

BUILDING HISTORIES

FOR BUILDINGS

371, 444, 447, 460, 707, 771,
776/777, 881, 883 AND 991

HISTORICAL RELEASE REPORT(HRR)

PREPARED BY

ENVIRONMENTAL RESTORATION
FACILITIES OPERATIONS MANAGEMENT

EG&G ROCKY FLATS, INC.

"REVIEWED FOR CLASSIFICATION"

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LIST OF ACRONYMS

ADEN	Air Pollution Emission Notice
AMC	automated machining cell
ASRF	Advanced Size Reduction Facility
CFCs	chlorofluorocarbons
D&D	Decommissioning and Decontamination
DCHP	dicesium hexachloroplutonate
DOE	Department of Energy
DOR	Direct Oxide Reduction
FBU	Fluidized Bed Unit
Freon 12*	dichlorofluoromethane
Freon 13*	1-dichlorofluoro-2-chlorodifluoroethane
Freon TF*	trichlorotrifluoroethane
GAO	General Accounting Office
GTA	gas tungsten arc
HEPA	high efficiency particulate air
HSA	high specific activity
HVAC	heat, ventilation and air conditioning
IHSS	Individual Hazardous Substance Site
ISP	Instrumentation and Special Projects Group
LLM	low-level mixed waste
LOSAC	low specific activity counters
LSA	low specific activity
MSE	molten salt extraction
Nd-YAG	neodymium-yttrium garnet (laser)
NDA	non-destructive assay
NDT	non-destructive testing
oralloy	enriched uranium
OY	oralloy (leach process)
PA	protected area
PCBs	polychlorinated biphenyls
PCE	perchloroethylene
PRMP	Plutonium Recovery Modification Project
PROVE	Plutonium Recovery Operational Verification Exercise

QA	Quality Assurance
R&D	research and development
RCA	Radiological Control Area
RCRA	Resource Conservation Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RFP	Rocky Flats Plant
RO	reverse osmosis
SNM	Special Nuclear Material
SST	Safe Secure Transports
TCA	trichloroethane
TCE	trichloroethylene
TIG	tungsten inert gas (welding)
TOPO	tri-n-octylphosphine oxide
TRM	transuranic material
TRU	transuranic
TRU-mix	transuranic mixed
tuballoy	depleted uranium
USAEC	United States Atomic Energy Commission
WSRIC	Waste Stream Residue Identification and Characterization
ZPPR	Zero Power Plutonium Reactor
1,1,1-TCA	1,1,1-trichloroethane

*Chemical trade name rather than acronym.

HISTORICAL RELEASE REPORT BUILDING HISTORIES

1.0 INTRODUCTION

Historically, the mission of the Rocky Flats Plant (RFP) was the production of nuclear weapons components, specifically production of plutonium triggers or pits. RFP also disassembled retired weapons to recover plutonium for reuse in weapons production. The plant's weapons production and disassembly mission was canceled in January, 1992, in conjunction with the cessation of work on the W-88 weapon. Since January, 1992, a new plant mission has been identified, namely environmental protection and plant shutdown. To better reflect this new mission, the plant name has been changed to Rocky Flats Environmental Technology Site (RFETS). One aspect of the activities conducted at the site to support the new mission is the decontamination and decommissioning (D&D) of the old process operations buildings. Building process histories are necessary to support these D&D activities since the materials used in the process operations constitute the materials that should be considered in D&D operations.

RFP's primary product consisted of assembled pits (also called triggers), or the core of a nuclear weapon. Over the lifetime of the plant, overall operations and manufacturing processes have remained largely the same with periodic refinements. Pits produced at RFP were constructed of interlayered nuclear and non-nuclear materials. The primary materials of pit construction were plutonium, enriched uranium, depleted uranium, stainless steel and beryllium. The general types of manufacturing activities conducted at RFP involving these materials were:

- casting operations that produced ingots or shapes in foundries to be used in the fabrication process;
- fabrication operations which involved rolling, forming, pressing, and machining cast parts to be used in weapons assembly;
- inspection and testing which involved a variety of quality assurance measures which took place repeatedly throughout the production process; and
- assembly operations which involved welding and joining various manufactured parts into weapons components and pits.

Disassembly of obsolete weapons returned to the site was conducted so that valuable plutonium and uranium could be recovered and reused. Other operations were conducted to recover plutonium and enriched uranium materials from processing scraps and residues. Other activities conducted in the buildings included waste handling, Special Nuclear Material (SNM) and waste storage, laboratory operations, tool manufacturing operations, Research and Development (R&D) operations, and utilities and maintenance operations.

