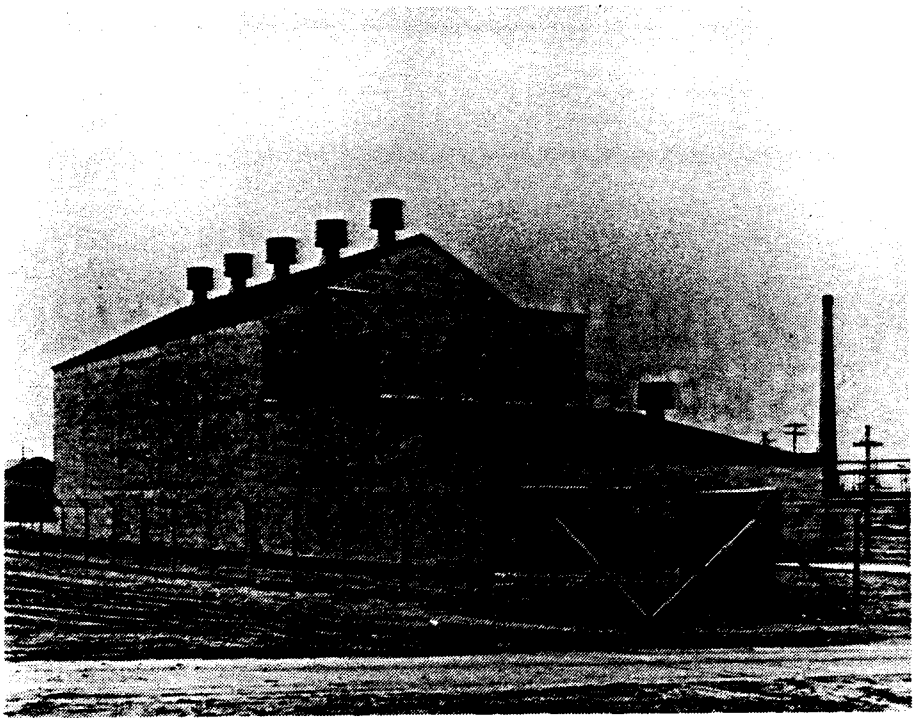

Figure 28. The 305 Test Pile Building, nearly complete in January 1945.

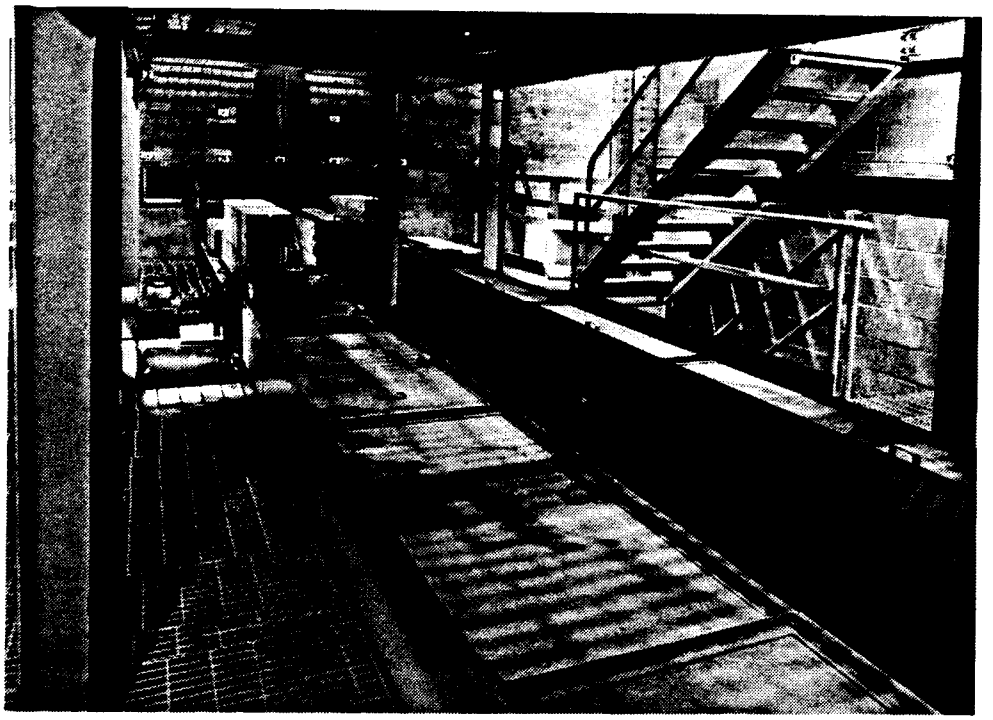

Figure 29. Stringer channels and entry ports into the 305 Test Pile, shown during the reactor dismantling operation in 1977.

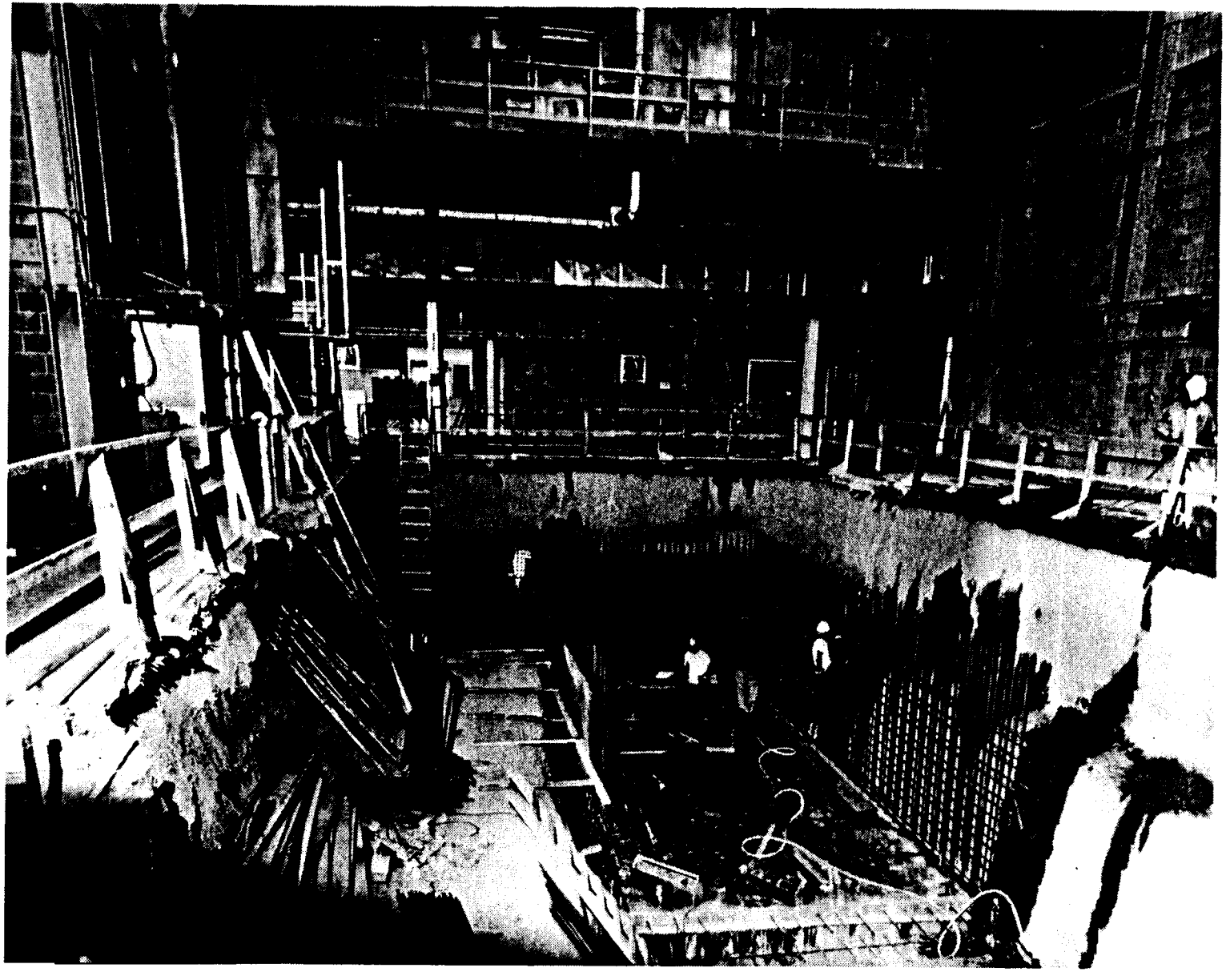

Figure 30. The 305 Building being modified to house the Hot Cell Verification Facility, 1978.

18.0 305-A STORAGE BUILDING

18.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 305-A Storage Building, a one-story wood frame structure, was built on a concrete slab just north of the 305 Test Pile in 1948. It was 24 ft by 84 ft, with a total area of 2,016 ft^2 and had a rolltar paper roof and asbestos shakes on exterior siding. It was constructed to provide storage for miscellaneous out-of-service equipment and other parts for the 305 Test Pile (and later also for the 305-B Building--see Section 19.1). On some occasions, irradiated equipment components were stored in the facility, and at other times, particularly hot experiments were conducted in the 305-A Building. For example, in late 1954 and early 1955 a trial with irradiated boron balls from the 100 Areas "Ball 3X" reactor control project was conducted in the 305-A Building. The experiment was moved there from the 3706 Building after initial work with six irradiated balls demonstrated readings of 150 r/h at 2 in. from their shipping cask.[40]

19.0 THE 305-B BUILDING

19.1 FACILITY DESCRIPTION

The 305-B Building was constructed in two phases. The larger underground portion was constructed to house two test reactors in 1952 to 1954 and is 121 ft by 18 ft by 8.6 ft (below-grade height). This portion contained two reactor rooms, two assembly rooms, a common control room, and a sanitary restroom. It had concrete walls and roof, with interior partitions of steel and asphalt tile in the control room. The aboveground addition was constructed in 1958 to 1959 and was 71 ft by 38 ft by 9 ft (high). It consisted of offices, a counting room, instrument room, computing room, maintenance shops, and change room. It had a concrete block exterior with structural steel supporting the tar and gravel-topped, plywood roof. The floor in some rooms was asphalt tile, and the interior partitions were plasterboard.[41]

Before the construction of the 305-B Building, exponential pile physics experiments had been conducted in the P-11 Project (1949 to 1950) and then in a portion of the 189-D Building. Neither of these facilities proved adequate to make the necessary critical measurements of various reactor lattice designs. The lattice configuration is the spacing of process (fuel) tubes and moderators within a reactor; varying the lattice design can generate vastly different reactivity power coefficients. In the early 1950's at HW, physicists were searching for a new, more closely spaced lattice configuration (later built into the 100-KE and 100-KW Reactors), that would create a negative coolant coefficient (an important safety consideration) and also would produce more plutonium.[42]

19.2 PHYSICAL CONSTANTS TEST REACTOR AND THERMAL TEST REACTOR OPERATIONS AND WASTES

The two reactors placed in the 305-B Building were the Physical Constants Test Reactor (PCTR) (Figure 31) and the Thermal Test Reactor (TTR). The PCTR was a graphite-moderated split-table machine. The reflector on one side was on a track and could be moved back to allow personnel walk-in access to the center of part of the core to change the experimental arrangements of the core. After the initial lattice configuration experiments for 100-KE and 100-KW Reactor design were completed, the PCTR conducted lattice configuration experiments for N Reactor. During the same period, a heavy water (D_2O) calandria (tank) was placed into the center of the PCTR, and experimental lattice measurements were conducted on the design of the Plutonium Recycle Test Reactor (PRTR) (see Part V). The PRTR, later built in the Hanford Site's 300 Area, was a heavy water-moderated machine with a core constructed entirely within a large calandria. In the PCTR's lattice experiments for the PRTR, plutonium, uranium and uranium oxide solutions (slurries) were used, and sometimes chemical "poisons" were mixed into the heavy water to determine whether the reactivity could be controlled by chemical means. The PCTR's calandria contained a dump valve as a safety device; in case of an operating problem, the heavy water, sometimes containing a chemical poison, could drain to the floor and though a trench to a catch tank. From these experiments came the only significant chemical or radiological contamination generated by the

PCTR. A cadmium-sulfate (chemical poison) deposit built up on bottom of the catch tank, and on one occasion in 1961 a significant spill of plutonium nitrate solution occurred in the facility. At that time, the catch tank was removed and buried in the 300 North burial grounds. Following this event, the PCTR conducted experiments in support of a gas-cooled, graphite-moderated, uranium oxide-fueled reactor that was planned at the Oak Ridge Site. Various other experimental physics work was conducted in the PCTR until 1970, when it was removed.

The TTR was a smaller graphite machine built at the Knolls Atomic Power Laboratory near Schenectady, New York and shipped to HW about 1957 to 1958. It had a graphite exponential pile attached to it for heated graphite work. The TTR conducted a variety of exponential pile physics experiments, but it was not used as extensively as the PCTR. In the same room as the TTR, HW scientists installed a tank for conducting approach-to-critical experiments. These were very simple trials in which fuel rods and safety rods would be manipulated within the tank to measure the multiplication factor (K infinity) within various systems and configurations. Criticality was never achieved within this tank because it was not designed to be an operating reactor. The TTR and the approach-to-critical tank experiments shut down about 1978. Today, the 305-B Building is used as a storage facility for hazardous materials.

In 1980, soil bearing very low-level gamma contamination was removed from an old berm around the 305-B Building. A complete radiological survey of the vicinity was made at that time. No areas of high-activity contamination were found.

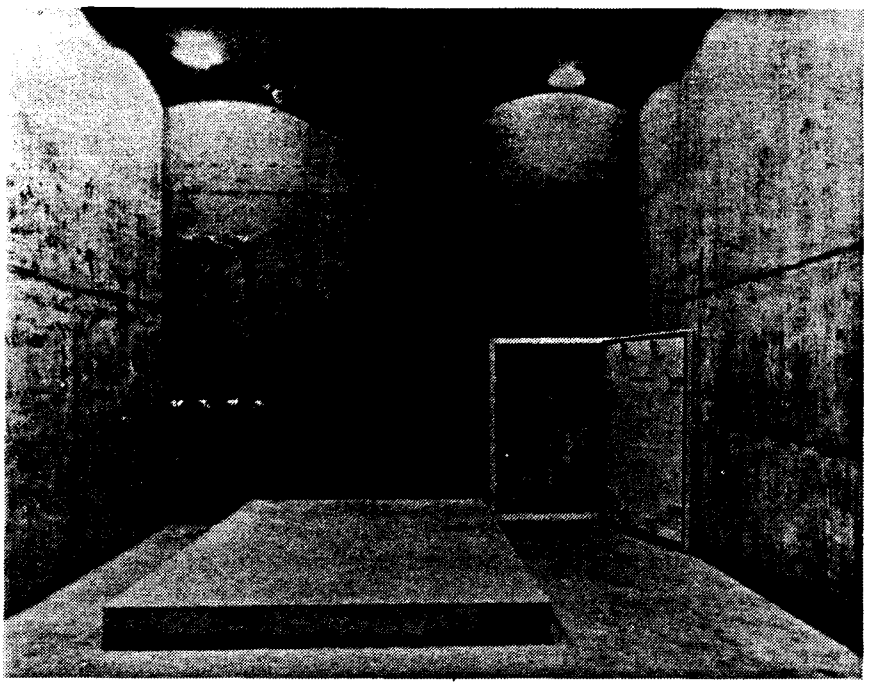

Figure 31. The containment shell stands ready for the Physical Constants Test Reactor in the 305-B Building, early 1950's.

20.0 THE 321 SEPARATION BUILDING AND 321-A (323) METALS CREEP LABORATORY

20.1 THE 321 FACILITY DESCRIPTION

The 321 Separation Building was constructed by MED and du Pont during World War II as the HEW's cold "semi-works," or pilot scale plant for testing chemical "process improvements" using unirradiated or low-activity substances. It was built in what was then the southwesternmost corner of the 300 Area, although now the 3760 Technical Library and the 323 Building lie south of it. It had overall dimensions of 122 ft by 87.5 ft by 33 ft (high) and a total area of 10,675 ft. It was a windowless two-story facility with a reinforced concrete frame, and concrete block exterior and interior walls. The foundations consisted of reinforced concrete walls with spread footings and reinforced concrete slab floors from 4 to 12 in. thick. The reinforced concrete slab roof varied from 6 in. thick above the north half of the building to 10 in. thick in the center to 20 in. thick at the sides of the south half. It had a tar and gravel surface and contained numerous air vents.

A series of cells and tanks ran the entire length of the building in the south half on a level 12 in. below ground. This section was known as the "canyon," and a mezzanine floor on the south wall held gauge boards and weight tanks. A large chemical storage room, heating and ventilating equipment, sample room 1, and a pipe gallery extending the entire width of the building occupied the belowground level of the north half. These sections were insulated with asbestos-bearing materials. The aboveground or second floor of the north half contained offices, various service rooms, a lunchroom, laboratory, receiving room, and sample room 2. This second level also held the control gallery, located above the pipe gallery along the center of the building. To the south of the building about 120 ft lay four belowground tanks, each 40 ft long and 10 ft in diameter and encased in concrete. Constructed to hold the strongest wastes from 321 Building processes, these tanks were accessed by stainless steel piping that sloped down to them from the building cells. Their tops were 3.5 ft below grade.[43]

20.2 EARLIEST 321 BUILDING MISSIONS

The 321 Building's original mission was defined by MED builders as that of "trouble-shooting" immediate problems as they developed in the early bismuth phosphate ($BiPO_4$) chemical separations plants of HEW (T Plant and B Plant). The bismuth phosphate process itself was a means of separating plutonium from uranium and attendant fission products by repeated dissolution, precipitation, and centrifugation. A batch operation, the bismuth phosphate process essentially achieved separation by varying the valent states of plutonium from +4 (the reduced or tetravalent state) to +6 (the oxidized or hexavalent state). In the reduced state, plutonium would carry along with various chemical solutions, and in the +6 state it would drop out of solution as a precipitate. In that form, it could be reduced again by combining it with other chemicals in a step-by-step process that would eventually yield a small quantity of purified product.

The 321 Building initially was conceived as a facility that would use only unirradiated substances. However, at the same time that it was being built, a small pilot plant to test the bismuth phosphate process on a scale larger than that achieved in minuscule processes at the Met Lab was being constructed at the Clinton Engineer Works (now the U.S. Department of Energy [DOE] Oak Ridge Site in Tennessee). This pilot plant, called the Clinton Semi-Works, began to operate in the summer of 1944 and quickly demonstrated that many variables, including acid strengths, batch size, the use of different reducing and oxidizing agents and other factors could affect processing operations. Additionally, equipment corrosion studies and methods of decontamination were immediately recognized as necessary because the operation was so corrosive and the need for remote equipment repair was so limiting.

For all of these reasons, HEW builders decided in the early autumn of 1944, during the equipment installation phase for the 321 Building, to add a Field Project Request for a "suitable laboratory for working with small amounts of active solutions several tenths of a curie to a curie of radioactivity" in that structure. Consequently, the laboratory to the left of the center door on the north side was modified with lead brick shielding, additional ventilation, a connection to the waste tanks buried south of the building, and other facilities. Work with very high-activity solutions and/or large amounts of radioactive solutions was still intended for, and performed in, the "head-end" (Cells A and B) of T Plant in the 200 West Area. However, the 321 Building soon assumed the wartime mission of demonstrating "the effects of proposed process changes on decontamination," performing separation on small samples irradiated in the large HEW production reactors in order to determine "whether troublesome new Pu [plutonium] or Np [neptunium] isotopes are formed at Hanford power levels," isolating new isotopes "which may be formed in secondary reactions with known isotopes at HEW levels," and preparing "tracer activities."[44]

20.3 SUBSEQUENT 321 BUILDING MISSIONS

In early 1947, soon after its creation, the AEC decided upon a huge expansion of HW. Among the highest priorities set for the eastern Washington atomic site at that time were the construction of two additional reactors and the development of the reduction-oxidation (REDOX) process. Reduction-oxidation, a continuous, solvent extraction method of separating plutonium from uranium and the attendant fission products resulting from irradiation, was seen as more efficient and much less wasteful of scarce uranium, as well as more economical. Development of REDOX in the opening years of the Cold War when the perceived national need for increased defense was very acute quickly became one of the HW's most important missions. The REDOX process was developed experimentally in the 3706 Technical Building (see Section 22.2), but the pilot scale tests were run in the 321 Building. Much new equipment for these trials was added to the 321 Building in 1948.

Most REDOX developmental tests used double-depleted uranium (0.17 uranium-235) that had been cycled twice through the Oak Ridge Gaseous Diffusion Plant (K-25). However, HW chemists soon discovered that some of the chemical reactions in the REDOX process worked differently on full-strength (i.e., not tracer or fractional) radiochemical solutions. At that time, the

original hot laboratory facilities in the A and B Cells of T Plant had been disassembled to make room for a radioactive lanthanum ("Rala") production mission, an operation that used vastly different equipment than the REDOX tests. Therefore, some testing with higher activity radiochemical solutions was initiated in the 321 Building. These tests continued until C Plant, a hot semi-works facility, was constructed in the 200 East Area in 1949.[45]

Subsequent HW defense production expansions from 1950 to 1955 generated the development of the Uranium Plant Metal Recovery process, the PUREX process, and the reclamation of uranium and plutonium by extraction (RECUPLEX) process. Pilot scale developmental testing using low-activity solutions for all of these processes was conducted in the 321 Building. Reduction-oxidation process improvement trials, including mercury-catalyzed dissolving studies, also were conducted during this period. Testing with full-strength radiochemical solutions was generally conducted in C Plant during these years.

The 321 Building modifications for these processes included the installation of new ventilating equipment in 1949 and addition of large chemical supply tanks on a back (south) dock and on the roof. Beginning in the late 1950's, in response to orders from the National Aeronautics and Space Administration (NASA) and from hospitals and medical laboratories and research centers, HW chemists embarked on the development of several pioneering methods of extracting high-heat isotopes from high-level nuclear waste. Among the most prominent isotopes extracted were strontium-90, cesium-137, cerium-144, promethium-147, and neptunium-237. At one time in the 1960's, HW was the only producer in the world of promethium-147, a rare earth extract that was used by the Donald W. Douglas Laboratories in the development of the artificial heart. Extraction of these various isotopes was accomplished by ion exchange, solvent extraction, carrier precipitation, and various other means. Many of the pilot scale developmental tests for these extractions were conducted in the 321 Building using tracer-level waste solutions. Additionally, several different attempts were made at HW during the 1950's and 1960's to produce uranium-233 from thorium. Known generically as "thorex" programs, these processes involved the chemical separation of various forms of thorium target fuel elements (powders, pellets, wafers, with many oxide blends) after irradiation. Thorex separations took place in the 321 Building.

Beginning in 1968, pilot testing of waste vitrification processes was slated for the 321 Building. At that time, extensive building modifications and new equipment installations were undertaken, including the cutting of a large hole in the roof to allow the installation of vitrification racks and melters. However, the building proved inadequate to the needs of vitrification work, and this program was moved to hot cells within the 324 Building (see Part V). During 1977 to 1979, a cold hydraulic core mock-up for FFTF development was installed in the 321 Building. The structure was again modified during 1982 to 1984 as a Hydromechanical Test Facility, but this project was short-lived. Use of the building as a computer facility for the Basalt Waste Isolation Project (BWIP) was planned in 1987 but did not occur because Congress canceled the BWIP characterization efforts in December 1987. The 321 Building was deactivated in 1988 and currently is empty and sealed. It meets NHPA criteria for inclusion on the National Register of Historic Places. Although modifications have been made, it has not been changed as significantly as some other Hanford Site World

War II Buildings. Therefore, the possibility of restoration to nearly original historic character exists and will have to be considered in cleanup and/or decommissioning and decontamination (D&D) decisions.[46]

20.4 THE 321 BUILDING WASTES AND CONTAMINATION

Wastes and contamination in and around the 321 Building are very extensive. They include all of the components of the many chemical processes tested in this facility over the years and result from both waste management practices and from unplanned contamination events and accidents. Components of the bismuth phosphate process included many acids (nitric, phosphoric, hydrofluoric, oxalic, and others), bismuth nitrate, sodium dichromate, potassium permanganate, calcium, lanthanum and sodium fluorides, ammonium fluosilicate, peroxide, sodium hydroxide, and other substances. Components of the REDOX process and its development included methyl isobutyl ketone (hexone), aluminum nitrate, ammonium nitrate, many acids (including nitric, sulfuric, oxalic, and others), ferrosulfamate, sodium hydroxide, mercury, resins and other substances.

Components of the Metal Recovery process and the PUREX process were quite similar to each other and included tri-butyl phosphate, normal paraffin hydrocarbon (a form of saturated kerosene), acids (including nitric, oxalic, and others), ammonium fluoride, ammonium nitrate, and other substances. The RECUPLEX process used tri-butyl phosphate, carbon tetrachloride (CCl_4), many acids (including nitric, oxalic, hydrofluoric, and others), sodium fluoride, sodium hydroxide, and other substances. All of these chemicals became waste constituents, along with trace isotopes of plutonium, uranium, thorium, strontium, cesium, aluminum, iron, copper, and zinc. Additionally, cell and equipment decontamination reagents, cleansers, and drying materials, including carbon tetrachloride (CCl_4), trichloroethylene, acetone, 2-butanone, and many commercial products, became a part of the 321 Building waste streams. Waste vitrification is not chemically intensive, and the later facility mock-up missions in the building generated very little waste.[47]

The 321 Building was never connected to the 300 Area RLWS. All of its radiochemical wastes drained normally to the process sewer or to the four large waste tanks buried south of the building. Additionally, a reverse well was dug to receive wastes just south of the structure during 1945 to 1947. As in early fuel fabrication work at HEW and HW, few precautions for work with uran and thorium as radioactive substances were taken during the early years of 321 Building operations. Some of these substances entered the sanitary sewer system from personnel who contacted these substances; additionally, the overflow pipe from the building's dissolver discharged directly into this sewer. Early spills and overflows were "cleaned up" by means of repeated water flushings.

A general cleanup of the building during 1946 to 1947 revealed radioactive material in lead sink traps of cold areas and maximum readings of 50,000 d/m in other building locations. During January and February 1947, a total of nearly 800 μg of plutonium was flushed from the inside of process lines and tanks in the 321 Building. Late that year, a large disposal of uranyl nitrate hexahydrate solution to the 300 Area Process Pond spiked radioactivity readings in that pond so high that a decision was made to build

the special 321 Cribs about 5 mi north of the 300 Area to contain uranium-bearing 321 Building solutions. In mid-1948, a process was developed in which some of these solutions were slurried into sodium diuranate and shipped offsite for uranium recovery operations. By April 1948, 321 Building operations had discharged 238 lb of uranium to the 300 Area Process Pond. Early that year, building modifications underway in the building for REDOX development revealed plutonium contamination in the concrete of sampling boxes in cold areas of the canyon, and readings up to 45,000 d/m (alpha) were discovered in sludge inside tank 1-AU. This tank was then repeatedly flushed and drained to the 300 Area Process Pond.[48]

Solid radioactive and chemical wastes from the 321 Building were buried in all of the various burial grounds used in 300 Area history with the possible exception of 618-3 (see Part III). Nitrous oxide fumes from bismuth phosphate process tests and fission gases including iodine-131 from all separations processes tests escaped from the 321 Building stack. Nitrous oxide (NO_x) fumes could be seen as a yellow/brownish airborne trail emanating from the building throughout all the years of chemical trials.[49]

Specific contamination events in the 321 Building included a large explosion of a hexone/nitric acid mixture known as IAX (an extracting solution the strength of 5 mol of nitric acid per kilogram of hexone) on January 23, 1949. The explosion occurred in E-Cell on the "graveyard" shift (midnight to 8:00 a.m.), when a spark from an electric motor being used to test a turbine pump bearing arced through the air and touched off the IAX. The solution was in a 55-gal drum. However, the actual volume was only about 20 gal of liquid, heavily concentrated with nitric acid since much of the hexone had evaporated. The explosion spread uranium powder and solution throughout the canyon and "lifted" the roof because there were no blow-out panels in the building. Ceilings and floors cracked, but the hard concrete walls did not. The aqueous makeup room in the north portion of the building and the back/south dock that held building process solutions also were severely jarred by the event, and some chemicals and process solutions splattered and spilled. An entire drum of uranyl nitrate hexahydrate flew through the air on the back dock, spilling its contents. Afterward, sandbags were placed on the roof, which was inspected for deflection but was not replaced. The cleanup consisted of large and repeated water flushings that spread the contamination to surrounding soils and to the Process Ponds. Building operations resumed by spring, but the explosion hastened the construction of C Plant in the 200 East Area.[50]

Other contamination events in the 321 Building included an explosion and resultant fire in dissolver vessel A-5, in A-Cell, in May 1957. The vessel contained enriched (0.95% uranium-235) uranyl nitrate solution. In January 1962, concentrator AQ-7 experienced an overpressurization and sprayed uranyl nitrate hexahydrate as far as the roof of the 3706 Building (about 100 ft to the north). A release of iodine-131 both within the building and out of the stack occurred during a chlorine gas-scrubbing experiment in 1964. Then, contamination was spread around the floor and various tanks of A-Cell that same year. There were many smaller leaks and contamination incidents in addition to these more serious events. A 1988 exterior contamination survey of the 321 Building found several areas of fixed contamination, including flaking exterior paint chips reading 150,000 d/m beta/gamma and 25,000 d/m alpha, attributed to "pre PUREX R&D radiological chemical separation operations." To control this contamination, the structure was painted

in 1990. Loose, smearable contamination was found during a routine survey of the building's interior in 1991, again attributed to "residual" remains from past operations. Presently, all entries to the structure are controlled by the Health Physics Department.[51]

21.0 THE 321-A (323) METALS CREEP LABORATORY

21.1 FACILITY DESCRIPTION AND MISSIONS

The 321-A (323) Metals Creep Laboratory was an Army mess hall that was emplaced just south of the 321 Building in 1959 to 1960. It is a rectangular one-story structure, 40 ft by 80 ft by 12 ft (high), with a total area of 3,952 ft^2 . It rests on a concrete foundation and floor, with the north 26 ft on grade and the south portion 5 ft below grade with a downward ramped entrance. The belowgrade portion is also 6 ft wider than the 40-ft width of the aboveground portion. The building has aluminum frame walls and roof.

The 321-A Building was brought to the 300 Area to be an annex for 321 Building chemical testing operations (see Figure 32). However, after the 321 Building lost its waste vitrification mission in 1968, the 321-A Building was converted to the Metals Creep Laboratory. As such, the facility conducted tensile tests on metal samples of FFTF components, including the fuel subassembly, reactor vessel, and primary system weldments. For this work, the building underwent modifications and equipment upgrades throughout the 1970's. It was later renumbered the 323 Building and transferred to PNL in 1987.[52]

21.2 THE 321-A (323) BUILDING WASTES AND CONTAMINATION

The 321-A (323) Building (Figure 33) was emplaced above the four large buried 321 Building waste tanks. The soil around and beneath these tanks and the tanks themselves are very contaminated with mixed wastes (see Sections 20.1 and 20.4), and some minor residual chemical contamination may exist within this structure as a result of early 1960's chemical work. However, the Metals Creep work produced almost no wastes. Irradiated samples were used in the building for these tensile tests, but no known significant contamination events occurred.

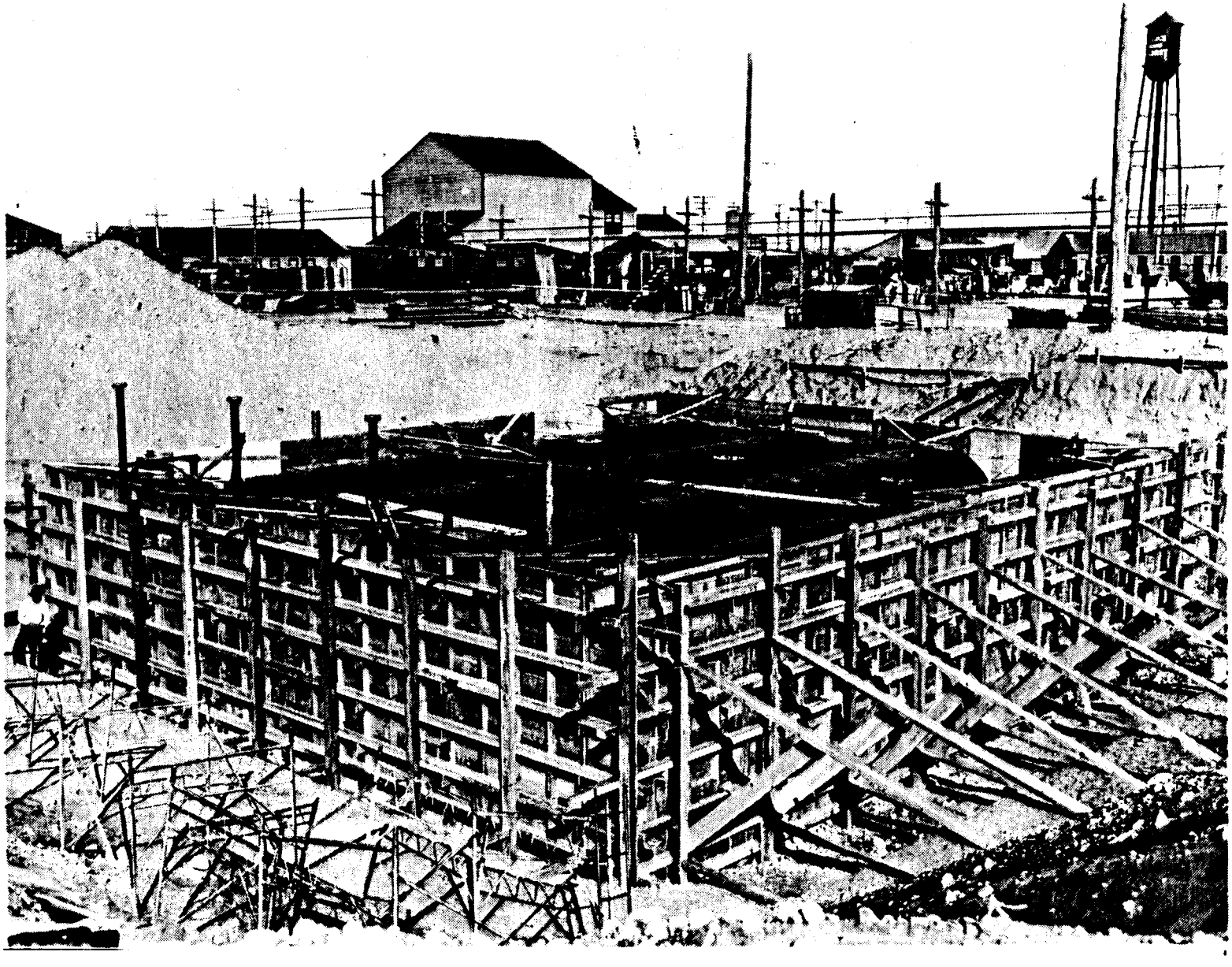

Figure 32. Four 40-foot-long, 10-foot-diameter stainless steel waste storage tanks ready to be set in concrete, just south of the 321 Separations Building, 1944.

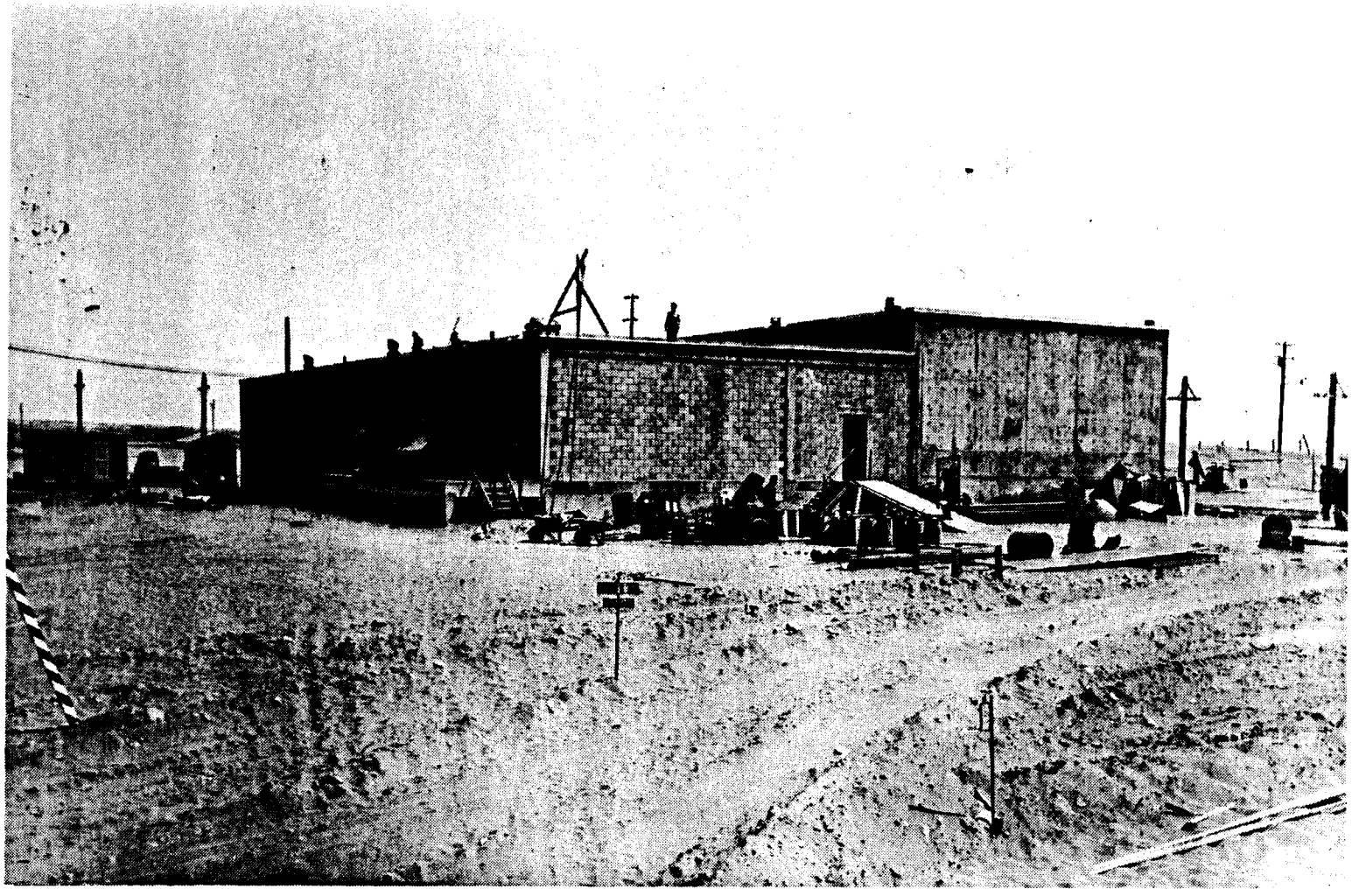

Figure 33. The 321 Building as seen from the east side, September 1944.

22.0 THE 3706 TECHNICAL BUILDING

22.1 FACILITY DESCRIPTION

The 3706 Building, located about 100 ft north of the 321 Building, was the original World War II radiochemistry laboratory for HEW. Built by MED and du Pont, this structure was a huge rectangular facility with a center court at one end and an open court at the other end, giving the building a winged appearance (Figure 34). It housed 57 laboratories, 19 offices, 2 shops, a dark room, 2 storerooms, a lunchroom, locker room, ventilating equipment room, and sanitary restrooms. Additionally, just a few feet south of and parallel to this structure, the 3706-A Air Conditioning Equipment Building was constructed. This small concrete block facility was 1,500 ft^2. The overall dimensions of the 3706 Building itself were 327.5 ft by 140 ft by 22 ft (high), with a total area of 30,100 ft^2.

It had a mastic tile-covered concrete floor supported by concrete foundation walls and a gable roof consisting of built-up asphalt felt supported by wooden rafters. The roof contained several dormers because the building was equipped with seven ventilating systems for air conditioning and laboratory exhausts. The inner side of the exterior walls, as well as both sides of interior partitions, were asbestos board, while interior ceilings were made of gypsum board. Two fire walls located near the center of the building divided the structure roughly in half. Exterior walls consisted of drop siding over sheathing, but the southeast portion of the building had concrete block walls. Inside that section near the center of the structure was a special laboratory reserved for the very hottest, largest volume work done in the building. It had 2-ft-thick concrete walls and roof and two separate offset concrete entrances, one from the outside and one from a central corridor.[53]

22.2 ORIGINAL 3706 BUILDING MISSION

The original mission of the 3706 Building was to perform small-scale experiments with both low- and high-activity radioactive materials in support of all HEW production activities. The largest portion of staff and facilities in the building performed radiochemical trials aimed at improvements in the bismuth phosphate process. During the war years, some of the important variables and factors studied in the 3706 Building were the substitution of potassium permanganate for sodium dichromate as an oxidizing agent for plutonium, variations in acid strengths in several steps of the separations process, a decrease in the "digestion time" in the reduction step, methods for improving the centrifugibility of lanthanum fluoride, the solubility of plutonium compounds and other substances in process solutions, methods of counting specific plutonium activity, characterization of fission products and plutonium decay products, the effects of hydrazine and lead in the dissolution process, and process equipment decontamination and corrosion studies.

Other large sections of staff time and laboratories in the 3706 Building were devoted to metallurgical examination (both destructive and nondestructive) of irradiated fuel elements from the reactors, fuel

development for the 313 Building, "physics technical" examination of graphite from the experimental levels of the 100 Area piles, special sample analyses from the 231 Plutonium Isolation Building and the 200 Areas separations plants, spectroscopy and radiocounting activities, and multifaceted sample analyses for the H. I. Division's environmental and personnel survey programs. The hottest work was done by the Analytical Development group in Rooms 57, 59, 62, 64, and 66. However, the Metallurgical Technology and Essential Materials groups, using Rooms 7, 8, 9, 10, 11, and 13, often produced and encountered very hot conditions when they drilled into irradiated fuel elements to obtain fission gas and metallurgical samples. Physics group work in Room 33 was not as hot as it might have been if the graphite samples had not first been cut and prepared in the 3741 Building (see Section 28.1). The Spectroscopy group occupied Rooms 56, 58, and 60, analyzing the isotopic content and decay curves of plutonium, uranium, and fission products. Other laboratories shared or interchanged various activities.[54]

22.3 SUBSEQUENT 3706 BUILDING MISSIONS

In 1947, under direct and urgent orders from the AEC, the primary 3706 Building mission changed from bismuth phosphate process improvement studies to the development of the REDOX process (see Section 20.3). Early that year, during 1946 to 1947, the building was reorganized, with several laboratories decontaminated and reassigned. From 1947 to 1953 much pioneering radiochemical work in the development of the REDOX, PUREX, and RECUPLEX processes took place in the 3706 Building. After initial laboratory scale development in this facility, the new processes were tested on a pilot scale in the 321 Building and/or C Plant (see Section 20.3). Metallurgical, physics, and counting functions also continued in the 3706 Building. A small annex for electronic instrumentation development, the 3707-C Building, was added in 1948. This 7,040-ft^2 concrete block building also housed the 3706 Building's lunchroom, change rooms and some sanitary restrooms. In the early 1960's, some of the first computers at HW were installed in the 3707-D Building, and this facility became known as the 3707-D Computer Laboratory.

In 1952 to 1953, several new laboratories were built in the 300 Area (see Part IV). At that time, the 326 and 327 Buildings assumed HW's physics and metallurgical work, the 329 Building assumed the counting and spectroscopy work, and the 325 Radiochemistry Building assumed most of the high-activity chemical work. In 1954, the 3706 Building underwent a major decontamination and remodeling effort, in which many of the laboratories were converted to offices. However, control (sampling) laboratories for fuel fabrication operations continued to operate in the building through the mid-1960's until they were transferred to the 3720 Building. Uranium fuel slugs (both unbonded and aluminum-silicon-jacketed), uranium powder, beryllium, and thorium continued to be handled, primarily in Laboratories 207-224, throughout this period. Rooms were renumbered in the building in early 1956, and the structure received a new roof in 1959.

By 1964, the 3706 Building was called the General Services Building. Although it still contained some analytical laboratories, a majority of its space was devoted to mail services, duplicating, photographic, and drafting services, a first aid station, 300 Area patrol headquarters, and other

administrative and clerical functions. During the 1970's and 1980's, the 3706 Building underwent several other minor remodelings as all laboratory work eventually was phased out. Today, the structure houses the Westinghouse Hanford Company Central Files as well as mail, duplicating, and other support services.[55]

22.4 THE 3706 BUILDING WASTES AND CONTAMINATION

Wastes and contamination in and around the 3706 Building are very prevalent, in some cases consisting of high-activity substances. These wastes are composed of all components of the bismuth phosphate, REDOX, PUREX, and RECUPLEX processes along with laboratory cleansers, reagents and drying agents, as well as plutonium, uranium, thorium, and beryllium (see Section 20.4). Mercury deposits from multiple laboratory uses also were very prevalent. Additional chemical wastes result from bioassay and environmental sample analyses. Among these substances were sodium thiosulfate, hydroxylamine hydrochloride, barium chloride, barium nitrate, magnesium perchlorate, sodium iodine, sodium carbonate, thenoyltrifluoroacetone, thenoyltrifluoroacetone-benzene solutions, boric acid, silver nitrate, cupric oxide, arsenic nitrate, zinc nitrate, ammonium chloride, tartaric acid, and cupferron. Other wastes result from the spread of irradiated metal dusts and fines from the machining and grinding of metallurgical test samples.

Contamination results from both inadequate containment systems and from innumerable spills, overflows, vaporizations, spreads of radioactive dusts and fines, and other incidents involving the loss of control of radioactive materials. The 3706 Building was never connected to the RLWS. All non-sanitary wastes from the structure were disposed to the 300 Area process sewer system. In the case of uranium, as with early work with uranium in other HEW facilities, few special precautions for work with radioactive substances were taken. Uranium contamination, especially dusts and fines from metallurgical testing, was spread from the hands, shoes, hair, and clothing of personnel into the 300 Area sanitary sewer system. Additionally, the 3706 Building was not equipped with modern shielding and ventilation systems designed for work with high-activity materials. Lead "brick piles," walls and half-walls, as well as hinged stainless steel hoods fabricated onsite provided shielding but allowed frequent contamination spreads. Each hood was equipped with a blower that sucked air upward to a single Chemical Warfare Service (CWS) filter. Building air exhausted directly to the atmosphere through the roof ventilators. There was no stack or stack filters. The interior ventilation system did not include negative pressure gradients in various building sectors; thus, contamination that did escape laboratory hoods was transported to and through the attic by the ventilating fans and ducts located there. Concerns over potentially high airborne iodine-131 exposures in the facility required that thyroid checks be performed on 3706 Building workers beginning in May 1947.

Many contamination incidents involving high-activity radioactive materials occurred in the 3706 Building. A general laboratory survey conducted by H.I. Division monitors in September 1946 found "gross contamination" in Rooms 33, 57, and 59, and readings of from 100,000 to 200,000 d/m (alpha) on equipment and furniture in Rooms 53, 57, 62, 64, and 66. Items that could not be satisfactorily decontaminated were removed to

300 Area Burial Grounds. A re-survey two months later discovered equipment, floor spots, and many other building surfaces in these laboratories with readings ranging from 50,000 to 280,000 d/m (alpha). An "ice cream container" (cardboard waste carton) found in Room 33 in early 1947 displayed a surface dosage rate of 7,150 mrep/h. That summer, the H.I. Division instituted more rigorous controls in the 3706 Building, including the mandatory use of protective clothing, time limitations on work, and other Special Work Permit (SWP) procedures. Plutonium analyses were confined to Rooms 57 and 33 and fission product work to Room 66. Monitors also began an intensive education campaign, warning personnel in a lecture series that, in the 3706 Building: "Whenever benches are repaired, lines broken, or parts of hoods worked on, there is a possibility of getting into unfound product [plutonium] contamination... All lines or the inside of equipment... must be considered contaminated with the most hazardous radio element [plutonium] until proven otherwise."[56]

In 1949, as high contamination readings continued to be found in the 3706 Building, an HW planning report concluded that the structure was undergoing "continuous and accelerating disintegration... [and contained] plutonium contamination [that must]... be treated for reasons of safety... the end of the usability of that building... [is] foreseen." The same report termed as "impossible" the use of the facility for radiochemistry work planned for the near future. A 1951 HW report reaffirmed that 3706 Building operations involved the "use of equipment beyond designed capacities," and that a new facility was "necessary to house safely and efficiently the multi-curie level chemical program."[57] This latter report led to the construction of the 325 Radiochemistry Building in 1952 to 1953 (see Part IV).

During the years 1958 to 1964, special HAPO-184 metal samples being analyzed in laboratories of the 3706 Building's 200-wing frequently produced dosages and contamination spreads above tolerance levels (up to 5 r/h on facility surfaces). One routine 1963 survey of building floors, tools, and equipment found readings up to 100,000 c/m in 100-wing rooms. Additionally, some uranyl nitrate hexahydrate spray from the 1962 contamination event at the 321 Building (see Section 20.4) reached the exterior roof of the 3706 Building. In 1990, 3706 Building employees jointly expressed concern about the safety of the building and requested a health and safety evaluation. The resulting report concluded, "The 3706 Building has many deficiencies, including several health and safety concerns that should be corrected. However, from a health and safety viewpoint, the facility is presently not unsafe to occupy." This structure currently is scheduled for demolition in 1995 to 1996 as part of the project that will bring construction of the South Operations Support Facility. The 3706 Building meets the criteria for designation as a historic place under the NHPA. However, the fact that original interior facilities and laboratories have been virtually wholly replaced prevents actual inclusion on the National Register of Historic Places. Nevertheless, the NHPA must be considered in decisions involving the structure.[58]

Figure 34. The 3706 Technical Building, the large winged structure in the center, as it stood in the midst of the 300 Area in 1945.

23.0 THE 3709 FIRE STATION

23.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3709 Fire Station is a one-story wood frame structure, with a concrete foundation and concrete slab floor, was 47 ft by 55.5 ft, with a total area of 2,613 ft^2. It also contained a hose tower approximately 10 ft taller than the rest of the building on the west side (Figure 35). Floors in the building were covered with asphalt tile, except for a work area accommodating three fire trucks, and the exterior walls were covered with asbestos shakes. The flat roof was a wood base covered with a built-up tar and gravel surface. In mid-1964, a new 300 Area fire station was completed (Building 3709-A), and the 3709 Building became the Engineering Mechanics Laboratory. It was used for static and dynamic stress testing of various equipment and materials. Today, the facility is known as the Paint and Sign Shop.

23.2 THE 3709 BUILDING WASTES AND CONTAMINATION

Wastes and contamination in and around the 3709 Building consist primarily of fire extinguishing chemicals including carbon tetrachloride, aluminum sulfate, sodium bicarbonate, carbon dioxide, licorice powder, organic phosphate, and sodium chloride that were stored and demonstrated in the period 1944 to 1964. Mandatory fire training classes were held in and near this facility throughout those years, and many chemical fire suppressants, as well as burning samples including oils, metal chips and slurries, and other substances, were spilled and flushed to surrounding soils as part of training exercises. Training exercises using these early chemical fire suppressants also resulted in the release of phosgene and chlorine gas, but these materials have disappeared from the immediate environment. Some residues from lead-based paints, paint removers, and thinners may remain.[59]

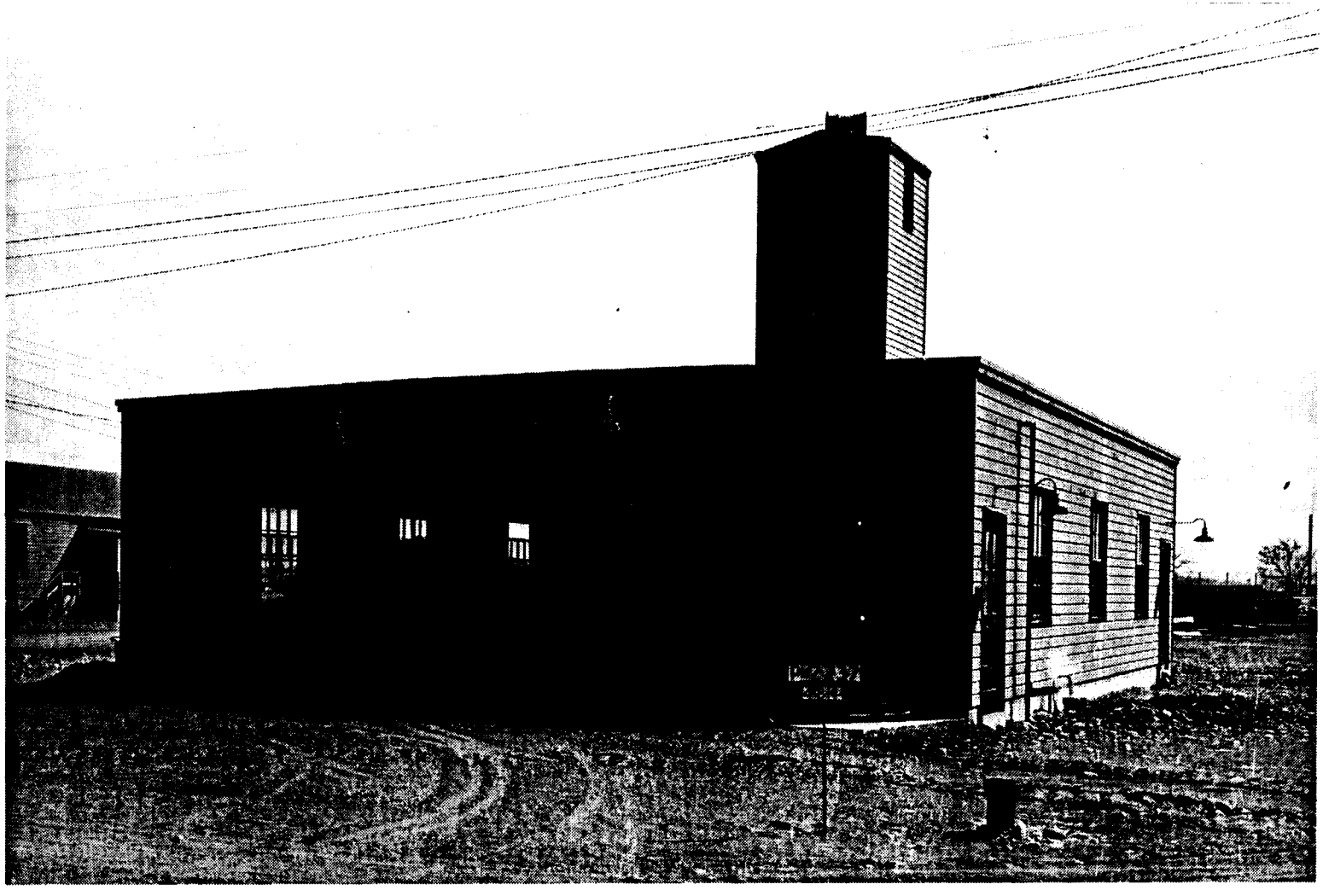

Figure 35. The 3709 Fire Station, photographed in February 1945.

24.0 THE 3713 RECEIVING STOREROOM

24.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

The 3713 Receiving Storeroom, a one-story wooden frame building located just south of the 314 Building, had a 4-in. reinforced concrete slab floor supported by concrete block foundation walls with concrete spread footings. It was 120 ft by 40 ft by 17 ft (high), with a total area of 4,800 ft^2. It had a flat roof with tar and gravel surface supported by wooden beams and interior wooden posts. Inside, the building was divided into three equal parts separated by presswood partitions. One part stored salvage materials, one stored spare machinery, and one stored miscellaneous items and housed a small office in the northwest corner. The building's original mission as a general receiving storeroom for the 300 Area was later converted to carpentry and painting shop functions, including sign painting. It is still being used as a carpenter shop.

Because the building was connected only to the sanitary sewer system, paints, paint thinners and removers and other miscellaneous construction oils were disposed to this facility over many years instead of to the 300 Area process sewer system. As a result, lead, chromium, copper, various paints and solvents, and other substances are located in the sanitary drains, pipes, and in the 300 Area sanitary septic tanks and leaching trenches (see Part III). Minor radioactive contamination also has entered the building via contaminated salvage materials and tools brought in from other facilities.[60]

25.0 THE 3717 AND 3717-B INSTRUMENT SHOPS

25.1 FACILITIES DESCRIPTION, MISSIONS, AND WASTES

The original World War II 3717 Building is a one-story wooden frame structure located approximately 100 ft north of the 3706 Building (Figure 37). It has a 4-in. reinforced concrete slab with a 6-in., built-up concrete curbing supported by concrete foundation walls. The built-up gable roof has a felt surface over sheathing supported by wooden trusses and a large plenum chamber located beneath the gable at either end. Interior partitions are of presswood and gypsum board. Upon construction the structure was 105 ft by 41.5 ft by 29 ft (high), with a total area of 4,360 ft^2. Originally, it contained a general repair and test shop, a valve repair assembly and test shop, offices, a storeroom, sanitary restrooms, and a two-ton monorail and hoist running along the center axis of the structure. The facility has been used for various craft, repair and shop functions over the years and is called the Sheet Metal and Engineering Building. It is now a storage facility.

In 1950, the 3717-B Instrument Shop, a one-story, concrete block and metal structure, was erected just north of the 3717 Building. It was 41 ft by 168 ft by 14.3 ft (high), with a total area of 6,972 ft^2. It has a curved quonset hut-type roof. In 1964, the building received an addition that brought its total area to nearly 9,000 ft^2. It has continued to serve as an instrument maintenance, calibration, and standards facility. Wastes and contamination in these two structures have been primarily chemical, including machinery and fabrication oils and cleaners. Minor radioactive contamination occasionally has entered the buildings via contaminated tools brought in from other facilities.[61]

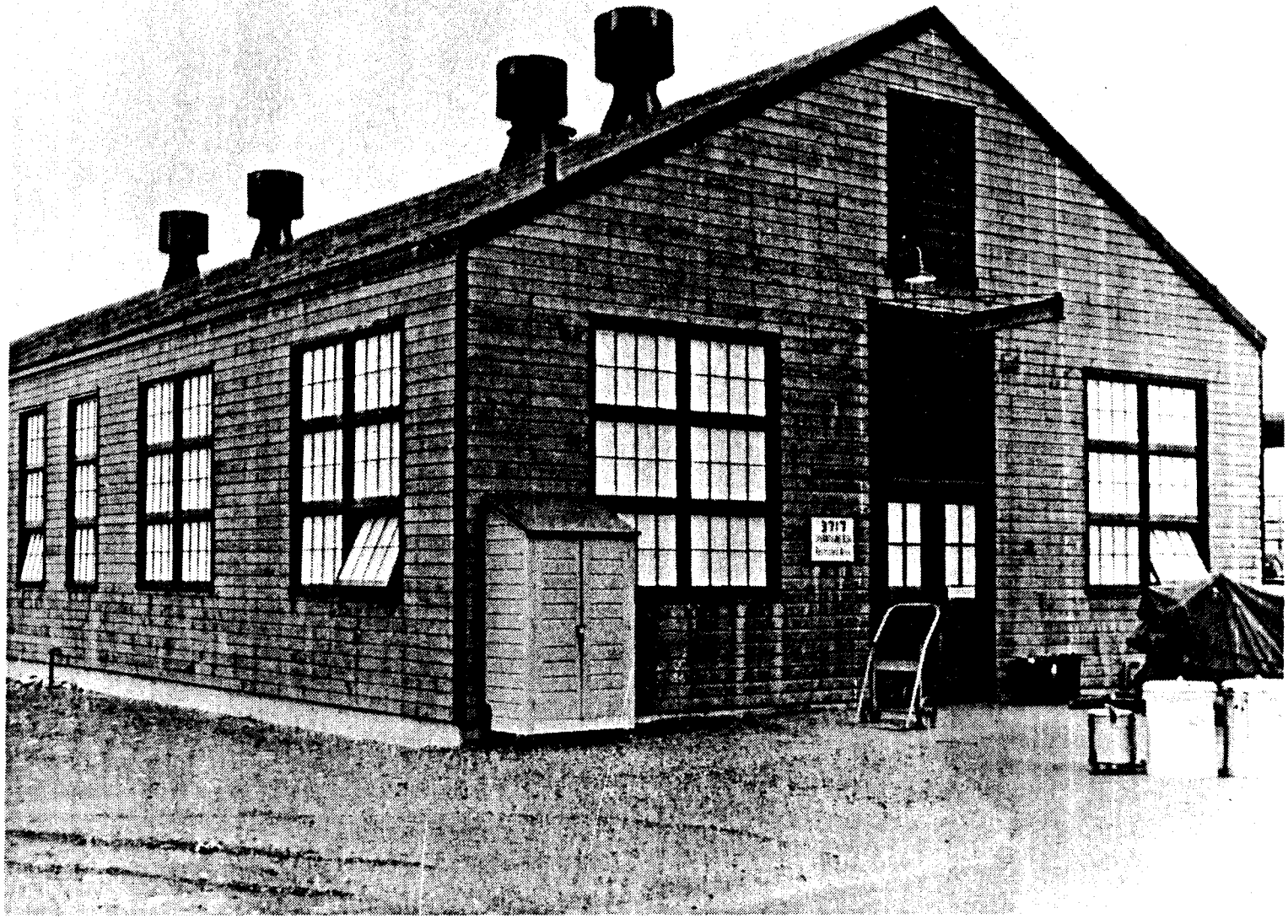

Figure 36. The original 3717 Instrument Shop built by the Manhattan Project, 1945.

26.0 THE 3719 FIRST AID BUILDING

26.1 FACILITY DESCRIPTION AND MISSIONS

The 3719 First Aid Building, a small wood frame structure (816 ft^2) with concrete foundation and concrete floor on grade was constructed as the original 300 Area First Aid Building (Figure 37). The outside walls were covered with asbestos shakes, and the gable roof was covered with roll tar paper. The facility, located about 75 ft west of the 3707-A Building, was sometimes called the "old laundry building" by HEW and HW workers, but no laundry existed there. In the 1960's it was used as Fire Protection Headquarters, but not as a fire station. It contained offices for fire protection supervisory personnel and storage space for spare and miscellaneous fire extinguishers and other fire protection equipment and tools. In the early and mid-1970's, it served as a transportation dispatching office. The structure was removed, and a new 3719 Building was constructed on the same site during 1977 to 1978. During the 1977 to 1978 removal, contamination readings of 50,000 c/m of uranium-235 and thorium were found in the sewer line. Some contaminated soil was removed at that time. The building then was used as a photography processing shop, and today is designated as a computer facility.

26.2 THE 3719 BUILDING WASTES AND CONTAMINATION

Wastes generated over the years have included medical supplies, disinfectants and alcohols from original usage, and some fire extinguishing chemicals including carbon tetrachloride (CCl_4) from early extinguishers. Low-level radioactive contamination was tracked into the building in its early years as a First Aid Station via the hands, shoes, hair, and clothing of fuel fabrication and chemistry personnel. Virtually no wastes were generated during the years of use as a dispatch office, and photographic processing chemicals have been disposed under controlled, modern standards.[62]

Figure 37. The 3719 First Aid Station, February 1945.

27.0 THE 3734 AND 3734-A CYLINDER STORAGE WAREHOUSES

27.1 FACILITIES DESCRIPTIONS, MISSIONS, AND WASTES

Cylinder storage warehouse 3734 was a small one-story building 24 ft by 10 ft by 12 ft (high), resting on a 4-in. reinforced concrete slab, with a total area of 2,880 ft^2. It had 8-ft, concrete curtain walls open at both the top and the bottom and sections of tongue and groove (T&G) sheathing in open panels reaching from the foundation to the flat, tar and gravel surfaced roof. It was divided into four interior spaces, each containing curved wooden storage racks. Two areas held cylinders that contained oxygen and hydrogen acetylene, and two areas stored empty cylinders.

The larger 3734-A cylinder storage warehouse was 36 ft by 26 ft by 14 ft (high), with a total area of 10,920 ft^2. It was a one-room, one-story structure with partially open T&G sheathing walls, concrete foundation walls, and a flat, felt-surfaced roof supported by wooden rafters and posts. It rested on a 4-in. reinforced concrete slab and contained numerous horizontal rails with grab hook pins hanging 3.25 ft above floor level. Wooden racks held full and empty cylinders similar to those stored in the 3734 Building. Both structures were located directly west of the 3713 Building.

The original cylinder storage mission of both facilities was replaced in the 1950's. The 3734 Building became a storage facility for insulating materials including asbestos and industrial glue and fixants. The 3734-A Building became the 300 Area paint storage building. As such, it held many lead-based paints, as well as paint thinners, removers, and solvents containing chromium, copper, and various resins. The 3734-A Building is still used for this purpose, while the 3734 Building is used for general storage. Paint, chemicals, glue, and asbestos, sometimes spilled and disposed in and near these structures, constitute the primary building wastes.[63]

28.0 THE 3741 BOX STORAGE BUILDING

28.1 FACILITY DESCRIPTION AND MISSIONS

The tiny, rectangular 3741 Box Storage Building was located near the 300 Area east fence, just east of the 384 boiler plant and its coal storage yard, and just south of warehouse 303-J. It was a one-room wood frame structure with a 4-in. reinforced concrete slab floor supported by concrete foundation walls. It was 30 ft by 14 ft by 16.5 ft (high), with a total area of 430 ft^2. The roof was a tar and gravel surface over wooden rafters that contained a ventilator on the west side. An 8-ft sliding door provided entrance and egress on the east side.

The name "box storage" was somewhat misleading in that the structure was used to store and prepare samples of irradiated graphite, flux wires, and uranium from the 305 Test Pile. The word "box" in the name was derived from the boxes of irradiated samples stored there in cardboard containers. The building also was called the "Special Machine Shop" by HEW workers because it contained lathes, drills, saws, and other machinery for opening ("uncanning" in some cases), sectioning and preparing samples as part of DE analysis in the 3706 Building. Because of the high radioactive contamination levels generated by this work, the building was torn down in 1956, and its operations were moved to the 3730 Building (see Part IV).[64]

28.2 THE 3741 BUILDING WASTES AND CONTAMINATION

The 3741 Building machining and drilling operations generated irradiated uranium, graphite, and other metallic dusts and fines from 305 Test Pile samples. Airborne contamination in and around the facility, as well as a virtual trail of metal dusts leading to and from the east door and high personnel exposures from handling bare, irradiated materials produced early H.I. Division concern. The facility was remodeled in early 1946, and a new lathe skirted by a lead shield and equipped with its own filtered line to the roof vent was installed. New ventilation equipment, as well as SWP work procedures, were instituted. However, by the spring of 1947, H.I. Division monitors again reported pervasive dust in the facility, commenting: "Inside of the building needs cleaning up." The old lathe sitting behind a rope gave a dosage reading of 400 mrep/h at 1 in., while boxes of incoming graphite samples read 40 mr/h at 2 in. (outside of box), and 2 r/h at 10 in. (inside of box).

As uranium enrichment levels were increased in the late 1940's at HW, and as the 305 Test Pile ran longer and more intense irradiation tests to correspond to increasing power levels in the 100 Areas production reactors, radiological conditions in the 3741 Building became more severe. Samples began to be transported in lead casks and stored in the 3741-B lead "storage cave" in the building. Lathe, saw, and drill operators began wearing assault masks, because dosage readings varied from hundreds of mrep/h up to 35 rep/h for workers unloading and machining samples in the early 1950's. The "general" radiation level to which building workers were exposed was estimated by H.I. monitors in mid-1954 to be 200 mrads/h, including a 20 mr/h field reading. Building wastes scheduled for burial during these years routinely

demonstrated readings up to 2 r/h at 2 in. and 150 mr/h in the truck cab on the way to the 618-1 Burial Ground. One waste shipment in November 1954 read greater than 5 r/h at 1 in. The following month a gamma shine of 10 mr/h was discovered at the southeast corner of the fence surrounding the 3741 Building, and the source was discovered to be a waste container stored in the southeast corner of the building generating a radiation level through the southeast wall of 1 r/h at 2 in. from the building. This waste container was removed to the 618-1 Burial Ground. As radiation levels in wastes and in samples being worked in the building continued to rise the following year, the decision was made to dismantle the facility.

In 1956, this structure was removed and the site it once occupied was used for the storage of additional coal as the 300 Area and its steam heating requirements expanded. Subsequently, coal residues were added to earlier contaminants that existed in soils on, around, and beneath this site.[65]

29.0 THE 3745 STANDARDS BUILDING AND 3745-A AND 3745-B BUILDINGS

29.1 FACILITIES DESCRIPTIONS

The 3745 Building, located approximately 100 ft southwest of the 3706 Building, was the calibration facility for all of the various instruments used in radiation detection at HEW (later HW). It was a two-story, wooden frame structure with a reinforced concrete floor supported by concrete foundation walls. It was 97 ft by 36 ft by 40 ft (high), with a total area of 3,370 ft^2. The majority of the multiple gable roof consisted of built-up felt over 1-in. sheathing and contained three large ventilators. However, a reinforced concrete vault in the southwest corner of the building had a flat, reinforced concrete roof with tar and gravel surface. Reinforced concrete walls also separated the vault, a large calibration room in the center of the building and two laboratories located in the north half. These walls also formed a part of the interior and exterior walls. The remainder of the interior partitions were of asbestos board. The calibration room contained an industrial (220-keV) X-ray unit and a wooden balcony 13 ft above the floor level. One of the laboratories extended the entire width of the building on the second floor, and the remainder of the building contained a ventilating equipment room.

In 1947, a small addition known as the 3745-A Building was constructed. This concrete block structure with 3-ft-thick end walls and 8-in.-thick side walls was 17.3 ft by 73 ft by 29.84 ft, with a total area of 1,277 ft^2. It had a concrete slab floor and a flat concrete roof with tar and gravel finish. Its purpose was to provide shielded laboratory space for electron accelerator research. In 1949, a separate shielded laboratory facility for positive ion accelerator research was constructed. This facility, known as the 3745-B Building, was similar to the 3745-A Building but was larger and had concrete walls and roof only in the target area. The rest of the building was of frame construction with asbestos shakes on the walls. It was 30.5 ft by 86 ft by 19 ft, with a total area of 2,469 ft^2. In 1956, the main 3745 Building received major upgrades.[66]

29.2 THE 3745, 3745-A, AND 3745-B BUILDINGS MISSIONS AND WASTES

Standards Building work involved calibrating a wide range of radiation detection instruments using X-ray, alpha, gamma and neutron sources. From the beginning, the building experienced contamination and personnel exposures resulting from contaminated portable survey instruments being brought in from the field and from instruments with faulty cases or shielding. Shortly after World War II, an SWP area for decontamination was established in the facility, and a lead shield was added to the building wall where the X-ray beam pointed. Although radiation sources were stored in the building's concrete vault, occasional minor contamination spreads in various building areas occurred as the result of leaking radium, polonium/beryllium - polonium/boron, cobalt-60, and other sources during the 1940's through 1960's. In these cases, personnel exposures usually were more significant than environmental contamination. Therefore, radiological wastes and contamination have been minor over the years; chemical wastes, except for the use of small amounts of instrument cleansers such as acetone, have been virtually nonexistent. The situation in

and around the 3745-A and 3745-B Buildings is similar. In 1988, the 3745 Building was scheduled for demolition, but this project was canceled in 1989 when the facility was identified for use in a DOE-U.S. Department of Defense (DOD) treaty verification program.[67]

ENDNOTES - PART II

35. DuPont, *Design*, IN-6263, Vol. II, pp. 214-216, and 232, and DuPont, *Operation*, HAN-73214, Book 10, p. 140.

36. DuPont, *Construction*, HAN-10970, Vol. IV, pp. 1014-1016; and Davis and Fowler, HW-43547, pp. 7-10 and 23-31.

37. Davis and Fowler, HW-43547, pp. 49-58; and DuPont, *Design*, IN-6263, Vol. II, p. 222; and DuPont, *Operation*, HAN-73214, Book 10, pp. 140-141, 148-151; and Fitch, HW-59085.

38. DuPont, *Operation*, HAN-73214, Book 10, p. 152; and Durum and Chamberlin, "300 Area Monthly Reports," June-September 1946; and Bixler, "300 Area Monthly Reports," February 1947, April 1947, and November 1947; and Parker, HW-07184, Lecture XX, p. 8.

39. Shaw, RL-GEN-1773; and Dronen, "HCVF Functional Description"; and Adams, "Fuels," 1977; and Nolan and Lorenzini, "Use" 1985.
NOTE: Mrep is a measurement of absorbed dose or of the ability to generate absorbed dose, while mr is a measurement of actual radioactivity in air.

40. AEC/GE Study Group, GEH-26434, p. 3.6; and Hervin, "Radiation Monitoring Coverage," November 1954, p. 3.

41. Romano, "Event Fact Sheet Trans and Pkg 90-001."

42. AEC/GE Study Group, GEH-26434, p. 3.7; and Kisterson, HWS-6337.

43. Henle, "Radiation Incident Investigation 61-0-5;" and Hanthorn, BNWL-CC-225, Rev. 1, Appendix E.

44. DuPont, *Construction*, HAN-10970, Vol. IV, pp. 1023-1025.

45. DuPont, *Design*, IN-6263, Vol. I, pp. 9-10, 153-154, and Vol II, pp. 172-174; and DuPont, *Construction*, HAN-10970, Vol. IV, p. 994; and Willard, HW-3-818; pp. 1-3; and Squires, "Laboratory;" and DuPont, *Operation*, HAN-73214, Book 14, pp. 166-171.

46. Curtis, HW-32848, pp. 1-3; and Barnes, RL-SEP-374; and Boldt and Ritter, ARH-1354; and Bray, Martin, Moore and Roberts, HW-73285; and Jackson, ARH-SA-247; and Schmidt, RL-SEP-373; and Szulinski, ARH-SA-36; and Wheelwright, HW-63051; and "H.I. Monthly Highlites," October 1964; and "Project V-746 Records;" and "Specifications for Abandoned Project V-746," and "Event Fact Sheet 300/400 OHP-88-002."

47. DuPont, *Design*, IN-6263, Vol. II. pp. 172-74; and HW-10475-C DEL; and Chemical Development, HW-19140, HW-18700-DEL, HW-31000 DEL and HW-44776-DEL.

48. Bixler, "300 Area Monthly Reports," September 1946, December 1946, February 1947, September 1947, December 1947, February 1948; and Beaton, "Special Hazards Incident Investigation Class I, #36," 1946; and Paas, HW-39076, p. 8, and Greagor, HAN-15750.

49. Paas, HW-39076, pp. 2-8.

50. Cooper, HW-42068 RD; and DOE/AD-0015, Incident L-1, p. 2-50.

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62. DuPont, *Construction*, HAN-10970 Vol. IV, pp. 989 and 1044; and AEC/GE Study Group, GEH-26434, p. 3.64; and Weiler, "Contaminated Solids..." (1978).

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PART III 300 AREA WASTE DISPOSAL AND WASTE HANDLING FACILITIES

30.0 SANITARY SEWER SYSTEM

30.1 FACILITY DESCRIPTION AND HISTORY

The original 300 Area sanitary sewer system built by MED and du Pont during World War II was designated as the 3903 system. Concrete and vitrified clay sanitary sewer pipes from all buildings, as well as one process line from the 313 Building, fed into a large septic tank near the northeast edge of the 300 Area. To allow for the percolation of liquid wastes into the soil, a tile field led out of this septic tank. In the summer of 1947, this system overflowed because of overuse and plugging. At that time, uranium contamination was found in the sanitary sewer sludge and water. A new tile field, overflow ditch, and connecting ditch were dug in August 1947 to a point about 200 ft from the Columbia River. These new facilities appeared adequate for the then-current flow of approximately 76 gal/min.

However, as many new buildings were constructed in the 300 Area during the HW postwar expansions, sanitary sewer facilities again became inadequate. In 1951, two more septic tanks, connected as a pair, were added east of the present location of the 306-E Building. The three-tank septic capacity then reached approximately 100,000 gal. North and south leaching trenches, along with an inductor system to pump waste from trench bottoms, replaced the old tile field at that time. This three-tank, two-trench system, since re-numbered the 3607 system, has continued in use in the 300 Area since 1951 unchanged. Current Hanford Site planners are designing a connection for this system into the Richland city water treatment plant, with completion of the tie-in and retirement of the old septic tanks expected in 1993.[68]

30.2 SANITARY SEWER SYSTEM WASTES AND CONTAMINATION

Materials handling procedures throughout the 1940's and 1950's, especially in fuel fabrication areas, introduced uranium, thorium, and other contaminants to the sanitary sewer system (see Part I). These contaminants entered the system via the hair, shoes, hands, and clothing of workers who used 300 Area change houses, lunchrooms, sanitary restrooms, and the First Aid Station. Another pathway for fabrication and chemical wastes to enter the sanitary sewer system was from the 300 Area Process Pond (later Ponds). A spring 1948 H.I. report found "highly significant increases" in uranium in 300 Area sanitary water "as a result of seepage of uranium from the waste pond." Residual contamination from earlier materials handling practices and from cross-contamination with other waste systems still persists in spotty deposits. Health Physics surveys taken in 1991 displayed readings of 25,000 c/m in pipes leading from the septic tank sludge pump. Currently, a plan is being designed to connect 300 Area sanitary sewer lines into a large, central pipe that would connect to the Richland city water treatment plant. This plan will include contamination surveys performed with removal of the old septic tanks and contaminated pipes, sludge and soil deposits.[69]

31.0 PROCESS SEWER SYSTEM

31.1 FACILITIES DESCRIPTION AND HISTORY

The original 300 Area process sewer system, built by MED and du Pont during World War II, was designated the 3904 system. It consisted primarily of 8-in. vitrified clay pipes with acidproof joints that connected the major 300 Area structures (except the 321 Building) to an 18-in. vitrified clay pipe with acidproof joints that ran eastward to a single Process Pond. The 321 Building was connected to this main pipe via a combination of 3-in. stainless steel pipes, 8-in. wrought-iron pipes, and 6-in. earthenware pipes. All manholes and pipe joints were of acidproof construction. Non-sanitary wastes from chemical, fuel fabrication, and other processing operations were piped from all of the buildings that performed industrial functions and drained in unsegregated form into the 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. It overflowed on the east side in August 1945, and a dike of crushed rock and earth was erected in September. Three months later, however, H.I. Division monitors reported that the dike top was only 15 in. above the average water level.

Some additional, temporary cribs and French drains were built to receive some process wastes at miscellaneous (as-needed) locations throughout the 300 Area. During a 1950 excavation just south of the 313/303-A Buildings vicinity, an undocumented French drain was found with contaminated timbers exhibiting a dosage rate of 50 mrep/h. That waste area had been created as part of a small, outdoor autoclave experiment in 1944.[70]

31.2 CONTAMINATION LEVELS RISE

Throughout the early years of 300 Area operations, radioactivity levels in the main Process Pond rose precipitously (see Tables 1 through 4).[71]

Table 1. Process Pond Water--Inlet or 25 Feet East of Entrance Ditch.

Date	Radioactivity level
December 1945	20 - 260 d/m per liter, alpha 6.8 x 10E-5 - 3.6 x 10E-4 μCi/L, beta
December 1946	340 d/m per liter, alpha 1.8 x 10E-3 μCi/L, beta
May 1947	944 d/m per liter, alpha 547 x 10E-5 μCi/L, beta
September 1947	2,372 ± 40 d/m per liter, alpha 2,426 x 10E-5 μCi/L, beta
June 1948	2.8 x 10E + 4 d/m per liter, alpha .01 - .12 μCi/L, beta

Table 2. Process Pond Water--Northeast Corner.

Date	Radioactivity level
December 1945	40 - 420 d/m per liter, alpha 2.2 - 9.0 x 10E-5 μCi/L, beta
December 1946	100 d/m per liter, alpha 1 x 10E-3 μCi/L, beta
May 1947	60 d/m per liter, alpha 18 x 10E-5 μCi/L, beta
September 1947	59 ± 7 d/m per liter, alpha (NW corner) 10 x 10E-5 μCi/L, beta (NW corner)
June 1948	1-7 x 10E + 3 d/m per liter, alpha (NW corner) 3 x 10E-4 μCi/L, beta (NW corner)

Table 3. Process Pond, Dry Sludge or Mud--Entrance or Ditch Near Entrance.

Date	Radioactivity level
May 1946	7,600 - 10,200 d/m per gram, alpha 1.2 - 1.6 x 10E-2 μCi/g, beta
May 1947	880 d/m per gram, alpha 8.6 μCi/kg, beta
September 1947	1,528 ± 24 d/m per gram, alpha 12.3 μCi/kg, beta
April 1948	30,464 ± 502 d/m per gram, alpha 4.1 μCi/kg, beta

Table 4. Process Pond, Dry Sludge or Mud--Northwest Corner.

Date	Radioactivity level
January 1947	26 d/m per gram, alpha 0.3 μCi/kg, beta
May 1947	180 d/m per gram, alpha 0.9 μCi/kg, beta
September 1947	272 ± 10 d/m per gram, alpha 3.02 μCi/kg, beta
April 1948	840 ± 22 d/m per gram, alpha 0.18 μCi/kg, beta

The spike in contamination readings in the Process Pond in September 1947, as the result of a large "dump" of uranyl nitrate hexahydrate that month, as well as overall observations of pond contamination levels and trends, led to sharp expressions of concern by H.I. Division monitors in early 1948. At a special hazards topics meeting that spring, monitoring officials stated "The level of activity in the Pond is nearing its upper safe limit, so care should be exercised to keep the amounts of activity entering this pond to a minimum." At that time, 321 Building Chemical Development group accounts showed that building's operations to have discharged 238.3 lb of uranium to the Process Pond since startup. These observations, and the desire to lessen uranyl nitrate hexahydrate buildup in the Process Pond, led to the 1948 decision to build the 300 North Cribs (also known as the 321 Cribs) about 5 mi north of the 300 Area. These cribs consisted of two buried inverted stainless steel tanks on concrete footings. These initial holding vessels allowed the liquid wastes to percolate into the ground. Constructed to hold uranyl nitrate hexahydrate, ammonium nitrate, hexone, and other solvents from 321 Building operations, these cribs received liquids containing about 2,070 lb of uranium between 1948 and 1956.[72]

31.3 DIKE BREAK AND CHANGES THROUGH ENSUING YEARS

On October 25, 1948, the 300 Area Process Pond dike broke on the northwest side, releasing the bulk of Pond contents to the Columbia River. Health Instruments Division reports estimated the 12 to 61 lb of uranium contained in 14.5 million gal of waste overall was discharged to the river in 90 min. 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. Burrowing activities of small rodents (beavers and muskrats) also were partially blamed.[73]

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. Dredgings occurred at least three times by 1957, at least twice more during the 1960's, and again during the 1970's. By 1955, so much uranium-bearing sludge had built up on the bottom of the North Process Pond that the facility was taken out of service for 14 mo. The extensive dredging operation that took place during that time period recovered 10,300 lb of uranium out of sludge deposits up to 9 in. thick in two major areas in the southwest region of the North Process Pond.

In 1953, in connection with the building of the 340 Retention and Neutralization Complex (see Section 33.1), two 307 Trenches (Figure 38) were constructed just north of the present location of the 324 Building. Active until 1963 when they were partially cleaned and filled as part of the 324 Building excavation, these trenches received liquid waste and sludge from the South Process Pond. Currently, the 3718-C, 3718-F, and 3718-G Storage Buildings exist over these former 307 trench sites. Approximate waste totals received by the 307 Trenches during their 10 yr of use included 11 tons of

uranium, 13,200 lb of lead, 6,600 lb nickel, 4,400 lb fluoride, 2,200 lb (each) zinc and chrome VI (hexavalent chromium), and other heavy metals and chemicals.[74]

The North and South Process Ponds were phased out of service in 1974 to 1975, with a final waste disposal on March 16, 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, 300 Area process wastes have gone to these 1,500-ft facilities for slow percolation into the ground, to the 183-H Solar Basins for evaporation (until 1985), or into the WATS process (from 1975 to 1992; see Part I). Most "spills" (off-standard releases) to the process sewer system since 1975 have involved WATS failures or operational problems.[75]

31.4 PROCESS WASTES AND CONTAMINATION

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 (see Part I), and all of the separations process chemicals and solutions (particularly uranyl nitrate hexahydrate) used in 3706 Building and 321 Building tests of the bismuth phosphate, REDOX, Metal Recovery, PUREX, and RECUPLEX processes (see Sections 20.4 and 22.4). Chemicals used in bioassay and environmental sample analyses also contributed a much smaller portion of 300 Area process wastes (see Section 22.4).

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. One-half curie of promethium-147 is known to have been disposed to the Ponds from a 1967 contamination event in the 325 Building (see Part IV). Lesser amounts of the above materials were disposed to the Process Trenches resulting from policies that diverted many fuel fabrication wastes to the 183-H Solar Basins and to the WATS facilities. Additionally, during the years that the Process Trenches operated, 3706 Building operations were primarily administrative and 321 Building operations were primarily mechanical.

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 300 Area also must be expected to contain some degree of process waste buildup, the amounts varying depending on the age and type of facility. Some such drains, pipes,

and manholes also contain radioactive contamination. For example, surveys conducted in the late 1980's found uranium and thorium contamination in a manhole southeast of the 321 Building and cobalt-60 contamination in a manhole west of the 3730 Building.

In 1987, the weir box at the south (entry) end of the 300 Area Process Trenches was cleaned out and separated using a 0.25-in. screen. Solids and rocks filtered out by the screen were buried in the 200 Areas, and samples of the remaining sludge were sent to the DOE site at Fernald, Ohio, for analysis. The sludge was found to contain 2.58% uranium, along with slightly lower concentrations of calcium, iron, and trace amounts of other substances. Eventually 911 lb of uranium were recovered from this sludge. In a 1991 Expedited Response Action (ERA), the Process Trenches were partially remediated to remove contamination prone to leaching further into the ground and the Columbia River. Trench bottoms were dredged, and now greater percolation occurs over a shorter distance. Portions of the trenches were then blocked off. Current cleanup plans incorporated in the *Hanford Federal Facility Agreement and Consent Order* (commonly known as the Tri-Party Agreement) call for the construction of an effluent treatment disposal facility at the north end of the Process Trenches. Scheduled for completion by December 1994, this facility will receive process liquids directly from building transfer pipes and will treat up to 400 gpm by carrier precipitation, filtration, and carbon and ion exchange columns.[76]

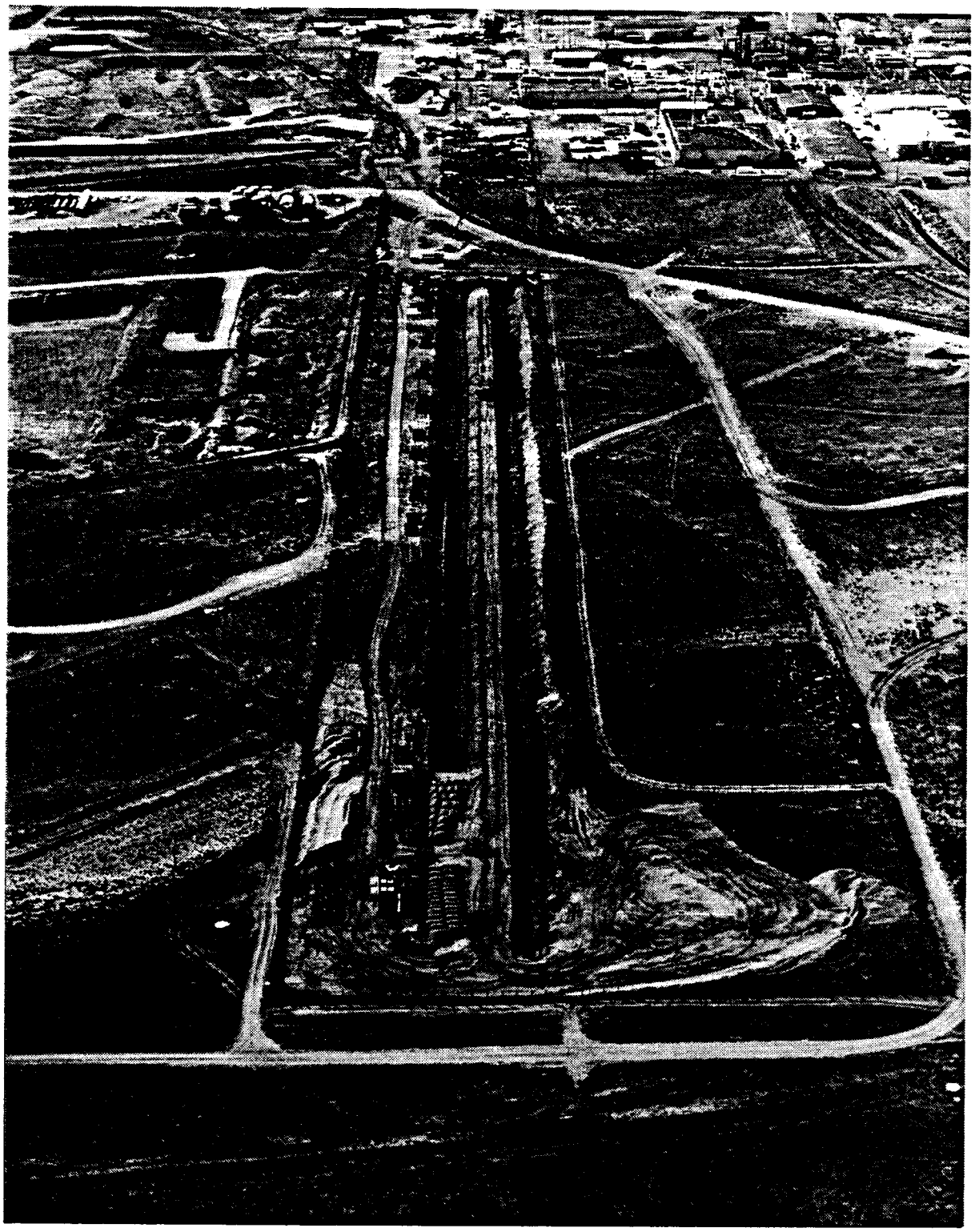

Figure 38. The East and West Process Trenches stretching north of the 300 Area in 1991.

32.0 SOLID WASTE BURIAL GROUNDS

32.1 FACILITIES DESCRIPTIONS AND HISTORIES

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. Two burning grounds, containing burning trenches for the latter substances from the 300 Area were established during World War II. One site was 2,300 ft north of the 333 Building, and one site was 400 ft north of the North Process Pond. One of these areas was designated a regulated burning ground because it also contained a storage area for uranium-bearing aluminum-silicon and for bronze crucibles bearing radiation levels from fuel fabrication work. During the late 1940's, some contaminated solid waste disposal, as well as the burning of uranium-contaminated trash, occurred in both of these burning grounds. When burning was stopped in these two areas in 1951 and 1953, respectively, clean soil was placed over them and radiation signs were posted. In 1961 and 1962, these areas were marked and designated as the 618-4 and 618-5 Burial Grounds.[77]

The earliest 300 Area waste burial ground (now designated Burial Ground 618-8) was located about 750 yd north of the 300 Area beneath the site of the current 300 Area North Parking Lot (just north of the electrical substation that is east of the 3703 Building). Maintaining waste burial records was a very low priority at HEW, and this burial ground, actively used in 1943 to 1944, was accidentally discovered while post holes were being dug for a power line in the 1952 HW expansion. The second 300 Area waste burial site used by HEW and HW was Burial Ground 618-1, active from 1945 to 1951, and located just inside the northeast corner of the 300 Area. This facility consisted of three east-west trenches and an unknown number of longer north-south trenches. It received some highly contaminated wastes from early 3741 Building operations and from the initial cleanout of the 3706 Building during 1946 to 1947 (see Section 22.3). About 1965, nitric acid leaking from tanks of the 334 Chemical Handling Facility, located above this burial ground, dissolved some of the belowground uranium and ferrous compounds in the south end, allowing them to migrate to groundwater (see Section 4.1). From 1975 to 1985, a solvent evaporator (a large, open container similar to a dumpster), used to evaporate some waste acids from the 313 and 333 Building's processes, operated over a portion of the north end of this burial ground.

Burial Ground 618-2, located just north of 618-1 and active from 1951-54, consisted of four east-west trenches. Most of the contents in this burial ground were destroyed by fire on February 17, 1954. A fourth waste burial site, Burial Ground 618-3, located just west of 618-2, was active from 1954 to 1955. It filled up quickly because it received the demolition and construction debris, including large equipment parts and structural materials, from the remodeling of the 313, 303-J, and 303-K Buildings and from the construction of the 311 Facilities (see Sections 1.6, 6.1 and 8.1).[78]

32.2 BURIAL CONTAINERS AND CAISSONS

As high-level radiochemical and radiometallurgical operations got underway in the 325 Building and 327 Building, respectively, in 1953, solid waste

burial practices for the 300 Area began to change. High radiation levels in and near Burial Ground 618-2, generated by 325 and 327 Buildings' wastes, concerned H.I. Division monitors (see Sections 34.5 and 36.5). On their recommendation, Burial Ground 618-10, known as "300 North," opened in 1954 about 4.3 miles northwest of the 300 Area. Until it was phased out of operation between 1962 and 1964, this burial ground consisted of trenches and rows of burial caissons known as "pipe fields." These caissons were made of 5 to 6 open-bottomed 55-gal drums welded together and buried upright. From the mid-1950's until about 1960, solid radioactive wastes, still collected from operations buildings in cardboard containers and then stored in lead pans known as "gunk catchers," were transported to 300 North in shielded "load luggers." These containers traveled to the burial ground on the far back platform of a lowboy truck, often with additional trailer equipment hitched between the truck's cab and the load luggers to give added radiation protection to the driver and disposal workers. The cardboard waste containers then were dropped from the gunk catchers down the caissons, and the hole was filled with sand and dirt until radiation levels declined to a safe or "tolerance" reading. If radiation levels could not be reduced to tolerance ranges, concrete was poured down the hole until such levels were achieved.