RFP handled a wide variety of chemicals and materials, but most process chemicals and materials handled in any quantity were associated with manufacturing operations involving plutonium, uranium, stainless steel and beryllium in eleven core production buildings which are addressed in this document. These buildings are: Buildings 371, 444, 447, 460, 707, 771, 776/777, 881, 883, and 991. Table 1-1 is a matrix which identifies the main buildings which handled these metals over the history of active production. It should be noted that in the case of assembly operations, some assembly operations were usually conducted in each fabrication building and then parts were sent for final assembly to either Building 991, Building 777 or 707. Following Table 1-1, a brief synopsis of the processing activities for the five major production metals is provided prior to the detailed process histories for each building.

Table 1-1
Locations and Operational Dates of
Major Production-related Operations at RFP from 1953 through 1989

Operation	Plutonium	Enriched Uranium	Depleted Uranium	Stainless Steel	Beryllium
Casting and/or Fabrication	771 (1953-1957)	881 (1953-1966)	444 (1953-1989)	(not active on a production scale at RFP until 1966)	444 (1958-1989)
	776 (1958-1969)	883 (1957-1964)	883 (1957-1989)	881 (1966-1984)	883 (1962-mid-1980s)
	707 (1970-1989)	(not active on a production scale after 1964)		460 (1984-1994)	
Assembly	991 (final) (1953-mid-1960s)	991 (final) (1953-mid-1960s)	444/447 (1953/56-1989) 991 (final) (1953-mid-1960s)	(not active at RFP until 1966)	444 (1958-1989)
	777 (1958-1969)	777 (final) (1958-mid-1960s)	777 (final) (1958-1969)	7777 (final) (1966-1969)	777 (final) (1958-1969)
	707 (final) (1970-1989)	707 (final) (1970-1989)	707 (final) (1970-1989)	460 (final) (1984-1994) 707 (final) (1970-1989)	707 (final) (1970-1989)
Disassembly of Site-returns	777 (1958-1989)	777 (1958-1989)	(not conducted for recovery)	(not conducted for recovery)	(not conducted for recovery)
Metal Recovery	771 (1953-1989)	881 (1952-1964)	(not conducted)	(not conducted)	(not conducted)
	371 (pilot-scale) (1980s)	771 (oralloy leach) (1964-1989)			

1.1 PLUTONIUM

From 1953 until 1957, plutonium recovery, casting, fabrication and inspection were housed within Building 771. The only plutonium-related operation not conducted within Building 771 during this time period was final component assembly. Final assembly operations were conducted strictly within Building 991 until the late 1950s when pit assembly operations began in Building 777.

In 1957, construction of Building 776/777 was completed and a major industrial fire occurred within Building 771. These two events contributed to modification of the Building 771 operations, and from 1957 until cessation of plant plutonium activities in 1989, Building 771 was primarily dedicated to plutonium recovery. Back-up plutonium casting and machining capabilities were maintained in Building 771, but these capabilities were not used in any significant production mode from 1957 to the present. Laboratories remained operative in Building 771 until the end of plutonium operations, with the emphasis of these laboratories being plutonium metallurgy.

Due to the age of Building 771, and due to development of new plutonium recovery technologies, Building 771 operations were to be replaced in the early 1980s with plutonium recovery operations within Building 371. However, significant plutonium recovery operations were never achieved in Building 371 due to design and process deficiencies. A number of programs were identified throughout the 1980s to address these design and process deficiencies, but these programs were either not completed or were not successful in achieving their ends. Due to the lack of any other significant plutonium recovery capability, Building 771 remained in operation throughout the 1980s.

Building 776/777 was the main plutonium production building for the time period of 1957 until 1969. For most of this period, Building 776/777 was essentially one building, with most of the casting and fabrication operations being conducted in one large room. Casting operations were conducted at the west end of the building, with fabrication operations (including rolling, forming, and machining) located east of casting activities, and inspection and assembly operations located at the far east end of Building 776/777. In 1969, a major industrial fire occurred within Building 776/777. A large portion of Building 776/777 was impacted by radioactive contamination that was released to the large production room when the glovebox containment was breached.