32.3 MILK PAILS, GRAPE JUICE CANS, AND GATLING GUNS

Beginning about 1960, after waste had become hotter in the 325 and 327 Buildings, cardboard waste containers and gunk catchers were replaced by the milk pail disposal system. Radioactive wastes were collected in the operations buildings in 5- to 6-gal aluminum milk pails. A commercial gelatin was poured in to seal the top because no hard cover was used. Each milk pail then was placed in an individual cask that contained 4 in. of lead shielding surrounded by an aluminum shell. These casks were transported to 300 North, and after 1962 to the Wye Burial Ground, and the milk pails (not the casks) were disposed down the buried caissons and covered with sand or concrete. The Wye Burial Ground (also known as 618-11) was active from 1962 to 1970, and was located about 6 mi north of the 300 Area near the present site of the Washington Public Power Supply System (Supply System) reactor number 2 (Figure 39). The Wye Burial Ground consisted of three trenches, three rows of burial drums (caissons) and, after 1966 to 1967, other rows of fabricated burial caissons (see Section 32.5). The 300 North and Wye Burial Grounds also received 1-quart "grape juice cans" that held used highly radioactive charcoal filters from the operations buildings. Grape juice cans were transported in cylindrical, shielded casks known as "Gatling Gun Casks" (Figure 40).

32.4 PAINT CANS AND LARD CANS

During 1966 to 1967, solid waste disposal caissons and containers used for 300 Area disposals changed in two ways. A new type of caisson (sometimes called a "silo"), with its top opening angled at 45 degrees to give better radiation shielding to disposal workers, was designed and fabricated in HW's 1100 Area shops (Figure 41). At the same time, the milk pail system was replaced by the paint can system. Radioactive wastes from operations buildings were collected in 1-gal paint cans with metal lids fastened on by two sets of clips. Eight paint cans together fit into a new cylindrical cask with 6 in. of lead shielding surrounded by a stainless steel shell. Thus more

securely sealed and heavily shielded, solid wastes traveled to the Wye Burial Grounds and, after 1970, to 200 Areas Burial Grounds. The casks themselves were not disposed, but were reused many times. The paint can system continued in use for many years and is still used to some extent today. Recently, however, the system has been augmented by the use of 50-lb "lard cans." These 10-gal containers are used for high-activity solid radioactive wastes generated in the 324, 325, and 327 Buildings and in other 300 Area structures.[79]

32.5 OTHER 300 AREA BURIAL GROUNDS

During the early and middle years of 300 Area operations some other solid waste disposal sites were used on both a planned and inadvertent basis. In 1950, contaminated topsoil was removed from the region surrounding the 303 Buildings and placed 0.5 to 0.75 mile northwest of the 300 Area. Two feet of clean earth was placed over the contaminated soil at that time. In 1954, approximately 5,000 gal of drummed solvent wastes (primarily uranyl nitrate hexahydrate and hexone) from 321 Building tests were buried about 0.5 mi due west of the 300 Area north perimeter fence. In this operation, nearly 100 drums that had been generated in 1949 to 1950, but stored on an outdoor pad for nearly 5 yr, were placed in what then was designated the 300 West Burial Grounds (now 618-9). About 20 batches (5,000 gal each) of used ammonium nitrate solution and unused powdered ammonium nitrate were disposed. Nearby, a 500-gal Columbian stainless steel tank and several agitators used by du Pont in early 321 Building bismuth phosphate tests had been buried in 1947.

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. Throughout the nearly three decades of single-pass reactor operations at HW, 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 1 mi 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. Another contaminated waste disposal site was located just west of the 300 Area West Gate along the highway. There, used resins from ion exchange columns in the 325 Building, and later the 324 Building, were disposed above ground in 30-gal cardboard drums known as "paper drums." Over months and years, these paper drums disintegrated, and their contents decomposed into the soil. This practice stopped in the late 1960's. Additionally, it is possible that other burial grounds exist that have thus far been completely forgotten in written and oral records.[80]

32.6 THE 1970 CHANGES

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 resulted in the final closure of the Wye Burial Grounds in 1970 and ended solid waste burials in the 300 Area and vicinity from that time on.[81]

32.7 BURIAL GROUND WASTES AND CONTAMINATION

Exact knowledge of burial ground contents is impossible because records of this type are among the poorest and least complete of all Hanford Site historical records. Nevertheless, some bits of information can be pieced together to yield a general characterization of certain burial grounds and sites. Before 1954, fairly small quantities of unsegregated radioactive solid wastes, generated mostly by radiochemical and radiometallurgical tests in the 321 and 3706 Buildings, were placed in 300 Area burial grounds. The startup of "hot cell" operations in the 325 and 327 Buildings in 1953 significantly changed the amounts and radiation levels of 300 Area wastes. Hot cell wastes included glassware, swipes, equipment parts, and pieces of piping and other structural materials contaminated with plutonium, irradiated uranium, and fission products. By 1954, transfers of solid waste "chips" from the 327 Building hot cells routinely produced readings of several rads per hour both during the transfer operation and on the load luggers used for transport to Burial Grounds 618-2 and 618-4. During the fire that destroyed a major portion of the contents of 618-2 in late February 1954, a dosage rate of 30 mr/h was observed at 10 ft from 327 Building waste in the southeast corner of this burial ground. The exposure rate to firemen of 5 mr/h at 20 ft brought H.I. Division concerns over the volatilization of hot wastes in such near proximity to the 300 Area. Discussions of the whole waste burial issue ensued, and the result was the opening of Burial Ground 618-10, over 4 mi to the north, and the imposition of stricter H.I. Division controls on waste transfers from hot cells and on waste transport in general.

Waste disposal operations and high radiation readings in and around Burial Ground 618-4 itself continued to be problematic throughout the years that the facility was active. Health Instruments Division monitors reported an exposure rate of 5 r/h (field reading) at the edge of this burial ground during a disposal of 327 Building waste in October 1954. The exposure rate in the cab of the transport vehicle during that waste disposal was 350 mr/h. Two months later, because of an ongoing exposure rate of 500 mr/h at the burial ground edge, the existing radiation zone fence line was moved to the south, and "high-level waste" was moved to the center of the burial pit. These actions reduced the average exposure rate at the edge of 618-4 to 50 mr/h. In August 1955, a fire in this burial ground spread particulate matter up to 1,500 ft northeast of the fence line. Contaminated particles read up to 4.5 r/h. According to an H.I. Division report, another fire in July 1961, destroyed "all flammable material" in one of the trenches in 618-4, contaminating the immediate vicinity with readings "exceeding 100,000 c/m."[82]

A contamination spread in the 300 North Burial Ground in early September 1963, which was a result of a loose lid on a 327 Building waste container, prompted a general re-evaluation of H.I. Division burial policy. Beginning soon afterward, Hanford Laboratories Operation (HLO), the GE-Hanford Company (GEH) division that operated 300 Area laboratories including the 325, 326, 327, and 329 Buildings, began to dispose of most plutonium-contaminated solid wastes in 200 Areas burial grounds.[83] Meanwhile, the Wye Burial Ground continued to receive high-level wastes containing strontium-90, cesium-137, neptunium-237, promethium-147, cerium-144, and other high-heat isotopes and fission products. Numerous contamination spreads and spills occurred in this burial ground over the years, including a spread of fission product contamination reading 35 mr/h over 9,000 ft^2 in December 1964, and contamination up to 100,000 c/m over a smaller area in April 1967. Beginning in 1968, nearly all solid wastes generated by 300 Area laboratories (by then operated by PNL) were disposed in 200 West Area burial grounds. After 1970, no further disposals of any kind took place in the Wye Burial Grounds. Core drillings conducted in 1980 in this burial ground, as well as in 300 North and other 300 Area burial grounds, identified mixed soil components as primarily lead-214, radium-226, thallium-208, bismuth-214 and -212, actinium-228, cesium-137, and naturally occurring potassium-40. High-level waste containers disposed to the caissons contain plutonium-239, neptunium-237, strontium-90, promethium-147, cerium-144, cesium-137, and other high-activity isotopes.[84]

In 1991, the 618-9 Burial Ground was remediated in a pioneering ERA conducted in 1991 (Figure 42). Hexone and kerosene were removed from drums that were still intact. Bags of powdered ammonium nitrate, several 321 Building agitators, one 500-gal tank, and additional building debris also were removed. This area was released as a radiation zone in late 1991.

Figure 39. The 618-11 (Wye) Burial Ground in 1987. Cooling towers of the Washington Public Power Supply System's Unit 2 can be seen in the background.

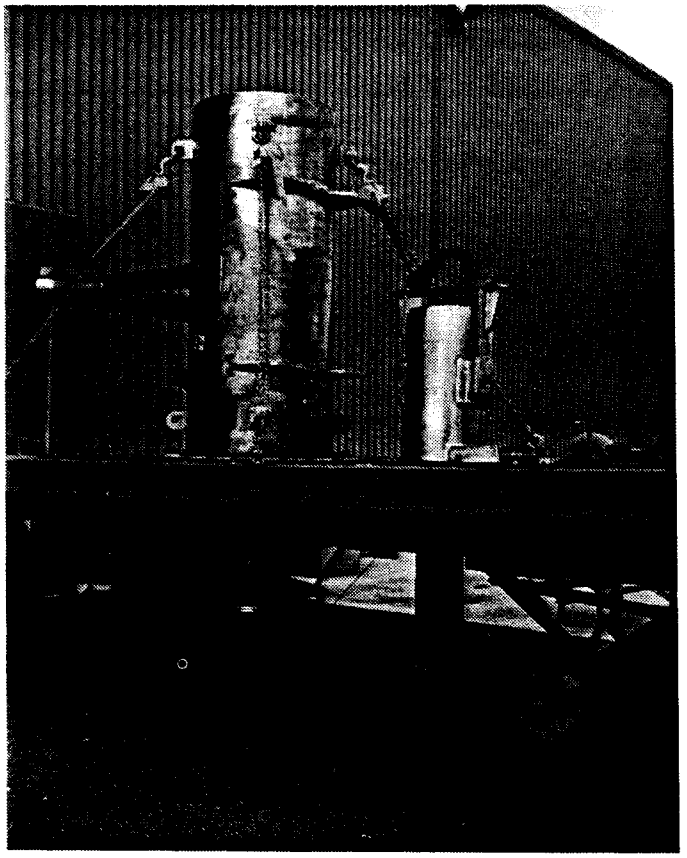

Figure 40. Canister containing solid radioactive waste sits atop a lowboy truck, ready for transport to the Wye Burial Ground, 1964.

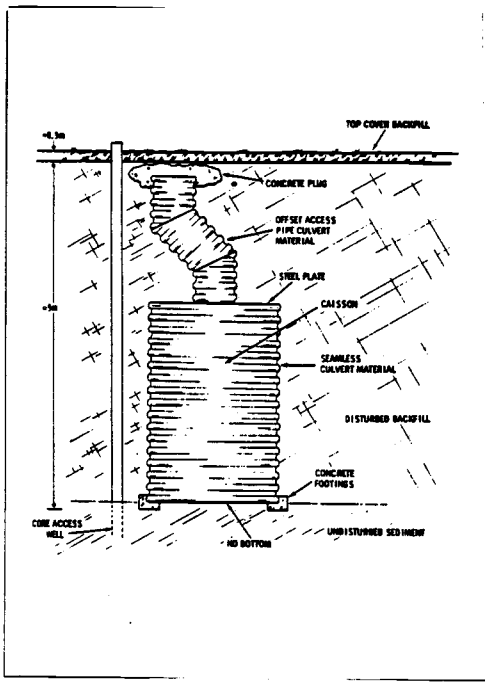

Figure 41. Underground waste storage caisson, consisting of five to six open-bottomed drums welded together and buried upright. The angled opening for better radiation shielding for waste disposal personnel was added in the mid-1960's.

Figure 42. Hanford Site workers remove drums containing methyl isobutyl ketone (known as hexone) and normal paraffin hydrocarbon (saturated kerosene) from the 618-9 Burial Ground in 1991. This Expedited Response Action, conducted on the 42-yr-old material, resulted in the release of the 618-9 area from control as a radiation zone.

33.0 THE 340 RETENTION AND NEUTRALIZATION COMPLEX, RADIOACTIVE LIQUID WASTE SYSTEM, RETENTION PROCESS SEWER, 340-A BUILDING, AND 340-B LOAD-OUT FACILITY

33.1 THE 340 BUILDING, RADIOACTIVE LIQUID WASTE SYSTEM, AND 307 FACILITIES DESCRIPTION

The 340 Complex and the RLWS were constructed as part of a very large defense production expansion that occurred in HW's 300 Area in the 1951 to 1953 period (see Part IV). Completed in 1953, the 340 Building, along with the initial RLWS piping system, the 307 Basins, and the Retention Process Sewer (RPS) piping system, represented an attempt to deal with radioactive effluents from several new laboratories in a modern, controlled manner. The original 340 Building had dimensions of 40 ft by 42.6 ft and had transite (corrugated asbestos) walls and roof and a total area of 1,880 ft^2. It contained a sampling room with sample wells and an air compressor for instrument air and an operating gallery with a caustic tank and control panels for operating flows to and from two stainless steel tanks located below the building. These 15,000-gal tanks were enclosed in a 94,000-gal concrete pit 37.8 ft by 25.6 ft by 25 ft (deep) with a removable concrete cover. Equipped with agitators, valves and transfer pumps, they were built to receive and sample liquid wastes from 300 Area laboratories. Radioactive wastes would then be taken by tanker truck to the 200 Area disposal facilities (usually cribs), and nonradioactive wastes could be disposed to the 307 Trenches. The tanks in the 340 Complex were fed by the RLWS, a network of 2-, 3-, 4-, and 6-in. single-walled stainless steel pipes buried at slightly varying levels approximately 20 ft below ground that brought wastes from the 325, 326, 327, and 329 Buildings (see Part IV) and later from other buildings.

At the same time that the 340 Building and the RLWS were built, the 307 Complex also was built. It consisted of four 50,000-gal basins, two trenches located just north of the current site of the 324 Building (see Part V), and a set of pumping controls located in a pit next to 307 Basin 1. Two of the 307 Basins were lined, and only these two were used. They were fed by pipes from the 325, 326, 327, and 329 Buildings (and later the 308 and 324 Buildings) in a system known as the RPS or the Diversion Waste System. In this system, liquid process wastes that had the potential to be contaminated were disposed to the RPS and routed to the 307 Basins for sampling. If radioactivity was not detected above release limits, these wastes were disposed to the 307 Trenches. If levels proved to be above release limits, the effluents were pumped into the 340 Building RLWS tanks.

33.2 THE 340 BUILDING ADDITION, 340-A, 340-B, AND 3707-F CONSTRUCTION

During 1960 to 1961, two additions were built: one was an actual extension of the 340 Building, and one was the 340-A Building. The 340 Building addition was a garage and load-out facility for the 5,000-gal tanker trucks used to transport radioactive wastes from the 340 tanks to the 200 Areas. It was a steel frame structure 40 ft by 42 ft by 23 ft (high) with steel siding and roof and a total area of 1,680 ft^2, enough space for three tankers to load simultaneously. The 340-A Building is a steel frame structure 32 ft by 42.6 ft by 23 ft (high), with a total area of 1,345 ft^2. It has a

concrete floor 3 ft below grade, concrete walls to grade, steel walls above grade, and a steel roof. It contains six 8,000-gal stainless steel tanks meant to provide additional storage space for radioactive wastes awaiting transport to the 200 Areas.

In 1963, the 3707-F Radiation Monitoring Building was constructed to provide a radiation monitoring office and a concrete shielded personnel survey cubicle for H.I. Division monitors and operations workers involved with the 340 Complex. This prefabricated galvanized steel panel structure sits on a concrete slab and is 12 ft by 12 ft by 10 ft (high), with a total area of 144 ft^2. Originally located northeast of the 340 Building, it was moved in 1968 to a location southwest of the 340 Building.

In 1965, the 340-B rail load-out facility was constructed as part of a modernization effort that substituted shielded rail cars for tanker trucks in the transport of radioactive effluents from the 340 tanks to the 200 Areas. The 340-B facility was a structure 50 ft by 64 ft by 28 ft (high) with corrugated steel walls and roof and a total area of 3,200 ft^2 (Figure 43). It had two large roll-top doors on the west side and could accommodate two 20,000-gal rail tank cars at once.[85]

33.3 RADIOACTIVE LIQUID WASTE SYSTEM, RETENTION PROCESS SEWER, AND OTHER 340 COMPLEX CHANGES

In 1960, the 308 and 309 Buildings (see Part V) were completed, and both were connected to the 340 Building via RLWS pipes. The pipe leading from the 309 Plutonium Recycle Test Reactor (PRTR) was a separate 3-in. carbon-steel line constructed as an added safety measure in anticipation of particularly hot reactor wastes. In 1964, when the 324 Building, then called the Fuel Recycle Pilot Plant, was completed, it too was connected to the 340 Building via RLWS pipes and RPS pipes. Meanwhile, the construction of that building had brought partial cleaning and leveling of two 307 trenches extending just north of it. Contaminated soil was removed to a depth of 20 ft and taken to a burial ground. The trenches then were nearly filled with scrapings from the South Process Pond, and fly ash from the 384 Power Station was laid in the top 1 ft of the trenches to complete the leveling process. In 1968, the 326 Building connection to the RPS was re-routed through a diverter station in the 329 Building. In 1975, the 340 Building vault, holding the large waste retention tanks, was decontaminated and resurfaced. Unplanned overflows from the two tanks had caused solidified radioactive waste to accumulate to a depth of approximately 1 ft on the vault floor. In the 1975 cleanout, this waste was dissolved, diluted, and pumped into containers for disposal. The remaining residue was flushed by high-pressure hose to the sump and pumped back into the 340 tanks as radioactive waste. Then a hydro-laser (high-pressure water jet) completed decontamination of the vault surface, and a lead sheet and new concrete were placed on the floor of the vault. The essential integrity of the vault liner was confirmed as being intact at that time.[86]

During August and September 1976, a comprehensive leak test of the RLWS network was conducted. Valves and clean-out vents were blanked out in a rotating series, and these locations as well as access manholes and soil samples were tested for contamination. The results of these tests led to a

decision to replace the entire RLWS piping network with double-walled stainless steel pipes, a leak detection system, many new valve boxes, and other system parts. The huge replacement project took place in 1978 to 1979. Many segments of contaminated dirt throughout the RLWS piping network were removed at that time. However, the old RLWS pipes themselves were not removed. They were abandoned in place, and portions of soil contaminated by their leaks still remain. At the end of this period, other policy changes and equipment upgrades designed to reduce radiation exposures in and around the 340 Complex were instituted. A batch control policy was implemented beginning in 1979. This coordinated system of applying for advance written permission before sending liquid effluents through the RLWS was necessary to prevent excessive amounts and curie levels of wastes from accumulating in the complex at any given time. Incomplete RLWS line and cask flushes, periodically followed by more comprehensive flushes, often accounted for the sudden arrival of wastes bearing highly concentrated curie loads. In a case in early 1979, a rail tank car full of high-activity cesium-137 raised radiation levels so high in the vicinity of the 340 facilities that portions of the 3762 Building nearby had to be declared a radiation zone and evacuated. In 1980, new charcoal filters, HEPA filters, exhaust fans, and improved instrumentation and pumps were added to the 340 facilities. Further instrumentation upgrades were added in 1986 and 1987.[87]

33.4 RECENT ISSUES

Management appraisal reports in both 1988 and 1989 identified waste minimization as the chief need of the 340 Complex because inadvertent contamination of low-level RPS waste with high-level radioactive waste had quickly overwhelmed the entire system on at least four occasions in the recent past. In 1989 and 1990, DOE surveillance reports expressed "concern regarding the overall operating conditions" at the 340 Complex. Issues of specific concern included housekeeping, physical condition of facilities, lack of an operator certification program, operational discipline, and record-keeping. Many equipment upgrades have occurred in the last 2 yr. Today, as a safety measure, management policies dictate that high-activity wastes must be stored only in the tanks located in the 340 Building's underground vault and not in the aboveground tanks of the 340-A Building. Currently, plans call for the 340 Facility to receive 200 Areas single-shell tank (SST) characterization waste that will result from characterization work required by the Tri-Party Agreement.[88]

33.5 THE 340 COMPLEX AND RADIOACTIVE LIQUID WASTE SYSTEM/ RETENTION PROCESS SEWER WASTES AND CONTAMINATION

The 340 Complex, through the old and new RLWS piping network and sometimes through the RPS network, has received and serviced some of the highest level liquid radioactive wastes generated in the 300 Area. In recent years it has also handled the transfer of that area's highest level solid wastes. Because of these inherent functions, and because of contamination spreads and spills over the years, wastes deposited in the pipes, tanks, and soils surrounding this complex and the RLWS/RPS network are extensive. Radioactive liquid wastes over the years have included radiochemical solutions from the 324, 325, 326, and 329 Buildings, as well as radiometallurgical fines

and metal-bearing solutions from the 327 Building (see Part IV). Sometimes, particularly in the weld joints of the old RLWS pipes, radiometallurgical fines collected into hot clusters. When that occurred, commercial reagents and acid washes would be flushed through the lines to dissolve the hot spots, and occasionally the pipes would be mildly shaken with rivet guns.

Many leaks to the soil occurred from the old single-walled RLWS, especially around weld joints and, in one case, from a section of cast iron pipe, 30 to 36 in. in length, that had been substituted mistakenly for stainless steel just outside the 327 Building (see Part IV). Additionally, an underground "T" junction just outside of the 340 vault leaked copiously over the years. This situation was discovered in October 1977, during RLWS replacement work. Soil in that vicinity read 1.5 rem/h in a 4-ft-diameter 17-ft-deep column near the side of the 340 Vault. This soil was removed to drums and disposed in the 200 Areas. Another portion of contaminated soil was found on the north side of the 340 Vault when that facility was decontaminated in 1975. The contamination resulted from a long-term HEPA filter condensate drip to the bottom of the filter enclosure. Additionally, an area of contaminated soil and groundwater containing fluoride, uranium, and beta-emitters was discovered near the 340 Building in 1979. The report of this incident cited the probable cause as old 325 Building wastes that had leaked from corroded pipes near the 340 Complex. An additional long-term pre-1970's leak to the soil was discovered in 1987 near valve box 9 of the 340 Facility. At that time, cesium-137, cobalt-60, and europium-154 were found in surrounding soils. Soils were disposed to the 200 Areas.

Contaminated mixed waste also leaked from 307 Retention Basin waste lines over long duration and was discovered in December 1969. According to the report generated by that discovery, nearby soils were "grossly" contaminated with ruthenium-103/106, isotopic heat sources such as cesium-144, promethium-147, strontium-90, cesium-137, and rare earths with complexing agents. Promethium-147 was the most significant contaminant, present to the extent of 800 Ci in 70 yd^3 of soil that was removed to the 200 Areas.

Leaks and drips from waste tanker trucks occurred sporadically over the years on nearby roadways and especially at the old truck load-out area (340 Truck Lock). Roadway drips were sprayed with hot oil and then covered with gravel, but pervasive contamination extends several feet through soils below the old tanker truck load-out facility near the south wall of the present 340 Building.

Major specific contamination events and losses to the environment over the years included a large disposal of low-level radioactive light water coolant from an accident at the PRTR in September 1965 (see Part V). At that time, sheer waste volumes overwhelmed the capacity of tanker trucks to carry the coolant to the 200 Areas, and it was disposed to the soil near the present site of the 3763 Building. In 1967, the capacity of the 340 facilities was again overwhelmed by a promethium-147 contamination incident in the 325 Building (see Part IV). The decision was made at that time to release about 150,000 gal of waste containing about 250 mCi of promethium-147 to 300 Area Process Ponds. In the mid-1980's, liquid wastes from N Reactor fuel manufacturing processes in the 333 Building migrated out of equipment at the Tank Truck Unloading Station (TTUS) at the 340 Facility. On other occasions in recent years, barrels storing hazardous wastes on a temporary basis have

leaked onto 340 Facility concrete storage pads and into soils. In 1989, a broken water strainer gasket in the 340-B rail load-out facility resulted in a spray of low-activity water reaching the south wall of the 340 Building, and another broken water line spread very low-level contamination to the ground in 1990.[89]

Wastes being routed through the RLWS to the 340 Complex increased dramatically in curie content and volume resulting from "isotope campaigns," plutonium-238 experimental work, and waste vitrification programs in 300 Area laboratories in the mid-1960's (see Part IV). Volumes received by the 340/RLWS network rose from 400,000 gal in 1954 to 14.5 million gal in 1965. After that point, volumes began to decrease, but concentrated curie content continued to rise, going from 200 Ci in 1954 to 180,000 Ci in 1969. Today waste volumes are generally below 80,000 gal per year, and curie contents also have dropped significantly. Curie levels are expected to rise as SST waste characterization work progresses in 300 Area laboratories in the coming years.

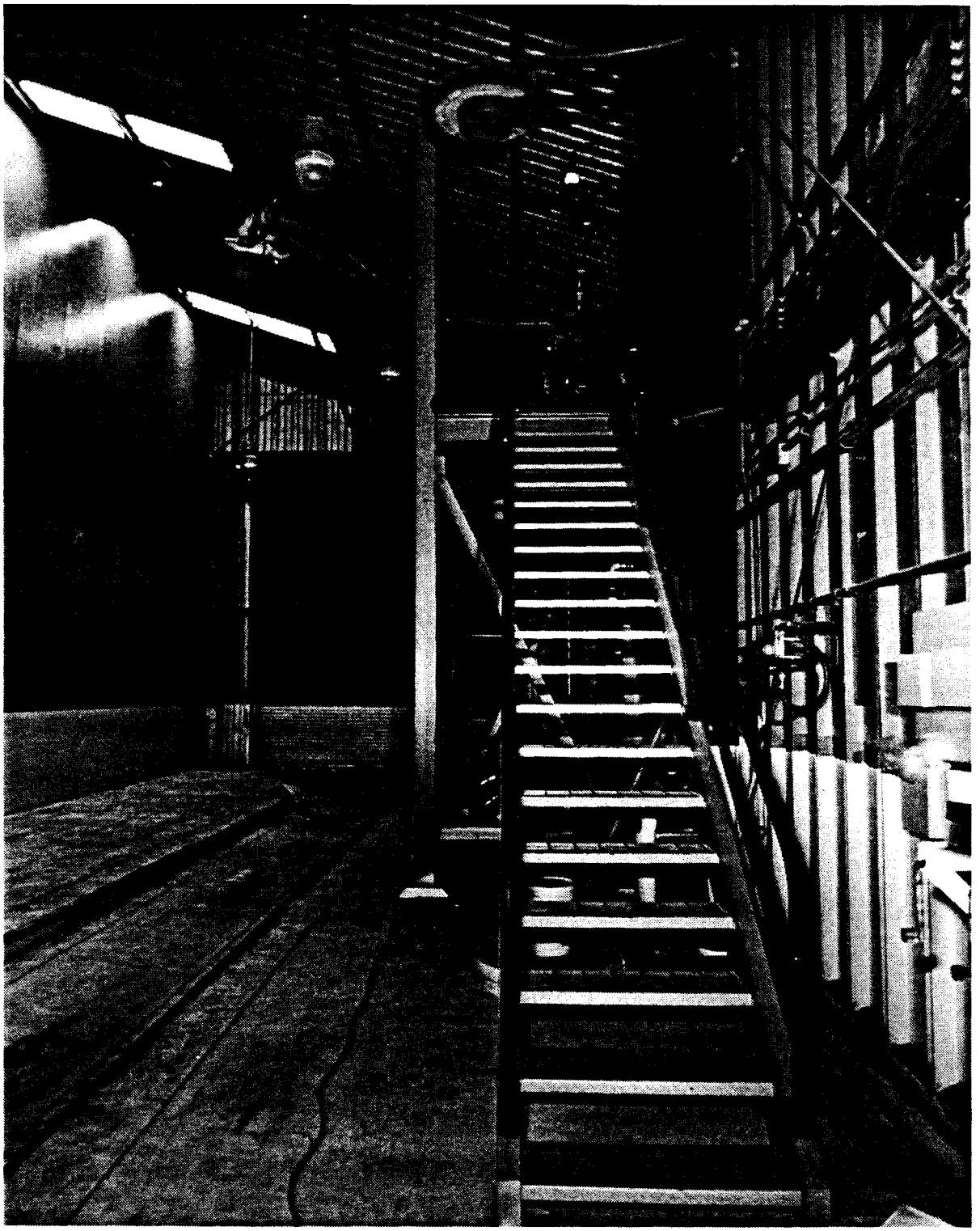

Figure 43. The 340-B Rail Load-out Facility in 1990.

ENDNOTES - PART III

68. DuPont, *Construction*, HAN-10970, Book IV, pp. 989-990 and 1211; and Bixler, "300 Area Monthly Reports," August 1947; and Singlevich, HW-11333, pp. 34-35, 42, 55.

69. Singlevich, HW-11333, pp. 34-35, 42, 55; and Compestine and Meinecke, R-91-02.

70. Durum and Chamberlin, "300 Area Monthly Reports," 1945-1946; and Special Hazards Incident Investigation, Class I, #159.

71. DuPont, *Construction*, HAN-10970, Book IV, pp. 1213-1214; and Durum and Chamberlin, "300 Area Monthly Reports," 1945-1946; and Bixler, "300 Area Monthly Reports," 1946-1948, partially citing Special Hazards Meeting Topic #8 (March 1948).

72. Ibid (all sources); and Paas, HW-39076, p. 8; and Heid, HW-47055, pp. 1-5.

73. Singlevich, HW-11534; and Singlevich and Paas, HW-13743-DEL, pp. 24-32; and Herde, HW-11381, pp. 1-2.

74. Clukey, HW-32762; and Clukey, HW-33305; and Heid, HW-47055; and Roberts, HW-48752; and Haney, HW-52401; and HEDL, TC-799-1, Rev. 4; and WIDS, "Hazardous Chemicals Inventory, 316-1, 316-2, 316-3.

75. Vance, WHC-SP-0137; and Dennison, Sherwood and Young, Draft: PNL-6442; and Loe, DUN-3155; and DOE/RL-90-11.

76. Paas, HW-39076; and Clukey, HW-32762; and Clukey, HW-33305; and Lindberg and Bond, PNL-2949; and Hall, "In Soil..."; and WHC, DRAFT: "300 Area Process Trenches," 1988; and Haney, HW-52401; and Backman, HW-73672; and Hall, "Contamination Release to the Environs," 1967; and Weakley, "Cleanout...," (1986); and Terry, "Authorization...," (1987); and Draper, WHC-UOR-88-26-300-1; and Vance, WHC-SP-0137; and "Hanford Employees...," *Hanford Reach*, January 27, 1992; and "New Treatment...," *Hanford Reach*, February 24, 1992. See also Washington State Department of Ecology, U.S. EPA, and U.S. DOE, *Hanford Federal Facility Agreement and Consent Order*, 89-10.

77. DuPont, *Construction*, HAN-10970, Book I, p. 136; and Paas, HW-39076, p. 5.

78. Paas, HW-39076; and Selby and Soldat, HW-54636, p. 11; and Phillips, Reisenauer, Rickard, and Sandness, BNWL-2184; and GE-Bouillon & Griffith, HWS-4955; and DOE/RL-88-08, pp. 1-1 - 1-12.

79. Paas, HW-39076; and ERDA-1538, Vol. II, pp. II, 1-E-8-9; and Stevens, "Burial ..."; and "Burial Site - 300 North (Wye)," (1962-1967); and Backman, Jerman, Roberts, and Vanderbeek, HW-77274; and Keene, "Disposal..."; and Stevens, letter to Backman, 1963; and Corley, "New Silos..."; and Voiland, "Waste Burial Ground Data," 1970; and Nelson, Ritter, and Szulinski, ARH-2075; and Phillips, Reisenauer, Rickard, and

Sandness, BNWL-2184; and Brown, Geiger, and Isaacson, RHO-CD-78; and Phillips et al., PNL-2557.

80. Stevens, "Burial..."; and Backman, HW-84619, pp. 10-11.

81. Hill, Corbit, Voiland, and Wilson, ARH-1596.

82. Stevens, "Burial...", 1961; and Hervin, "Radiation Monitoring Coverage," February 1954, October 1954, November 1954, December 1954; and Selby and Soldat, HW-54636, pp. 11-12; and Brady, Radiation Occurrence Report 61-0-22.

83. Sanders, Radiation Occurrence Report 63-0-27; and Backman, "Plutonium Contamination Waste Disposal," 1963.

84. Sanders, Radiation Occurrence Report 63-0-29; and Selby, Unusual Radiation Exposure Report No. 1127 (1963); and Erickson, Radiation Occurrence Report 64-15; and Essig, Radiation Occurrence Report 65-08; and Sly, Radiation Occurrence Report BNW-67-21; and Corley, "New Silos...", 1967; and Wye Burial Ground Monthly Reports (1964-1967); and Corley, "Wye Burial Ground," (1968); and Albaugh, "Review of Solid..."; (1968); and HEDL, TC-799-1, Rev. 4; and Phillips et al., PNL-2557-UC-70.

85. AEC/GE Study Group, GEH-26434, p. 3.38; and "HEDL Facilities Catalog," 1971, pp. 340, 340-A, 340-B; and Bovay and GE, HWS-7452; and Asay, HEDL-MG-17-Rev. 6, pp. 77-79; 115.

86. Lanning, DeMershman and Hansen, BNWL-CC-1906; and Purcell, HW-SA-2556; and Harmon and Faulk, HEDL-TC-1008 (Draft); and Schaben, Project V-644.

87. Briggs, DRAFT: "Radiological History..."; and "Leak Test Procedure," 1976; and Jackson, "Project V-654 Weekly Construction Review Meetings," 1978; and Hall, TC-1040; and Lust, Unusual Occurrence Report HEDL-35-77; and Daugherty, "340 Facility," 1989.

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PART IV BUILDINGS CONSTRUCTED FOR POST-WORLD WAR II DEFENSE PRODUCTION EXPANSIONS

The years 1947 to 1955 brought continual expansions at HW. Undertaken in response to perceived Cold War imperatives, three huge expansion periods brought the federal government's capital expenditures at HW up from approximately $250 million at the close of World War II to just over $1 billion in 1955. At that time, HW operations were split into three major segments: the Irradiation Processing Department (IPD) for reactor operations and fuel fabrication, the Chemical Processing Department (CPD) for chemical separations work, and HLO for research and development. In the 300 Area, many new buildings and facilities were constructed, many of which were part of HLO. Of these, the most prominent were five large laboratories and shops known as the 325, 326, 327, 328, and 329 Buildings, all of which opened in 1952 to 1953 at the same time as the 340 Complex and the RLWS constructed to serve them (see Part III). The 3730 Building, constructed very early in the expansions, also functioned as a shop to fabricate specialized graphite shapes. In 1966, after these major expansions, the 320 Low-Level Radiochemistry facility was built to complete postwar plans for HW to house a broad spectrum of nuclear laboratory capabilities.

34.0 THE 325 RADIOCHEMISTRY BUILDING AND HIGH-LEVEL RADIOCHEMISTRY ADDITION

34.1 FACILITIES DESCRIPTION

The 325 Radiochemistry Building, completed in 1953, was built to safely house and handle multi-curie level chemical development work with high-activity substances (Figure 44). During 1959 to 1960, a large addition known as the High-Level Radiochemistry wing was constructed, making the overall building the largest among Hanford's laboratories. Contractor changes at HW transferred the 325 Building to BNWL in 1965. In 1970, the operations responsibility for the structure was split between BNWL (who had the large hot cells in the newer addition) and Westinghouse Hanford. The entire building was then transferred to PNL in 1987 and now is called the Applied Chemistry Laboratory.

The 325 Building, including its 1959 to 1960 addition, is 194 ft by 196 ft in its trunk, with wings 110 ft by 75 ft, 122 ft by 48 ft, and 65 ft by 33 ft, with a total area of approximately 140,000 ft^2. The height at the rear of the highest section is 40 ft. The framework is welded steel, with exterior walls of fluted steel insulated panels. The first and second floors are steel deck topped with concrete and finished with sheet vinyl. The extremely high load capacity of the first floor averages 200 lb/ft^2. The roof is steel deck topped with a tar and gravel finish. In its years of prime use in the 1960's, the building contained over 50 laboratories and 11 hot cells. Standard laboratories were bays 10 ft by 12 ft, bracketed by moveable metal partitions, but second floor and basement partitions were concrete block. The building also contained over 20 laboratory hoods and many gloveboxes for work with radioactive materials.

The entire ventilation system was engineered in a reverse flow, which was a state-of-the-art concept in the 1950's. All air pressure was below atmospheric but was highest in offices so that air passed first through these facilities, then through corridors, then through cold and low-level laboratories, and then through hot cells (where air pressure was lowest). The original filtration system consisted of CWS and charcoal filters. High-Efficiency Particulate Air filters were installed in the early 1960's, and a second HEPA filtration bank was emplaced for added protection in 1970. All of the filters (except for individual cell and hood filters) were located in a network of stainless steel ducts, and air was pushed through them via ten large fans to a 55-ft-high 8-ft-diameter stack located on the north side of the building. A second stack was built as part of the 1959 to 1960 addition. Major stack decontamination efforts and repairs were undertaken in late 1967 and in 1970, and the main stack was replaced in 1978. Air in the cell and laboratory sections of the building was completely changed and recirculated about every two minutes, but air changes in the offices and corridors occurred less frequently.

The original 325 Building contained eight hot cells, each 6 ft by 6 ft by 5.5 ft (deep) surrounded by 2.5-ft-thick concrete walls with stainless steel liners. Two of these cells were located in Room 203, and the other six were located in a first floor bay known as the "canyon." Three larger hot cells were added in the 1959 to 1960 construction of the High-Level Radiochemistry

wing. The largest, A-Cell, was 15 ft by 16 ft by 6 ft (deep); the others, B-and C-Cells, were 15 ft by 7 ft by 6 ft (deep) (Figures 45, 46, 47, 48, and 49). All of these larger cells were surrounded by 4-ft-thick, high-density concrete walls with stainless steel liners. Each of the 11 hot cells was equipped with remote manipulators (hydraulic in the earlier cells and electric in the cells built later), periscopes, and lead glass windows. Each hot cell drained to a holding and sampling tank. The central RLWS connection was located on the northeast side of the building. Additionally, a transfer line between the 324 and 325 Buildings to facilitate waste vitrification work was installed in 1971. Finally uncapped and upgraded in 1978, this triple-walled, deeply buried stainless steel system allowed high-level wastes to be liquified in the 325 Building and then pumped to the 324 Building for vitrification.[90]

34.2 ORIGINAL 325 BUILDING MISSIONS

The original project proposal for the 325 Building stated that it was "urgently needed to support existing processes and to explore improvements in them." Initial building missions listed as high priorities included production support and process improvement for REDOX, improvements for the Uranium Metal Recovery process (especially in the areas of handling wastes and acid supernates), and studies of separations waste treatment aimed at the development techniques to reduce high-level wastes to "cribbing tolerance" (i.e., to lower activity levels). Other important early missions were stated as production development for "Rala" (radioactive lanthanum), which is a tracer gas in non-nuclear test explosions, temporary technical support to the bismuth phosphate ($BiPO_4$) process (until this process could be completely replaced by solvent extraction separations at HW), support studies for tritium production, and basic investigations of plutonium chemistry (described by GE officials as being of "outstanding interest to the Hanford Works"). These missions, along with development of the PUREX, RECUPLEX, and Plutonium Recovery Facility (PRF) processes occupied the 325 Building during its first decade of operations.[91]

34.3 ISOTOPE CAMPAIGNS

The High-Level Radiochemistry addition, with its three larger hot cells, was completed just in time to house several pioneering "isotope campaigns" at HW. During the 1960's, the burgeoning United States space programs and experimental new programs using radioisotopes for medical purposes brought NASA and many medical research facilities as prime customers to HW. In many cases, HW high-level waste was the prime source (and in some cases the only source) to supply these isotopes. A number of new techniques developed in the 325 Building separated or fractionized specific isotopes from high-level waste by ion exchange, carrier precipitation, solvent extraction, and various combinations of these and other methods. The feed material was generally PUREX 1WW (first cycle waste) or waste from the commercial nuclear power plant at Shippingport, Pennsylvania. The isotopes in highest demand included strontium-90, cesium-137, curium-244, americium-241, and promethium-147. During these years, HW was the only supplier in the world of promethium-147, used by the Donald W. Douglas Laboratories in the development of the artificial heart. During the first years of operation, 14 million Ci of

promethium-147, 1 kg of strontium-90, 3 kg of americium-241, and 65 g of curium-244 were purified in A-Cell, while the flowsheet for a large strontium-90/cesium-137 recovery mission that took place in HW's B Plant from 1968 to 1978 was developed in the 325 Building's B-Cell. Strontium fluoride and cesium chloride encapsulation chemistry for the B Plant mission also was studied in B-Cell. During the same period, compatibility studies for strontium fluoride capsule development of the B Plant mission and experiments in the recovery of plutonium-238 from special, irradiated neptunium-237/aluminum target material were conducted in C-Cell.[92]

34.4 WASTE VITRIFICATION AND OTHER PROJECTS

The development of workable methods of vitrifying (solidifying or "glassifying") high-level waste into solid ceramic form also became a high priority at HW during the 1960's as concerns over tank space and underground waste migration mounted. From 1962 to 1964, waste solidification tests and demonstration of an early phosphate glass melter were conducted in A-Cell. At that time, the first spray calcination of 200 gal of PUREX 1WW was achieved. Studies that were part of a large DOE Nuclear Waste Vitrification Project (NWVP) took place in A-, B-, and C-Cells from 1977 to 1980. Meanwhile, experiments in high-level waste behavior during thermal concentration and light water reactor fuel dissolution tests for waste partitioning took place in B-Cell. During the same period, demonstrations of the molten salt electrodeposition of uranium oxide (UO_2) and plutonium oxide (PuO_2) occurred in C-Cell, as did solvent degradation tests from LMFBR processing (part of FFTF development).

The large NWVP mission was placed on standby by the DOE in 1980, and much contaminated material was left in A-, B-, and C-Cells. Because budget authorizations did not provide for cell and equipment decontamination and removal, space in these cells has been partially occupied ever since. However, since 1980, remaining available cell space has been used for materials characterization leach tests of waste glass and of spent nuclear fuel, post-irradiation examination of the boron thermal shield from N Reactor, and characterization of neutralized cladding removal waste (along with the testing of a potential method of converting it to non-TRU waste). Other radiochemical work conducted in these cells has included characterization of double-shell tank (DST) slurry, tests of fuel iodine control and fuel uranium dissolution methods for N Reactor, and experiments in the recovery of strontium using antimonic acid.[93]

34.5 THE 325 BUILDING WASTES AND CONTAMINATION

Work in the 325 Building, especially in the High-Level Radiochemistry addition, was conducted on highly radioactive materials. These substances and their resultant waste streams include all of the components of the bismuth phosphate, REDOX, Metal Recovery, PUREX, and RECUPLEX Processes (see Sections 20.4 and 22.4). Additionally, PRF process development introduced dibutyl butyl phosphonate, one of the most corrosive chemicals ever used on the Hanford Site, into 325 Building waste streams. Additionally, cell decontamination chemicals and reagents including nitric acid, ethanol, acetone, many commercial products of the Turco Corporation, and other

cleansers were blended into the high-activity waste streams. Gaseous and particulate wastes included iodine-131 and -132, cerium-144, ruthenium-103/106, strontium-90 and yttrium-90. The latter two usually were measured together and were expressed as Sr/Y-90. Many liquid radioactive wastes were piped through the RLWS connection on the northeast side of the building to the 340 Complex. However, extremely hot liquid wastes were loaded into "bowling ball casks" (200-gal or 500-gal capacity) and taken by truck directly to the 200 Areas (Figure 50). Shipping took place from a truck loading station on the north side of the building.

Solid radioactive wastes were collected in various types of containers used at HW over the years including gunk catchers, milk pails, paint cans, and lard cans. See Sections 32.2, 32.3, and 32.4. These wastes were stored at collection points in Room 524 and in various basement rooms, including at times rooms 32, 40A, 40B, 40C, and 50, and then disposed in the various burial grounds designated for use by 300 Area buildings at different times (618-10, 300 North, Wye, and 200 Areas Burial Grounds) (see Section 32.5). Additionally, Room 50 was the exit point for the very hot wastes routed to the 324 Building for vitrification. Uncontaminated liquid chemical wastes were piped to the 300 Area Process Ponds until 1975 and thereafter to the 300 Area Process Trenches. Before 1967 and 1968, some contaminated, used resins from 325 Building ion exchange columns were placed in 30-gal paper drums and disposed aboveground west of the 300 Area West Gate. Gaseous and particulate wastes were exhausted through cell, hood, and stack filters.

34.6 CONTAMINATION SPREADS WITHIN 325 BUILDING

Over the years, there have been numerous liquid and airborne contamination spreads outside of designated radiation zones inside the 325 Building. Examples of such loss of control incidents include a plutonium waste container reading 5 million d/m inadvertently left in a low-level rinse waste collection area in January 1958. A September 1961, incident deposited spotty plutonium contamination up to 6 million d/m on a laboratory floor, and a backup in a high-activity waste jetting line in the new addition spread liquid contamination up to 450 r/h on the waste transfer hood and nearby floor in October 1962. The upset of a sample carrier deposited promethium-147 contamination throughout six laboratories in February 1963, and UO_2 crushing operations in a basement ceramic fuels laboratory seven months later spread uranium dusts and fines around that facility. This same type of grinding and crushing work resulted in an explosion in a grinder within a hood in the ceramic fuels laboratory in March 1966. That same year, a joint report prepared by Industrial Safety and Radiation Monitoring personnel attributed several basement contamination spreads to "deteriorated housekeeping," especially in waste collection areas.[94]

A leak of solution containing plutonium-239 from B-Cell in August 1972 produced readings ranging from 40 to 100 r/h (alpha) in the 325 Building basement. In other cases in the 1970's, condensate drips and leaks in and from the filtration tunnel spread radioactivity in the basement to the extent that a June 1977 Radiation Protection report commented: "This is the fourth time in 18 months that the moisture removal system has failed... This moisture not only threatens to spread radioactivity in the basement, it threatens the integrity of the HEPA filters." Four months later, in a

different type of episode, alpha contamination comprising plutonium-238, plutonium-239, and americium-241 to the level of 120,000 d/m was spread on the outside of a glovebox and on other surfaces in Laboratory 400. In August 1981, a vacuum pump was mistakenly wired in the reverse direction and pressurized. This action spread waste solution in two main floor rooms and in basement Room 50. Contamination readings in that incident reached 1 million d/m. A contaminated water leak from B-Cell in April 1988, produced dose rates of 150 to 200 mr/h in the affected area, and a similar leak of aqueous cell wastes (albeit with lower activity levels) occurred in 1990. Today, residual internal contamination from historical operations is still being found in the 325 Building. The opening of a sink trap leading to the sanitary drain system in February 1991 revealed radioactive mercury and uranium-235 contamination attributed in the investigative report to "past... work practices."[95]

34.7 CONTAMINATION RELEASES TO THE ENVIRONMENT

In addition to events involving contamination spreads within the 325 Building, some contamination releases to the environment over the years have resulted from facility operations. Stack emissions of iodine-131 and iodine-132 totalling about 95 mCi and resulting from the chemical dissolving of a sample of a "green" (short-cooled) fuel element from the PRTR occurred in November 1963. The isotope campaigns conducted in the 1960's generated additional stack releases of cerium-144 in 1966 and iodine-131 in 1967. The 1967 discharges, totalling nearly 300 mCi over several months, were the most serious airborne releases in the building's history. They resulted from early attempts to make plutonium-238 from irradiated neptunium/aluminum targets. This plutonium-238 campaign also produced releases exceeding tolerance standards from the 327 Building stack (see Section 36.4) and contamination spreads within both the 325 and 327 Buildings. After major 325 Building stack decontamination and repair efforts and the addition of a second layer of HEPA filtration, a stack release of 350 μCi of strontium/yttrium-90 occurred in April 1973. Promethium-147 in the 325 Building generated liquid effluents in excess of 340/307 Complex acceptance criteria in June 1967, with the result that wastes containing 250 mCi of this isotope were discharged to the 300 Area Process Ponds (see Part III).