Construction of Building 707 was also nearing completion in 1969. Similar to the events which occurred in Building 771 in 1957, the 1969 fire and construction of a new building with plutonium fabrication capabilities contributed to modification of the operations within Building 776/777. From 1969 until cessation of plant plutonium activities in 1989, Building 776/777 continued to support plutonium activities in a more limited manner, but an increasing amount of the floor space in these buildings was dedicated to waste-related operations and drum storage.

From 1970 until cessation of plant plutonium activities in 1989, Building 707 became the main plutonium production building. Building 707 housed plutonium casting, fabrication, inspection and assembly operations. Building 707 was built as a series of entirely separate rooms, or modules, in order to help minimize damage in the event of a fire.

1.2 ENRICHED URANIUM

Enriched uranium operations began in 1953 in Building 881. From that time until approximately 1964, enriched uranium casting, machining, recovery and inspection operations were housed within Building 881. The only enriched uranium-related operations not conducted within Building 881 during this period were rolling and forming and final assembly.

Rolling and forming of enriched uranium parts took place in Building 883 from the late 1950s until the shutdown of enriched uranium work at RFP in 1964. During this time, enriched uranium castings were made in Building 881, transferred to Building 883 for rolling and forming, and then transferred back to Building 881 for final machining. Inspection of enriched uranium parts took place in Buildings 881 and 883. These inspection operations were conducted after machining and shaping the parts. Final assembly operations took place in Building 991, Building 777 or Building 707, depending on the time frame.

Enriched uranium recovery operations were conducted in Building 881 from 1952 through 1964. Recovery operations involving site-returns were also conducted on a limited basis in Building 771 from 1964 through 1989.

In 1964, enriched uranium activities within the DOE complex were consolidated, and enriched uranium production operations at RFP phased-out between 1964 and 1966. From that time forward, the enriched uranium components required for pit assembly were shipped to RFP from

another DOE facility for assembly. After enriched uranium was removed from Building 881, the building was dedicated to other uses.

1.3 DEPLETED URANIUM

Depleted uranium operations began in 1952 in Building 444. From that time until the end of production activities in Building 444, depleted uranium casting, machining, cleaning and inspection were housed within Building 444. Depleted uranium-related operations that involved rolling and forming, final assembly, and some limited production-related and waste-management related activities also took place in various buildings on plant site.

Rolling and forming of depleted uranium parts took place in Building 883 from the late 1950s until the shutdown of production work at RFP in 1989. During this period, depleted uranium castings were made in Building 444, transferred to Building 883 for rolling and forming, and then transferred back to Building 444 for final machining. Final assembly operations involving depleted uranium were conducted in Building 991, 777 or 707, depending on the time frame.

Building 447 housed miscellaneous furnaces and limited machining equipment to support the Building 444 depleted uranium operations, but the most important role of Building 447 was related to waste management. In particular, Building 447 housed a depleted uranium chip roaster, cementation activities for some wastes, and a shipping and receiving area.

Depleted uranium recovery operations have not been conducted at the plant site.

1.4 STAINLESS STEEL

Enriched uranium operations were phased-out in the mid-1960s at RFP. This left considerable floor space in Building 881 available for other operations. Due to this fact, as well as favorable economics, the decision was made to begin stainless steel machining at RFP in the mid-1960s. The phase-in of stainless steel machining work began in Building 881 in 1966, with all stainless steel work consolidated on plant site by 1968. Stainless steel machining work had previously been conducted by an offsite vendor located in Albuquerque. From 1968 until 1984, stainless steel work was conducted in Building 881. In 1984, stainless steel machining was moved to Building 460, a new facility specifically designed for stainless steel machining operations.

Inspection and assembly operations for stainless steel parts were conducted in Buildings 881 and 460, depending upon the time period. Final assembly of some components containing stainless steel was also conducted in Building 707.

Stainless steel casting or forging processes were not conducted on a production scale at the plant. Similarly, stainless steel recovery operations were not conducted at the plant, but scrap and turnings were generally collected for resale to an offsite recycler.

1.5 BERYLLIUM

In 1958, production-scale beryllium operations began at RFP. These production operations initially involved only the machining and final inspection and assembly of beryllium parts which were supplied by an offsite vendor. However, by the mid-1960s, RFP beryllium operations also included the casting and shaping of beryllium parts to the proper dimensions. By 1975, the beryllium was being supplied in the form of blanks from an offsite contractor, and foundry casting of beryllium on plant site had ceased. By 1980, the foundry had been cleaned of all beryllium, and the associated equipment was removed. Machining of beryllium parts continued in Building 444 until production shutdown in the late 1980s.