Other environmental releases from the 325 Building have occurred primarily in the form of leaks to the soil from the old RLWS pipes and from other drains, pipes, and cell and basement encasements. Core drill dirt samples under the 325 Building addition taken in 1976 found soil contamination containing manganese-54, cobalt-60, ruthenium-106, antimony-125, cesium-134/137, and potassium-40, a naturally occurring isotope found in all potassium. Some contaminated soil was removed during the 1978 to 1979 replacement of the old RLWS line, but some pockets of contamination remain. In 1990, nearly 400 gal of ethylene glycol was discharged to the 300 Area sanitary sewer system, the result of a leak in a 325 Building heat exchanger.[96]

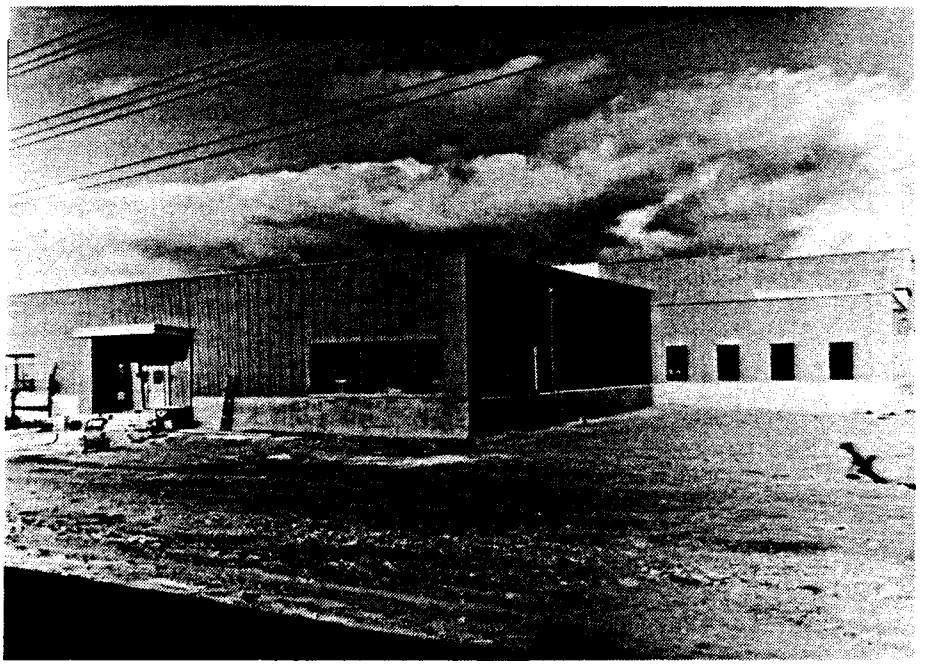


Figure 44. The 325 Radiochemistry Building, 72% complete in early February 1953.

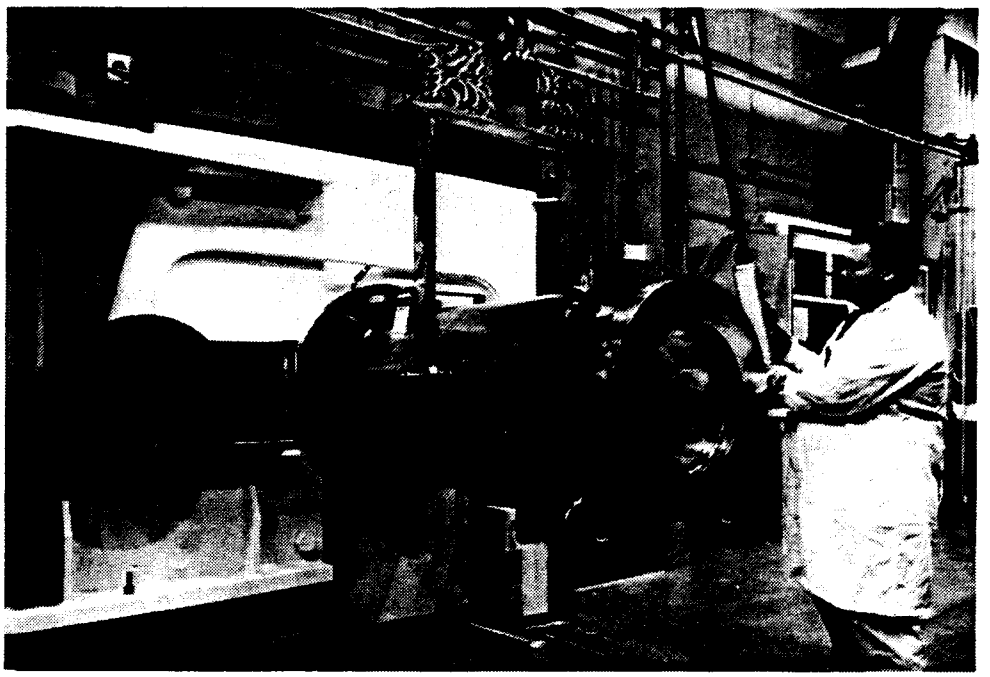


Figure 45. Radioactive material being loaded into C-Cell through a 7-ton cylinder gate cask attached to the back cell door, 1964. C-Cell is part of the 1960 addition constructed at the 325 Building.

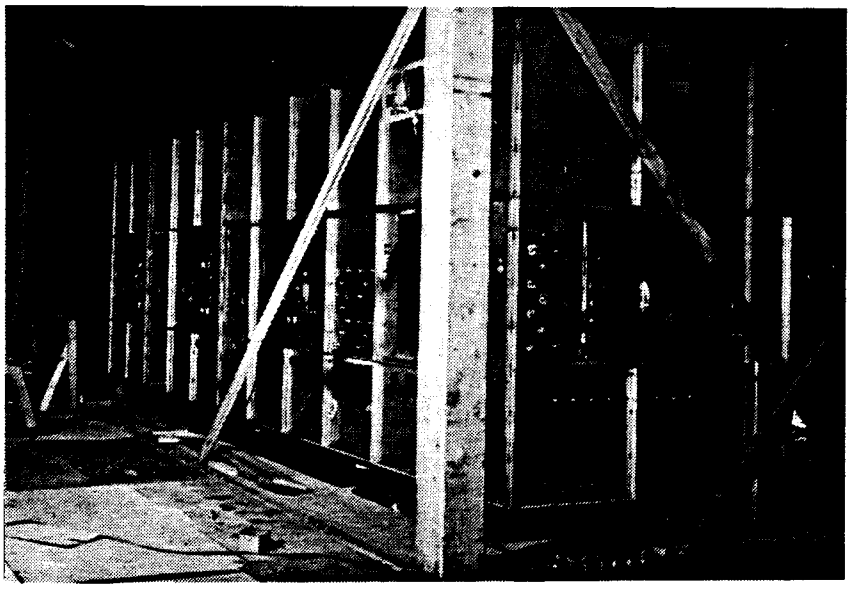


Figure 46. Stainless steel shell of hot cell under construction in the 325 Building addition, 1959.

Figure 47. High-density concrete is sprayed around reinforcing steel bars that surround hot cell shells during 1959 construction of the 325 Building addition.

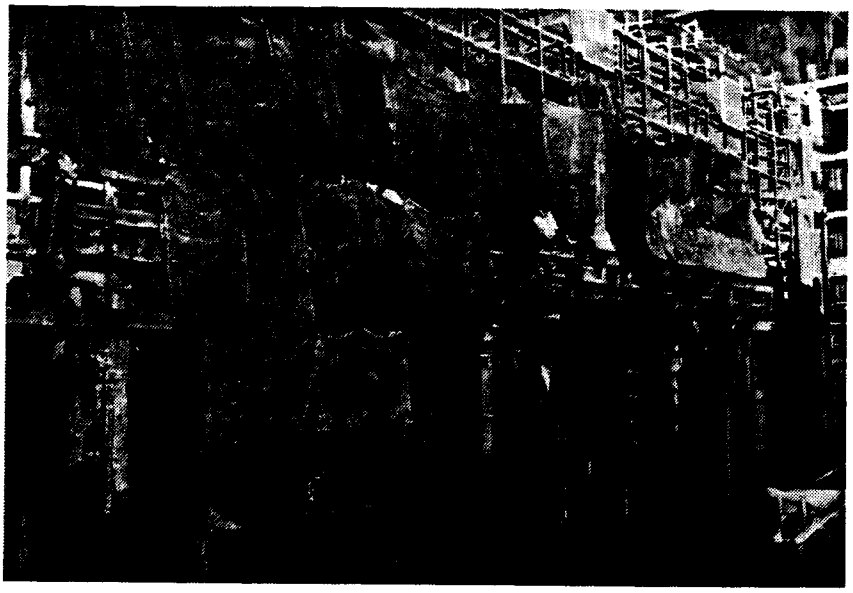


Figure 48. Wet gunny sacks hang over the freshly sprayed high-density concrete that surrounds A-, B-, and C-Cells during the 1959 construction of the 325 Building addition. The wet sacks were needed to prevent the concrete from drying too quickly and cracking.

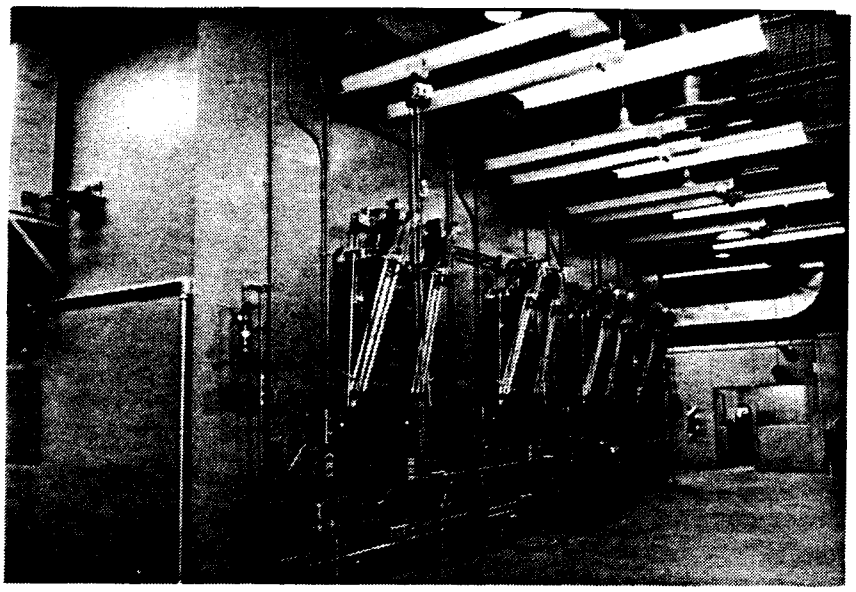


Figure 49. New manipulator equipment attached to the front faces of A-, B-, and C-Cells, 1959. Cell construction was still incomplete, as indicated by some of the empty cell plugs and ports near the bottom.

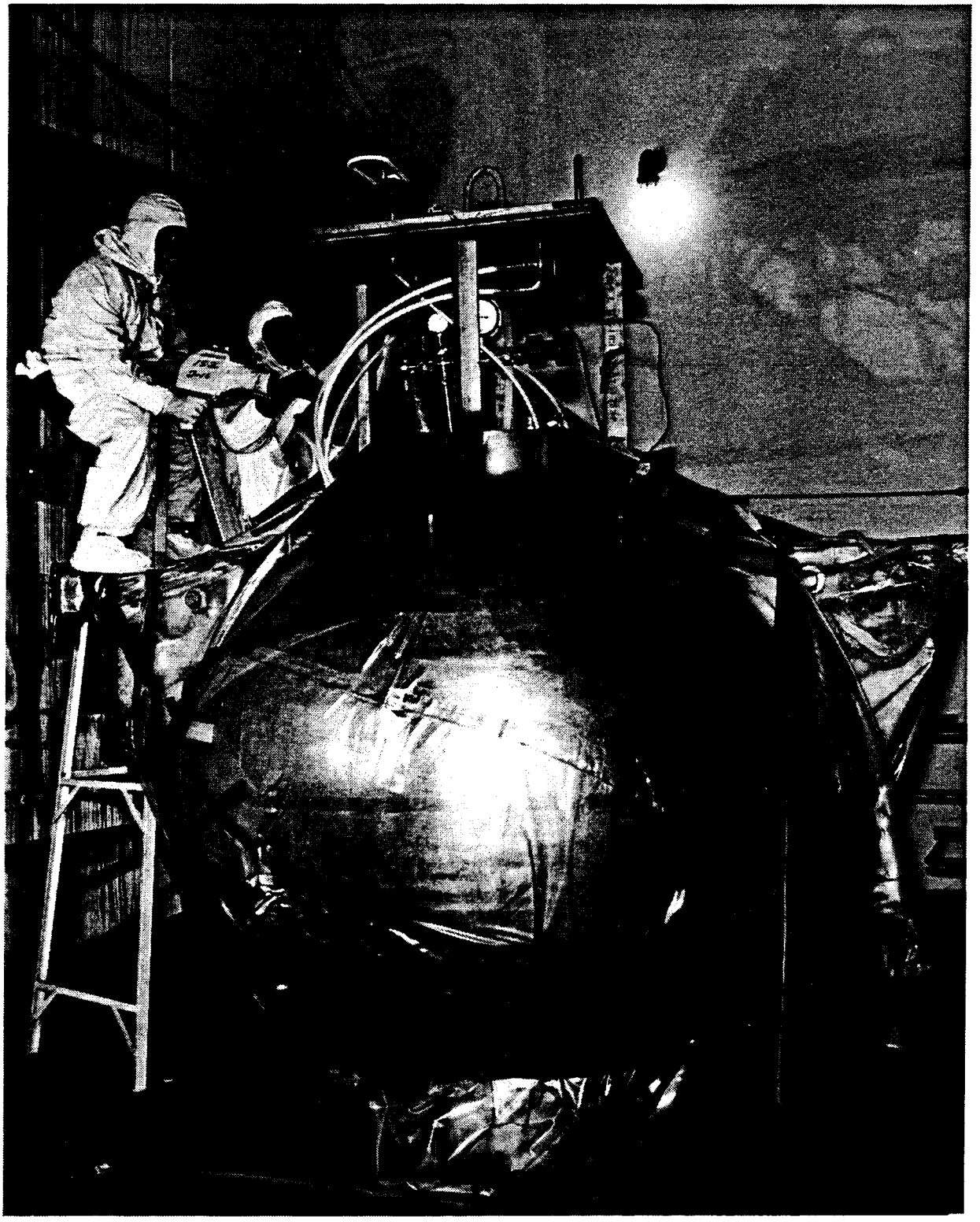


Figure 50. A 30-ton bowling ball cask loaded with crude waste from the REDOX Plant, ready for shipment to the 325 Building for use in the isotope campaigns and vitrification experiments of the 1960's.

Figure 51. A manipulator is changed out of C-Cell in 1968.

Figure 52. A Hanford worker dressed in protective clothing known as Special Work Permit (SWP) issues and attached to a hose supplying fresh air decontaminates A-Cell in the newer section of the 325 Building, 1965.

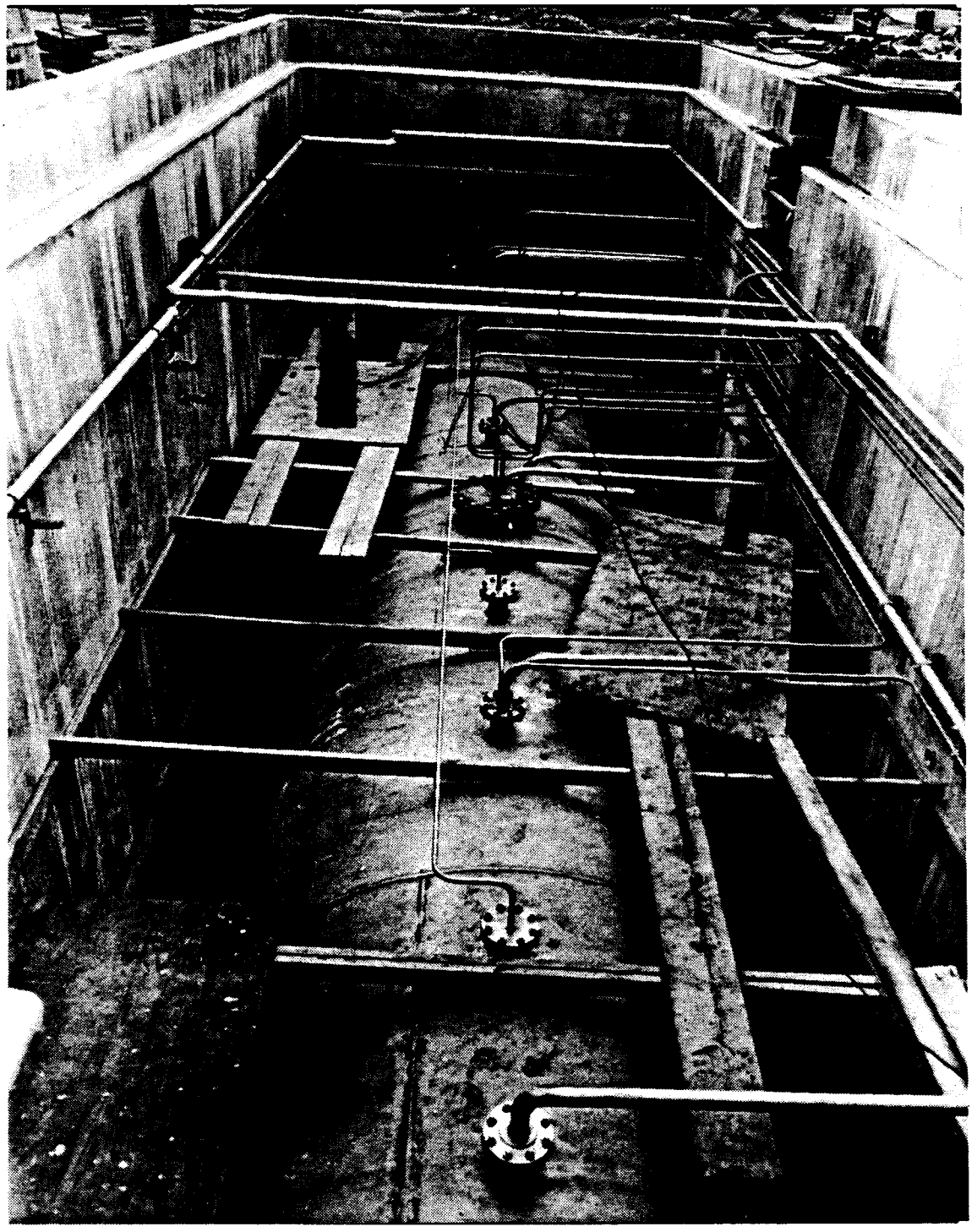


Figure 53. Waste Tank 1 (known as WT-1) rests on its concrete support during construction of the 325 Building addition in 1959. The emplacement of large concrete shielding blocks over the top of this belowground tank then completed the construction of this waste vault on the north side of the new addition. The tank held hot cell wastes until sampled and routed either to the 340 Retention and Neutralization Complex or through casks to the 200 Areas.

35.0 THE 326 PHYSICS AND METALLURGY BUILDING

35.1 FACILITY DESCRIPTION

The 326 Building, known early on as the Pile Technology Building, opened in 1953 with two primary missions, both associated with the support of production pile (reactor) operations (Figure 54). The original building, although it has undergone upgrades and modifications over the years, has never received an addition. The structure is 190 ft by 180 ft by 38 ft (high), with a total area of 63,107 ft^2. It has a bolted steel framework over a concrete basement; the exterior walls consist of fluted steel insulated panels. The first and second floors are steel with concrete, finished originally with asphalt or vinyl asbestos tile. The floor loading capacity is approximately 100 lb/ft^2. Internal partitions on the first and second floor are moveable metal, while the basement partitions are plastered gypsum block. A special counting room has high-density concrete walls, and the parapeted roof is a slightly sloped steel deck topped with tar and gravel finish.

The L-shaped building contains offices along the outside and laboratories along the inside on the first and second floors. An equipment room is located on the first floor in the angle of the L. The basement contains large laboratories with 15-ft ceilings. These laboratories were originally designated for heavy metallurgical work, large reactor mock-ups, and exponential pile physics experiments. One of these laboratories has an exterior door served by an 8,000-lb lift and a 2-ton monorail. The first and second floor standard laboratories were 20 ft by 25 ft. The building contains no hot cells, but work with high-activity substances was performed in lead brick "caves" that sometimes were termed "hot cells" in slang usage. Ventilation for contamination control supplied air first to offices and corridors and then exhausted it from laboratories. The CWS filters originally operated in individual laboratory hoods, but these were replaced by HEPA filters about 1960. The building also has a 45-ft-high, 6-ft-diameter stack. A 3,000-lb hydraulic elevator serves all floors.[97] Major equipment upgrades were added in 1962, fire protection sprinklers and new instrumentation were added in 1977, and additional modifications and upgrades occurred throughout 1981 to 1984. The building transferred to PNL operations in 1987 and now is called the Material Sciences Laboratory.

35.2 THE 326 BUILDING MISSIONS

According to high-level HW planning officials, the original 326 Building was constructed to "assure continuity of operations [of production reactors], to maintain and to improve the present plants [reactors], and to develop the technical information required for the design of future plants." The primary physics mission was to conduct the exponential pile physics development work that had been done first in the P-11 Project and later in the 189-D Building. This work consisted of approach-to-critical, lattice design experiments conducted in graphite piles directed toward finding new lattice configurations to improve reactor efficiency and safety (see Part II). During the earliest years of building history, 4-ft, 8-ft, and 12-ft graphite cubes operated as approach-to-critical, exponential piles in basement laboratories.

The primary metallurgical mission was to examine reactor components and fuel elements to evaluate characteristics and performance. This work was performed on unirradiated fuels (either natural uranium or 90% enriched uranium) and on irradiated metal specimens. Radiometallurgical examination of irradiated fuels was performed in the 327 Building (see Section 36.2). Some early analysis of irradiated graphite took place in the 326 Building, but the samples were ground up and prepared in the 3741 Building (see Part II). Solid state nondestructive examination (NDE) methods such as X-ray diffraction, ion microprobe, and other spectrometry work were the principal means of analysis used in the 326 Building. Fuel jacketing process improvement studies also were conducted, including etching experiments and experiments with aluminum-silicon blends, beryllium-zirconium ratios, and various other alloys. Plutonium and plutonium oxide (PuO_2) fuels experiments also were conducted in the 1960's as part of the Plutonium Fuels Utilization Project (see Part V).

In the 1970's and 1980's, several of the laboratories were converted to accommodate chemical work involving unirradiated or low-level radioactive materials. The central mission continued to be support and study of reactor components and fuel elements during this period, including development and analysis work performed for the PRTR, N Reactor, the High-Temperature Lattice Test Reactor (HTLTR--see Part V), and the FFTF. These studies were enhanced by the addition of equipment including mass spectrometers, electron microprobes, quantitative image analyzers and tensile test equipment.[98]

35.3 THE 326 BUILDING WASTES AND CONTAMINATION

The earliest and most intense radioactive work in the 326 Building was the operation of exponential piles in the basement beginning in 1953 to 1954. However, pile operations, like 305 and 305-B Building activities, produced little environmental contamination (see Part II). In most cases, personnel exposure was the more serious hazard. The piles, shielded only by lead brick piles and caves, used polonium-beryllium and radium-beryllium sources, sometimes emitting as much as 100 million neutrons per second. These piles irradiated cobalt, copper, and other metallic foils to the point where post-irradiation readings of 10 r/h at 3 in. distance were achieved. In December 1954, one plutonium-bearing foil in the building read 210 million d/m. Such foils were examined in hoods and lead caves. According to H.I. Division reports, high personnel exposures were involved in both the analysis work and in pile loading tasks, and sometimes inadequate shielding around the piles and irradiated samples caused gamma shine in building hallways and offices. Monthly surveys of the pile rooms read 40,000 to 80,000 c/m on a routine basis during the 1950's, but radiation levels in the building decreased significantly after the Critical Mass Laboratory (209-E) was constructed for pile work in 1961. The physics work produced few liquid radioactive or chemical wastes and almost no airborne wastes. Solid radioactive wastes, including very hot foils, were removed to 300 Area burial grounds via "ice cream containers" throughout the years that the exponential piles operated (see Part III).

Wastes generated by metallurgical work in the 326 Building consisted primarily of chemicals and heavy metals. The etching experiments used many acids, including hydrofluoric, nitric, sulfuric, aqua regia, and even picric acids. Sodium hydroxide and potassium hydroxide were the principal caustics

used in the building, and many reagents and industrial cleansers including CCl_4, acetone, ethanol, and various commercial products also were used. As in other HW buildings, work with uranium and with other fuel and jacketing materials was conducted with few precautions in the early years. An H.I. Division report in November 1954 stated: "A general laxity towards radiation and contamination precautions exists in the operation of the Metallorgraphy [sic] laboratories in the 326 Building." Personnel often handled uranium slugs with bare hands, refused to wear respirators, and disposed of mercury and other regulated substances down sanitary and process drains. Particulate wastes, in the form of uranium and beryllium fines and grindings, were collected in a "bag" filter system before the installation of absolute (HEPA) filters in the early 1960's. Some of these escaped into and through the vent system. High-energy electron microscope work with plutonium samples and irradiated steel samples produced contamination spreads in the building in 1971 and 1972. Additionally, a radioactive materials shipping cask known as a "lead pig" containing irradiated steel samples spilled in the structure in 1972.

The 326 Building was connected to the RLWS network upon its original construction, and a diverter line allowing liquid wastes from the 329 Building to flow through the 326 RLWS connection was installed in 1968. Pipe chases within building partitions contain carbon-steel, copper, and stainless steel piping. The 326 Building sinks, drains, and trenches have demonstrated residual contamination when opened or when liquids in the lines backed up over the years. A 1976 survey of pipe trench sediment found evidence of uranium-235/238, thorium-231/234, radium-223/226, lead-211, protactinium-231, and other isotopes. In particular, soil samples taken near a leak in the 326/329 diverter line to the RLWS in 1976 indicated the presence of cesium-137, with lesser amounts of cesium-134, cerium-praseodymium 144, europium-155, americium-241, actinium-228, and other nuclides in trace quantities. A 1980 to 1981 building upgrade found much mercury in the drain system and basement. Later in the 1980's, the diverter line experienced multiple problems including valve and instrumentation malfunctions, backups, and the unauthorized disposal of radioactive materials from the 329 Building. Six such incidents occurred from 1986 to 1989, two of which resulted in radioactive liquid backups into 326 Building laboratories. In general, however, wastes and contamination in and around this structure are less serious than those at most 300 Area Manhattan Project buildings and/or at the 325 and 327 Buildings.[99]

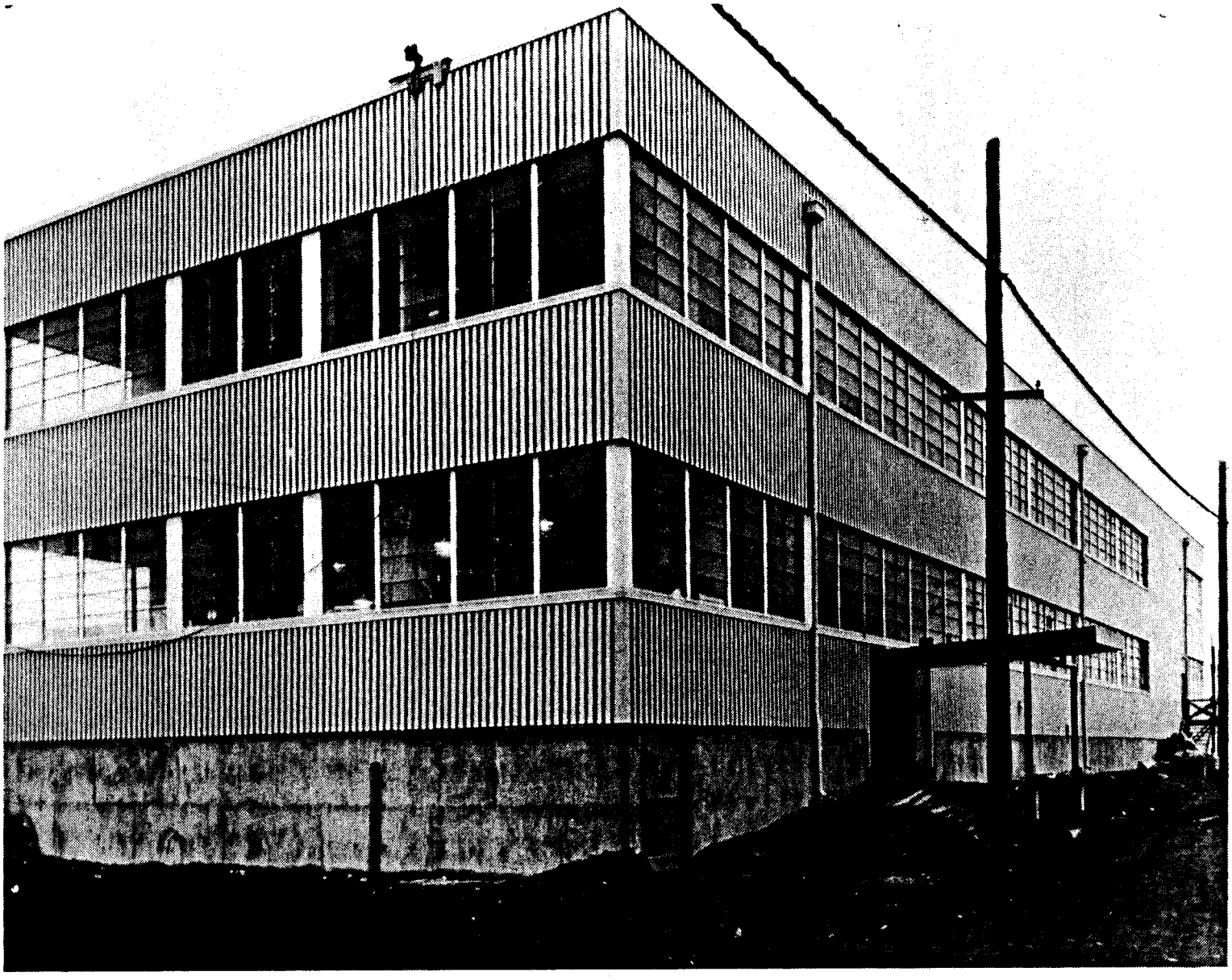


Figure 54. The 326 Pile Technology Building, 67% complete in early December 1952.

36.0 THE 327 RADIOMETALLURGY BUILDING

36.1 FACILITY DESCRIPTION

The 327 Building opened in 1953 to house the examining and testing of irradiated materials, particularly fuel elements and fuel cladding materials. It replaced the World War II "Test Building" (111-B), where the earliest HEW and HW metallurgical work had been done. The original 327 Building received two additions and two major modifications over the years. The actual additions consisted of a two-story extension to the west coupled with laboratory modernizations in 1960 and a one-story extension on the southwest end for office space during 1962 to 1963 (Figures 55 and 56). Together with the original construction, these additions brought the dimensions throughout most of the building's operating history to 215 ft by 140 ft by 32 ft (high), with a total area of just under 30,000 ft^2. The building is roughly cruciform in shape and consists of one story on grade and a basement. The framework is welded steel, with fluted steel insulated panels for exterior walls and a parapeted, slightly sloped steel deck roof topped with a tar and gravel finish. The first floor is reinforced concrete or steel decking covered with concrete finished with sheet vinyl. Interior partitions that are not part of laboratories or hot cells are moveable metal.

The main laboratory area is an east-west "canyon" 210 ft by 29 ft by 21 ft (high) that originally held eight small hot cells (B, C, D, E, F, G, H, and I), two water basins for holding irradiated fuel rods, two lead brick cells, a burst test facility, and a decontamination chamber. Each cell was 6.08 ft by 4.3 ft by 4.3 ft (high) with meehanite cast iron high-density walls. These walls were 18 in. thick in two of the cells, 10.5 in. thick in six of the cells, and 15.5 in. thick in A-Cell, a cell added in 1960 of comparable size to the others. The same 1960 addition also enlarged the two water basins and added the High-Level Radioactive Materials Receiving and Storage Bay on the west end. The canyon area was served originally by a 15-ton capacity bridge crane, and another 25-ton bridge crane was added in 1970. Each original cell had a 14-in.-square lead glass window (the largest available at the time) and hydraulic manipulators (because electric manipulators were not available in the 1950's). Additionally, each cell had its own bag filter, supplanted by a HEPA filtration system about 1960. Stainless steel ducts also contained additional filtration (originally CWS, but later HEPA combined with charcoal filters for iodine-131 control) and led to a 44-ft-high, 5-ft-diameter stainless steel stack. The entire building was maintained on air pressure lower than atmospheric, with hot cell air kept at the lowest pressure of all to ensure that air flowed from offices to canyon to cells and then through the filtration system and up the stack.

In 1970, the decontamination chamber in the north-central portion of the canyon was torn out to make room for the Special Environmental Radiometallurgical Facility (SERF), a large hot cell with a controlled atmosphere of inert nitrogen. The SERF contained an operating area of 12 ft by 6 ft by 8 ft (high), with additional storage area of 4 ft by 4 ft by 5 ft. It had electric manipulators and 18.5-in.-thick steel plate walls. In 1978, the 327 Building also received extensive office modifications. The building

passed from GE to BNWL in 1965, then to Westinghouse Hanford in 1970, and then to PNL operations in 1987. It was renamed the Postirradiation Testing Laboratory (PITL) about 1980.[100]

36.2 THE 327 BUILDING MISSIONS

The original 327 Building mission was conceived as "largely one of plant assistance to the present piles" (reactors). It was extremely important in the early 1950's, when HW's primary task of production was increasing yearly, to determine the "nature and causes of dimensional instability" in fuel elements and the effects or irradiation stresses on pile materials. Specific early reactor problems addressed in 327 Building studies included the "blistering" or distortion of fuel elements during irradiation, the control of uranium grain structure during fabrication and of uranium "growth" during irradiation, and the metalography of canning and corrosion. The effects of higher power levels of irradiation on new and different pile structural materials also was assigned as an important "long range mission" early in 327 Building history.

Missions in the late 1950's and early 1960's included the establishment of specifications for N Reactor fuel rods and process tubes, the conduct of DE and NDE to evaluate the performance of these rods and tubes after N Reactor startup in 1963, and the examination of various isotope combinations and capsules in the HW chemical "isotope campaigns" (see Section 34.3). As part of Hanford's waste vitrification projects of the 1960's and 1970's, performance evaluations of both components and glassified products were conducted in the 327 Building. Both destructive examination (DE) and NDE analyses also were performed during the 1960's through 1980's on fuel rods from the PRTR and the FFTF (see Part V), from the GETR [a GE fast flux test reactor built in Vallecitos, California, that used enriched UO_2 fuel], and from the EBR-II (Experimental Breeder Reactor II) and the MTR (Materials Test Reactor) at the Reactor Testing Station (now the Idaho National Engineering Laboratory--INEL). In the course of this work, several pioneering fuel examination and recording techniques were developed in the 327 Building. Among these were the capacity to produce multi-dimensional photomosaics to depict all facets of metallurgical results and the development of nonphotographic recording capabilities and of neutron radiography film. Additionally, the new concept of "gas-tagging" and the development of "cover gases" for the FFTF achieved reality through work largely conducted in the 327 Building (see Part V).[101]

36.3 THE 327 BUILDING WASTES AND CONTAMINATION

The very nature of the work performed in the 327 Building involved and generated extremely high-activity wastes. Irradiated materials, including ruptured or failed fuel rods containing plutonium and fresh fission products, were examined while they were "green" (i.e., when they had experienced very little decay or stabilization time). Destructive examination of an irradiated fuel rod called for drilling a pinhole from which was collected a fission gas sample. Next the element was sawed open and a metallurgical sample was ground and polished for analysis. Irradiated process tubes and other reactor components likewise were cut, ground and polished to produce workable samples.

The irradiated fines generated by this work were swept up and treated as solid waste, but powdery dusts left behind clogged air filters, sifted through the canyon, or were flushed into the RLWS as liquid wastes. There they collected in "hot spots" in cell drains, pipes, and around the weld joints where they were periodically discharged using strong chemicals and by occasionally mildly shaking the RLWS line with rivet guns.

36.4 AIRBORNE RADIATION EVENTS

Intense waste and contamination problems developed in the 327 Building almost as soon as it opened, especially in connection with high airborne radiation readings and with sample and waste transfers. High airborne radioactivity readings with "external contamination potential" produced a July 1954 H.I. Division recommendation that a separate 327 Building stack sampling system similar to that at REDOX be installed. Such a system was emplaced in 1955 because canyon air contamination events continued. In one 1956 incident, a waste transfer produced airborne radiation readings in the canyon of 4.6×10^{-8} μCi/cm^3, and in 1957 the transfer of a ruptured fuel slug from its shipping cask produced canyon air readings of 4.1×10^{-8} μCi/cm^3. Both air conditions were well above HW tolerance limits. Uranium dusts and fines also continued to settle in the canyon at the same time that irradiated products and wastes become hotter and contained more hard gamma-emitting isotopes as 100 Areas production reactor power levels were raised repeatedly throughout the 1950's and 1960's. By 1960, routine H.I. Division surveys of the 327 Building canyon frequently found surface spot contamination readings of 20 to 30 r/h.

Sometimes airborne contamination from irradiated uranium and graphite fines was discharged outside of the 327 Building. After one E-Cell filter failure in 1956, H.I. Division monitors reported: "There was an obvious passage of airborne contamination... to the atmosphere. An estimated 6 to 40 millicuries of fission products were released." However, the most severe airborne contamination releases outside the building came in 1967. That March and April in connection with the same plutonium-238 test production campaign that produced stack releases from the 325 Building (see Section 34.7), destructive analysis performed on some of the irradiated neptunium-aluminum fuel targets resulted in discharges of over 40 mCi (iodine-131) from the 327 Building stack. In April and May of that year, over 300 mCi (iodine-131) was released as the result of DE work on PRTR fuels, and in August another 88 mCi (iodine-131) was discharged as a consequence of other fuel examinations.[102]

36.5 SOLID SAMPLE AND WASTE TRANSFERS

Some of the most severe instances of contamination spreads within the 327 Building occurred as the result of the transfer of radioactive materials and of wastes in and out of hot cells and/or radioactive materials storage basins. Such transfers produced numerous floor and other surface contamination events throughout the 1950's to 1970's, some of which were termed "gross" in H.I. Division monitoring reports. In the earliest years, liquid cell wastes were "slurped" by a vacuum pump into plastic bottles held in lead boxes or "gunk catchers" outside the cells. This operation produced

high worker doses as well as contamination spreads, both from the procedure itself and from the wastes. Soon, assault masks and SWP conditions were imposed on this work and later, waste handling methods were changed to make them completely remote, in-cell procedures. Meanwhile, in the month of September 1954 alone, three contamination events producing readings of 80,000 c/m in the 327 Building canyon resulted from sample transfers. In each case, according to H.I. Division reports, "infrequent use of step-off pads" led to contamination spreads throughout the building. As a result, a second radiation monitor was assigned to full-time work in the 327 Facility. Three months later, a waste transfer brought readings of 9 r/h, including 4 r/h at 4 ft from the waste itself and 5 r/h at 18 in. from the "load lugger" that transported the waste to the newly opened 300 North Burial Ground.

Other transfer problems occurred at the truck loading area on the building's north side when incoming sample containers leaked. In one 1960 case, tantalum-182 and chromium-51 were spread on the bed of a truck arriving from 100-C Reactor. Three months later, in early 1961, a ruptured fuel element in a leaking container spread contamination of up to 4.5 r/h on an incoming truck and up to 200 mr/h on the ground at the 327 Building truck loading area. Other contamination spreads that resulted from sample transfer problems in and around the building occurred in 1963, 1965, 1972, 1973 (two events), 1974 (two events), 1979, and 1990. In the 1963 incident, a manipulator removed from A-Cell and placed in the "PRTR Room" produced readings of 350 r/h on floors and flat surfaces in that room. In the 1965 incident, a criticality alarm sounded in the building when it was subjected to a radiation flash exposure as an N Reactor fuel element was being pulled out of a cask. In 1990, cesium-137 waste from transfer operations out of D-Cell spread contamination in the 327 Canyon.[103]

36.6 LIQUID WASTE LEAKS

Cell, drain, and waste piping leaks also accounted for some of the contamination events and waste losses to the environment that occurred in 327 Building history. Liquid waste from this facility included various irradiated materials in dissolved particulate form and an array of chemical reagents and cell cleansers including CCl_4, acetone, ethanol, kerosene, many commercial products, and others. Problems with C-Cell developed early because two Class I (most serious) and one Class II radiation incidents resulting from drain line leaks occurred in February 1955. Attempts to plug the leaking drain line resulted in splashes and spills of radioactive material reading 250 r/h on the floor below the cell.[104] Leaks from the cut-off cell produced "puddles" reading up to 5 r/h in the canyon on two occasions in 1956, and waste line leaks produced readings of 110 r/h in 1961 and of 100 r/h in the basement in 1963. During the 1960 building expansion, it was discovered that a 30- to 36-in. section of the RLWS consisted of cast iron instead of stainless steel. Corrosion of the cast iron by waste transfers over the years had deposited radioactivity in nearby soils. During RLWS replacement in 1978, additional smaller leaks were found. In 1968, mercury used in the fission gas sampling apparatus ran out onto the canyon floor from a disconnected sample line leading out of A-Cell. Both the A-Cell and C-Cell drain lines backed up into the 327 Canyon in a hydrostatic test of the underground waste system in 1973, and the radioactive waste sump leading to the RLWS backed up into the 327 Building basement in late 1979.[105]

36.7 EXPLOSIVE OR COMBUSTION CONTAMINATION EVENTS

In some cases, explosions and/or fires spread contamination in and around the 327 Building. Such a chemical explosion and fire occurred in E-Cell in October 1959 during the processing of an irradiated stainless steel capsule containing sodium-potassium. In 1966, a drill bit was blown out through a steel port in the side of A-Cell as the result of strong internal gas pressure from an irradiated lithium-aluminate target fuel element. Minor sodium-potassium explosions occurred in F-Cell in 1973 and 1974, and then a similar but more powerful explosion took place there in January 1976 (Figures 57 and 58). That hydrogen explosion destroyed the RLWS drain where it occurred and blew the drain contents out through cell ports and splattered them in the canyon and onto the outside walls of nearby cells. The resultant heat in F-Cell also melted and fused several equipment pieces. Cleanup included major renovation and painting throughout the canyon. The most serious explosion in 327 Building history, however, took place in February 1986 in SERF Cell. In that case, ethanol in the cell atmosphere ignited when an electric vacuum cleaner was turned on during cell decontamination operations. The cell's entire atmosphere, as well as the glovebox that made up the interface between the regular and nitrogen atmospheres, blew up, driving one cell plug far across the canyon and distending two others. Plutonium and other fission products were spread around the canyon to varying degrees, and the cleanup required 7 mo.[106]

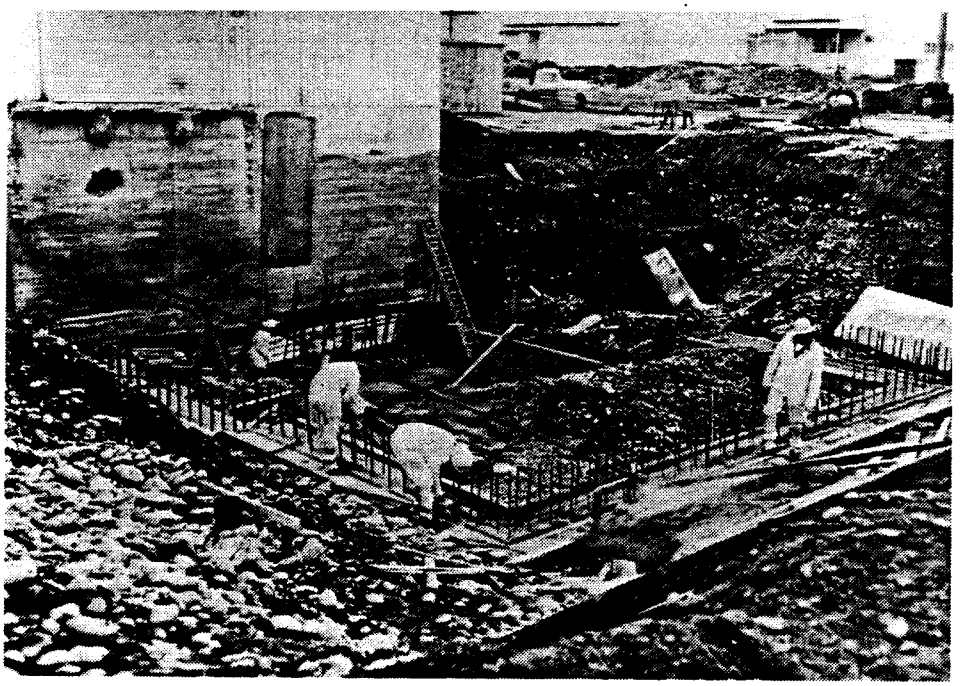


Figure 55. The 327 Radiometallurgy Building's Radioactive Material Receiving and Storage addition under construction in December 1958.