Building 883 also conducted significant beryllium processing operations. These operations involved the rolling and forming of beryllium into shapes that were then sent to Building 444 for precision machining. The Building 883 beryllium operations took place from the early 1960s to the mid-1980s.

Inspection of beryllium parts took place in Buildings 444 and 883 after machining or shaping the parts. Assembly of beryllium parts into final assemblies took place in Building 777 from the late 1950s until the early 1970s and in Building 707 until production curtailment. In addition to final assembly, some limited interim assembly of beryllium parts with other components also took place in Building 707 from the start of 707 operations in the early 1970s until 1989.

Beryllium recovery operations were not conducted on plant site, but some beryllium-related waste management activities were conducted in Building 447.

2.0 TECHNICAL APPROACH

The technical approach used for developing building process histories involved reviewing existing documents and conducting original research, which included interviews with past and present Rocky Flats Plant (RFP) employees. Several existing documents were initially reviewed to create a framework of operations for each building. These references included the following documents for each building:

- Waste Stream and Residue Identification and Characterization (WSRIC) Reports (EG&G, 1993);
- Air Pollution Emissions Notices (APENs) (EG&G, 1990);
- Project Tasks 3 & 4 Final Draft Report, Reconstruction of Historical Rocky Flats Operations & Identification of Release Points (ChemRisk, 1992);
- Draft Mission Transition Program Management Plan Appendices (EG&G, 1992);
and
- The Final Historical Release Report (HRR) (DOE, 1992).

Each of these documents contained operations descriptions from various perspectives. For example, WSRIC focused on waste stream generation, APENs focused on air emissions, ChemRisk focused on chemical inventories, the Mission Transition Plan focused on contamination existing in the building and activities necessary for mission transition, and the HRR focused on releases of contaminants to the environment. When these perspectives were combined, they provided a strong base of information on historical operations at RFP.

In addition to these documents, original research was conducted to obtain documents unique to the historical operations of each building. These documents were obtained from the ChemRisk files, the HRR files and the Environmental Master File (EMF) managed by the RFP Legal Documents group, the Front Range Community College Reading Room, and the Building 706 classified library. In some cases, early historical operations had been well documented in reports such as *A History of the Rocky Flats Plutonium/Actinide Recovery Plant, 1952 to 1991* (Crisler, 1992) and *Facility History for Building 771 at the Rocky Flats Plant* (Chew and Associates,

1992). In the case of Buildings 776/777 and 771, investigative reports on major fires in the buildings also provided detailed descriptions of early process operations. In other instances, however, records of early operations have largely been destroyed at the order of DOE or its predecessor agencies. For instance, records of Building 881 enriched uranium activities were destroyed when the building lost its enriched uranium production mission. In these cases, it was necessary to rely almost completely on interviews and recollections.

Both recent and historical documents were supplemented by personal interviews with past and present RFP employees. Wright Water Engineers, Inc., personnel contacted these employees both over the phone and in person to fill in historical gaps in building histories. In addition, the interview notes from the historical investigation interviews conducted by ChemRisk in 1991, or that were conducted in support of the HRR, were also used. After completing draft building descriptions, each building's operational history was reviewed by either the current building operations manager and/or personnel familiar with the historical operations of the building.

When available information from various sources was collected and integrated into one document, a number of discrepancies were identified between information presented in the various source documents. The operations and issues pertinent to these discrepancies were then further researched in order to determine the true facts. Many discrepancies were traced to information provided in interviews. In many cases, these discrepancies were resolved by obtaining written documentation from the time of the operation or event, and the discrepancy was attributed to imprecise memories of events and processes.

It is important to note that the level of detail of the reports used to construct the history of RFP varied considerably. For example, square footage devoted to particular processes was available for some, but not all, buildings. The authors of this document opted to include this information where available in the belief that it would assist managers and others involved in decontamination and decommissioning of the buildings at RFP. Where possible, a similar outline was followed for each building which identified the major processes conducted in each building including the following: casting, fabrication, assembly and disassembly, testing and inspection, waste handling, special projects and support operations. Although not all buildings housed all of these operations, the same general order of operations was followed to help the reader follow the complex processes conducted using different materials in each building.