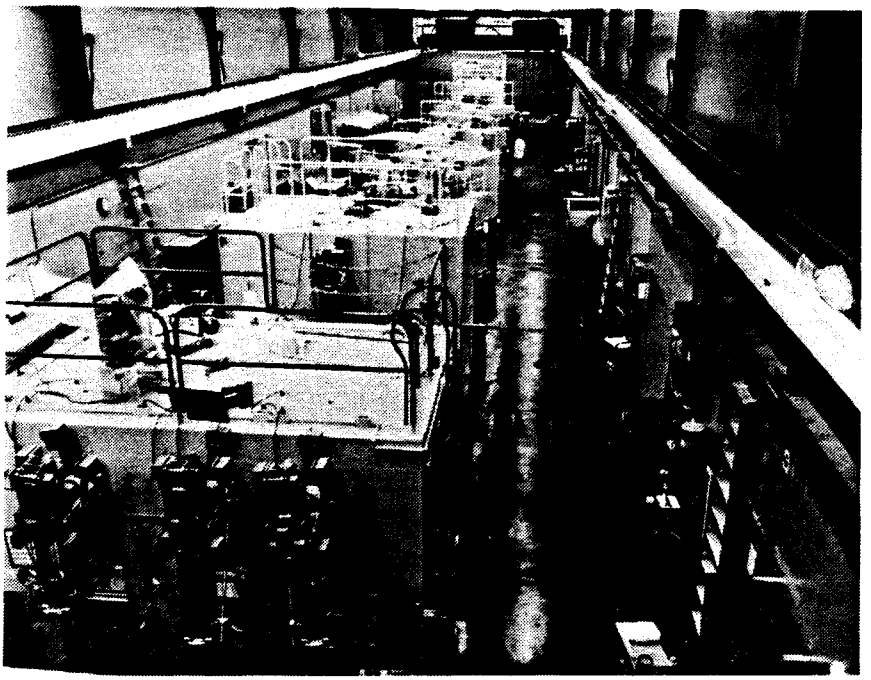
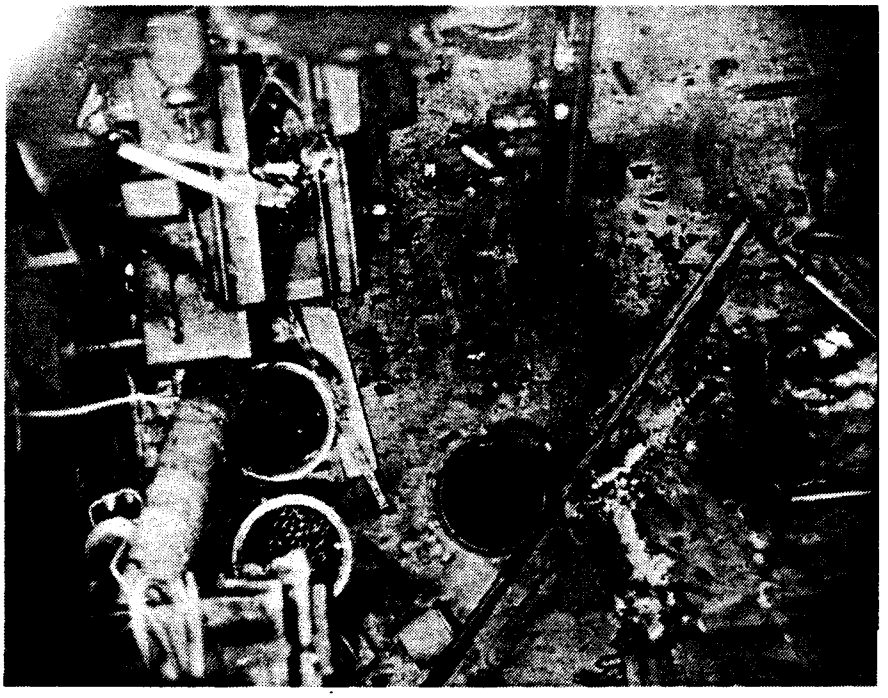
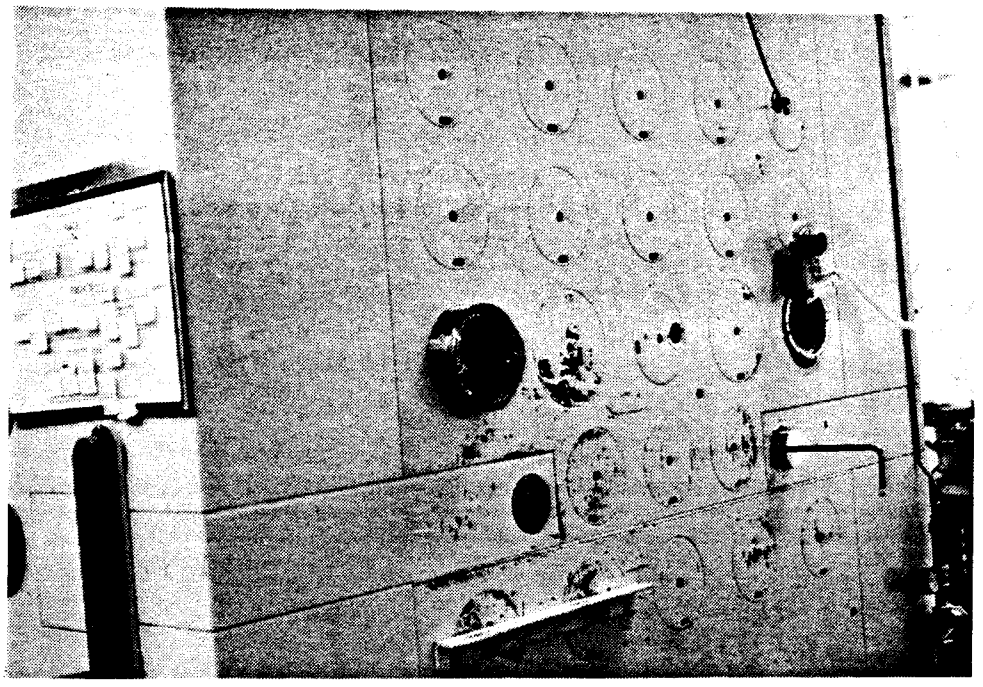


Figure 56. The 327 Building's "canyon," containing hot cells and water storage basins for irradiated materials.



Figures 57 and 58. Aftermath of the sodium-potassium and water explosion that occurred in F-Cell in 1976. The interior of F-Cell is shown above, and the damaged ports on the exterior of the cell are shown below.



37.0 THE 328 ENGINEERING SERVICES AND SAFETY SHOP AND 328-A ANNEX

37.1 FACILITIES DESCRIPTION

The 328 Engineering Services and Safety Shop, called the Mechanical Development Building when it was constructed in 1952, was built to contain craft, equipment, and fabrication services for the 300 Area laboratories (Figure 59). The building did not serve the fuel fabrication facilities, which incorporated their own shops within the Irradiation Processing Department. Instead, the 328 Building housed fabrication and servicing of specialized and intricate apparatus and equipment needed by the chemistry, physics, biophysics, and metallurgy laboratories of the HLO. The original three-story structure was 110.8 ft by 222.3 ft by 42.25 ft (high). In 1960 an office wing 46 ft by 48 ft was added. In 1961 an annex 25 ft by 48 ft known as the 328-A Building was added. Altogether, the 328 and 328-A facilities provided an overall shop and office area of nearly 40,000 ft^2.

Construction materials used in the main building and in the annex were similar, including a basic framework of bolted steel with exterior walls consisting of smooth steel insulated panels. The 328 Building contained a large shop area on the reinforced concrete first floor. The second and third floors, which contained smaller specialty shops and offices, were steel deck topped with concrete. Stationary interior partitions were made of gypsum board on steel studs, while moveable partitions were made of steel. The gable roof was insulated, built-up, three-ply, hot-mopped asphalt felt.[107]

37.2 THE 328 AND 328-A BUILDING MISSIONS

The 328 Building and its annex were constructed to replace the wartime 3717 Instrument Shop and the two 3722 Area Shops rendered obsolete in 1952 by the specialized needs of radiochemistry, radiometallurgy, and physics laboratories. The inclusion of a "well-equipped" central shop in the 300 Area expansions of 1952 to 1953 was termed "mandatory" by HW planners. The construction of the 328 Building allowed designers of the specialized 325, 326, 327, and 329 Buildings to reduce the shop facilities in these structures to "the minimum required for repairs to contaminated equipment not permitted to leave the 'hot' buildings." The 328 Building was a "cold" facility not equipped or permitted to contain radioactive materials. It housed a main metal and machine shop, two mock-up shops, a drafting room, as well as welding, paint, carpentry, and glass-blowing shops (Figures 60, 61, and 62). The large shop contained a spark erosion machine for cutting conductive metal, controlled atmosphere heat treating equipment, metallizing and hard chrome plating apparatus, a paint spray booth, and hooded facilities for working with quartz. Compressed air was distributed in many locations around the shop, while oxygen, acetylene, helium, and argon were piped to the welding areas. Hydrogen, hydrogen-propane, and oxygen were piped to the glass shop. Asbestos was embedded in many areas as a fire retardant.

Over the years, 328 Building functions changed very little, although it did undergo a name change to the Engineering Management and Technical Shop during the 1960's, and then another change to the present name. The building

still contains specialized and general equipment fabrication and repairs for Hanford Site laboratories, although it does not house glass blowing, optical, or instrument calibration work.[108]

37.3 THE 328 AND 328-A BUILDING WASTES AND CONTAMINATION

Wastes and contamination generated in these facilities were and are almost exclusively chemical. Machinery oils, degreasers, paints, glazes, acids, caustics, CCl_4, trichloroethylene, perchloroethylene, acetone, various alcohols, commercial cleansers, and other chemical substances all were used in the building over the years. Sometimes leaks and spills to surrounding soils occurred.

The building was never connected to the RLWS, and there are virtually no known instances of radioactive contamination. On a few occasions, contaminated pieces of equipment found their way into the facility from other structures, and on two occasions radioactive contamination incidents in other buildings affected the 328 Building. In one of these events, an individual sprayed with uranyl nitrate hexahydrate in the 1962 contamination incident in the 321 Building was brought into the 328 Building to be showered. The contamination flushed from this individual into the sanitary sewer system was so minor that it did not register there. Radioactive specks from the 1976 explosion at F-Cell in the 327 Building reached walkways around the 328 Building, and an individual from the 327 canyon was brought in to be showered. In this instance also, contamination levels were virtually undetectable in 328 Building sewer systems.[109]

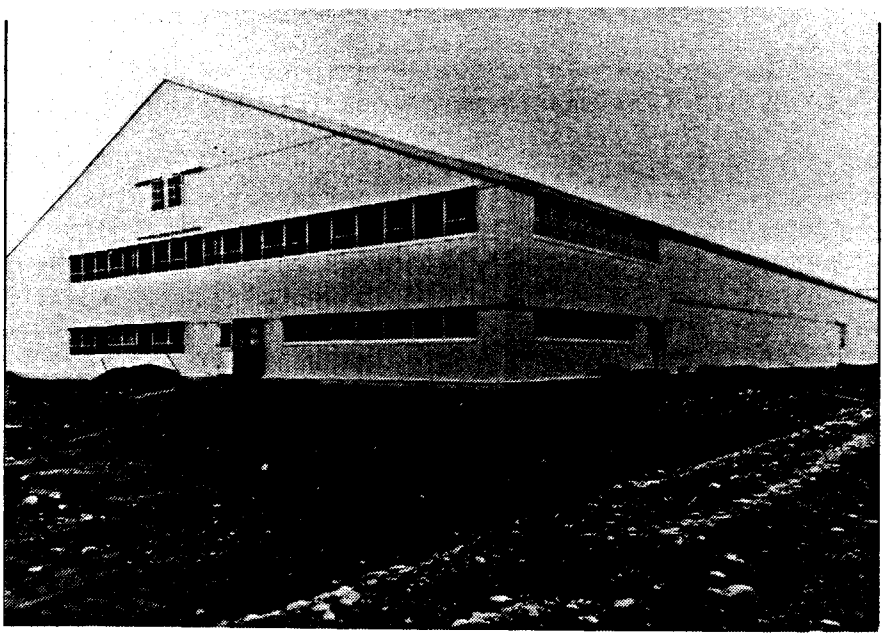


Figure 59. The 328 Mechanical Development Building under construction in 1952.

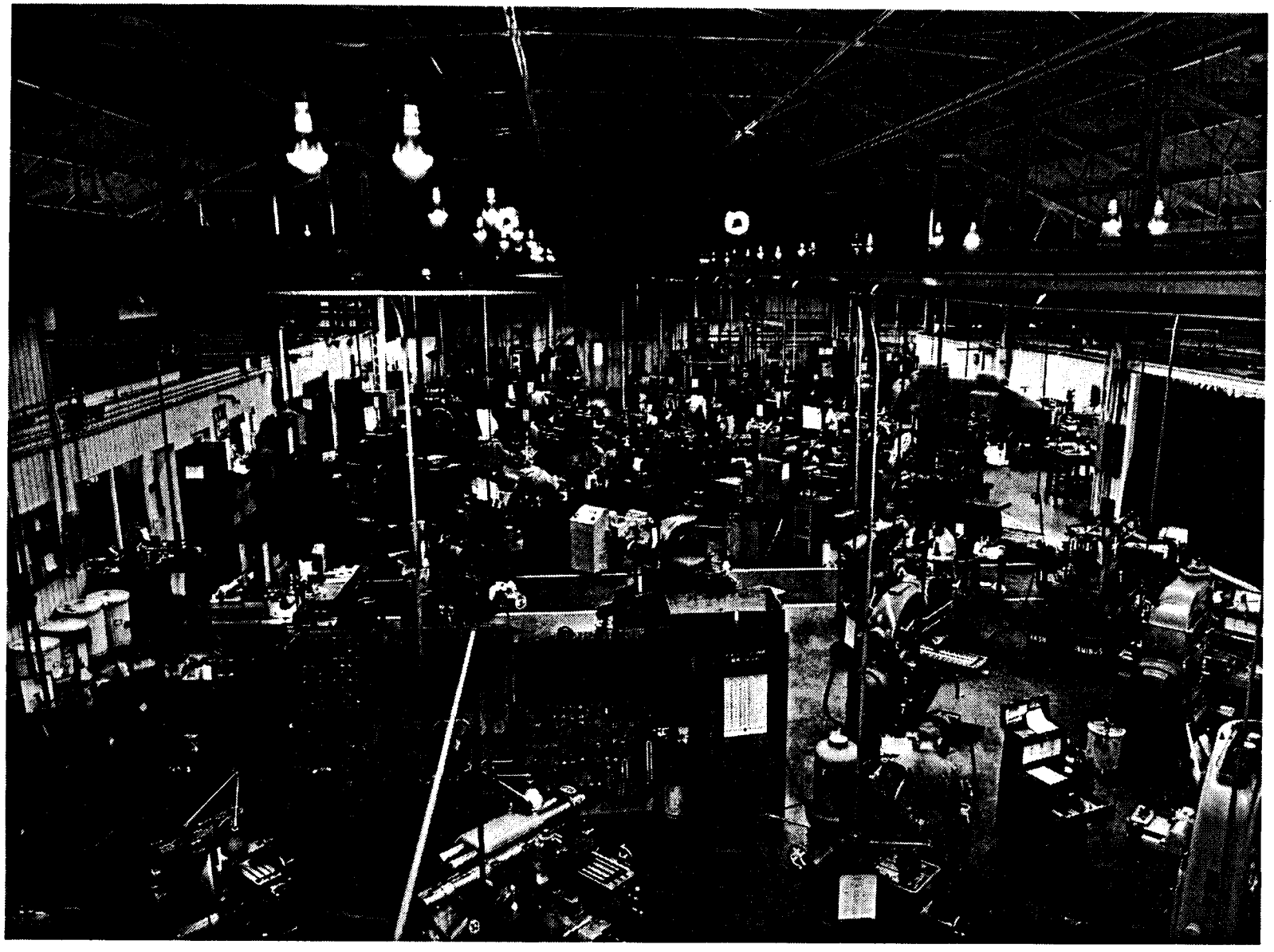


Figure 60. Interior of the Central Machine Shop in the 328 Building, about 1960.

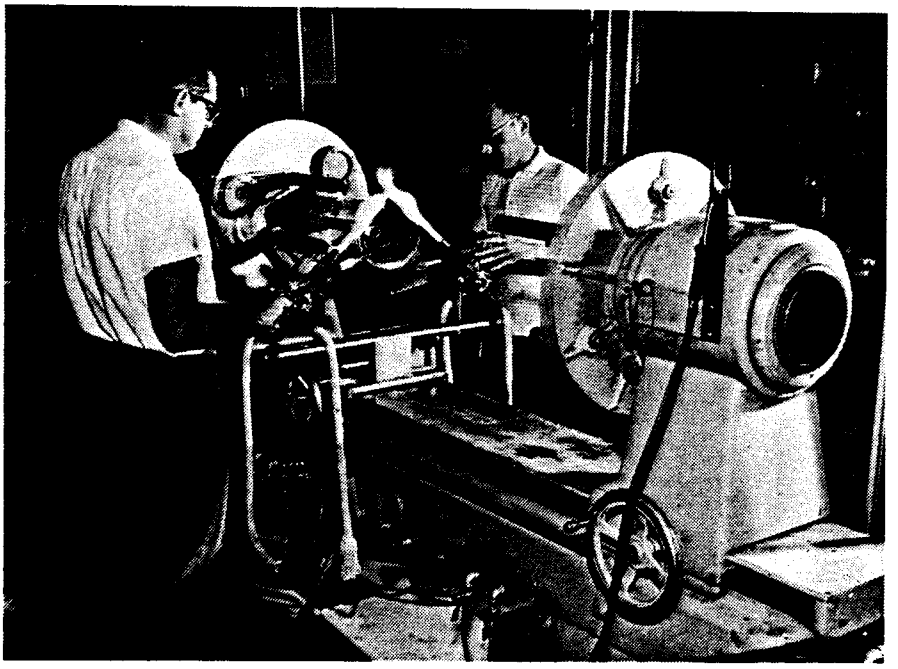


Figure 61. Operators in the 328 Building's Glass Shop fabricating a dessicator used in a Hanford Works laboratory during the mid-1960's.

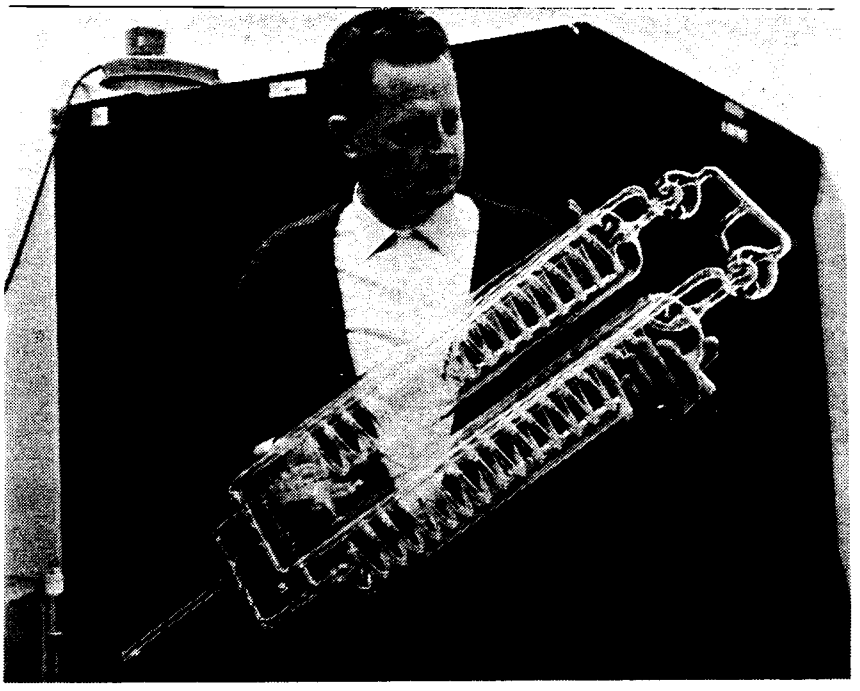


Figure 62. Hanford worker holds a laboratory-scale distillation column precision blown in the 328 Building's Glass Shop, mid-1960's.

38.0 THE 329 BIOPHYSICS LABORATORY

38.1 FACILITY DESCRIPTION

The 329 Biophysics Laboratory was built in 1952 to 1953 to support the pioneering HW environmental and bioassay programs. Many unique techniques in the science of environmental monitoring were developed at the Hanford Site during the 1940's and 1950's, along with much new surveying and analytical instrumentation. Discoveries about the variety and magnitude of radiological exposure potential of HW operations to workers and to the environment inspired the creation of the H.I. Division, an organization that grew from a wartime staff of five people to one that required 4% of Hanford's budget by 1950. As part of this rapid expansion, a "Health Instruments Control and Development Laboratory" was proposed in 1949. Soon afterward, it was constructed and renamed the Biophysics Laboratory (Figure 63).

As originally built, this structure was 217.5 ft by 121.5 ft by 34 ft (high, partial), with a total area of 35,803 ft^2. This bolted steel framework facility had no basement and had a second story over only part of the building. The exterior walls were fluted steel insulated panels, and the parapeted, slightly sloped roof was steel deck topped with tar and gravel finish. The floors were reinforced concrete finished with vinyl asbestos tile; and interior moveable partitions were metal. The building consisted of three sections (A, B, and C). Sections A and B contained a mixture of laboratories, offices, chemical storage rooms, and counting rooms, with two particularly large counting rooms. All counting rooms had 1-ft-thick concrete shielding walls and roof. Other standard laboratories were approximately 13 ft by 24 ft. There were no hot cells in the building, although thousands of lead bricks were used to construct walls, partial enclosures and "caves" to shield work with radioactive substances. Atmospheric pressure barriers operated in Sections A and B to bring air to offices and corridors first and to laboratories just before exiting the building. In 1970, HEPA filters were installed in some laboratory hoods in these sections, but the building has no exhaust stack.

Section C was a large machine/fabrication shop equipped with lead bricks to fabricate, test, and calibrate radiation measurement instrumentation. In 1974, Section D, a pit known as the Neutron Multiplier Facility, was added to the building, but it did not receive nuclear material until 1977. A proposal was made to install a gamma irradiator, but because of safety concerns, a californium-252 neutron source for sample irradiation was emplaced instead. Today, this 100-mg source fueled by 93% enriched uranium-235 has decayed to approximately 1% of its original level.[110] In 1975, Room 14-C was designated as an Isolated Facility for work with plutonium and enriched uranium, and Room 1 and the rear loading dock were so designated in 1977. Like other HLO laboratories, the 329 Building was transferred to BNWL operations in 1965. In 1970, it was split between Westinghouse and BNWL management but was transferred wholly to PNL operations in 1987. Today it is designated the Chemical Science Laboratory.[111]

38.2 THE 329 BUILDING MISSIONS

The primary, original mission of the 329 Building was to house the preparation and counting of radioactivity levels in samples taken of the air, vegetation, soil, wildlife, river and well water and various types of bioassay samples. Other building functions included the development of new sample counting procedures and methods, the invention and improvement of radiation monitoring instruments, and the application of industrial hygiene techniques from other industries to Hanford's health physics needs. One instrument developed in the building was a large volume Columbia River water sampler.

Very soon after the structure was completed, building programs expanded to include a major role in monitoring and counting fallout from atmospheric nuclear bomb tests conducted by the United States, the USSR, and later by Great Britain, France, and China. Scientists in the 329 Building also conducted fission product analysis on ocean and marine life samples taken for hundreds of miles around the Pacific Proving Grounds over a period of nearly two decades, and they performed fallout deposition studies on caribou and other terrestrial organisms in Alaska. Marine life and other tissue analyses also were performed in 329 Building programs when radionuclides from HW were found in shellfish in Pacific coastal waters near the mouth of the Columbia River in the late 1950's.

Other building missions over the years have included counting and spectrometry studies of activation products found in film buildup on the inside of reactor process tubes, and of fission products found in HW's underground waste storage tanks. In the 1970's and 1980's, examinations of moon rock, oil shale, solvent refined coal, and volcanic ash from Mt. St. Helens also have been conducted in the building.[112]

38.3 THE 329 BUILDING WASTES AND CONTAMINATION

Wastes and contamination in the 329 Building resulted both from the chemicals used to separate various isotopes before analysis and counting could be done and from occasional spreads of fission product activity from contaminated samples that were brought in from the field. During the 1950's and 1960's, much "wet" chemical separation was necessary in sample preparation. However, more modern counting instruments have multi-channel analyzers that can "read" each isotope separately, thereby eliminating the need for extensive chemical preparation. During the 1950's, many chemicals were used routinely in the 329 Building, including many acids (e.g., nitric, hydrochloric, hydrofluoric, boric, sulfuric, tartaric), as well as sodium thiosulfate, hydroxylamine hydrochloride, ammonium chloride, hydrogen peroxide, sodium sulfate, magnesium perchlorate, aluminum nitrate, sodium fluoride, lanthanum fluoride, sodium iodide, acetone, thenoyltrifluoroacetone, thenoyltrifluoroacetone-benzene solutions, lanthanum nitrate, potassium permanganate, silver nitrate, CCl_4, cupric oxide, copper nitrate, arsenic nitrate, ferric chloride, zinc nitrate, cupferron, and many other generic and commercial substances. Asbestos sheets also were used in many procedures. They were placed over wet samples as insulators to reduce the evaporation rate and also placed under open, hot beakers to cool them.[113]

During the 1960's, many of these same chemicals were used as HW scientists surveyed for radio-iodine (mostly iodine-131) in milk and beef thyroid samples and on air filters and for phosphorus-32, zinc-65, zinc-69, arsenic-76, chromium-51, neptunium-239, strontium-90, and cobalt-60 in aqueous, marine organic, and integrated samples. Hanford researchers also monitored for rare earths and yttrium in reactor effluent and for sodium-24, scandium-46, manganese-54, manganese-56, gallium-72, copper-64, chromium-51, and neptunium-239 in river and sanitary water samples. The HW scientists also performed broad spectrum analyses for total alpha, total beta, total nonvolatile beta, and total gamma emitting content in Columbia River water, well water, effluent water from the 100 Areas reactors and the PRTR, air, vegetation, milk, and animal tissue samples. During these years, they added several commercial products to their standard inventory of sample preparation chemicals, as well as formalin, methyl orange, ammonium molybdate, ammonium phosphomolybdate, phenolphthalein; several acids including citric, acetic, and oxalic; many carrier agents such as gallium chloride, strontium nitrate, zirconium nitrate, yttrium nitrate, ferric nitrate; and various carriers for iodine, manganese, arsenic, and other substances.[114]

Additionally, throughout the years of 329 Building operations, many standard laboratory alcohols, acids, and other cleansers and drying agents were used. Sometimes acids were not neutralized, and they damaged the facility's RLWS and process pipes on several occasions. The building was connected to the RPS or "diverter" system (see Part III), and this system was activated in several incidents when radioactive substances were disposed to process pipes. The RLWS line from the 329 Building was routed through a connection in the 326 Building in 1968, and this line needed to be replaced because of corrosion in 1986. At that time, strict procedures for use of 329 Building drains leading to the RLWS were instituted. On numerous occasions during 1988 to 1990, instrument malfunctions and improper disposals resulted in the deposition of hazardous and radioactive components in the RPS line. In February 1989, radioactive waste water backed up through a drain and flooded the 329 Building basement. Today, radioactive waste disposal from this structure requires the permission of a supervisor to unlock the specified sink.[115]

Radioactive contamination was introduced in the 329 Building early in its history when highly active samples from REDOX stack filters were brought in for analysis. At that time, the REDOX plant was experiencing serious ruthenium-103/106 particle releases, and the spread of some of these "specks" resulted in both a Class I and a Class II Radiation Incident in the 329 Building in July 1954. The following month, ruthenium-103/106 particles reading up to 7 r/h still were being examined in the building. At the same time, a radium-beryllium source being used to calibrate a cobalt-60 source was dropped in the facility, spreading contamination throughout six laboratories and adjacent hallways.[116] A sample containing tributyl phosphate process waste from uranium Plant exploded in the building in 1956, spreading contamination throughout a laboratory and the adjacent hallway, and a glass ampoule containing arsenic-76 exploded in the building in 1963. At other times, samples in casks leaked unexpected amounts of radioactivity into the building. Events of this type occurred in 1967 (involving thulium-170), twice in 1974 (involving silicon-31 and mixed contaminants from irradiated sea salts), in 1987 (involving cobalt-60, and cesium-134/137), and in 1989

(involving mixed alpha-emitting contaminants).[117] Additionally, wastes have been spread in the 329 Building by the spill of a carcinogenic solvent-refined coal product in 1978, and by a small fire in an atomic absorption spectrometer in 1981.[118]

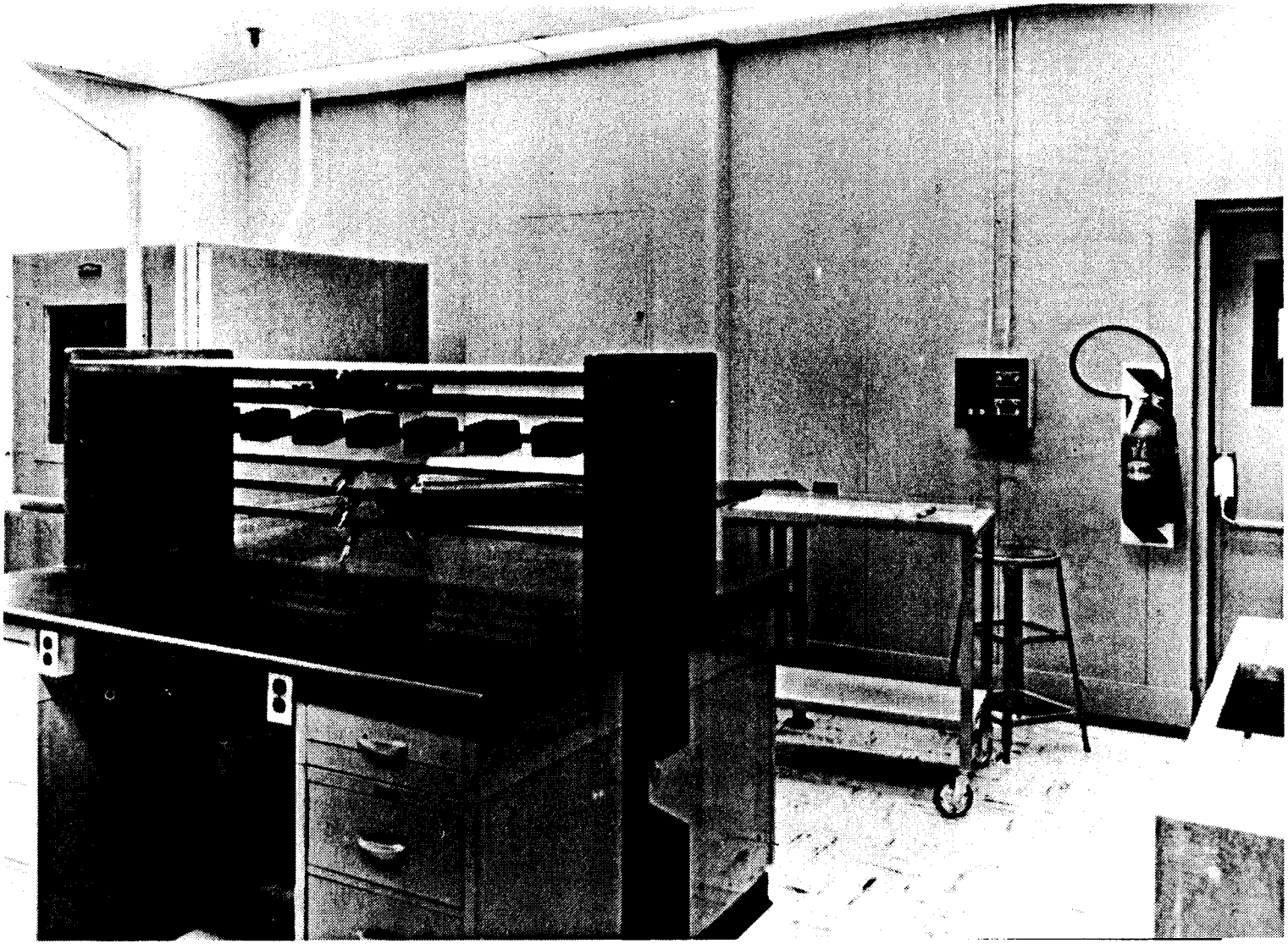


Figure 63. The Shielding Instrument Development Laboratory in the 329 Biophysics Laboratory Building 99% complete in early December 1952.

39.0 THE 3730 GAMMA-NEUTRON IRRADIATION FACILITY

39.1 FACILITY DESCRIPTION

The 3730 Building was constructed in 1949 as an unnamed "steel building" to house fabrication operations for specialized graphite shapes. It was a prefabricated steel frame building with aluminum siding and roof, seated on a concrete pad. The 32-ft by 72-ft structure had interior walls lined with transite and an asbestos board ceiling. Heat was provided by space heaters. During 1955 to 1956, it received a new roof and a 25-ft concrete-walled addition (Figure 64). A concrete vault 18.5 ft by 16.84 ft also was added on the north end, giving the facility a total area of nearly 3,500 ft^2. At that time, the structure was named the Graphite Laboratory and Shop but termed the "Hot Shop" by HW workers. In the late 1960's, a 350,000-Ci cobalt-60 irradiation source was placed in a small, water-filled belowground pit. Safety upgrades, including improved ventilation, filtration, a central heating system, and sewer connections were made during 1974 to 1976. Additions in 1980 included gloveboxes (used for the examination of irradiated fuel coupons), HEPA filters, and a blower addition. Building operations transferred to PNL in 1987.[119]

39.2 THE 3730 BUILDING MISSIONS

The original 3730 Building mission as a shop facility to fabricate specialized graphite shapes was supplemented by the storage of uranium turnings and contaminated materials (including ruptured fuel slugs) waiting for analysis in other structures. These functions made it an obvious choice to replace the 3741 Building when that facility was demolished in 1956 (see Part II). The 3730 Building's 1956 addition and modifications enabled it to better house the examination, study, and storage of irradiated graphite samples from the 305 Test Pile and the 100 Areas production reactors. The 100 Areas reactor closures and the cessation of 305 Test Pile operations at HW in the late 1960's almost completely ended the need for traditional 3730 Building functions. At that time, the emplacement of the 350,000-Ci cobalt-60 source in the building's pit changed the facility mission to that of instrument measurements and corrosion and stress corrosion testing of nuclear waste container materials. Parts, gaskets, electrical cables, and other materials with potential use in hot cells or in geologic waste repositories also have been tested in the 37 stainless steel tubes of this gamma irradiation test facility.[120]

39.3 THE 3730 BUILDING WASTES AND CONTAMINATION

Graphite dusts circulating in the building's atmosphere proved to be the most serious waste problem during the early years. In May 1954, a positive urine sample from one worker prompted a general reevaluation of facility working conditions by the H.I. Division. By July, new work procedures mandated the wearing of respirators for electric drill and belt sander operations. Additionally, a commercial air exhauster was installed in the roof, and a separate exhaust system was emplaced for the belt sanders. Despite these measures, an H.I. survey conducted the following month found

contamination reading up to 270 mr/h near a ruptured fuel slug being stored in a 2-gal bucket and generalized contamination reading from 20,000 to greater than 80,000 c/m, both within the building and in a 15-ft perimeter around it. Contaminated soil was removed in September 1954, and a radiation zone fence was emplaced behind the structure. In October of the same year, H.I. Division monitors reported that "process shoes worn in the 3730 Building are all above the permissible limit of 1,000 c/m." Maximum contamination read 80,000 c/m, despite recently instituted efforts to reduce floor contamination with daily moppings. After this building assumed the former functions of the 3741 Building in 1956, radiation levels in the facility rose. Irradiated and cold graphite grindings including sulfur-35 and carbon-14 particles sometimes escaped from bag filters and settled in the ground. Some samples of graphite and irradiated flux wires examined in the building in the early 1960's read up to 50 r/h, and in 1962 an irradiated graphite capsule exploded in the facility, scattering graphite fragments reading up to 500 mr/h throughout half the Hot Shop.[121]

In later years, the most serious contamination resulted from a leak in the cobalt-60 source. Although this source was leak tested successfully in 1966, it sprang a long-term leak in the early 1970's that was not detected until 1974. An aerial survey performed that year using infrared photography detected a plume, determined to be cobalt-60, leading from the pit water below the 3730 Building. This long-term leakage through the liquid pathway contaminated the 300 Area Process Ponds, sanitary sewer lines, and manholes and groundwater near the 3730 facility. While repairs were being made during 1974 to 1976 the radiation level in the gamma pit was measured at 7.2 million r/h. Another contamination event involving cobalt-60 occurred when a shielding cask containing 10 kCi of the isotope arrived at the building with a loose lid in 1978. In 1986, the seismic and structural qualifications of the gamma irradiation tank were confirmed in a special examination.[122]

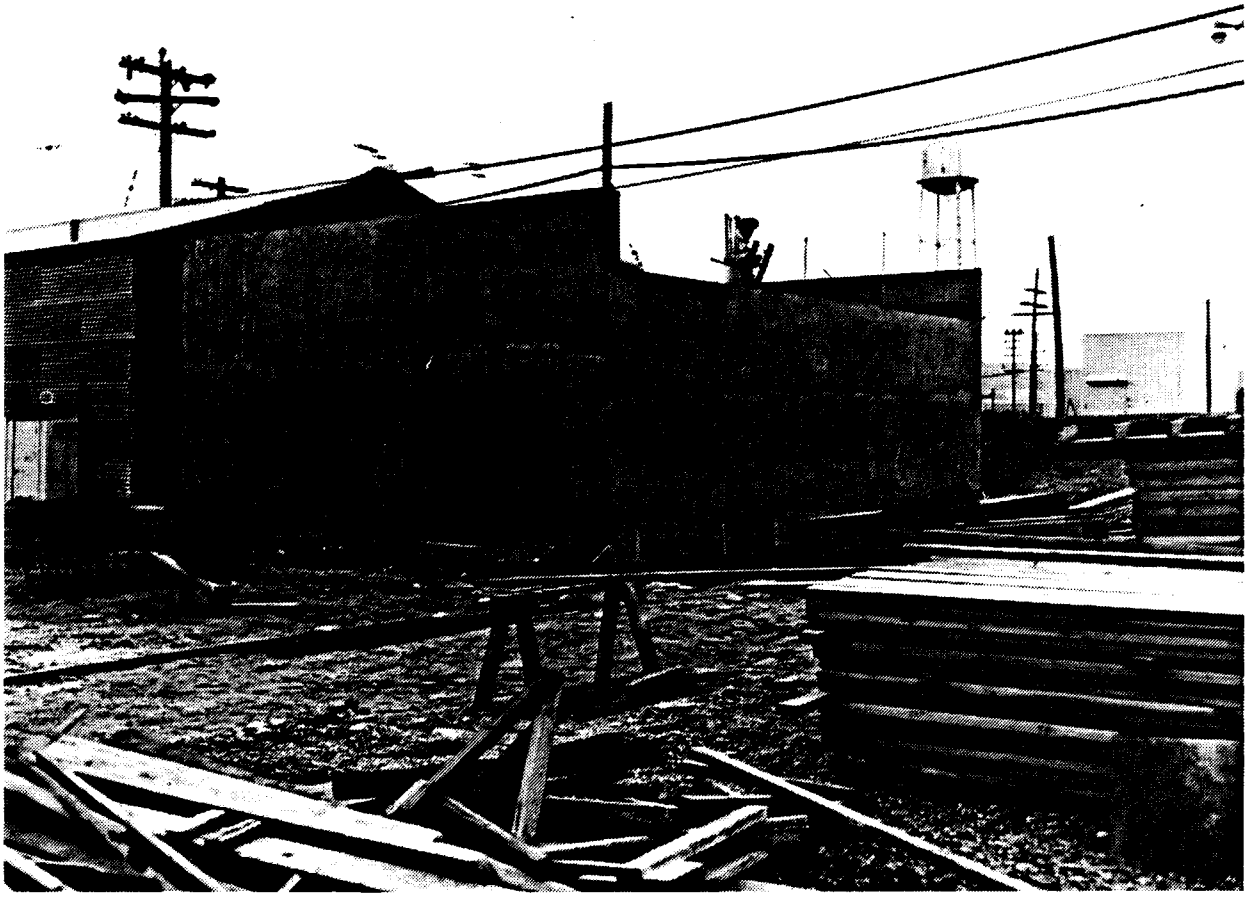


Figure 64. The 3730 Building receiving its 1955 to 1956 addition to become the Graphite Laboratory and Shop. With the completion of this addition, the 3730 Building undertook the graphite fabrication functions formerly performed in the 3741 Box Storage Building.

40.0 THE 320 LOW-LEVEL RADIOCHEMISTRY BUILDING

40.1 FACILITY DESCRIPTION

The 320 Low-Level Radiochemistry Building, a concrete and steel frame structure, was built in 1966 as virtually the last facility in HW's postwar defense construction. The original basement and ground floor levels both received a large addition consisting of four laboratories and eight offices in the early 1980's, bringing the total building size to 144 ft by 84 ft, with an area of just over 25,000 ft^2. The flat roof contains several vents that separately exhaust air from the "cold" areas of the building through HEPA filtration from eight laboratories. A 39-ft-tall, 60-in.-diameter metal stack equipped with double HEPA filtration also serves the building. Twenty-two laboratories are located in the structure including several devoted to wet chemistry, a large radiochemistry laboratory (Room 113), an analytical research and development laboratory (Room 114), and a heavy element chemistry laboratory (Room 115), all on the first floor. The remainder of the building is divided into offices, restrooms, supply rooms, and additional laboratories. A liquid nitrogen supply tank sits outside the structure, as does a covered bottled gas dock for gas bottle storage and for two manifolds for oxygen and propane that supply various laboratories. Today, two ancillary trailers provide offices for overflow personnel.

40.2 THE 320 BUILDING MISSIONS

The 320 Building's original mission, conceived nearly 15 yr before the facility was constructed, was to house analytical chemistry services and plant support for many HW groups and departments in work involving low-level and nonradioactive samples. It was recognized that metallurgy and physics groups would need a broad range of chemical analyses, including the testing of graphite and various other reactor materials for impurities, the testing of uranium and uranium alloys for "a great variety of constituents in a wide range of concentrations," the sampling of pile gases, organic compounds, metals other than uranium "including ferrous and non-ferrous alloys," acids, bases, salts, and the analysis of multifarious production test results. Additionally, wrote early postwar HW planners, "a large plant such as the Hanford Works requires regularly the analysis of a large number of miscellaneous samples... [among which are] oils and greases, paints and related products, other protective coatings, unknown materials submitted for identification, corrosion product identification... gas analysis... biological and pathological samples, comparisons of materials from prospective vendors, materials of construction, sand, gravel, masonite, asphalts, soil, etc., steel analysis [and] physical testing of numerous materials for quality comparisons." In order to save the use of laboratories equipped to handle hot samples for specialized chemistry, physics, and metallurgy work, a low-level radiochemistry and "plant assistance" building was included in overall HLO plans. However, budgets and other, higher priorities prevented the construction of such a facility until the 1960's.[123]

The original work performed in the 320 Building included gamma ray spectrographic analysis, physical measurements with instruments, and various types of radiochemical separations processes similar to those performed in the

325 Building but involving samples with low levels of radioactivity. Among these processes were solvent extraction, ion exchange, carrier precipitation, and electrodeposition. Some analytical support also was provided to environmental monitoring and bioassay samples, again on materials with lower radioactivity levels than those analyzed in the 329 Building.

Virtually, as soon as the 320 Building was completed, production cutbacks overtook HW. To diversify and expand the facility's work, Hanford planners took on a great many assignments from offsite. Soon, about half of the work performed in the 320 Building was classified, with some of it done for other AEC (later the Energy Research and Development Administration [ERDA] and DOE) sites and programs and for the DOD. Additionally, a number of basic research programs were started. These projects resulted in the development of several pioneering techniques in the building, including radiometric techniques, new mass spectrometric techniques, combined (simultaneous) atomic absorption/mass spectrometric analysis, and laser-based spectrometric techniques. Recent missions have included radiochemical environmental analyses, sample preparation, methods development, and many classified programs that cannot be described. The facility now is called the Analysis and Nuclear Research Building. It has been managed by PNL ever since its construction.

40.3 THE 320 BUILDING WASTES AND CONTAMINATION

The 320 Building wastes have been primarily chemical, including standard laboratory cleansers, reagents, solvents, neutralizers, and drying agents. Over the years, as in other HW facilities, regulations have been imposed that prohibited the use of certain chemicals such as acetone and that tightened disposal practices, container labeling, and many other procedures. Throughout its history, the 320 Building has produced very small amounts and very low levels of wastes. It was not connected to the RLWS because radioactive wastes (liquid as well as solid) were of such small volume that they were removed in containers and casks. Occasionally, through the years, small spills of radioactive material have occurred in the facility, usually when quartz ampoules containing irradiated samples were dropped in laboratories. In all known cases, the contamination was contained within the building, and there have been no known instances involving airborne radioactive releases.[124]

ENDNOTES - PART IV

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PART V BUILDINGS CONSTRUCTED FOR RESEARCH AND TESTING OF PEACEFUL USES OF ATOMIC ENERGY

PART V BUILDINGS CONSTRUCTED FOR RESEARCH AND TESTING OF PEACEFUL USES OF ATOMIC ENERGY

The mid-to-late 1950's was a very expansive time in United States nuclear history. The belief was widespread that atomic energy would be the fuel of the future adopted for virtually all civilian and industrial power needs. Knowing that worldwide supplies of uranium were limited, the AEC directed the HW to embark on a large research effort to develop and test plutonium and thorium fuels (see Part I). The most ambitious early efforts were directed at demonstrating the effectiveness of various plutonium oxide (PuO_2) and mixed (plutonium, uranium, and other metallic) oxide fuel blends. Several facilities, including the 308, 309, 315, 318, and 324 Buildings were constructed for this purpose. In the 1960's, experiments with these types of fuels gave way to the concept of "breeder reactors," or reactors that produced (or transmuted) more fuel than they burned. The Hanford Site was chosen as the location for the DOE's prototype breeder reactor, the FFTF. The building of this demonstration and test facility in HW's new 400 Area brought about the construction of several experimental and pre-assembly buildings. Among these were the 335, 336, 337, and 338 Buildings. During these same years, other miscellaneous buildings and facilities were emplaced, including the 331 and 3705 Buildings, the Hanford Grout Lysimeter Facility, and the 300 West In Situ Vitrification Site.[125]

Chapters 41.0 through 49.0 describe buildings constructed for research and testing of peaceful uses of atomic energy. Chapters 50.0 through 52.0 describe miscellaneous buildings.

41.0 THE 308 PLUTONIUM FABRICATION PILOT PLANT AND 308-A ANNEX

41.1 FACILITIES DESCRIPTION

The Plutonium Fabrication Pilot Plant (PFPP) was completed in 1960 as a two-story nearly square building that was 140.75 ft by 142.5 ft by 33 ft (high). It had a rectangular office wing 169.3 ft by 40.6 ft by 10.75 ft (high) extending across and beyond the front, giving a total area of 52,744 ft^2. The framework was bolted steel and reinforced concrete, with exterior walls of reinforced concrete and concrete block. Interior walls were concrete block with plaster and polyvinyl chloride finish. The parapeted, slightly sloped roof was steel deck topped with concrete and finished with tar and gravel, except in the office wing where the concrete topping over the steel deck was omitted. Floors on both stories were very heavily reinforced concrete with painted vinyl tile finish. On the first floor, a loading of 200 lb/ft^2 was permitted, and 150 lb/ft^2 was permitted on the second floor. Main floor laboratories were 18 ft high and held a variety of large stainless steel gloveboxes containing metallurgical apparatus. Original machinery available for work with metal, ceramics, and ceramic metallic blends ("cermets") included air and vacuum induction furnaces, high-energy rate impaction equipment, a 280-ton horizontal extrusion press, a small rolling mill, crushing and grinding equipment, a pellet press, swage, sintering furnace, a vibrational compactor, TIG and spot welding equipment (Figure 65), vapor degreaser, autoclaves, a radiograph, etching tanks, sieves, and other fuel fabrication equipment.

Because the 308 Building was designed to contain and fabricate plutonium, it had elaborate ventilation and contamination control features. The main floor was divided into 11 separate zones, with 3 large supply fans and 3 large exhaust fans operating to create a negative-to-atmosphere pressure gradient. The supply fans also had anti-backflow dampers, and each exhaust fan had its own "stub" stack. There also was an emergency exhaust fan for the hood ducts, and each hood and glovebox had its own exhaust duct containing an absolute (HEPA) filter. Additional HEPA filters were located in each laboratory room register and in large filter rooms at the rear (north) of the building. A tunnel under the main corridor contained downdraft exhaust ducts that drew air from each laboratory toward the rear filter room. The office wing had its own separate air supply fan, and other utilities were located in a service gallery above the main corridor and below the second floor.[126]

In February 1971, an approximately 7,000-ft^2 high bay addition was completed on the northeast corner of the 308 Building. It contained laboratory facilities for the initial storage, handling, testing, assembly, and instrumentation of FFTF fuel and was equipped with humidity, air flow, and dust control capabilities. In the late 1970's, a Training Research Isotopes, General Atomics (TRIGA) reactor was installed in Room 160 in the building's A-wing to perform neutron radiography QA testing of fuel elements and fuel jackets. The TRIGA reactor sat in a double containment water tank and operated at only a 250-kW power level. Its primary recirculating coolant water ran through an ionizer that removed aluminum and lead, and its neutron beam port was shielded by 10 ft of water. In 1979, the 308-A Annex was constructed on the PFPP's east side, consisting of office space and a loading dock with a 10-ton capacity bridge crane. Such a crane was needed for

handling the 8-ft-long fuel rods used in the FFTF. The 308-A addition brought the total 308 Facility area to just over 94,000 ft^2. In the 1970's, the 308 Building was sometimes called the Plutonium Laboratory, but the name was changed officially in the 1980's to the Fuels Development Laboratory.[127]

41.2 THE 308 BUILDING MISSIONS

The original 308 Building mission was to provide laboratories and actual fuel fabrication facilities for the development of reactor fuels containing plutonium. The first fuel mixtures produced were metallic, but ceramic fuel blends were being worked in the facility within 5 yr. The earliest PFPP fuels were irradiated in the PRTR (see Section 42.8), a test reactor located just a few feet from the 308 Building. However, operational problems brought major cutbacks in PRTR functions after 1965. For a brief time between 1966 and 1968, neptunium-aluminum alloy fuel target elements clad in Zircaloy-2 were produced in the 308 Building for a plutonium-238 production test that was conducted in N Reactor. In the late 1960's, lithium-aluminate fuel targets with a rod-in-tube configuration and Zircaloy-2 cladding also were manufactured in the 308 Building for co-product (tritium) production testing in N Reactor. From that time until the startup of FFTF test functions in the late 1970's, most fuels produced in the PFPP (early test prototypes for the FFTF) were irradiated in the EBR-II reactor located at INEL. Over 2,000 fuel configurations were produced in the 308 Building before 1976, many for a variety of offsite reactors. During that period, the facility was operated by BNWL from 1965-1970 and then transferred to Westinghouse Hanford operations. It has remained as a Westinghouse Hanford-operated facility since that time and now is called the Fuels Development Laboratory.

Beginning in 1976, the main mission within the building became the preparation and QA testing of all FFTF fuel assemblies. This mission has continued through nearly the present and has included the preparation of driver fuel assembly irradiation experiments performed in the FFTF, as well as tests of the first grid space assemblies for vibration-packed ("vi-pack"), high-density pellets in fuel pins. Today, the TRIGA reactor in the 308 Building is in a shutdown mode, with no operations in progress, and all plutonium inventories have been removed from the building. The uncertain future of the FFTF provides an equally uncertain future for the 308 Building.[128]

41.3 THE 308 BUILDING AND 308-A ANNEX WASTES AND CONTAMINATION

The 308 Building wastes comprised mostly plutonium oxide and plutonium-UO_2 blends in various forms, including metallic, ceramic, and cermet, as well as multiple laboratory and fuel fabrication chemicals, acids, neutralizers, degreasers, reagents, and cleansers. Laboratory wastage of plutonium averaged 3%, and this material was sent to the PRF, located in 236-Z Building, for recycling beginning in 1964. The 308 Building was connected to the sanitary, process, and old RLWS systems but was not connected to the new RLWS system that was installed in much of the 300 Area in 1978 to 1979 (see Part III). With laboratory wastes containing significant amounts of plutonium being sent to PRF, it was decided that the remaining volume of liquid radioactive wastes was so small that it would be better placed in casks and shipped directly to

the 200 Areas for disposal. Liquid chemical and process wastes were disposed using standard Hanford Site methods; they were piped to the 300 Area Process Ponds until 1975 and thereafter routed to the 183-H Solar Basins or the 300 Area Process Trenches. Solid radioactive wastes also were disposed using standard Hanford Site containers, including milk pails, paint cans, and lard cans (see Part III). The TRIGA reactor operated at such a low power level that it produced very little spent fuel as such. However, such fuel was buried in 200 Area solid waste burial grounds designated for retrievable TRU waste.

There were many incidents involving the loss of control of radioactive materials within the PFPP throughout the facility's history. Some of these events involved high surface and/or airborne radiation readings, but most were contained within the building (usually in one laboratory and sometimes in adjacent corridors). Glovebox fires, explosions, and/or ruptures were the most frequent cause of contamination spreads, and improperly sealed irradiated sample containers were another common cause. Examples of surface contamination spreads include a reading of nearly 5 million d/m (alpha) as the result of a messy plutonium oxide bagout procedure from a glovebox in Room 220 in 1961 and a nearly identical floor surface reading as the result of a spill in Room 208 in 1962. The most serious contamination event in the building's history took place in August 1965, when a spark ignited acetone vapors in a glovebox in Room 113. The resultant explosion and fire spread nearly 10 g of plutonium throughout Rooms 113 and 101 and adjacent hallways. Still, no contamination is known to have entered the environment from this occurrence.

In 1973, a process pipe failure caused a backup of process water in the 308 Building. In 1979, leaking quartz ampoules being irradiated by the TRIGA reactor spread cesium-138 contamination in the immediate TRIGA vicinity, and for an unknown period between 1981 and 1983, a slightly leaking cesium-137 source for TRIGA instrument calibration was uncontrolled in the 308 Building. There have been no known airborne radioactive emissions to the environment from the 308 Building because multiple HEPA filters have been used.[129]

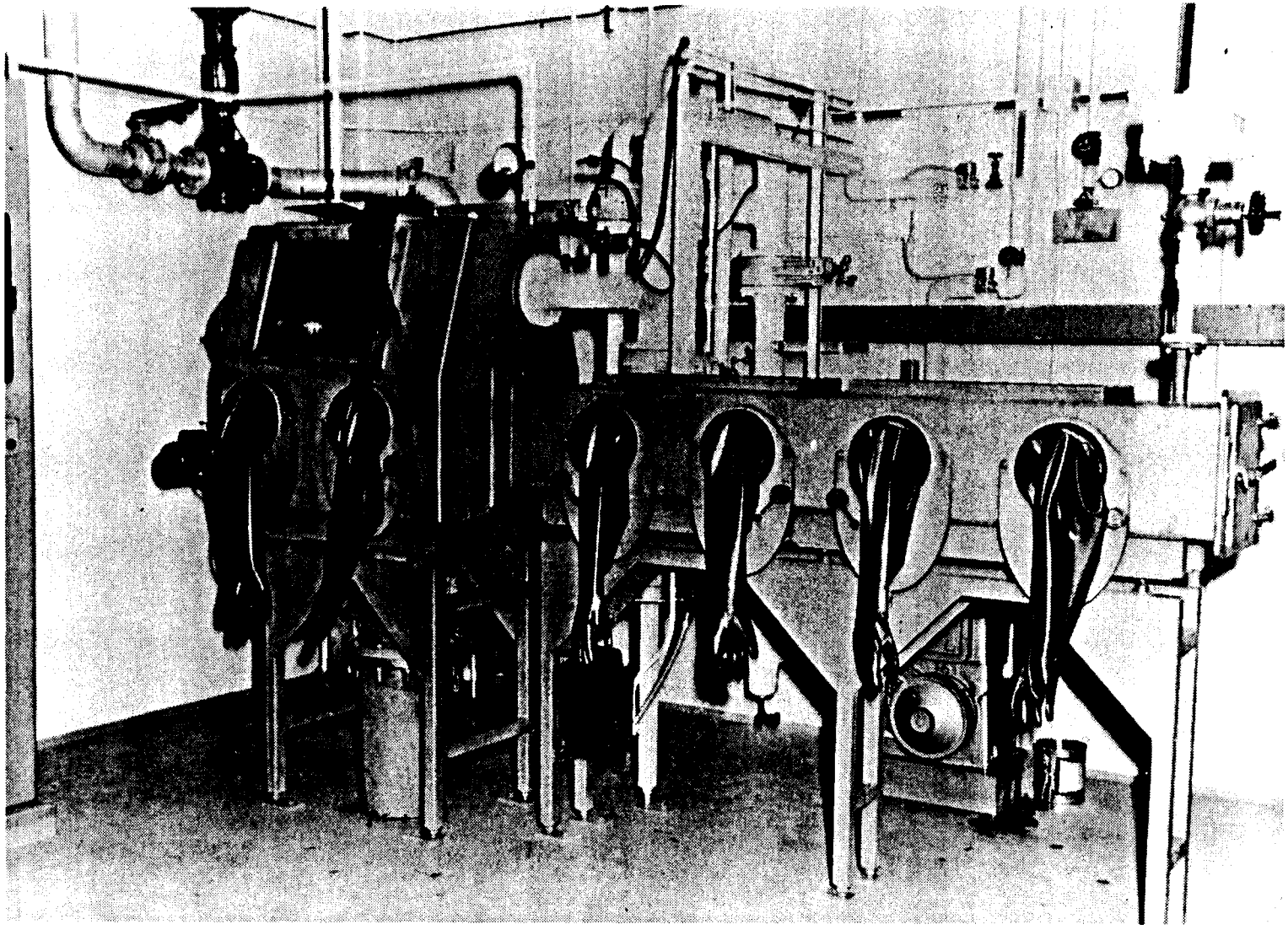

Figure 65. A welding hood with auxiliary glovebox equipment for performing work on radioactive materials in the 308 Plutonium Fabrication Pilot Plant, about 1960.

42.0 THE 309 PLUTONIUM RECYCLE TEST REACTOR BUILDING

42.1 THE FACILITY DESCRIPTION

The PRTR, located within and below the 309 Building, was completed in 1960 as the operating test reactor in the HW Plutonium Fuels Utilization Program. The main building was 80 ft by 100 ft, with the reactor located below grade and covered by a 5-ft-thick concrete slab at ground level and then by a welded, carbon steel cylindrical containment vessel 80 ft in diameter and 121 ft high (75 ft above grade) (Figure 66). The remainder of the north-south running building was a service area connected to the containment vessel via an air lock and housing an irradiated fuel storage basin, instrument shop, electrical shop, electrical switchgear, mechanical and ventilation equipment, and maintenance shop, offices, lunchroom, and sanitary restrooms. The framework of this one-story and basement service area was welded steel, with exterior, aboveground walls constructed of fluted steel insulated panels. The roof was slightly sloped steel deck topped with a tar and gravel finish, and the floor was steel reinforced poured concrete covered with vinyl tile, capable of a loading average of 200 lb/ft^2. Some interior partitions were metal lath and plaster, and some were drywall construction.

In 1960, a maintenance and mockup (M&M) wing 61 ft by 100 ft was added west of the containment dome. Construction materials were similar to those of the service area, with the unique feature being a 40-ft by 40-ft belowgrade open mockup area designed to resemble one quadrant of the PRTR containment area. The mockup area (sometimes called a "cell" but not truly a hot cell) was enclosed on all sides to provide a sound barrier to the rest of the wing and was used for cold, pre-reactor assemblies. The remainder of the M&M addition housed a maintenance work area for the mockup cell, management and engineering offices, a conference room, and sanitary restrooms.

A second addition, built east of the containment dome in 1962 to 1963 to house the Plutonium Recycle Critical Facility (PRCF or the "Critical Facility"), was 37 ft by 40 ft. This addition brought the 309 Building to a total area of nearly 45,000 ft^2. Construction materials in the PRCF area were similar to those of the building's service area and M&M wing except that the Critical Facility itself was located below grade in a heavily shielded concrete cell 10 ft by 13 ft by 32 ft (deep) covered by a 4-ft-thick concrete plug. The Critical Facility itself consisted of an aluminum tank containing a heavy water (D_2O) moderator, with fuel elements suspended vertically from a top grid plate.

42.2 THE PLUTONIUM RECYCLE TEST REACTOR

The PRTR itself sat in a calandria (tank) 12 ft in diameter and 9.5 ft high located in the center of the containment vessel (Figure 67). The reactor core consisted of 85 vertical aluminum tubes, each 4 in. in diameter. Zircaloy-2 process tubes fit inside these aluminum tubes, and each held a fuel "bundle" or "cluster" of 19 fuel rods. Eighteen of the positions within the core contained a total of 54 half-rods (safety or shim rods, 3 in each of the 18 positions). These shim rods were an auxiliary control feature; primary control was achieved by varying the moderator level. The heavy water

moderator was stored in a moderator storage tank below the calandria and was brought into the calandria via helium pressure. This high-pressure helium flowed between each fuel process tube and the reactor aluminum tube's inner wall. The PRTR also had a secondary light water coolant that ran through a large pressure tube in the center of the calandria.[130]

42.3 REACTOR CELLS

Below the reactor were located three large cells with their floors 32 ft below ground. These were known as the "minus 32 feet" facilities. A-Cell was the largest, occupying nearly half of the area under the 80-ft-diameter containment dome. It was the reactor process cell, containing pumps and motors for both the primary and secondary coolant systems as well as the heat exchangers (see Section 42.4). The B-Cell occupied about one-fourth of the area under the containment dome and was the experimental cell. It contained the in-vessel rupture loop equipment, the gas loop equipment, and cooling blowers for the Fuel Examination Facility (see Section 42.5 and Figure 68). C-Cell, about the same size as B-Cell, was the instrumentation cell. Each cell had its own concrete sump, from which liquid drain-offs, or flushes, were pumped to three 5,000-gal "TW" tanks buried north and slightly west of the dome. The TW tanks served as hold-up and sampling containers for a variety of liquid wastes. If the wastes were free of contamination, they could be pumped through manhole 2 to manhole 3 and then to the Columbia River. If they were contaminated, they would be pumped through 3-in. carbon steel 40-gauge RLWS piping to the 340 Complex (see Part III). This pipe, initially filled by pumping action, sloped downward as it approached the 340 Complex and actually drained by gravity.

42.4 HEAT EXCHANGERS

Inside A-Cell was located the principal PRTR heat exchanger in which heat was transferred from the heavy water (primary) side into process (light) water that ran through the secondary side. The light water then flashed to steam, which traveled out to the condenser east of the 309 Building and was condensed with cold Columbia River water. This condensate then flowed through manhole 3 into the Columbia River. Most of the PRTR heat was released, although at two different times attempts were made to use this heat in the 300 Area steam heating grid. From about 1961 to 1962 through mid-1965, the north-south service wing of the 309 Building (basement and ground floor) were heated with PRTR steam on a demonstration basis. This experiment was ended by a major operating accident on September 29, 1965 (see Section 42.15). During 1964 to 1965, a connection also was made between the light water steam outlet and the major 300 Area steam heating grid in the 3802-A Building. However, after this connection was tested, the decision was made not to use it. If a hole developed in the PRTR heat exchanger, it was reasoned, contamination from irradiated heavy water could spread throughout the entire 300 Area steam system. Smaller moderator, reflector, and shield cooling heat exchangers also existed in the secondary cooling system of the PRTR.

42.5 HOT FUEL EXAMINATION FACILITY

Other portions and equipment of the 309 Building included a Hot Fuel Examination Facility located at "minus 32 feet" between A-Cell and B-Cell. This 6-ft by 4-ft space was 27 in. deep and functioned as a hot cell, where personnel conducted preliminary gamma scans and other tests on breached, irradiated fuel to study warpage, swelling, and other characteristics. It was concrete, with a 16-gauge stainless steel liner on the walls that stopped 1 ft from the cell bottom and was equipped with manipulators, periscopes, and other remote handling devices. A control console for this facility was located on the ground floor level within the PRTR's containment dome, but the cell could be physically accessed from B-Cell through a heavy metallic bank vault-type door. The cell was normally air cooled, and a 4-in. bottom drain line in the cell flushed liquid wastes to the B-Cell sump.

42.6 FUEL STORAGE PITS AND RUPTURE LOOP ANNEX

Between A- and C-Cells, approximately 30 ft below grade was located an irradiated fuel storage pit. Constructed of concrete, this 26-ft-deep pit was directly above a pipe chase that ran between A-Cell and C-Cell. It could be accessed via a 9-ton plug in the containment dome floor. The PRTR also had a rupture loop annex, known as Room 20, located underground northwest of the dome. It contained the rupture loop mechanical equipment, including tanks, pipes, and pumps. This cement-floored facility with its own sump was accessed through a 20-ft-wide tunnel known as Room 19. The 309 Building also contained a "green" (fresh) fuel storage pit located below grade between A-Cell and C-Cell and just north of the Irradiated Fuel Storage Pit. This small concrete facility was 3.5 ft by 6.3 ft by 21 ft (deep).

42.7 MISCELLANEOUS BURIED EQUIPMENT

A 90,000-gal rupture loop holding tank was buried northeast of the dome, just southwest of the present location of the 324 Building. This black iron tank was 40 ft in diameter and nearly 10 ft deep, with a sloping top. Liquid wastes routed to this tank would be sampled and sent through a 3-in. pipe to the 340 Complex if contaminated or through manhole 3 to the Columbia River if uncontaminated. Two ion exchange (I.X.) pits also were buried just off the PRTR's containment area; the reactor I.X. pit was to the northeast, and the rupture loop I.X. pit was to the northwest. Both pits were constructed of concrete, with the northwest (rupture loop) pit being much more shallow and wide because the I.X. columns in this facility were positioned horizontally. The rupture loop pit was 26.16 ft by 15.83 ft by 16 ft (deep), while the reactor I.X. pit was constructed with a top section 14 ft square and 16 ft deep (holding the I.X. columns), and a subsection 18 ft in diameter and 22 ft deep. A concrete salt brine container 30 ft by 12 ft by 9 ft (deep) also was buried just west of the 309 Building. It held salt that would be slurried and pumped through a 2-in. plastic pipe to three brine tanks located in the 309 Building basement. These tanks in turn supplied the process water used to cool the smaller heat exchangers in the reactor. Additionally, a 5,000-gal diesel fuel storage tank holding fuel to power the PRTR's emergency generator was buried south of the 309 Building.[131]

42.8 INITIAL 309 BUILDING OPERATIONS

The PRTR first went critical in November 1960, full power tests were begun in May 1961, and first full power of 70 MW (thermal) was achieved in July 1961. The original core loading was a zone type, with natural UO_2 fuel in the central and outer zones and plutonium-aluminum (Pu-Al) alloy driver fuel elements (nicknamed "Pew-Als" by HW workers) in the middle rings. The Pew-Als were highly enriched, consisting of Al-2 wt%, Ni-1.8 wt% Pu. This fuel was phased out in April 1962 when mixed oxide fuel testing began. The first mixed oxides were 0.48 wt% plutonium oxide (PuO_2) and were inserted one or two at a time in appropriate, varied locations within the core and burned long enough to satisfy various fuel testing requirements. In November 1963, the enrichment level in these mixed oxide assemblies was increased to 1.0 wt% plutonium oxide (PuO_2). That same month, Fuel Element Rupture Test Facility (FERTF) operations began in one fringe channel of the PRTR. The FERTF itself was a pressurized, light-water-cooled loop within the main, heavy-water-cooled calandria. It was used as a pilot irradiation facility to test new fuel element designs and new operating regimes. Many of its tests involved pre-defecting fuel elements with pinhole breaks to study the stability of various pre-defected materials under irradiation.

42.9 HIGH POWER DENSITY AND FUEL ELEMENT RUPTURE TEST FACILITY OPERATIONS

In October 1964, a new type of High Power Density (HPD) fuel element was first charged into the PRTR. The enrichment level was increased to 2.0 wt% plutonium oxide (PuO_2), and the active fuel length was shortened to 58.5 in. from the 88.5 in. of earlier PRTR fuel elements. The "tops" and "bottoms" of these newer fuel elements were loaded with depleted uranium, and a 7-in. plenum (empty tube space) was left at the topmost portion of each fuel rod to accommodate gases released during irradiation. Like many of PRTR's other fuels, these elements consisted of "vi-pack" pellets. In April 1965, the PRTR channel designated for FERTF work was changed to the largest, central tube (#1550). It was nearly 7 in. in diameter; normal PRTR channels were 4-in. Tests in the FERTF with both pre-defected and non-defected HPD fuel elements under partially molten conditions began in May 1965. Such tests continued under increasingly thermally hot conditions until a Type A (most serious) operating accident occurred on September 29, 1965 (see Section 42.15).

42.10 BATCH CORE EXPERIMENT

After this contamination event and its subsequent cleanup, the PRTR again began critical experiments in July 1966, leading to a large power testing study known as the Batch Core Experiment. This test ran for about 18 mo throughout 1967 and into mid-1968. It used the shorter, HPD fuel rods and also experimented with augmenting the standard control rods with a "chemical shim" in the form of varied concentrations of boric acid dissolved in the heavy water moderator. The Batch Core Experiment ran only about half its planned duration before a flaw was discovered in the P-4 valve (the main valve in the primary coolant inlet system). The PRTR then was shut down for about a

year while a large replacement valve was procured and welded into place. In mid-1969, the AEC made the decision not to complete repairs on the PRTR and to pursue breeder reactor technology instead.

42.11 PLUTONIUM RECYCLE TEST REACTOR LAYAWAY AND CLEANOUTS

The PRTR's initial layaway occurred in 1969; the heavy water was drained and shipped to the Savannah River Plant (SRP--an AEC site in South Carolina), the electrical system was disconnected, and the pumps and motors were wrapped in plastic. During 1972 to 1973, its irradiated fuel was processed through PUREX. Some PRTR fuel elements containing special oxide blends were processed in hot cells in the 325 Building in 1976 and then cut into 10-in. lengths for burial in the 200 Areas. In about 1975, the PRTR's control room was torn out to make room for a computer facility for the LMFBR program. At nearly the same time, two large pumps and motors and their attendant electrical equipment were removed from the Rupture Loop and Rupture Loop Annex and shipped to INEL for use in nuclear programs there. In all, INEL received about 20% of the mechanical equipment from the Rupture Loop.

Then in the late 1970's the ground floor level inside the PRTR's containment dome was emptied and converted into a "clean shop" (i.e., one using no radioactive materials and no sodium) to fabricate loops that would be used in the 324 and 337 Buildings (see Sections 45.8 and 47.2) to test sodium flow. The PRTR itself was left in place, but all of the ports and plugs in the top reactor shield (at ground level) were sealed with grout and painted over with Amercoat*, a heavy epoxy-based paint and sealant used to fix radioactive contamination in place. There are many varieties of Amercoat, but the types in use in this time period contained resins, solvents, thickeners such as carbon black, crystalline silica, and titanium dioxide, diethylene triamine, chlorinated paraffin, methyl ethyl ketone, methyl isobutyl ketone, and possibly lead and asbestos. Also in the late 1970's, the PRTR's buried rupture loop tank was removed to 200 Area solid waste burial grounds, all RLWS connections were severed and plugged, and the power supply line to the TW tanks was cut. In the early 1980's, gold-seated valves that separated the PRTR's secondary light water cooling injection pumps from the primary coolant system were removed for use in the FFTF.

In 1986-87, a new space technology development program known as SP-100 was assigned to the 309 Building. This program immediately undertook much more extensive clean-out of the old PRTR facilities in the building. All of the equipment was removed from A-, B-, and C-Cells, and the A-Cell sump was painted with Amercoat. Three 2,000-gal heavy water tanks in the north end of the south basement wing of the 309 Building were removed, as were the three process water (brine) tanks in the basement. All of this equipment was disposed in 200 Areas solid waste burial grounds. In 1991, the SP-100 Program was placed on a 5-yr "hold," and no further clean-out of the 309 Building was accomplished. Many contaminated facilities and pieces of equipment remain, including the essentials of the PRTR reactor itself (the calandria with its

*Amercoat is a tradename of the Ameron Protective Coatings Company.

process tubes, the moderator storage tank, and the piping connecting the two). Still embedded in concrete are the reflector piping and the shielding for the calandria. Additionally, approximately 80% of the equipment in the Rupture Loop Annex remains, as do the three buried TW tanks and the piping of the old RLWS. The reactor and rupture loop I.X. pits located northeast and northwest, respectively, of the 309 Building dome, containing the I.X. columns and their contaminated resins, remain. Additionally, from two to seven (exact number unknown) used I.X. columns were disposed to the sub-pit below the plugs in the reactor pit. These I.X. columns, each 4 to 6 ft high and 6 to 8 in. in diameter, could include any or all of the PRTR's exchangers (moderator, reflector, boron and primary). The irradiated fuel storage pit, still very radioactive with smearable contamination when its plug was partially lifted and sampled in 1988, as well as the very radioactive Hot Fuel Examination Facility, also remain, along with the possibility that contaminants have leaked through the concrete floors of either or both of these facilities. Additionally, the 30-ft-long concrete salt brine "tank" remains buried just west of the 309 Building, as does the diesel fuel tank buried to the south. Today the 309 Building houses offices and engineering records.

42.12 PLUTONIUM RECYCLE CRITICAL FACILITY

During the years immediately following the PRTR layaway, another nuclear facility called the Plutonium Recycle Critical Facility (PRCF, or the "Critical Facility") continued to operate in the 309 Building (Figure 69). Built in the early 1960's but active from 1969 until 1976, the graphite block PRCF was located in Room 304, a concrete cell 12 ft by 10 ft by 27 ft (deep) with its bottom at 32 ft belowgrade. The cell was below the east wing of the 309 Building, just south of the fuel storage basin but not inside the containment dome. Originally, the PRCF was designed to support PRTR operations as the place where the reactivity values of the fuel assemblies before and after irradiation were checked. Its lattice had the capability of holding and taking measurements on fully irradiated fuel assemblies from the PRTR, but the PRCF was used for this purpose only in its very earliest operations. The PRCF's major mission soon became housing experimental lattice testing for the design of various light-water-cooled reactors. A commercial license was obtained from the Nuclear Regulatory Commission (NRC) along with special permits from the AEC, which became the ERDA beginning in 1975. These permits allowed the PRCF to operate as a private business venture of BNWL (later PNL). It then housed experiments for both AEC (ERDA) projects and for private nuclear fuel vendors such as Westinghouse Corporation, Babcock and Wilcox Corporation, Combustion Engineering, Inc., Framatome (a French reactor agency), and others.

The PRCF examined burnable poisons for reactors, flux distributions produced in the fuel assemblies by two various control rod configurations, different control rod materials, and many other variables in reactor operations. Its core size could be changed from 26.25 in. to 48.75 in. by the addition or omission of graphite packing blocks, and the number of driver fuel rods could range from 22 to 73. The PRCF's closure came about when

computational tools became advanced enough to replace most of its testing capabilities. In 1988 to 1989, PRCF hardware and equipment were removed and buried in the 200 Areas.

42.13 INTERIM EXAMINATION AND MAINTENANCE CELL

Today the 309 Building houses offices, shops, computer systems and the interim examination and maintenance (IEM) Cell. The latter facility was built in 1975 to be an exact "cold" replica of an operating cell in the FFTF. Located in the old maintenance and mockup cell area, the IEM Cell is used to train and requalify operators and to check operating procedures for the FFTF. The current standby status of the FFTF lends uncertainty to the future of the IEM Cell, but the containment area under the 309 Building's dome is being examined for use in other testing programs.[132]

42.14 THE 309 BUILDING WASTES AND CONTAMINATION

The 309 Building originally was connected to the 300 Area sanitary sewer, process sewer and RLWS system, but not to the RPS ("diverter") system. The RLWS line ran from the "TW" tanks to a nearby valve box, turned east, then ran north in a straight, albeit downward sloping line under the 3718-C Building to the 340 complex. All reactor systems also were equipped with HEPA filtration. However, the PRTR's secondary coolant water operated in a single-pass (nonrecirculating) system and discharged through a 36-in. pipe directly to the Columbia River. Throughout the years of PRTR operations, multiple difficulties plagued the reactor and resulted in waste and contamination buildup and in some contamination releases. Various valves, pumps and gaskets leaked sporadically and at times frequently, releasing liquid effluents to the A-, B-, and C-Cell sumps and to the process sewer or the RLWS. Gaskets in the pressure tube-to-outlet nozzle joint and valves on the inlet piping for each pressure tube leaked to a degree termed "excessive" in a summary operations report.

Pressure tube fretting (striations and crevices) caused in the first 2 yr of PRTR operations by vibration from a faulty straightening vane upstream from the primary coolant flow valve provided a pathway for corrosion and the buildup of radioactivity. In a 2-mo shutdown to inspect for pressure tube fretting in the summer of 1962, fretting marks were found on virtually all tubes, and two tubes had fret marks up to 26 mils (.001 in.) in depth. Replacement of the faulty straightening vane at that time lessened the vibration level and decreased subsequent fretting. Nevertheless, lithium hydroxide generated by the high pH in the primary coolant continued to bring about crevice corrosion in various reactor components. Such corrosion on a fuel element cladding wall caused corrosion that led to the failure of a mixed oxide [magnesium oxide-plutonium oxide ($MgO-PuO_2$)] fuel element on August 21, 1962. This incident released about 9 in. of fuel material, including 1.8 g of plutonium and 15,000 Ci of fission products and caused a shutdown that lasted many weeks.

During the late 1962 shutdown, the PRTR's primary system underwent decontamination from both the August 21 incident and from the overall levels of radioactivity accumulated over nearly 2 yr of operations. During the

decontamination procedures, however, a hose pumping hot waste from B-Cell burst at a joint near the air lock. Contamination readings reached 80,000 c/m on the ground near the spill, and contamination up to 4.5 r/h was spread on some surfaces within the building's lunchroom and stairwell.

By mid-1964, however, primary system radioactivity levels, including cobalt-60 as the primary constituent, were again increasing. At that time, they were measured at 200-300 mr/h over a majority of the piping and at 2 r/h on the piping directly beneath the reactor. Concern over these levels became a salient factor in scheduling operational and maintenance work, and a major decontamination was planned for late 1965. Additionally, tritium buildup within various PRTR systems always was a concern because heavy water converts to tritium when irradiated. By September 1965, tritium accumulation had reached 1.3 Ci/L in the reflector, 1.0 Ci/L in the moderator, and 0.36 Ci/L in the primary coolant itself. According to a summary operations report, by this time "exposure to tritium was a major consideration...and careful control of exposure was necessary." The months immediately preceding the September 29 accident also brought elevated releases of iodine-131 and xenon-133 gases both within the containment area and to the atmosphere from tests with pre-defected fuel rods.[133]

42.15 MAJOR OPERATING ACCIDENT

The major contamination event that occurred at the PRTR, on September 29, 1965, was FERTF test 17 using UO_2 - 4 wt% plutonium oxide (PuO_2) fuel. It was part of a series of tests designed to examine the effects of temperature increases on fuel growth, distortion, and other factors. Previous tests had been conducted at incremental levels that brought larger and larger percentages of the fuel core to a molten state without bringing the fuel cladding to a molten state. In test 17, conducted at the 1,790-kW level, a fuel element pre-defected with a 1/16-in. pinhole was heated to the point that 75% of its core radius was molten. The 1/16-in. pinhole then enlarged to 5/8-in. diameter, releasing 705 g of fuel (or about half of the fuel material in that rod) and bursting the FERTF process tube. The release grossly contaminated the PRTR's heavy water moderator with fission products and with light water from the FERTF coolant. Loss of materials and heavy water caused this to be listed at a Type A event under AEC guidelines. Measurement of surface contamination, which was first allowed October 4, gave results ranging from 1,000 $\mu Ci/ft^2$ in A-Cell down to 0.75 $\mu Ci/ft^2$ throughout "reactor hall" (the ground-level area under the containment dome).

Fission gases released at the time of the accident traveled through the helium system and into the HEPA filtration system, which automatically shut down and trapped them within the containment dome. Airborne contamination readings reached 20 r/h within reactor hall but declined from 2×10^{-5} $\mu Ci/cm^3$ on September 30 to less than 1×10^{-10} $\mu Ci/cm^3$ on October 10. The PRTR did not have special charcoal filters to trap iodine-131. After several days of decay, the xenon-133 (half-life 5.3 d) was vented through the filtration system to the atmosphere.

The most serious contamination spreads, however, concerned the PRTR's primary and secondary coolants. The heavy water was held within the containment area, was passed through ion exchange columns for initial cleaning and then shipped back to SRP for decontamination. Nearly 1 million gal of light water were contaminated initially, but the total rose to nearly 14 million gal as cooling water was added for many days afterward. At that time, contaminated effluents still were being carried from the 340 Complex to the 200 Areas by 5,000-gal tanker trucks. Such trucks, bearing contaminated light water from PRTR, left the 340 Complex on an around-the-clock basis for many days after September 29. However, as contamination levels decreased gradually and as the capacities of HW disposal facilities became overwhelmed, remaining amounts of contaminated light water were disposed to a natural depression in the ground just east of the 309 Building parking lot (approximately beneath the present site of the 3763 Building).

Cleanup from the September 29 accident cost approximately $900,000 and took about 6 mo. It consisted of three phases.

- The first phase was the gross decontamination of operating areas to achieve radiation levels permissible for the discharge of the ruptured fuel element and pressure tube.

- The second phase was the physical removal of the fuel element and pressure tube.

- The third phase was a series of massive scrubbings with steam jets and hand-applied detergents to achieve final and normal restoration of reactor systems.

The primary decontamination chemicals used were buffered oxalic acid-peroxide solution, alkaline permanganate and sulfamic acid. These substances were flushed through sumps to the TW tanks for sampling and then disposed to the 340 Complex, the process sewer, or the Columbia River, depending on contamination levels. Much solid waste, in the form of the element and the tube itself, as well as tools, cloths, and SWP clothing and masks were generated by the cleanup. These items were disposed in the Wye Burial Grounds and in 200 Area burial grounds.[134]

After the PRTR's restart for the Batch Core Experiment, very few serious wastes were produced. In one event in the 1967-68 time frame, a pump in the M&M wing sump failed, and process water backed up in that sector of the building to a depth of approximately 6 ft. The Hanford Fire Department pumped this nonradioactive water onto the lawn just north of the 309 Building, where it percolated into the ground. In another case in August 1973, the irradiated fuel storage basin, then nearly empty of fuel rods but still contaminated, overflowed when a hose supplying cooling water accidentally was left on. This event spread contamination within the 309 Building.[135]

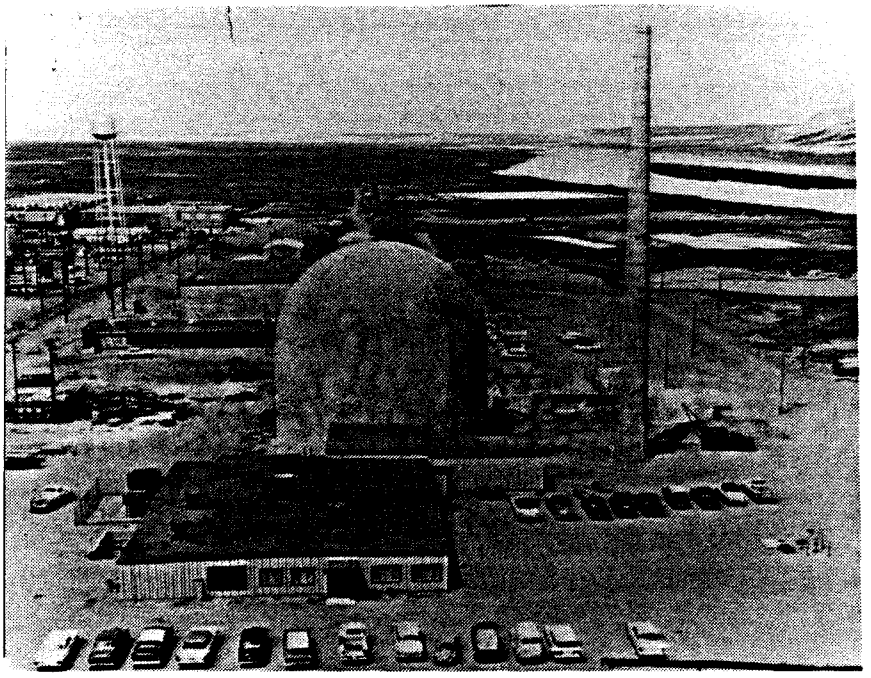

Figure 66. The 309 Building's distinctive silver dome, containing the Plutonium Recycle Test Reactor, as it appeared during its first year, 1960.

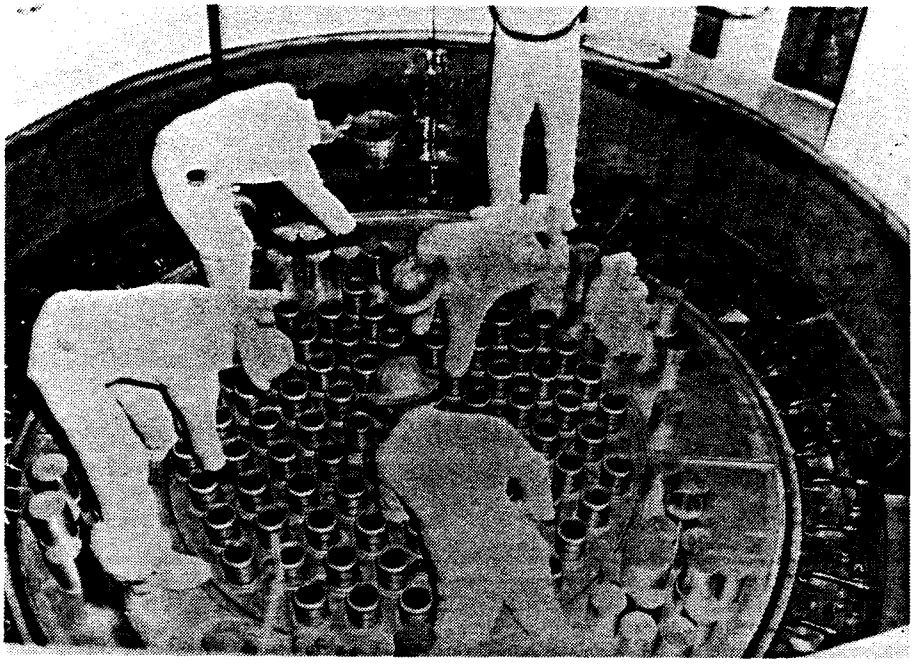

Figure 67. Hanford workers prepare the initial fuel assembly for the PRTR in the 309 Building, 1960.

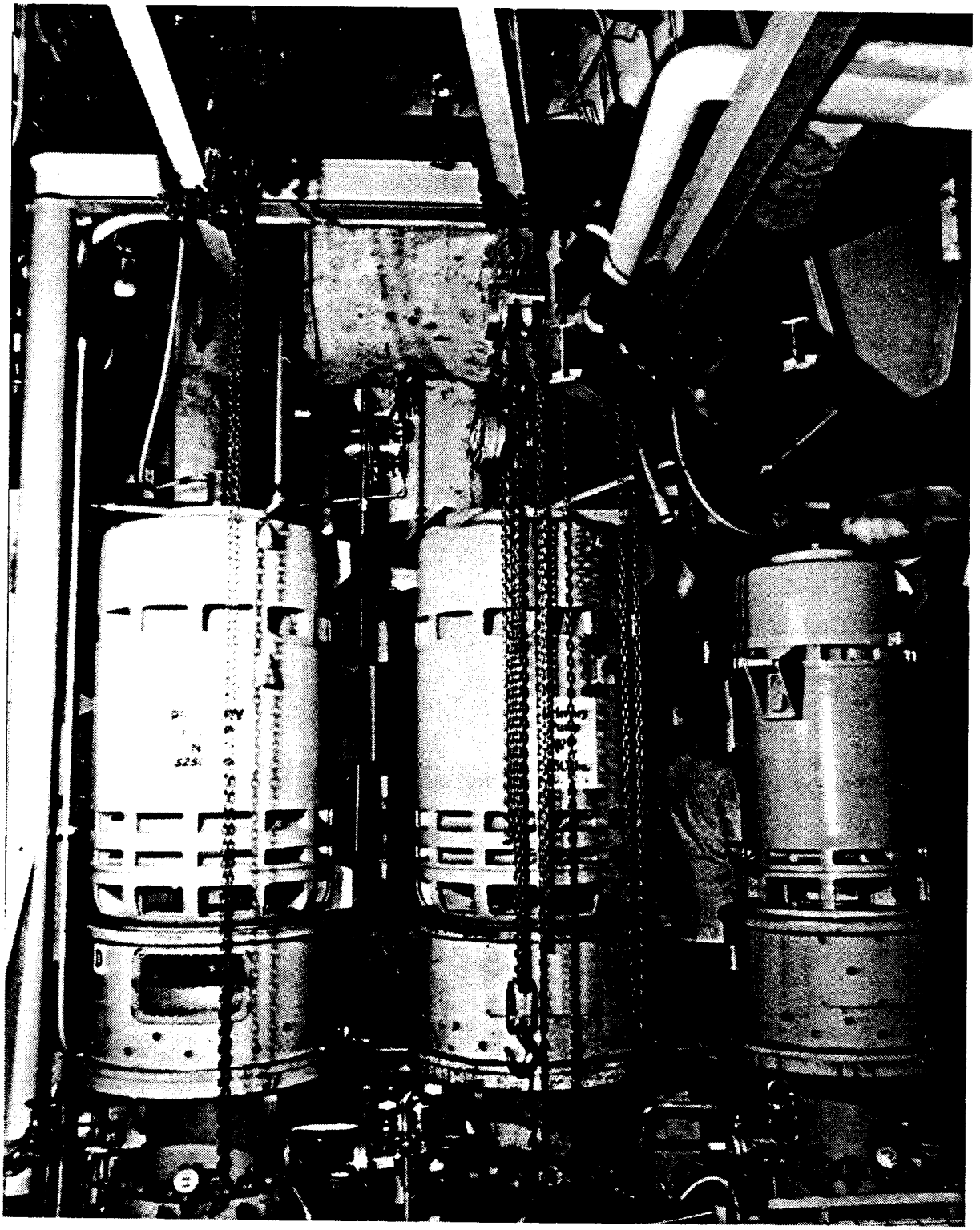

Figure 68. The primary coolant pumps located in B-Cell in the 309 Building, used to circulate heavy water through the PRTR, 1964.

43.0 THE 315 WATER FILTER PLANT

43.1 FACILITY DESCRIPTION AND MISSIONS

The 315 Water Filter Plant was a 49-ft by 124-ft concrete structure located 285 yd east of the PRTR site was constructed at the same time as the 309 Building (1960) to filter raw water from the Columbia River to supply the PRTR's reservoir and secondary (rupture loop) cooling system. During most of its years of operation, the PRTR's reservoir demand varied between 1,500 and 2,200 gpm, and the rupture loop demand stood at or below 200 gpm. Therefore, the 315 Water Plant's capacity of 2,400 gpm, with a 70,000-gal clearwell storage area, was adequate. Within the filtration system, river water impurities first were agglomerated with alum and settled in a sedimentation basin. The water then passed through anthracite, sand, and gravel filters. The 315 Water Plant could be operated from a control room in the facility or from the 325 Building. A sample laboratory for the filter plant was located in the northeast portion of the control room. In the 1970's, after the decision to shut down the PRTR permanently, the 315 Water Plant was enlarged by approximately 2,000 ft^2, to a total working area of 8,000 ft^2. Equipment for the addition of chlorine and other constituents of potable water were added, and the 315 Plant became the filtering facility that provides sanitary water to the entire 300 Area. It continues to function in that capacity today with another settling pond added in the mid-1980's.

43.2 THE 315 WATER FILTER PLANT WASTES AND CONTAMINATION

Process wastes from the early filter plant included drain-offs and overflows from the sedimentation basin and from the various filters, filter backwash waste, and drain-offs from service area equipment and from floors. These wastes drained directly into the Columbia River. The filter plant had its own 500-gal steel sanitary septic tank, along with a 50-ft drain field of 4-in. tile. After the plant's conversion to its current function, the backwash drain line was re-routed to empty into the 300 Area South Process Pond, and the sanitary sewer was routed to the 3906 Lift Station to feed into the overall 300 Area Sanitary Sewer System (see Part III). No airborne or radioactive wastes have been produced by the 315 Water Plant.[136]

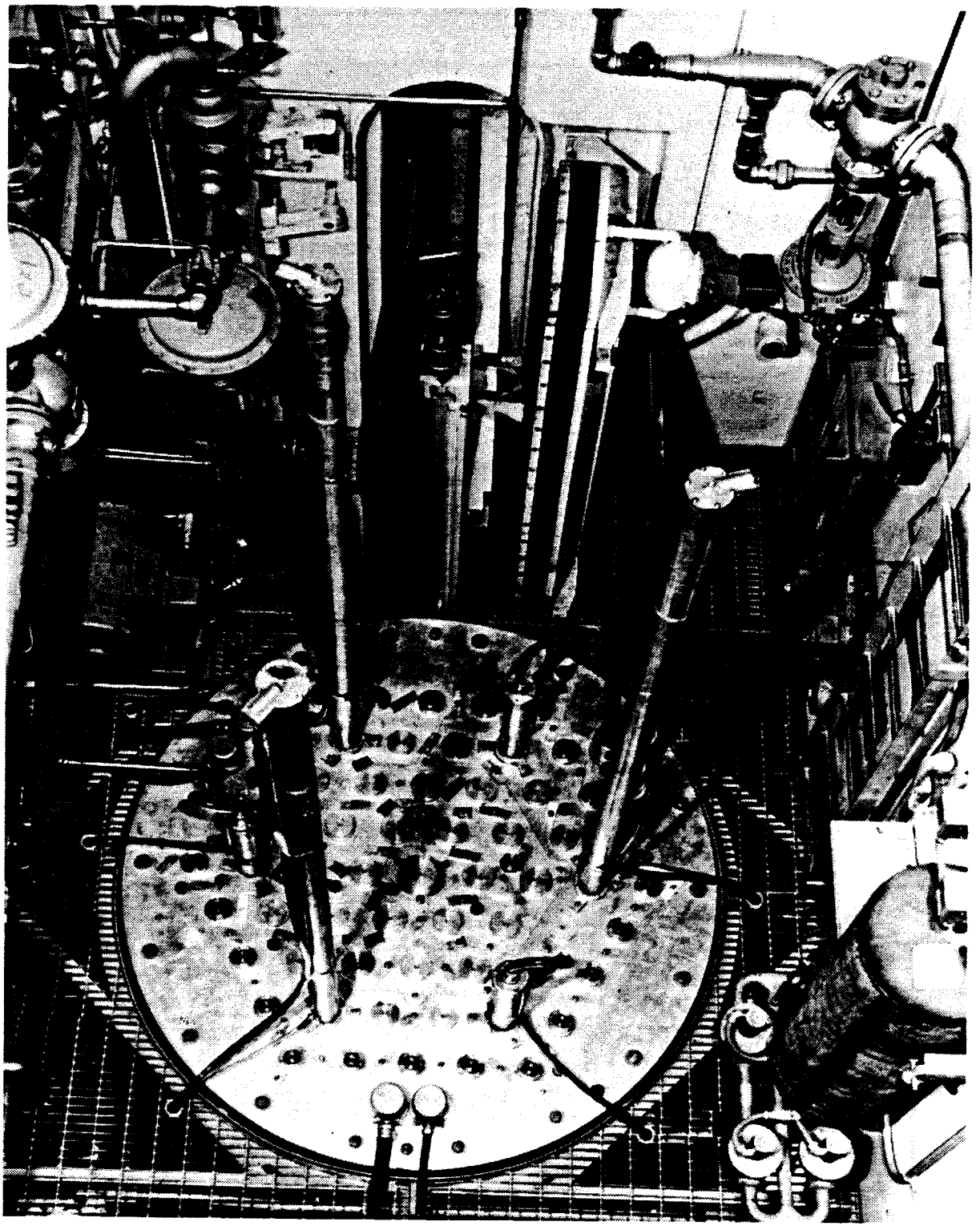

Figure 69. The Plutonium Recycle Critical Facility in the 309 Building, about 1970.