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3.0 OPERATIONAL HISTORY OF BUILDING 371

3.1 INTRODUCTION

Building 371 was originally built to assume Building 771's and Building 776's plutonium recovery operations using advanced technology for plutonium handling, recovery and safety. The projected operations for the building focused primarily on recovery of plutonium from both solid and liquid wastes. The final product from the process operations was intended to be recycled plutonium metal, which was to be reused in the primary manufacturing process. Pilot-scale recovery operations began in 1981 and continued until the mid-1980s when serious design and construction deficiencies were identified, hindering full-scale operation of this facility. Although several projects to upgrade the system were proposed (i.e., the Plutonium Recovery Modification Project [PRMP]), none were approved to be undertaken. The last significant recovery operations in the facility were terminated in 1986 (Crisler, 1992). Current operations in Building 371 focus mainly on waste and Special Nuclear Material (SNM) handling and storage and laboratory operations (EG&G, 1993a).

3.2 HISTORICAL TIMELINE

- 1968 The decision was made to replace the Building 771/774 Plutonium Recovery Facility with the Building 371/374 complex (ChemRisk, 1992; Weaver, 1994). Building 374 was intended to handle the waste generated from Building 371 and was constructed as an essential part of Building 371's operations. Its operations complemented Building 774's high-level waste treatment operations for Building 771 (Hornbacher, 1994; Weaver, 1994).
- 1970 Dow Chemical was authorized to start the construction plan for Building 371 (Crisler, 1992).
- 1973 Site preparation, groundbreaking and fencing for building construction began (Buffer, 1993; Crisler, 1992).
- 1976 Building construction was temporarily stopped due to problems with the contractor (Buffer, 1993); the building was originally scheduled for start-up (ChemRisk, 1992).

- 1978 Waste treatment operations began in Building 374 (Weaver, 1994).
- 1980 Waste treatment in Building 374 began handling radioactive wastes from Building 371 (Buffer, 1993; Weaver, 1994).
- 1981 Construction was completed on Building 371 (Weaver, 1994). Plutonium recovery from site returns and the molten salt extraction (MSE) began on a limited basis. The first electrorefining run in the tilt-pour furnace began. DOE authorized "hot operation" (Crisler, 1992; Buffer, 1993).
- 1982 Pilot-scale operations began. These included primary aqueous recovery of plutonium in March, primary purifications in April and initial operation of the aqueous recovery system on August 4 (Crisler, 1992).
- 1983 Rocky Flats Plant (RFP) produced the first plutonium metal processed entirely through the building's aqueous recovery system (Buffer, 1993). The Plutonium Recovery Modification Project (PRMP) was established as a result of plutonium inventory accountability problems during pilot-scale operations in the aqueous recovery process. Its purpose was to identify processing deficiencies in Building 371 and to design replacement processes (Crisler, 1992). Aqueous recovery operations closed in April and never restarted (Weaver, 1994).
- 1985 Rockwell submitted the Conceptual Design Report to DOE detailing modifications needed to bring Building 371 into full operation, and a General Accounting Office (GAO) study of the modification cost was begun (Buffer, 1993).
- 1986 Electrorefining activities ceased (Crisler, 1992). Approximately half of the processes that were originally operating in the building had been shut down by this date (Weston, 1986). The last major recovery operations terminated (Crisler, 1992).
- 1987 The GAO Report on alternatives to Building 371 was released (Buffer, 1993).
- 1988 Pyrochemical processing ceased (EG&G, 1992a).

- 1989 DCHP preparation was the major recovery-related process conducted in Building 371 (EG&G, 1993a). It continued operation until 1990 (EG&G, 1993b).
- 1990 Funding for the PRMP project was denied by Congress (Buffer, 1993).

3.3 PHYSICAL BUILDING DESCRIPTION

Building 371 is located in the northwestern portion of RFP within the Protected Area (Figure 3-1). The building is a four-level, partially buried structure constructed of reinforced concrete. It contains approximately 186,000 square feet of floor space. Building features include a glovebox system and a large central storage area equipped with a stacker/retriever system (Weaver, 1994). Additional features in Building 371 include office areas, maintenance shops, locker rooms, outside loading docks and a cafeteria. The heating, ventilation and air conditioning (HVAC) system provides specified volume changes, and temperature and humidity control of the atmosphere within areas of the building. The HVAC system also maintains confinement of radioactive materials by means of pressure differential control and exhaust air filtration. The ventilation pressure is increasingly negative toward areas of higher radioactivity. In addition, gloveboxes, conveyors, vaults and their associated exhaust loading and cooling systems are enclosed by air locks, and the gloveboxes are inerted with nitrogen gas. Each glovebox has its own High Efficiency Particulate Air (HEPA) filter on the glovebox exhaust duct which filters the air prior to being routed through one of two ventilation systems. These systems pass the air through at least one packed-tower caustic scrubber into a 4-stage HEPA filter plenum prior to release to the atmosphere (EG&G, 1990).