44.0 THE 318 HIGH TEMPERATURE LATTICE TEST REACTOR

44.1 FACILITY DESCRIPTION

The main 318 Building was constructed during 1966 to 1967 to house the HTLTR, a reactor designed to test very high-temperature fuel performance in gas-cooled reactors. Near the center of the building was located the two-level reactor enclosure, with reinforced concrete walls 4.25 ft thick on three sides and 4.6 ft thick on the west (office) side. The reinforced concrete roof of this segment was 3 ft thick, and the floor, also made of reinforced concrete and recessed 2 ft below grade, was 2 ft thick. The reactor room, the ground-level portion of the reactor enclosure where the HTLTR was located, was 33 ft by 54 ft by 29.5 ft (high). The basement portion below the reactor was 14.5 ft deep. A 50-ton, 11-ft by 10-ft shield door composed of steel and high-density concrete allowed access to the reactor room on the west side, and a 7-ft square door of similar construction accessed the reactor basement on the west side. Concrete plugs were located in the north and east walls of the reactor room, and a circular exit port in the south wall was provided for the flight tube of the neutron energy analyzer. A 10-ton bridge crane served the reactor room. The reactor enclosure had its own separate ventilation system, with the intake system consisting of filters, dampers, blowers, and a heating system located on the roof. The entire reactor area was maintained at negative air pressure and exhausted to a 40-ft-high stack.

The 318 Building also contained a three-story steel paneled service wing west of the reactor enclosure. Its roof was metal framed and covered with built-up roofing asphalt. The ground floor of this area comprised an experiment assembly area where unfueled test cores were prepared before being charged into the reactor (Figure 70), a 21.5-ft by 17.5-ft control room (Figure 71), an instrument shop, and a change room with a lavatory. The second story contained offices, a lunchroom, sanitary restrooms, and corridors. The basement level contained an experimental mock-up area with an adjacent concrete counting room. It also housed the heating and ventilating equipment for the 318 Building's two additional ventilation systems. One of these systems supplied areas such as lunchrooms and offices where no radioactive or fissile materials existed. These areas were maintained at positive atmospheric pressure. Another ventilation system supplied air to the work and mockup areas, instrument shop, control room, counting room, and change rooms. These areas were maintained at atmospheric pressure.

An ancillary detector building was located approximately 34 ft south of the reactor enclosure of the 318 Building. An 18-in.-diameter drift tube about 25 m long extended from the reactor into this long, narrow (50.5 ft by 16 ft) prefabricated galvanized steel facility. The drift tube and the neutron detector assembly were housed in this structure, which had its own heating and cooling system. Nitrogen gas, the primary coolant for the HTLTR, was supplied to the reactor at 100 psig from an 8,000-gal liquid nitrogen tank located on a concrete storage pad about 60 ft to the southwest of the 318 Building's service wing. The dry nitrogen reached the HTLTR through a 2-in.-diameter, 132-ft-long gas discharge line located 18 in. below grade.

44.2 HIGH TEMPERATURE LATTICE TEST REACTOR DESIGN

The reactor itself consisted of a graphite moderated core 10 ft on each side. It was composed of 4 3/16-in^2 nuclear grade graphite bars 4 ft and 2 ft in length, stacked, keyed, and doweled together to form a solid unit. A 5-ft-square, 10-ft-long central section of the solid cube was removable and could be adapted to various test core sizes up to a 5-ft cube. For smaller test cores, it could be lined with graphite blocks that could be loaded with driver fuel. The reactor was surrounded by 2-ft-thick thermal insulation consisting of insulating firebrick, stagnant nitrogen, and a fibrous mineral blanket. This insulation, in turn, was surrounded by a 1/8-in.-thick Boral liner for radiation shielding and then a gas-tight carbon-steel shell. This container had a removable (but gas-tight) door on the front (west) reactor face for complete core access and a smaller door on the rear (east) face for the test core access only.

The HTLTR operated at 1,000 °C, with maximum nuclear power of 2 kW. The primary coolant was dry nitrogen gas, but the reactor's two heat exchangers were light water cooled. The HTLTR was controlled by eight horizontal shutter-type control rods and four gravity-drop, blade-type vertical safety rods. These rods were composed of graphite, UO_2 graphite, and thoria dispersed nickel. Additionally, gadolinium oxide "poison" shim rods, sometimes tempered with samarium, iridium, or with hafnium oxide, were loaded into varying channels of the core to control excess reactivity at room temperature and to level reactivity changes caused by temperature fluctuations during experiments. Driver fuel consisted of graphite-clad enriched (5% uranium-235) UO_2 ceramic pellets, and test fuels were composed of mixed oxides in pelletized or block form. The HTLTR's operations were completely computer controlled, with a manual "over-ride" feature.

In 1982, after the HTLR had ceased operations and been removed, the 318 Building received a one-story prefabricated steel frame addition on the south side. This annex was erected on concrete footings and slab and had an insulated metal roof.

44.3 THE 318 BUILDING MISSIONS

The original 318 Building mission, that of housing, servicing, and supplying the HTLTR, was part of the fuels diversification research being carried out at HW in order to facilitate "peaceful atom" projects worldwide. The key functional concepts being tested in the HTLTR were high temperature operation and nitrogen gas cooling. The experiments with mixed oxide blend fuel rods and poison rods, as well as with different test core configurations, also were important. No weapons grade plutonium or any other weapons material was researched or produced in the HTLTR. It operated from 1968 to 1972, at which time its funds were diverted to the pursuit of breeder reactor technology (the FFTF project at the Hanford Site). In 1973, the HTLTR's irradiated fuel rods were processed through PUREX, and its unused fuel was excessed commercially as part of a large HW fuel scraps clean-out program at that time. The reactor itself, along with its control room computer, was removed between 1978 and 1982.

The 318 Building has been used since that time as a PNL site services facility to house offices, computers, and work involving the calibration of dosimeters and survey instruments. It is known now as the Radiological Calibrations and Development Laboratory and has been managed by PNL (formerly BNWL) since its construction. The basement of the former reactor enclosure now houses an X-ray room and X-ray control room, a photon facility, mechanical room, and several radiation source wells. The first floor contains laboratories, a low-scatter room, a computer room, and storage space for Hanford Site monitoring equipment. The second floor contains offices, a lunchroom, and a mechanical equipment "penthouse." The former detector building now holds one laboratory, while half of the structure is used for storage. The prefabricated addition to the 318 Building houses a photon source room, calibration room, receiving area, monitoring equipment survey room, and an acceptance and evaluation room.[137]

44.4 THE 318 BUILDING WASTES AND CONTAMINATION

The high operating temperature of the HTLTR brought about many problems with reactor components and fuels. Prominent among these difficulties were thermal expansion of the TD-nickel nuts within the fuel rods, the fuel rod "boots" (flux leveling slugs occupying 4 to 8 in. on the ends of "regular" fuel rods), and the gadolinium-samarium within the control rods. However, these thermal expansions produced simply maintenance consequences, not fuel or waste releases. The 318 Building was connected only to the 300 Area sanitary and process sewers. A large volume of liquid nuclear wastes was not anticipated because of the use of a dry nitrogen gas cooling system. Solid nuclear wastes and spent fuel were shipped in casks to the 200 Areas for processing and/or disposal. Indeed, no records of contamination events or waste releases can be found concerning this building. Essentially, no serious wastes or contamination were produced.[138]

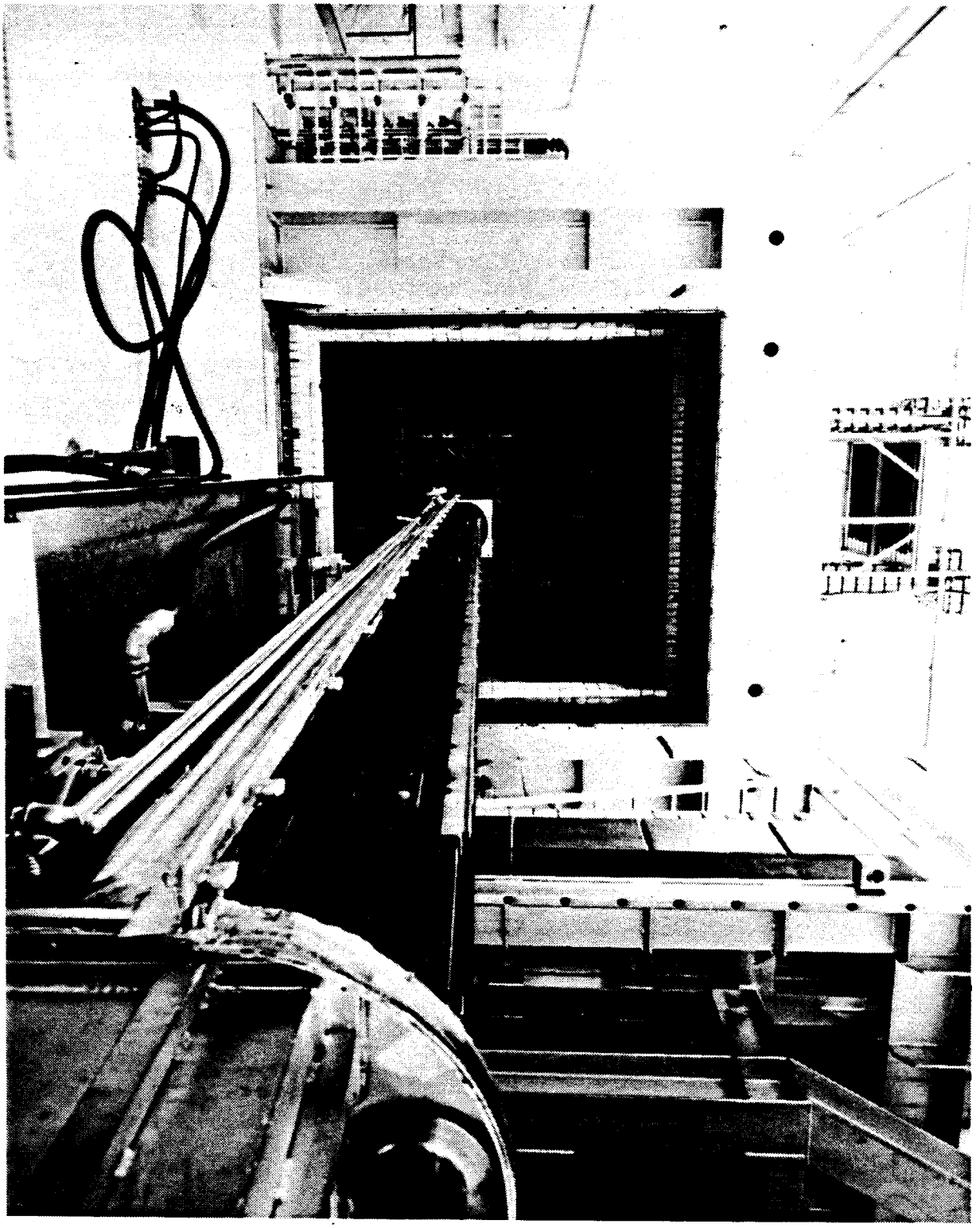

Figure 70. The fuel insertion assembly for the High Temperature Lattice Test Reactor in the 318 Building, 1969.

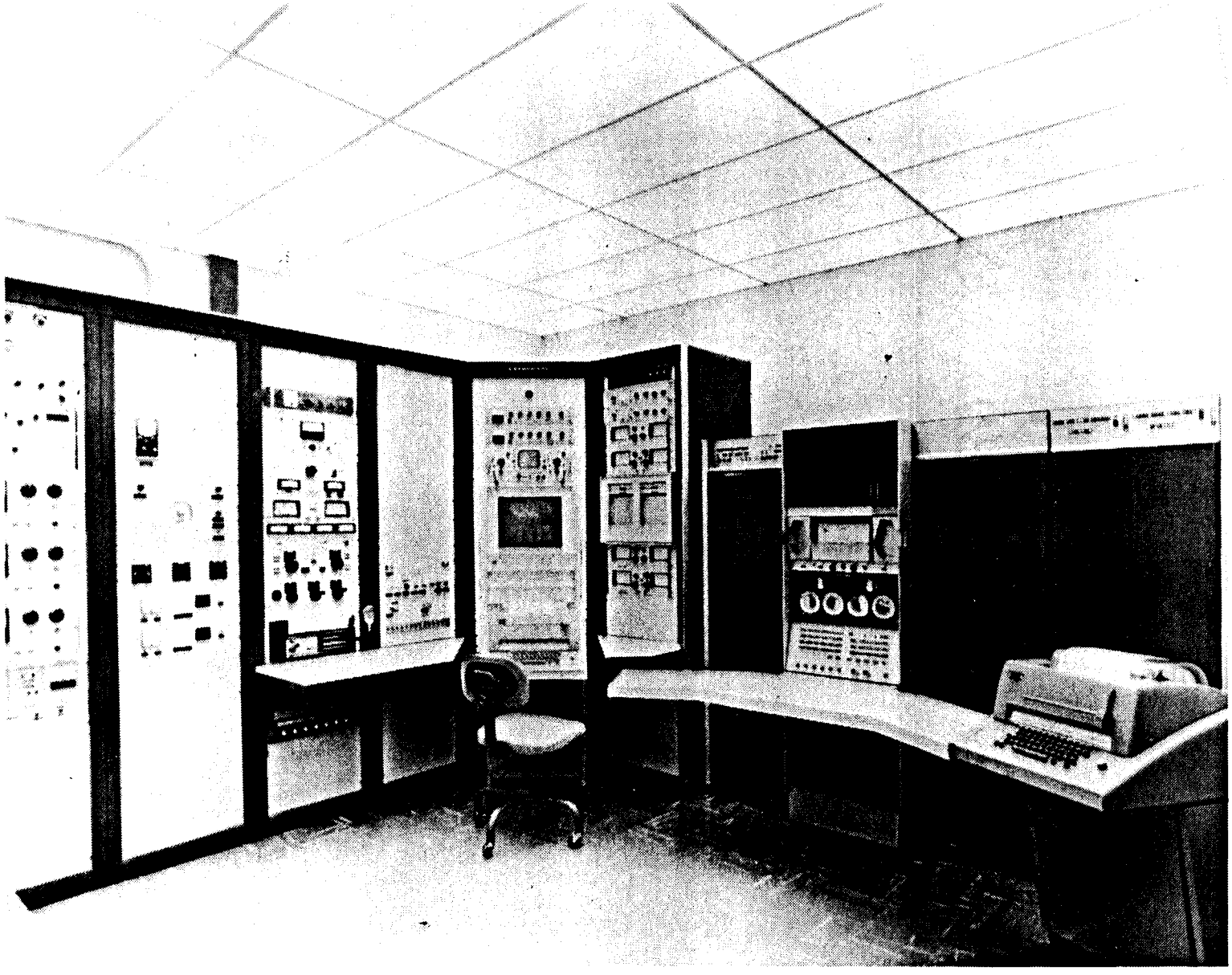

Figure 71. The High Temperature Lattice Test Reactor's computerized control room in the 318 Building, 1969.

45.0 THE 324 WASTE TECHNOLOGY ENGINEERING LABORATORY

45.1 FACILITY DESCRIPTION

This large and complex 324 Building was constructed during 1964 to 1966 as a Fuel Recycle Pilot Plant (FRPP). However, mission changes caused the facility to be known as the Chemical Materials Engineering Laboratory throughout most of its history (Figure 72 and 73). The original 324 Building was a concrete and steel structure 205 ft by 235 ft by 45 ft (high), with a total area of approximately 80,000 ft^2. Various additions over the years brought the total area to just over 91,000 ft^2 by 1983 (see Sections 42.2 to 42.7). It was designed partially to support PRTR operations by housing chemical reprocessing and metallurgical examination on the PRTR's fuel elements. As such it was built as a dual facility, with both radiochemical and radiometallurgical hot cells and laboratories. It also was designed to house the Waste Solidification Engineering Project (WSEP), one of the first high-level waste vitrification demonstration programs in the world.

45.2 RADIOCHEMISTRY CELLS

The radiochemical portion in the north side of the building contains four hot cells (A-, B-, C-, and D-Cells), along with an Air Lock Cell. All of these cells are contained by high-density concrete walls and at least partial stainless steel liners. A-Cell (Room 136) is 9.25 ft by 21 ft by 29 ft (deep) (two stories), with 54-in.-thick concrete walls, a 1/8-in.-thick stainless steel liner, and a concrete basement underneath. The cell contains the Waste Canister Storage Engineering Test Facility which consists of 6 cubicles in the north wall, each 3 ft deep with 4-in.-thick steel doors. These cubicles stored canisters containing high-level, solidified radioactive waste in a controlled environment. Some canisters containing cesium-137 heat sources manufactured for the Federal Republic of Germany (FRG) in the late 1980's still are stored in A-Cell, and some decontamination operations for the FRG program were performed in this cell. The B-Cell (Room 133) is the largest, at 25 ft by 22 ft by 30.5 ft (deep) (three stories) with 48-in.-thick concrete walls and a stainless steel liner up to the 27-ft level. There is no concrete basement under B-Cell, but the facility has its own 10.5-ton bridge crane and a 3-ton crane.

The C-Cell (Room 134) is 19.25 ft by 12 ft by 15 ft (deep) (one story), with a basement underneath. The east and west walls of C-Cell are 6.25-ft-thick normal concrete, the north wall is 4.5-ft-thick normal concrete, and the south wall, facing the operating and service galleries, is 4-ft-thick high-density concrete. D-Cell (Room 246) is 13 ft by 21 ft by 17 ft (deep) (one story) and sits above C-Cell. Its walls are constructed of 4-ft-thick high-density concrete, and its floor is lined with stainless steel. The Air Lock Cell (Room 135) is a maintenance, decontamination and transition zone for other radiochemistry cells. It includes a pipe trench located below grade and covered by concrete blocks and a basement that extends as part of the basement below A and C Cells. Within the pipe trench are located connections between some equipment pieces and between process lines carrying radioactive materials from cell equipment and tank vaults within the building. All cells are equipped with HEPA filtration. All air pressure within the cells is

maintained negative to atmospheric. In the late 1960's, a shielded load-out port was added to the left of the doorway of the Air Lock Cell for use in the NWVP. In the 1970's, because of the very hot nature of this work, stainless steel sleeves were added around transfer pipes that carried NWVP materials between the 324 and 325 Buildings and around some floor piping. Stainless steel trays were added beneath the A, C, and Air Lock Cells and under the High-Level Waste Vault (see Section 45.6).

45.3 RADIOMETALLURGY CELLS

The southeast section of the 324 Building contains the Radiometallurgy and Materials Testing Laboratories, including three large hot cells known as the Shielded Materials Facility (SMF) (Figure 74). Among these, South Cell (Rooms 139 and 140) is the biggest. It is 16 ft by 50 ft and contains a 3-ton bridge crane and five compartments. Compartment 1, located farthest south, has the most negative air pressure gradient and has contained materials with the highest levels of radioactivity. Compartment 5 held irradiated fuel pin storage racks until 1991, when these racks and the partition to this compartment were taken down. East Cell (Room 142) is 16 ft by 23 ft and contains a 3-ton bridge crane, and the Air Lock Cell (Room 141) is 16 ft by 20 ft and contains a 10-ton bridge crane. All SMF cells have stainless steel liners. An operating gallery (Room 139) surrounds these three cells, and the basement beneath the SMF contains a critically safe slab tank. In case of a fire within the SMF area, this tank can accept the fire quenching water or chemicals, but it is not used to accept ordinary cell effluents.

45.4 ENGINEERING DEVELOPMENT LABORATORIES

In addition to hot cells, the 324 Building contains many other laboratory facilities. Among these are four Engineering Development Laboratories (EDL), two designed for work with nonradioactive materials (EDLs 101 and 102) and two designed for hot work (EDLs 146 and 147). EDL-101 was built as an addition to the 324 Building in the early 1970's as a cold support shop containing a 4-ton bridge crane. Sodium loops were added to this 28-ft by 60-ft by 33-ft (high) laboratory during 1974 to 1975 for liquid metal research. The facility was modified again in 1981 with the addition of lithium loops and an associated exhaust scrubber system, to become the Experimental Lithium System (ELS). The ELS provided a test bed for hydrodynamic trials of prototypical target assemblies for the FFTF's Fusion Materials Irradiation Test (FMIT). The EDL-102, a part of the original 324 Building, is 64 ft by 60 ft by 30 ft (high) and contains a 5-ton bridge crane. This laboratory is divided into eight 2-story modules (numbered 1 through 16), each having 350 ft^2. Each module has functioned as a laboratory for the development of cold chemical processes, process equipment, instrumentation and/or mechanical equipment. Extraction columns in EDL-102 performed cold fuel reprocessing verification trials for the REDOX and PUREX plants. Pump development work for 200 Areas processes also was conducted. The Cold Waste Solidification System was installed in EDL-102 in the mid-1980's and still functions there to demonstrate and test the conversion of nonradioactive liquid wastes to solids.

The EDL-146 is a multipurpose laboratory 30 ft by 48 ft by 34 ft (high) containing a 4-ton bridge crane. Located adjacent to the Cask Handling Area (CHA) (see Section 45.5), this facility performed experiments with radioactive sodium in the 1970's and 1980's. EDL-147, also adjacent to the CHA, is 28 ft by 45 ft by 34 ft (high) and contains a 5-ton bridge crane. It is known as the Regulated Shop because it performs decontamination and repair of manipulators having high radiation levels. Another facility in the 324 Building known as the Regulated Manipulator Shop (Room 139-C) performs decontamination and repair on manipulators having lower levels of radiation.

45.5 TRUCK LOCK AND CASK HANDLING AREA

The original construction of the 324 Building also included a high-bay truck lock and rail load-out station (Room 138), located on the north side of the building just east of center. This facility, which is 36 ft by 34 ft by 35 ft (high), is separate from a truck ramp that leads down to a basement receiving station on the southeast side of the 324 Building (see Section 45.6). Adjacent to the north side truck/rail lock is the CHA (Room 137). Within the CHA is a stainless steel enclosure 7.5 ft by 5 ft by 10 ft (high) known as the decontamination and load-out stall. This small facility, equipped with manipulators and a remote viewing window, is used to transfer highly radioactive solutions between shipping casks and shielded facilities casks. In 1981, an Irradiated Pin Storage Facility (Room 137) was emplaced in the CHA. This steel-reinforced concrete facility, which is 17 ft by 15 ft by 8 ft (high), was capable of storing up to 300 eight-ft-long irradiated fuel pins after discharge from the FFTF. However, no fuel pins actually were stored there, and this facility was removed in 1991.

45.6 SAFEGUARDS VAULT AND LABORATORY AREA

This large basement area within the 324 Building contains four laboratories, three facilities connected with shipping and packaging, various tanks, and the Fissile Materials Storage Vault. One of the laboratories (3K) handles plutonium and is accessed by its own airlock. It contains two gloveboxes having inert nitrogen atmospheres and separate HEPA filtration, and an open-faced hood. Laboratory 3K is used for the inspection, packaging, mixing, consolidation, weighing, and sampling of all chemical and physical forms of fissionable materials. Laboratories 3C, 3D, and 3J are used to perform NDE analysis on sealed containers of fissionable materials. Additionally, 3C contains an open-faced hood for the inspection, weighing, and sampling of normal and depleted uranium and thorium. In the Inspection Packaging Area (Room 3A), inspections are performed on all sealed, fissionable materials storage cans entering or leaving the 324 Building. There is a Small Shipping Container and Equipment Storage Area (Room 3B), as well as a Shipping, Receiving, and TRU Waste Storage Room (3H). The latter facility, a truck stop at the bottom of the 324 Building's southeast truck ramp, is used as a shipping and receiving point for fissionable materials. It also has been used for the short-term storage of TRU waste containers. A chemical tank pit containing 20 tanks existed in the northwest basement area just below EDL-102, but 18 of these tanks have been removed.

The Fissile Materials Storage Vault, a 1970 addition that received extensive modifications in 1975, is a structure 23 ft by 27 ft with 1-ft-thick concrete walls. Located beneath the SMF cells, this vault is topped with 4.5-ft-thick concrete shielding beneath East Cell, except for the area beneath the cell sump. That region has a 2-ft-thick concrete barrier with a 6-in.-thick layer of lead (together giving an effective thickness of 4.5 ft of concrete). The vault has a 4-h fire-rated metal door and contains 12 fissile materials storage cabinets arranged in a diamond array and further separated by two 16-in.-thick concrete pillars. It also holds a freezer for the storage of high-exposure plutonium. Before the storage cabinets and freezer were emplaced, the vault served as the location of HW's earliest sodium loops to perform corrosion, deposition, and other testing for FFTF development. Hand-built, lead brick caves containing portable leaded glass windows were installed for this work, and irradiated iron alloys were exposed to flowing liquid sodium. In 1985, extensive security upgrades were performed in the Fissile Materials Storage Vault. Motion detectors, alarm systems, and dry powder fire suppression systems were installed.

45.7 OTHER 324 BUILDING FACILITIES

Three additional basement chemistry laboratories are located in the 324 Building. The largest, 3G, is 27 ft by 27 ft and contains a shielded (stainless steel and lead) glovebox that handles various fission products, sodium, and up to 15 g of irradiated plutonium oxide fuel. Previously, this laboratory contained the Fission Product Transport Loop (FPTL), a facility that studied the transport behavior of trace amounts of various fission products in flowing sodium. Laboratory 3G also previously held an inert atmosphere glovebox that studied cesium-137 in molten sodium. Laboratory 3F, 10 ft by 69 ft, contains two vented hoods and now functions as a low-level metalography laboratory involved in tritium work. Previously, the two hoods were used for alkali metal processing and for preparing materials involved in Run-Beyond-Clad-Breach deposition sample studies. Laboratory 3E, 8 ft by 22 ft, is now a storage room.

The 324 Building also contains a general-purpose "cold" laboratory in Room 115. This 15-ft by 20-ft facility had a glovebox for handling sodium-wetted hardware for the LMFBR program and housed corrosion tests for the BWIP until the mid-1980's. There are four second-floor chemical engineering laboratories (Rooms 207, 208, 210, and 212) in the 324 Building used for sample preparation, small scale studies of waste solidification processes, mixing studies, and materials performance testing. There also is a large maintenance and fabrication shop in the west end of the building. Additionally, the 324 Building has a High-Level Waste Vault containing eight tanks and a Low-Level Waste Vault containing four tanks. These vaults are located below grade on the north side of the building beneath the wall that divides the CHA and EDL-147. The waste in the high-level tanks is removed from the building via casks, and the low-level waste is piped to the 340 Complex for disposal. Previously, the high-level waste tanks served as the receiving vessels for material brought from the 200 Areas and from the 325 Building to be vitrified in 324 Building developmental programs. A high bay addition known as the HBE was completed on the northwest corner of the 324 Building in 1979. Equipped with a 5-ton bridge crane, this large facility

housed the "cold" prototype testing of large equipment components such as melters. Fresh chemical storage tanks are located in the 324 Building's central chemical makeup area on the third floor (Room 309).[139]

45.8 THE 324 BUILDING MISSIONS

The 324 Building, originally designed to support PRTR tests and waste solidification work, was completed just after the serious PRTR accident of September 1965. The PRTR's operating problems, combined with the AEC decision to emphasize LMFBR research and deemphasize the fuels diversification research for which the PRTR had been designed, signalled a nearly immediate end to the 324 Building's PRTR support work. From the time of its completion in 1966 until 1968, the 324 Building performed primarily WSEP work in the radiochemistry cells. During 1968 to 1969, the SMF and other portions of the building attracted much developmental work for the FFTF.

The waste vitrification work was performed largely in "solidification units," including a large platinum melter and a titanium concentrator, located in B-Cell. Glassification pots and much other equipment for this program were made in the 324 Building's own maintenance and fabrication shop. The first waste vitrification programs in the building used 1WW waste from PUREX or from B Plant (then retrofitted for a large 1968 to 1978 strontium-90 and cesium-137 recovery program). Extremely high-level waste with heavy concentrations of cerium-144/praseodymium, and sometimes "spiked" with extra strontium-90, was used as the feed material until the mid-1970's, when spent commercial reactor fuel began to be used. Vitrification continued as the major radiochemical mission in the 324 Building until 1980. During the early 1980's, radiochemistry work included the solidification, encapsulation, and packaging of spent ion exchange resins from the Three Mile Island (Pennsylvania) reactor, and the pilot testing of Radioactive Liquid-Fed Ceramic Melter (RLFCM) operations. The FRG cesium heat source manufacturing project was the major radiochemistry program underway in the building from 1986 to 1990. Additionally, bioremediation techniques were investigated, and high-temperature melters were used to experiment with the treatment of medical and other radioactive wastes.

Radiometallurgical programs in the 324 Building have centered on NDE of irradiated fuel elements and other irradiated structural materials including reactor process tubes. The large capacity of the SMF cells made them capable of handling the longer fuel elements from reactors such as the PRTR (88-in. fuel elements), the EBR II, and the FFTF (8-ft fuel elements). Between 1968 and 1980, gamma scanning, profilometry, and other types of NDE were conducted on fuel elements from these reactors, and some reconstructive work (reassembly of breached fuel pins) also was conducted. Since 1980, the SMF cells have processed at least one MOTA from the FFTF each year and have tested, reassembled, and stored many irradiated fuel elements and structural components. Currently, capsules containing cesium chloride for medical uses are being pressed and assembled in South Cell for the Nordion Corporation of Canada. This 1991 to 1992 project will manufacture several capsules ranging from 500 to 3,000 Ci each. Additionally, Hanford Waste Vitrification Plant (HWVP) engineering verification and process verification missions are important parts of current 324 Building work.

In addition to other missions and functions not previously described, important sodium work has been performed in the 324 Building. After the 337 Building was completed in 1971 (see Section 47.2), the sodium testing loops were removed from the 324 Building's Fissile Materials Storage Vault area. However, a Sodium Removal and Decontamination Apparatus (SRDA) then was installed in EDL-146 to perform sodium decontamination testing on various irradiated metallic coupons. Other liquid metal studies, including caustic stress corrosion testing, electropolishing, and cesium absorption experiments, also were conducted in EDL-146 and in Laboratories 3E, 3F, and 3G. A SRDA-II for the removal of sodium, lithium, and sodium-potassium from equipment by using denatured alcohol or kerosene was installed outside, north of the 324 Building in the 1970's. Both SRDA and SRDA-II now have been removed. Beginning in the 1980's, a Sodium Ethanol Cleaning System (SECS) also operated in the SMF's South Cell to remove sodium from test specimens that had been irradiated in the FFTF.[140]

45.9 THE 324 BUILDING WASTES AND CONTAMINATION

The 324 Building has been connected to all four of the 300 Area sewer systems since its construction: the sanitary, process, RLWS and RPS systems. The old RLWS was changed out in the 1978-79 upgrades to a double-walled system. At that time, the "slab tank" below the SMF cells was tied into the new RLWS; it had not been connected to the original RLWS. Some of the processes involving the highest activity materials in the 300 Area have taken place in the 324 Building and have included all components of the hot cell and laboratory processes. Waste casks in the building (containing liquids and solids) often displayed radiation readings in excess of 100 r/h. Radioactive solid wastes have been disposed through casks, via the paint can and lard can systems (see Part III) using standard Hanford Site disposal procedures and locations throughout the 324 Building's history.

High-activity liquid wastes have been disposed through bowling ball casks to the 200 Areas, while lower activity liquid wastes have been routed through the RLWS to the 340 Complex. Liquid wastes in the RLWS included metallurgical fines, which sometimes built up in transfer lines and produced high radiation readings in nearby areas of buildings. Steam jet flushings and chemical rinses were used to dissolve these fines, and accumulations diminished after the installation of the new RLWS with its smoother weld joints. The 324 Building's basement safeguards vault and laboratory area contains eight floor drains, but these remain closed until drainage is required. This policy was instituted to prevent the accumulation of a critical mass in their common sump and to prevent the discharge of high-level radioactive liquids.

Chemical wastes generated in the 324 Building have been varied and have included the components of multiple laboratory processes, as well as exchange column resins and cell cleansers, reagents, drying agents, and other substances. In general, waste vitrification, a major 324 Building process, is

not a chemically intensive operation. The hot cells received steam cleanings done with Turco* detergents or more ordinary commercial detergents. Acetone was used to clean small, delicate equipment parts such as manipulator hands, and to degrease equipment. In the 1970's, acetone was replaced by Freon** for many jobs, although isopropyl alcohol was used for some large cleanup needs, and xylene was used for quick-wipe jobs. Purely chemical wastes (uncontaminated) were flushed through the process sewer system to the 300 Area Process Ponds before 1975, then were sent to the 183-H Solar Basins for approximately 10 yr and have been drummed since about 1985. Airborne wastes have been trapped, for the most part, by HEPA filtration located in the hot cell exhaust lines and in the building stack. At changeout, however, these filters often demonstrated readings up to 500 r/h. Since little to no destructive testing of "green" fuel elements was carried out in the facility, almost no iodine-131 was discharged.

45.10 CONTAMINATION EVENTS

A number of significant contamination events have occurred throughout 324 Building's history. However, in most of these cases, radioactive contamination has been confined to the building and has not spread to the environment. Among examples of the more serious occurrences is a November 1968 incident in which the load-out stall floor became contaminated with liquid cerium-144. A steam jet cask transfer line backed up, releasing contamination to the floor reading up to 100 r/h, while the steam manifold valve itself read 500 r/h. Just 2 mo later, a contamination spread occurred as operators tried to install a TV camera through a B-Cell access port. In that incident, radiation readings up to 150 r/h were found on the floor, piping and tools of the building's second floor operating gallery just outside of B-Cell. In October 1971, a contamination spread of cerium-144 occurred virtually throughout the building. In that instance, a plastic liner within a waste container ruptured in the SMF area and was tracked around by employees when a shoe counter malfunctioned and failed to indicate the presence of easily airborne cerium-144. The rupture of storage casks containing cesium-137 and calcium-252 also led to localized contamination spreads in 1972 and 1973. In the case of the cesium-137, a leaking lead pig (radioactive materials container) discharged visible particles and produced radiation readings up to 500 r/h in the 324 Building basement.

Another contamination release occurred in the operating gallery outside B-Cell during decontamination operations in the Air Lock Cell's crane in July 1979. A subsequent spread of contamination throughout the operating gallery of D-Cell then took place as the result of foot traffic. During January 1981, two nearly identical contamination spreads of high-level waste into the D-Cell jet steam supply line occurred. Radiation alarms sounded in the B-Cell gallery in both cases, and the cause of both events was found to be insufficient air purge of the D-Cell line, aggravated by poor line design. The line contained liquid traps where contamination could lodge. A major overhaul, with a system re-start in June 1981, corrected the problem.

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*Turco products are tradenames of the Turco Purex Industrial Corporation.

**Freon is a trademark of E.I. du Pont de Nemours Company.

In 1986, cesium-137 contamination was spread in the truck lock when a highly contaminated filter from B-Cell was dropped during a removal procedure. A more worrisome event in terms of recurrence potential occurred in July 1989 when a B-Cell furnace plug leaked during water flushing (decontamination) operations in the cell. Floor spots outside the cell (in Room 18) read up to 500 r/h. The final Occurrence Report stated: "There are many penetrations into B-Cell that staff cannot assume to be water tight. The root cause of this event was... [ignoring] the 'unwritten' policy to avoid spraying water on the walls of the radiochemical cell. A contributing cause was inadequate design of cell plugs." As recently as October 1990, cesium chloride contamination was spread in the SMF's gallery when a contaminated plastic "sleeve" was being withdrawn from South Cell. The negative air pressure gradient system failed between cell compartment 1 and the SMF gallery. Some floor contamination remains there today, currently painted with a contamination fixant and taped with plastic until the floor can be replaced.

Other incidents have occurred in connection with the sodium work carried out as part of the 324 Building's participation in FFTF development in the 1970's. A flash fire caused by a sodium/alcohol reaction occurred in Sodium Loop 1 in the Basement Safeguards Vault and Laboratory in December 1973. Overpressurization due to the failure of a vacuum pump used to exhaust the hood caused a glove to blow out of an inert glovebox used for handling sodium and sodium-potassium-wetted substances in November 1976. A lithium fire occurred in the basement truck transfer station as lithium was being melted for transfer from its shipment barrel to loops for the FMIT program in September 1977. Damage remained localized to the "melt station," but another, nearly identical fire occurred there in September 1979.[141]

The 324 Building currently is undergoing a significant cleanup, with a major decontamination effort underway in B-Cell in addition to the removal of several tanks, older laboratory equipment, and in-cell storage compartments. The FRG cesium heat sources are expected to be removed by late 1993, thus eliminating the need for cooling water. When 18 of the 20 tanks in the chemical tank pit were removed recently, no evidence of leakage was found. Additionally, major building systems, SMF equipment in particular, recently have undergone thorough safety reviews by RL in preparation for the current cesium chloride demonstration programs.

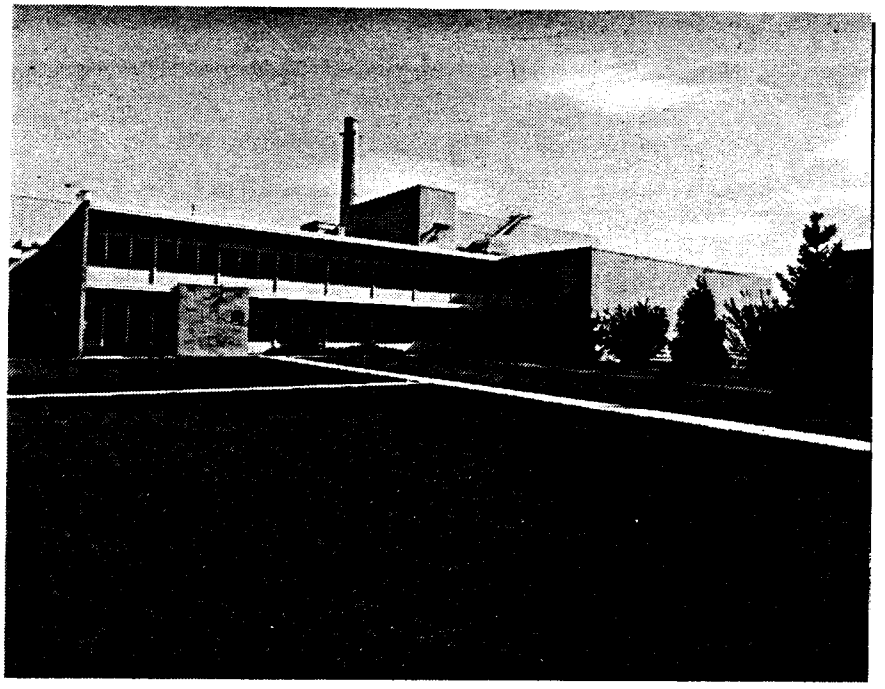

Figure 72. The 324 Chemical Materials Engineering Laboratory in 1974.

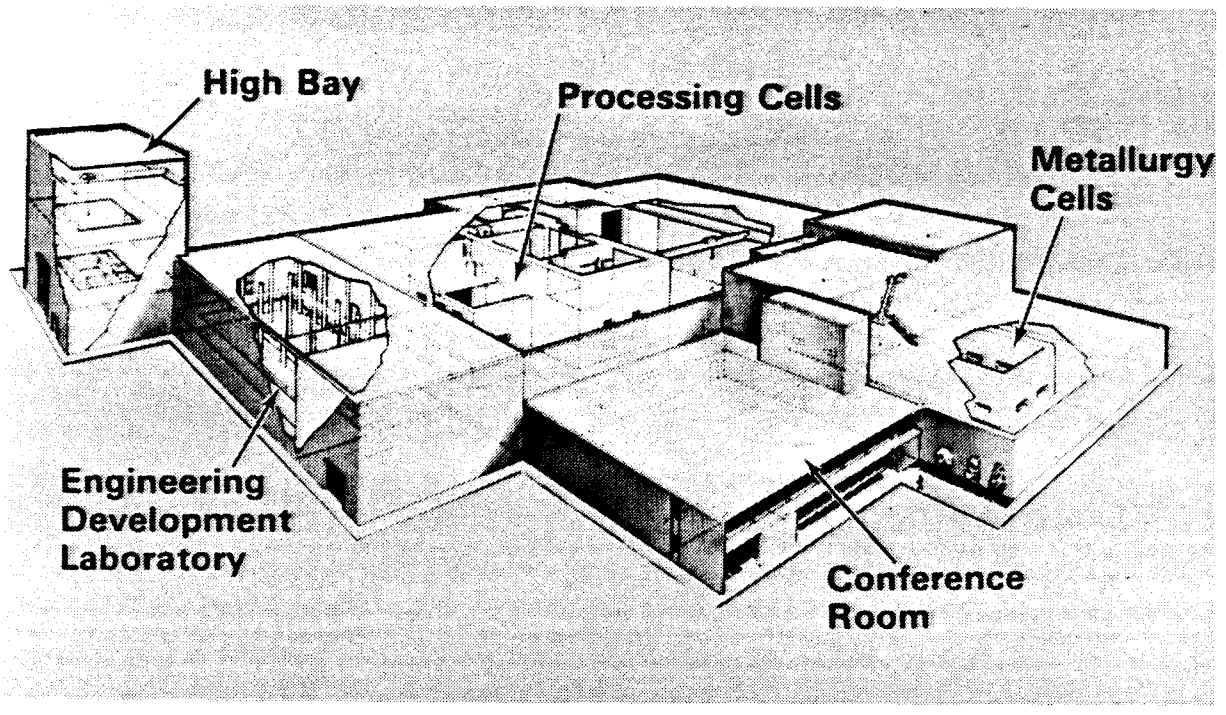

Figure 73. Cutaway view of the 324 Building's major processing and handling facilities, about 1980.

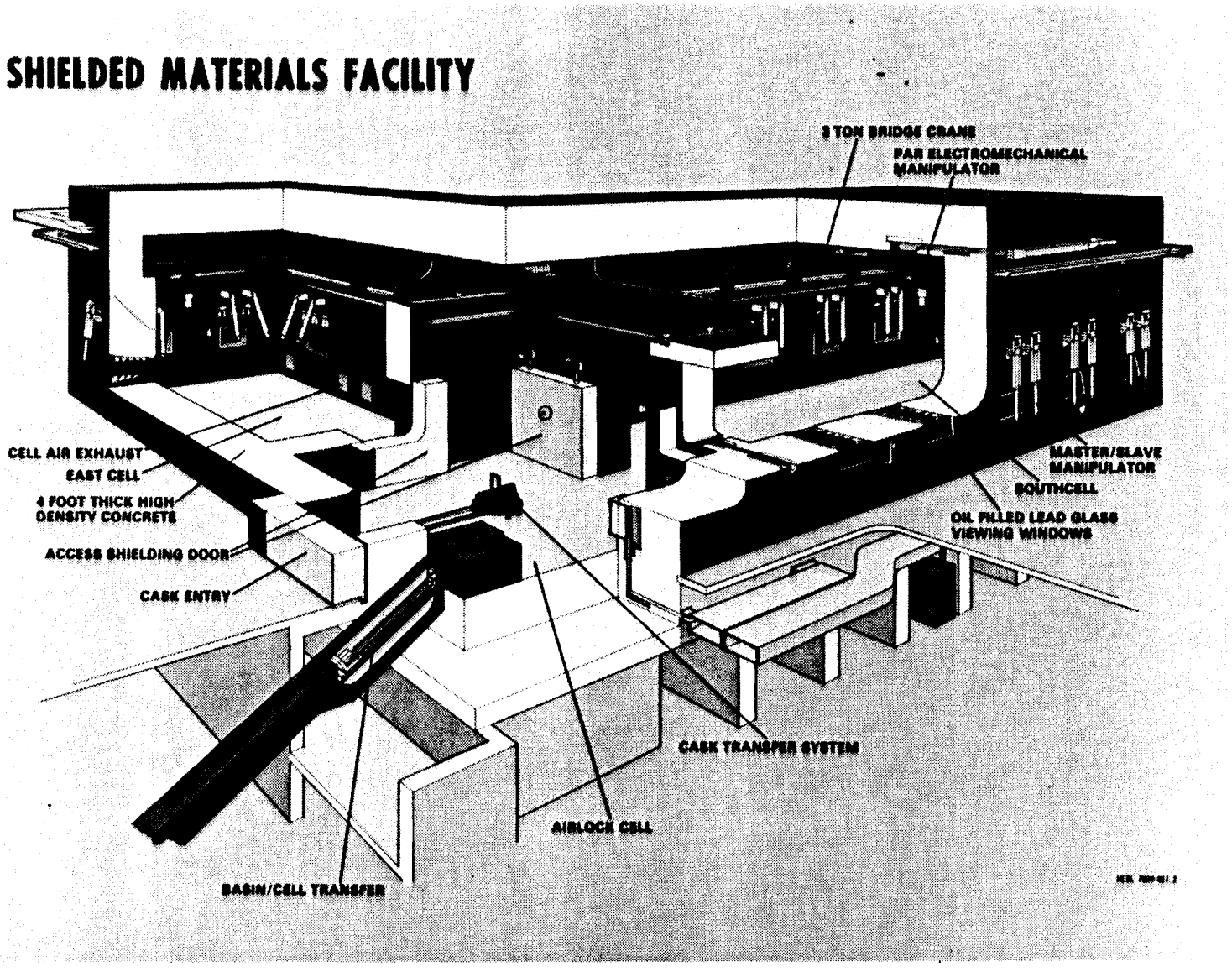

Figure 74. Diagram of the Shielded Materials Facility hot cells in the 324 Building, 1970.

46.0 THE 335 AND 336 SODIUM TEST FACILITIES

46.1 FACILITIES DESCRIPTION

The 335 and 336 Sodium Test Facilities were constructed to house experimental equipment for the study of the properties of sodium and the behavior of mechanical components to be operated in a sodium environment. In actuality, many of the experiments were conducted with a sodium and potassium mixture with properties very similar to pure sodium. The 335 Building, known initially as the Fast Reactor Thermal Engineering Facility, was completed in 1968 as a one-story structure 100 ft by 60 ft by 24 ft (high). It had a concrete floor, corrugated steel sides, and a corrugated steel roof topped with gravel. Almost immediately, a concrete block addition 20 ft by 24.3 ft by 10 ft (high) was built to house a change room, giving the 335 Building a total area of 7,610 ft^2. The 336 Building was completed in 1969 and was known initially as the Core Segment Development Facility. It housed a "cold" sodium purification and characterization system used in FFTF developmental studies. The structure contained a 5-ton bridge crane, sodium storage vessel, argon supply tank, a computer room and various electronics equipment. It is a small but very tall corrugated steel building 50 ft by 50 ft by 65 ft (high) seated on a concrete floor and having a total area of 3,863 ft^2. The roof is corrugated steel with insulation and built-up roofing topped with gravel.[142]

46.2 THE 335 AND 336 BUILDING MISSIONS

The 335 and 336 Buildings functioned in their original roles of containing sodium-related tests for FFTF development through the late 1970's. In 1977, the sodium test loops were deactivated, and they were removed during 1983-84. Eddy Current Flowmeter Calibration equipment (for use by fuel fabrication facilities) was installed in the 336 Building in 1977. In 1984, building modifications began in preparation for use as a cold mockup area for the extraction portion of a tritium production program being planned for N Reactor. However, funding was cut from that program before the modifications were complete. In 1986, the 336 Building transferred to PNL management. In 1987, the 335 Building was identified for use as a computer facility in the BWIP operation, but the termination of that program in December 1987 precluded this use. Today, it is known as the Radionuclide Logging System Laboratory. The 336 Building is known as the Fuels Dynamics Laboratory.[143]

46.3 THE 335 AND 336 BUILDING WASTES AND CONTAMINATION

Numerous small sodium leaks from faulty valves, bellows and closure points in the test loop systems occurred during the years 1969-78. On some occasions during that period, sodium fires took place in the 335 Building, and a sodium reaction within a vessel occurred in the 336 Building during loop modification in 1975. However, none of these events spread large amounts of sodium or fire suppressing agents to the environment. Many thousands of gallons of caustics (sodium hydroxide and potassium hydroxide), as well as alcohol cleansers (primarily ethanol) were used to clean and maintain the sodium loops, and some small amounts of these substances may have leaked into

soil beneath and near the buildings. Virtually no wastes have been generated by operations in these buildings since 1979, and no radioactive substances have been used in these facilities except for a small radiation source in the 335 Building. The buildings are connected to the 300 Area sanitary and process sewers.[144]

47.0 THE 337 HIGH TEMPERATURE SODIUM FACILITY

47.1 FACILITY DESCRIPTION

The 337 High Temperature Sodium Facility was built in five segments during 1970 to 1972. This huge structure (Figure 75) originally housed engineering studies including sodium loops and large mechanical mockups in support of LMFBR development, plus a service area and offices. The most prominent feature of the building is a high-bay 175 ft by 75 ft by 93 ft (height above grade) with a total area of 16,665 ft^2. Walls in the high bay area consist of 5-ton precast concrete panels supported by 35 tons of concrete columns. The roof is constructed of precast and prestressed concrete covered with asphalt and gravel and weighs a total of 25 tons. The floor loading in this massive structure was built to hold 250 lb/ft^2. There are two rollup doors 18 ft by 24 ft (high) on the north and west sides, and the facility originally housed a 50-ton capacity bridge crane (now a 100-ton capacity bridge crane). The building was served by a railroad spur connection on the north side. A 25-ft-diameter, double-steel-lined concrete caisson was built in the high bay area, beginning 20 ft below grade and extending 60 ft below grade. The concrete walls of this caisson ranged from 2 to 5 ft thick. Additionally, an 8-ft-diameter unlined concrete assembly pit began 20 ft below grade and extended down to 35 ft below grade, with a 2-ft-diameter shaft penetrating down another 13 ft.

The 337 Building also includes two reinforced concrete office wings extending to the east of the high bay, each 165 ft by 50 ft and 3 stories high. A cafeteria and lunchroom was placed between the two wings on the east end. Altogether, these areas total 64,900 ft^2. Additionally, a service area consisting of a control room, instrument shop, electric shop, change room and mechanical room, was located between the high bay and the two office wings. The service area included 24,835 ft^2, bringing the total area of the 337 Building to 106,400 ft^2.

47.2 THE 337 BUILDING MISSIONS

The initial research and development activities housed in the high bay area included a Core Mechanical Mockup (CMM), an accessible test bed for operational trials of selected FFTF components in an air environment. Among the earliest components mocked up and tested were the In-Vessel Handling Machine (IVHM) (Figure 77), the Instrument Tree, and the Control Rod Drive Lines. Another original research function performed in the high bay was known as the Composite Reactor Components Test Activity (CRCTA). This test facility experimented with FFTF components in the actual operating environment that included the argon cover gas and molten sodium coolant. The Prototype Closed Loop Development Installation (PCLDI) also provided a test bed to verify final design, operability and maintenance capability for the FFTF's closed loop. By 1974, an Alkali Metals Cleaning Facility (AMCF) also had been emplaced in the high bay to develop methods to react sodium off of mechanical components without damaging underlying materials. All of this testing was done on unirradiated materials.

Additional FFTF developmental missions performed in the 337 Building included the invention of the pioneering gas-tagging system that attached a unique identifying gas to each fuel assembly or experiment. Gas-tagging gave FFTF operators a ready means of locating breaches in fuel elements by periodic gas sampling. Sodium purification and cover gas purification methods for the FFTF also were developed in the 337 Building. Closed loop, in-reactor assembly fabrication work was done, as was the Postirradiation Open Test Assembly (PIOTA) project and a Solar Demonstration Project. In 1977, all sodium loops and other FFTF components work was deactivated and remains in standby status today. In 1987, the office wings of the building were transferred to PNL management, and this portion became known simply as the 337 Building. The high bay and service areas remained under Westinghouse Hanford management. During 1990-91, equipment was brought into the high bay for a Robotics Technology Demonstration project important in developing safer and more accurate means of performing in-cell and in-reactor operations. It is anticipated that the high bay will house mock-up and test equipment to be used in Hanford Site tank waste remediation projects.[145]

47.3 THE 337 BUILDING WASTES AND CONTAMINATION

The 337 Building has been connected to the 300 Area sanitary and process sewers since its construction. The primary wastes generated by FFTF development work were sodium, sodium-potassium, caustics including sodium hydroxide and potassium hydroxide, and copious amounts of alcohol cleansers (especially ethanol). During the construction phase, a liquid propane storage tank ruptured adjacent to the north office wing, spilling about 100 gal of liquid propane into the soil. In another construction accident, gas ignited when it was struck by a spark from nearby welding operations, but fire damage was slight and localized. Other construction and mechanical accidents occurred throughout the first decade of 337 Building operations, but none caused serious damage. On other occasions, mercury, sodium, sodium-potassium and alcohols spilled in and near the facility, and some sodium and sodium-potassium fires occurred, but none of these events spread extensive wastes. No radioactive materials were used in the building, but some residual contamination entered via contaminated tools and equipment brought in from other facilities. There have been virtually no wastes generated in recent years.[146]

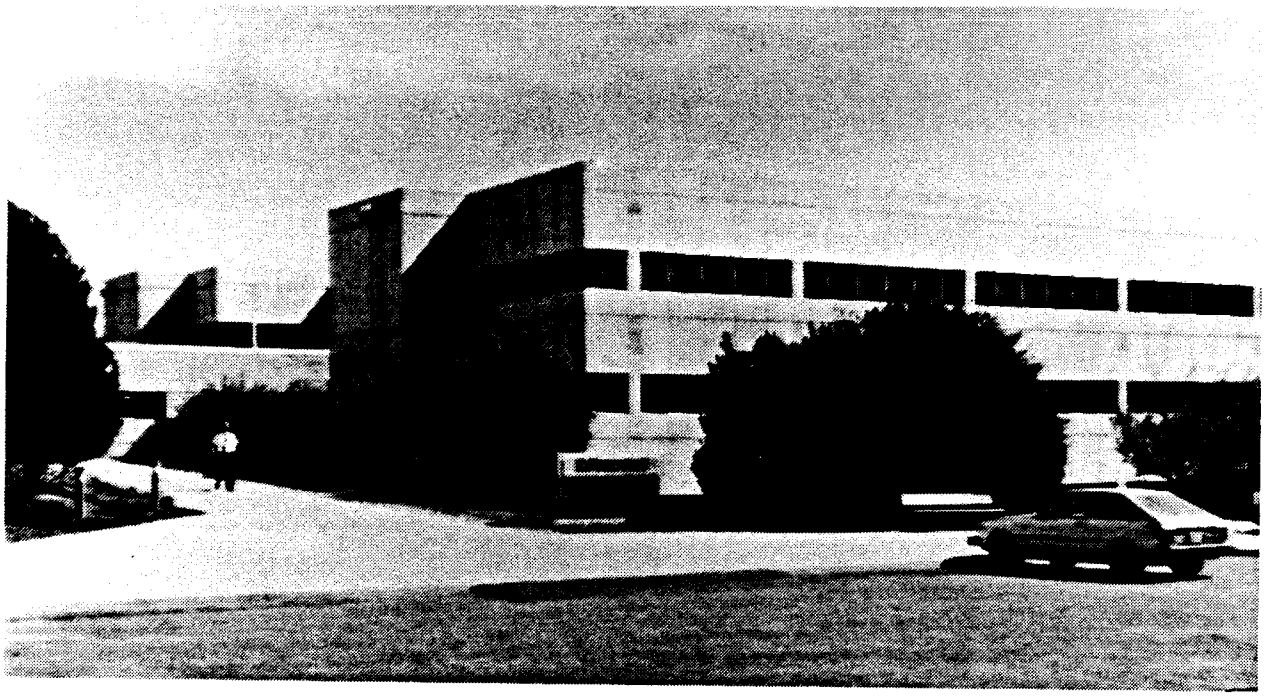

Figure 75. The 337 Building, Pacific Northwest Laboratory portion, in 1991.

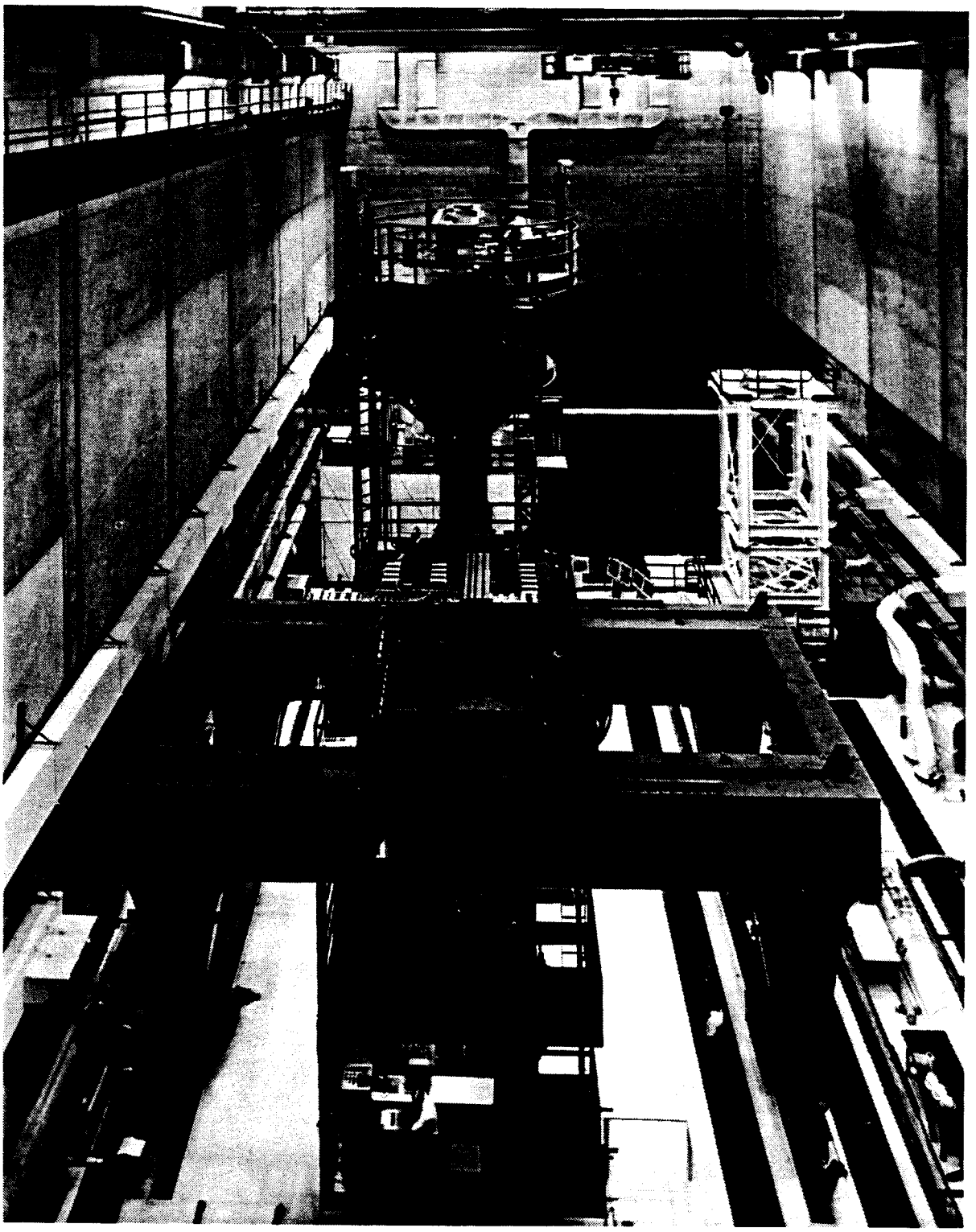

Figure 76. The Closed Loop Ex-Vessel Machine, used to transfer fuel out of the Fast Flux Test Facility, is mocked up and tested in the 337 High Temperature Sodium Facility's high bay area in 1975.

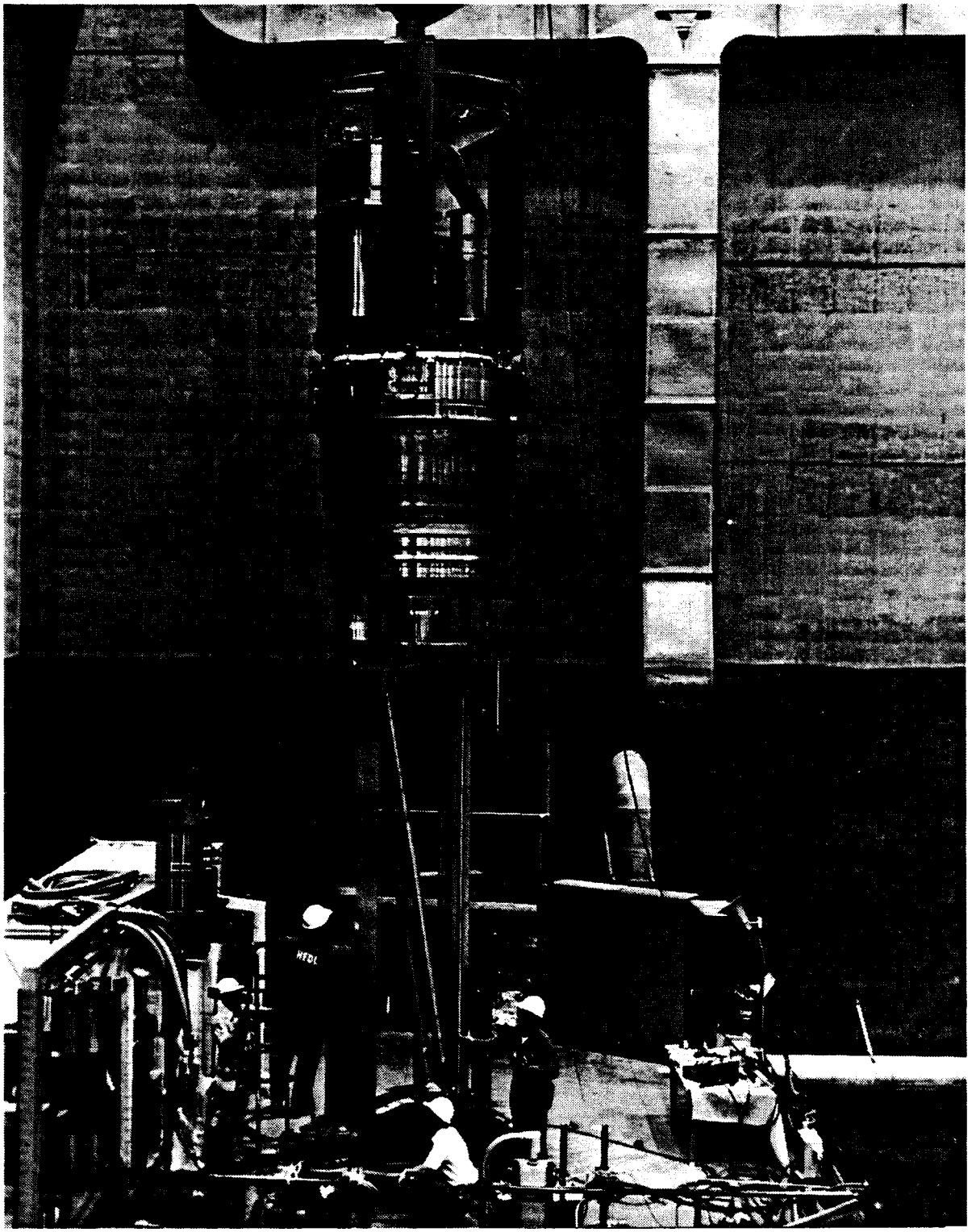

Figure 77. An engineering model of the In-Vessel Handling Machine built in the 337 Building's high bay for use in the FFTF, 1975. Electronics instrumentation sits in the top portion, followed by (top to bottom) the rotating gear, the reactor refueling plug, radiation shielding, the thinner thermal shielding, and the tall braces or legs.

48.0 THE 338 COMPONENTS MOCKUP AND MAINTENANCE FACILITY

48.1 FACILITY DESCRIPTION

The 338 Building, a single-story bolted steel frame structure, was moved from the 100-F Area in 1971 to provide space to receive, mock up, test and store components and certified materials for use in the High Temperature Sodium Facility (HTSF). An equipment development, fabrication and sodium maintenance shop also was included. The structure, 80 ft by 196 ft by 30 ft (high), had served as the annex to the 190-F Reactor pump house and contained a total area of 16,000 ft^2. The 1940's construction included corrugated transite (steel and asbestos) siding. The slightly sloped roof had a built-up asphalt and gravel finish, and the main floor was very heavy, painted concrete with a loading capacity of 250 lb/ft^2. Interior walls were constructed of metal studs covered with gypsum board siding. The structure included a pit 50 ft by 65 ft by 33 ft (deep) in the north end, covered by a truss-supported steel plate that also possessed a loading capacity of 250 lb/in^2. A sump 20 ft by 12 ft by 4 ft (deep) was located in the south end of the pit. Room 100 on the main floor, known as the Operations Center, had a raised floor with a loading capacity of 1,000 lb/ft^2. A 20-ton bridge crane served the building's entire interior floor space.

Almost as soon as the building was completed, four attached cubicles were added on the east and west outer walls to provide space for heat pumps. An additional cubicle housing change rooms and sanitary restrooms also was added on the east side, and an entry air lock to provide a barrier against blowing dirt and dust was placed on the south end. These additions brought the building's total area to 20,869 ft^2.

48.2 THE 338 BUILDING MISSIONS

The 338 Building served in its initial functions of varied LMFBR equipment support activities through the early 1980's (Figure 78). In 1978, it was evaluated as the possible location of the Hot Cell Verification Facility, a cold mockup of a processing cell in the FMEF (427 Building), but this mission went to the 321 Building instead (see Part II). Instead, a Remote Maintenance Evaluation Facility was emplaced in the 338 Building. By 1981, FFTF developmental work had diminished greatly, and the 338 Building was converted that year to house the Secured Automated Fabrication (SAF) Cold Test Facility, a nonradioactive demonstration project for oxide fuel processing line operations for the FMEF. A truck lock was added on the southwest, along with a new roll-up equipment door and fire protection sprinkler system. In 1983, the north end of the building was considered as a place to house an equipment development and operator training project for the PUREX Facility Modification Program (PFMP). However, the PFMP mission went to the 305 Building instead. During 1985 to 1986, SAF equipment was removed from the 338 Building, and in 1988 the facility was converted to a chemical and hazardous materials storage area. A roofed concrete pad 6 in. thick and 20 ft by 15 ft was installed on the northeast corner for this purpose. Building modifications during this period included exterior wall penetrations that had to be performed under strict asbestos handling procedures because the transite

walls of the old structure contain asbestos. Today, the 338 Building is known as the Maintenance Building and continues to serve as a less-than-90-d storage facility for hazardous materials.[147]

48.3 THE 338 BUILDING WASTES AND CONTAMINATION

Very few wastes of any kind have been spread in or around this facility. Its maintenance and mockup missions involved completely unirradiated materials and were conducted during years when chemical, oil, and other potentially hazardous waste discharges were controlled by modern regulations. Additionally, very little sodium or sodium-potassium was brought into the building except when storage tanks for these materials needed maintenance. In one 1989 case, a drum containing stored hazardous material was observed to be bulging and the contents were observed to be bubbling, but the drum was remediated before any of its contents reached the environment. The asbestos in the original construction creates airborne contamination whenever walls are drilled or otherwise disturbed.[148]

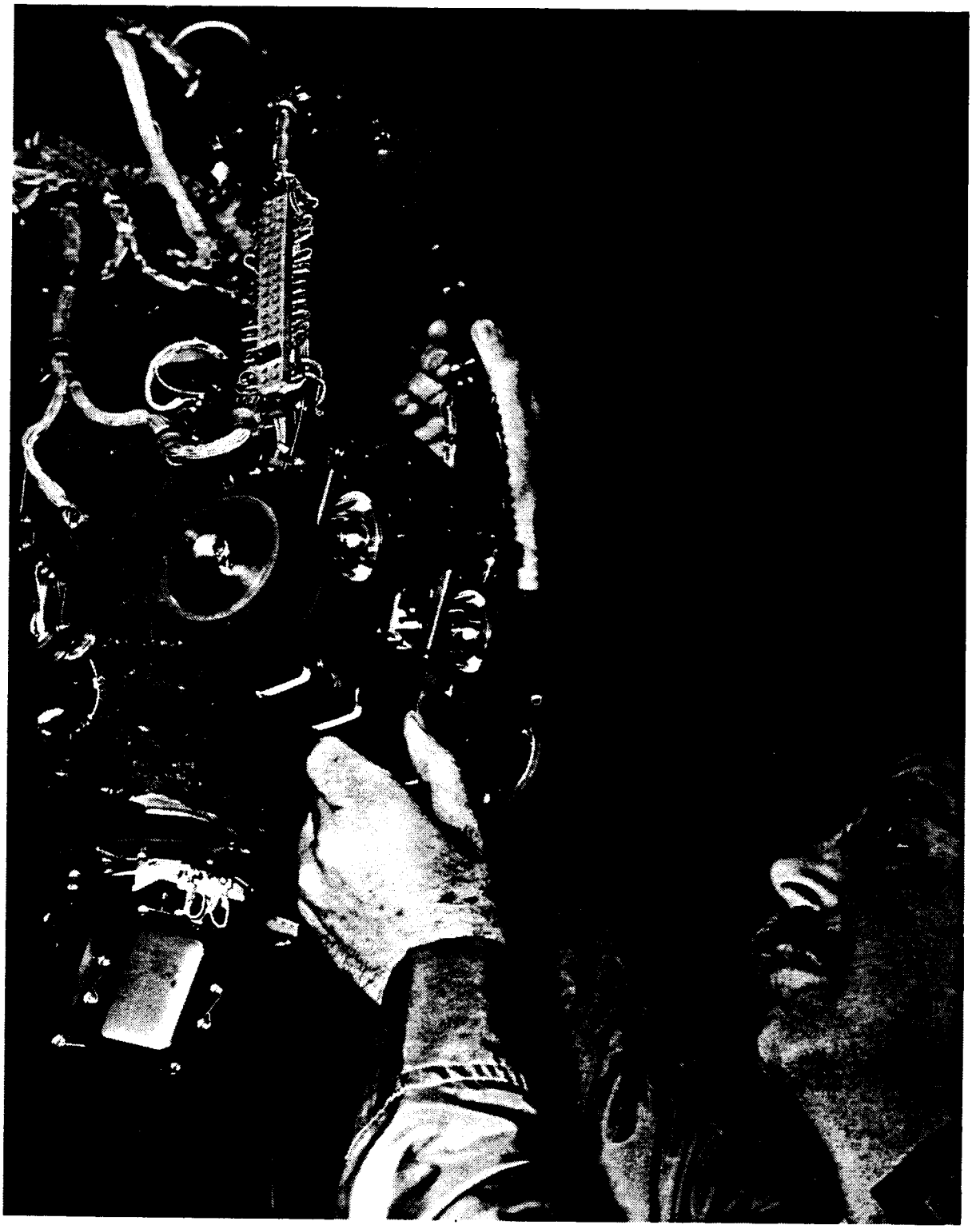

Figure 78. Surveillance In-Service Inspection equipment undergoes testing in the 338 Building in 1977. This equipment later would be used to examine reactor vessel and guard vessel welds in the FFTF before initial sodium fill and during each refueling cycle.

49.0 THE 331 LIFE SCIENCES LABORATORY AND 331 A, B, C, D, E, F, G, H, J, AND HB1-HB12 BUILDINGS

49.1 FACILITIES DESCRIPTION

The 331 Life Sciences Building (Figure 79), constructed in 1970 to replace the old HW Biology Laboratory (108-F Building), is a three-part structure. The largest original portion was a three-story, reinforced concrete facility consisting of laboratories on the first and third floors and a mechanical-electrical services floor (mezzanine) between them. The main (first) floor laboratory area contained a multi-room inhalation toxicology exposure suite that held plexiglas animal exposure chambers and related metabolism rooms. This floor also contained a 26-ft-by-26-ft cobalt irradiation room, holding a cobalt-60 source, an electron microscope suite, and laboratories devoted to dosimetry, isotope preparation, plant physiology, terrestrial ecology, aquatic biology, and biochemistry. Support facilities located on this main floor included a counting room, change room, offices, a receiving area, and instrument, mechanical and electrical equipment rooms and maintenance shops.

Third floor laboratories in the central 331 Building area included small animal facilities and related animal physiology and inhalation toxicology laboratories, low-level and high-level radiochemistry laboratories, as well as tissue culture, virology, histology, hematology, biochemistry, histochemistry, pathology and microbial physiology laboratories. Several support services also were located on the third floor, including central glassware washing facilities, special instrument and equipment rooms, controlled temperature rooms, aquatic biology head tanks and their related mechanical and water treatment equipment rooms, change rooms, offices and sanitary restrooms.

A second segment of the 331 Building consisted of an entrance foyer and court area, as well as a two-story administrative wing that housed offices, conference rooms, a life sciences library, mail and copying rooms, and a lunchroom. A third story was added to this wing in 1982, bringing the total area of the 331 Building itself to 117,240 ft^2. A chemical storage dock also stood on the west side of the building.

Two smaller, ancillary structures labelled the 331-A and 331-B Buildings made up still another "segment" of the original 331 Building. The 331-B Building, located just southwest of the 331 Building, actually was constructed in 1967, before the 331 Building itself. The 331-B Building is a one-story concrete block structure 36 ft by 36 ft with a long, narrow animal "run" (15.3 ft by 138.5 ft) attached to it. The run area originally contained 110 concrete living units for dogs, and the north (concrete block) section contained four laboratories including an animal clinic, hospital, food preparation room and change room. This portion of the flat-roofed 331-B Building was connected to the main 331 Building by an enclosed corridor and an open walkway. An equipment room and a metabolism room were located at the south end of the animal runs, and a gas storage facility ran lengthwise (north and south) on the east side of the dog run. The original 331-A Building, located just northwest of the 331 Building, was completed in 1972. It is a one-story concrete block structure 67 ft by 20 ft with an extension 33 ft by 44.25 ft containing 15 pen areas for large animals. The

main portion of this flat-roofed structure originally contained three laboratories, a mechanical equipment room, and an office area, while the pen areas contained swine. Together, the 331-A and 331-B Buildings were known early as the "hog and dog runs."

49.2 THE 331 COMPLEX ADDITIONS

In 1972, a Butler building 100 ft by 50 ft designated the 331-C Building was erected on a concrete slab south of the 331 Building. It had a low gable metal roof and served as a storage warehouse for 331 Complex needs. During 1973-74, the 331-D Building, a semi-high bay, prefabricated, metal Butler building was erected on a concrete slab to the southeast of the 331 Building. This structure, 42.16 ft by 32.16 ft, originally served as the Animal Waste Treatment Facility. It contained a 25,000-gal per day (net) capacity waste treatment plant that operated to chemically treat, mechanically flocculate and settle, and then gravity filter animal wastes. A sludge dryer also was installed to heat and dry 120 lb per hour of sewage sludge product from the treatment facility and to produce a 65 to 100% solid waste material that could be buried in 100 and 200 Areas trenches. This treatment facility was needed because hog hairs, sawdust, and undigested animal feed frequently plugged the unlined animal waste pit in use along the Columbia River (see Section 49.4).

In the years between 1975 and 1984, several additional buildings were constructed in the 331 Complex. The 331-E greenhouse, 30 ft by 52 ft and constructed in 1975, is a wood and metal frame structure covered with translucent, corrugated fiberglass sheets. Located just south of the 331-D Building, this facility has a rounded, quonset hut-type roof and was built to provide an environment in which to grow plants for PNL's ecosystem studies. The 331-F Building, a prefabricated metal structure 70 ft by 16 ft, was moved to a location nearly 400 ft southwest of the 331-E Building in 1975. This structure was the 142-F Facility, part of the old aquatic biology complex at the 100-F Area. In the 331 Complex, the building provided storage space for equipment and materials used in animal and pasture maintenance. At the same time, a new, 18-acre pasture was built at the south end of the 331 Complex. It contained 12 animal shelter units, erected in pairs on concrete pads. Each corrugated aluminum unit was 12.5 ft by 8.5 ft, and had a rounded roof and a guillotine-type door. Also in 1975, the 60-ft by 20-ft concrete block 331-G Farrowing Facility was constructed just east of the 331-F Building. The flat-roofed structure sat on a concrete slab and was used to house laboratory animals (specifically swine) while they were giving birth.

In 1979, the 331-H Plant Exposure Facility was constructed just north of the 331-F Building. This one-story concrete block structure 17.6 ft by 64.6 ft was erected on concrete foundations and a concrete slab and has a flat, built-up roof covered with gravel. In 1980, a 22.6-ft by 44-ft metal lean-to that previously had been attached to the 2400 Stevens Building in north Richland was attached to the northwest corner of the 331-H Building. This lean-to contained a wind tunnel room, a growth chamber alcove, two air locks, mechanical and equipment rooms, change rooms, and an entry area. The facility was moved to the 331-H Building to house an exposure test chamber to study the effects of various aerosols and actinide elements on plants. In 1984, the 331-J Hay Storage Barn was erected just east of the 331-H Building. This beam and column steel structure 24 ft by 16 ft by 14 ft (high) also had a

roof and cave extension of 3 ft and a steel framed roof covered with galvanized steel decking. The south end of this hay and bulk feed storage facility was open.

49.3 THE 331 COMPLEX MISSIONS

The functions of the 331 Building and its many ancillary facilities always have involved biological and botanical research. Originally, the large animal studies involving sheep were kept at the 108-F facility until that research center closed completely during 1973 to 1974. After that time, a very small number of sheep were kept at the 331 Complex for just a few years, and then these studies were phased out completely. During its initial years of operation, the 331 Complex conducted plutonium inhalation studies on dogs, plutonium injection studies on rats, cigarette addiction and effect studies on monkeys, and research leading to new heart surgery techniques and hip replacement surgery capabilities on goats and other animals. Experiments with the effects of radiation exposure on hair and skin were conducted on swine, and a miniature (160-lb average) hairless strain of swine was developed for this purpose in the 331 Complex. Extensive aquatic biology studies, including gill disease research, also were performed, with up to 800 gpm of Columbia River water pumped through large-capacity tanks in the main 331 Building during the years 1971 to 1975. Animal feeding studies involving strontium-90 pellets were discontinued at HW when the biology studies left the 100-F Area, and feeding studies involving iodine-131 pellets were discontinued in the 1960's.

In the years after 1983, life sciences studies were cut sharply, and several of the buildings assumed new functions. The 331-A swine facility was converted in the early 1980's to a virology laboratory for the study of bacterial and viral growth in animals. The 331-D animal waste treatment facility was converted in 1977 to a biomagnetic effects laboratory, where electromagnetic field studies were conducted on rats. The 331-J hay storage barn was enlarged, and a new incinerator was installed about 1988 to cremate animal remains. In 1989, the Hanford Cultural Resources Laboratory (HCRL) was moved into the main 331 Building to conduct archaeological surveys and preservation work concerning native American and other prehistoric artifacts on the Hanford Site. Some long-term experiments involving dogs continue, but the number of laboratory dogs being studied has diminished from the original figure of nearly 600. Aquatic biology experiments likewise have diminished dramatically. Some plant studies continue in the 331 Complex, but other botanical work and some cattle studies now are conducted at the Arid Lands Ecology (ALE) reserve on and near Rattlesnake Mountain. At this time, the 331 Building also houses PNL's Earth Sciences Department, and the Hanford Site Patrol guard dogs are kenneled in the 331-B Building animal run area.[149]

49.4 THE 331 COMPLEX WASTES AND CONTAMINATION

Animal wastes were the most prominent wastes, in terms of volume, generated by 331 Complex operations. Originally, liquid animal wastes from the 331, 331-A, and 331-B Buildings as well as the washdowns from the "hog and dog runs" were disposed to a large, unlined pit located along the Columbia River just south of the 331 Building. Sewers from the 331 Building also were

connected to this pit, but the facility frequently plugged and had to be scraped out. At those times, the plugging material was transported to a trench in the 100-F Area for burial. All radioactive solid animal wastes from the 331 Complex also were transported to 100-F Area trenches on a regular basis. When the 331-D Animal Waste Treatment Facility was constructed during 1973-74, use of the 331 Complex waste pit along the Columbia River was discontinued. By that time, however, so much liquid waste volume had been discharged to this pit that temporary water-table mounds had formed below it. In 1977, when the 331-D Building was converted to electromagnetic studies, "clean" animal sewage was routed to the regular 300 Area sanitary sewer system for disposal. Nonradioactive solid animal wastes (primarily animal carcasses) originally were incinerated outdoors in a roofed, locked enclosure just east of the 331 Building. However, a modern incinerator was installed in the 331-J Building about 1988. Contaminated animal carcasses were considered to be solid radioactive waste and were placed in barrels and buried in 200 Area burial grounds.

Chemical and radioactive laboratory wastes, along with fish tank waters, constituted the other categories of wastes generated in noteworthy amounts by 331 Complex operations. The 331 Building was connected to the 300 Area sanitary, process and RPS sewers, and the ancillary buildings within the complex were connected only to the sanitary and process sewers. Some of the smaller, early structures, including the 331-B Building, also had French drains for waste drainage into the ground. Radioactive wastes were removed via containers and casks. Laboratory operations included the use of several radiation sources (radionuclides in various forms) used for animal exposure. Some laboratories were designated as "plutonium confinement" areas, and access and waste disposal were controlled. Laboratory chemicals and cleansers included a standard array of acids, caustics, reagents, alcohols, germicidal soaps, commercial bleaches, and acetone. The original water flow system between the 331 Building fish tanks and the Columbia River was a single-pass system, with immediate water return to the river via a 10-in. pipe just north of the 331 Building. However, in 1977, National Pollutant Discharge Elimination System (NPDES) regulations brought about the installation of filters, diversion of much of the fish tank effluent water to the 300 Area process sewer, and permit-controlled levels of various substances in the water being returned to the Columbia River.

49.5 SPECIFIC CONTAMINATION EVENTS

There have been several instances of the loss of control of radioactive and chemical materials within the 331 Building Complex. Some such events were confined within the buildings, but in other cases, contamination reached the environment. Many of the events involving radioactive substances occurred in connection with a 10-yr-long experiment to determine the effects of plutonium oxide-238 microspheres administered to dogs by pulmonary intubation and intravenous injection. Artificial heart research with swine also involved the use of the very potent plutonium-238. In one case in January 1975, between 25 and 2,500 μCi of plutonium-238 was washed into the process sewer from contaminated soil used in a botanical experiment. In another incident later that year, alpha contamination (again plutonium-238) reading up to 2 million d/m inside the 331-A Building and 800,000 d/m on the concrete outside of that structure was released when a stored waste container leaked. In 1977, liquid

waste, again containing plutonium-238, leaked from a swine research laboratory in the 331 Building and is thought to have reached the 300 Area sanitary sewer system. Later that same year, a small plutonium-238 spread in a 331 Building laboratory was tracked by a scientist throughout other areas of the building, further spread onto the shoes and clothing of eight personnel, and tracked into the home of one scientist. In 1981, the small cobalt-60 irradiation source in the 331 Building was shut down resulting from numerous safety violations. After correction of the conditions that led to these violations, the cobalt-60 source was re-activated, but in one 1985 incident a shielding door on the device failed to return to a closed, storage position and a momentary radiation exposure occurred. A small fire occurred in a first floor laboratory of the 331 Building in 1981, and on two occasions in 1982 and 1985 the 8-in. water line bringing Columbia River water to laboratory and animal facilities ruptured. In the 1985 incident, the rupture occurred within the building, and extensive first and second floor flooding occurred.[150]

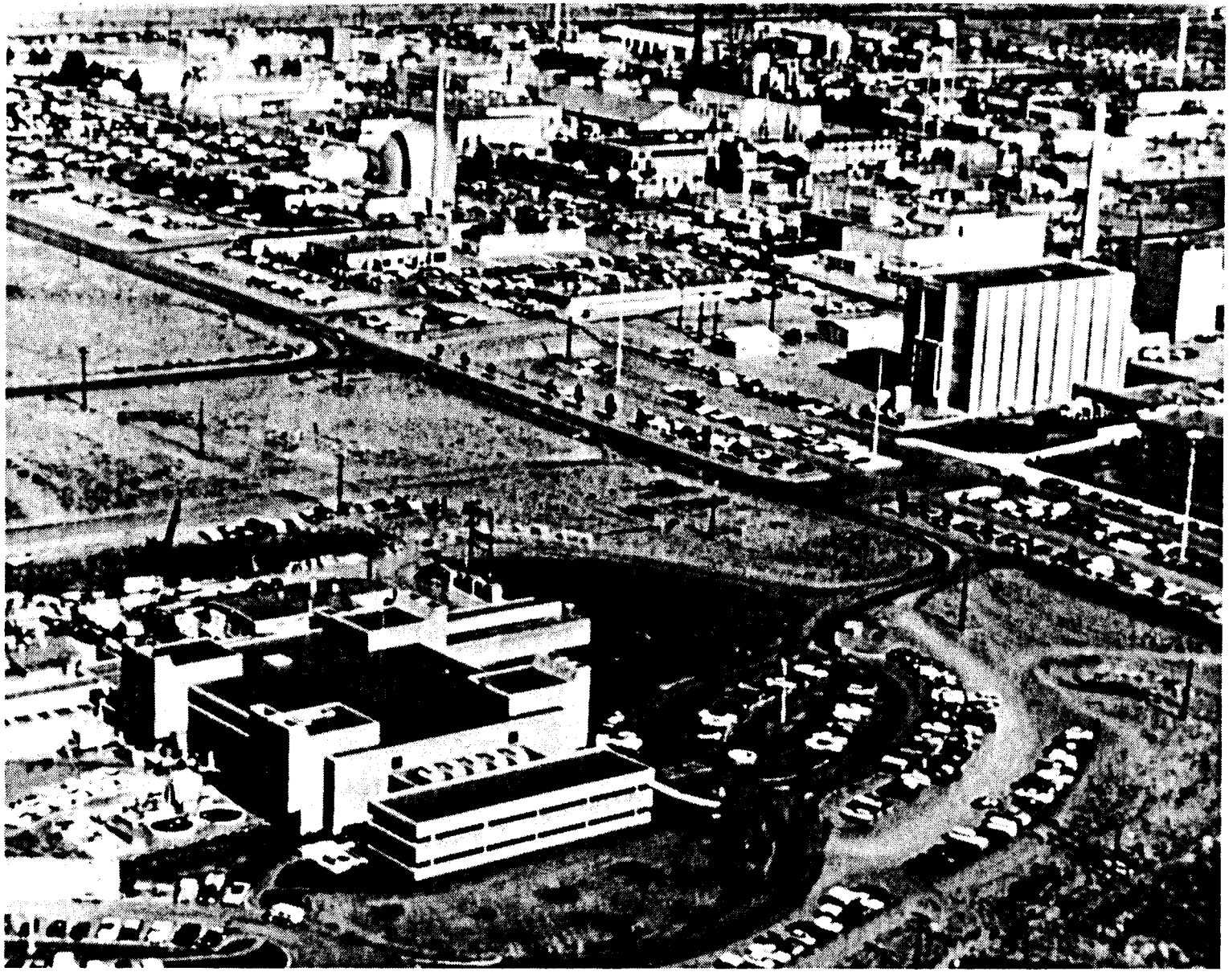

Figure 79. The 331 Life Sciences Building dominates the lower section of this northwestward-looking view of the 300 Area during the 1980's. The ancillary structures of the 331 Complex stretch to the south of the main building, or out of sight beyond the lower left photo corner.

50.0 THE 3705 PERSONNEL METERS AND RECORDS BUILDING

50.1 FACILITY DESCRIPTION AND MISSIONS

The 3705 Building, a one-story concrete building 67.75 ft by 94 ft by 23 ft (high), was constructed in 1963 to provide laboratory space for processing film badges and meters worn by HW personnel and for storing personnel exposure records. It had a total area of nearly 7,000 ft^2, including a corrugated-metal-sided equipment room "penthouse." The concrete-floored structure lacked windows but had a flat built-up tar and gravel roof. Some interior partitions were moveable metal, and some consisted of gypsum board on stud frames. The 3705 Building functioned in its original capacity through the early 1970's, when it was converted to a photography processing shop. It maintains the latter mission today and is known as the Photography Building. It was managed by BNWL (later PNL) from 1965 through mid-1987, when it transferred to Westinghouse Hanford management.

50.2 THE 3705 BUILDING WASTES

The 3705 Building was and is connected only to the 300 Area sanitary and process sewers. During the years when the facility functioned to process personnel dosimeters, a few contamination spreads involving radiation sources, particularly americium-241, occurred in the northwest corner (processing area). On other occasions, X-ray machines sometimes released uncontrolled beams, but no environmental contamination was spread from this type of occurrence. Photographic processing has taken place under modern, controlled disposal conditions, and virtually no wastes have been spread from this activity.[151]

51.0 HANFORD GROUT LYSIMETER FACILITY

51.1 FACILITY DESCRIPTION, MISSIONS, AND WASTES

In 1984, the Hanford Grout Lysimeter Facility (HGLF) was constructed about 3 mi northwest of the 300 Area. It consisted of six large-diameter boreholes 6 ft in diameter and 25 ft deep. A watertight sealed caisson of welded steel pipe with a welded steel bottom was emplaced in each hole. Wastes containing both radioactive and nonradioactive tracer agents embedded in a solidification agent (grout) were then buried in these caissons to test leaching and migration rates under actual Hanford Site soil burial conditions. Radioactive wastes used in this project consisted primarily of cobalt-60 (up to 330 Ci/L), as well as lesser amounts of cobalt-58, iron-59, chromium-51, manganese-54, and trace amounts of other radionuclides. For the most part very little waste migration was recorded by the PNL monitoring instrumentation, but the bottom of one caisson containing simulated cladding removal waste did fail in 1991, releasing 300 L of drainage containing trace amounts of technetium-99. Because this facility is located near some potential 300 Area suspect waste burial grounds, extensive testing of the area may be necessary in the future.[152]

52.0 IN SITU VITRIFICATION SITE 300 WEST

52.1 FACILITY DESCRIPTION, MISSION, AND WASTES

During the late 1980's, PNL conducted in situ vitrification (ISV) tests at a site just west of the 300 Area. Various waste materials to be tested for potential immobilization were buried in the soil and then heated via four buried electrodes. An offgas hood and stack sampler were installed on a scaffolding over the buried waste area. Radionuclides in the waste materials tested included small amounts of americium-241, plutonium-239, plutonium-238, cesium-137, ruthenium-106, strontium-90, and cobalt-60. As tests were completed, the blocks of vitrified material were removed and stored. Soils around the vitrified blocks were sampled, and contaminated soils were removed and disposed in various locations depending on their constituents and levels of contamination. In one case in 1987, airborne PCB dusts were released to the environment when an electrical surge occurred during a re-start of the vitrification heating system. Site recovery operations resulting from this event cost $42,000, after which all contaminated equipment and soils were removed to the point that ISV site soils tested at no more than background radiation levels. However, because in-soil immobilization tests took place in the vicinity of some older, 300 Area suspect waste disposal and burial grounds, additional soil testing may be desirable.[153]

ENDNOTES

125. Advance Engineering Operation, HW-50700; and AEC Commissioners Meeting #621, p. 516; and WHC, "FFTF...," (1990).

126. AEC/GE Study Group, GEH-26434, pp. 3.10-3.11; and Lanning, DeMershman, and Hansen, BNWL-CC-1906.

127. "HEDL Facilities Catalog," (1971), pp. 308 (3 pp.); and Asay, HEDL-MG-17, Rev. 6, pp. 15-18.

128. AEC/GE Study Group, GEH-26434, p. 3.10; and Dunn, HW-SA-1823; and Merker and Bloomster, HW-SA-3029; and Bloomster, BNWL-131-A, B, and C; and BNWL-311 and BNWL-519; and Cooperstein, DUN-6925.

129. Williams, Radiation Occurrence Reports 62-0-41 and 62-0-70 and 62-0-69; and Valentine, Radiation Occurrence Report 65-03; and DeHalas, PNL-7755 and PNL-7756; and Keene, BNWC-8-8-F; and McConnan, Radiation Occurrence Report BNW-65-20; and Weber, Incident Report 46-72; and Nelson, Incident Reports 11-73 and 20-73; and Keenan, Incident Report 5-74; and Dahl, Unusual Occurrence Report 18-75; and Brown, Unusual Occurrence Report HEDL 10-77 and McCord, Unusual Occurrence Report HEDL-78-52-308-4; and Perfect, Unusual Occurrence Report HEDL-79-5; and Sheely, Unusual Occurrence Report 84-011; and Williams, Occurrence Reports WHC-90-0161-308; and McCord, Occurrence Reports WHC-91-0022-308 and WHC-91-0186-308; and DOE-RL-88-20.

130. AEC/GE Study Group, GEH-26434, pp. 3.12-3.17; and "HEDL Facilities Catalog," (1971), pp. 309 (3 pp.); and Asay, HEDL-MG-17, Rev. 6, pp. 19-22.

131. Koberg and Purcell, HW-SA-2556; and Foster, Backman, Wittenbrock, and Skarpelos, HW-SA-2475; and Purcell, BNWL-SA-557.

132. Dunn, HW-SA-1823; and Koberg and Purcell, HW-SA-2556; and Purcell, BNWL-SA-557; and Haney, HW-67514; and Bloomster, BNWL-131-A; and Hensley and Rogers, NUREG/CR-3669 (PNL-5003); and Carpenter, "Radiation Safety...," (1969); and Investigating Committee, Radiation Incident 73-BNW-17; and Nightingale, "Criticality Safety...," (1976); and Van Tuyl, RL Occurrence Report 76-BNW-2.

133. Purcell, BNWL-SA-557; pp. 16-21; and Newton, "Highlight-PRTR...," (1965); and Newton "Follow-up...," (1965).

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