Other buildings in the Building 371 complex included Buildings 374, 373 and 381. In 1980, Building 374 became operational for the purpose of handling high level process waste generated in Building 371 and high level waste from Building 771 (Hornbacher, 1994). Building 374 has successfully operated since that time (Weaver, 1994). Building 373 is a cooling tower and Building 381 is a fluorine storage area, which is no longer in use (EG&G, 1992a).

3.4 DESCRIPTION OF OPERATIONS

Building 371 operations can generally be divided into three categories: pilot-scale recovery operations, SNM and waste storage and handling operations and plant-wide support operations which include a plutonium analytical laboratory and a standards laboratory. Although the original

purpose of the building was plutonium recovery operations, most of these operations only operated on a pilot scale during portions of the 1980s. Areas of the building designed for these recovery operations are now used for SNM and waste handling and storage operations (EG&G, 1990; EG&G, 1990; EG&G, 1993).

3.4.1 RECOVERY

Pilot-scale recovery operations included plutonium metal recovery, americium recovery, pyrochemical processing and nitric acid recovery. During 1989-1990, Building 371 housed a support operation which involved dicesium hexachloroplutonate (DCHP) preparation for use in the recovery process in Building 776.

3.4.1.1 Plutonium Metal Recovery

The plutonium metal recovery operations which were intended to operate in Building 371 only operated on a pilot-scale from 1981 to 1983. These processes never achieved full-scale operations because of plutonium inventory accountability problems associated with process hold-up identified in 1983 (Weaver, 1994). Plutonium recovery operations involved a series of steps which are vastly simplified as follows: (1) dissolution of plutonium in nitric acid; (2) anion exchange processes to isolate the plutonium from other elemental impurities in the nitric acid solution; (3) evaporation of plutonium nitrate solution; (4) purification of plutonium through the peroxide precipitation process; (5) production of plutonium dioxide powder through the calcination process; (6) conversion of the plutonium dioxide to plutonium tetrafluoride through the hydrofluorination process; and (7) reduction of plutonium fluoride to pure plutonium buttons through the thermite reduction process. (For more detail on these processes see Section 8.0, which discusses Building 771's full-scale plutonium recovery operations.)

Step 1, site return and dissolution operations, occurred in Rooms 3202, 3204, 3204A, 3206 and 3208. This system contained a series of gloveboxes which performed disassembly, deforming, calcination, decontamination and dissolution operations prior to plutonium recovery (EG&G, 1992a).

Steps 2 and 3, anion exchange and evaporation, took place in Rooms 3543, 3545, 3547, 3549, 3553, 3555, 3557, 3559, 3563, 3565A, 3569A, 3561A, 3551 and Control Room 3541. Equipment included two tank vaults for oxides and residues, two canyons for anion exchange and

evaporation, a control room and eight other rooms for valve manifolds, gloveboxes, air locks and down-draft tables. The anion exchange step of the process was the main purification step (EG&G, 1992a).

Steps 4 through 7 took place in Rooms 3521, 3525, 3529, 3531, 3511, 3515 and 3513. The metal production system contained the precipitation and calcination canyon, the fluorination canyon, and the reduction and button breakout canyon and control room (EG&G, 1992a). The hydrofluorination system generated caustic scrubber waste which was treated in Building 374 (Crisler, 1992; Gisler, 1991). The hydrofluorinator used fluorine gas, which rapidly decomposed into hydrogen fluoride (Conner, 1991).

3.4.1.2 Americium Recovery

Americium recovery operations never became operational (EG&G, 1990; Weaver, 1994). However, the americium recovery system was set up in Rooms 3331, 3337, 3341, 3323, 3335, 3321, 3329, 3325, 3333, 3342 and 3343A. This system consisted of a series of pumps, ion exchange columns, evaporators and tanks (EG&G, 1992a). Americium recovery processes were planned to include thiocyanate ion exchange, potassium hydroxide precipitation, cation exchange and extraction chromatography recovery processes (Crisler, 1992). Several vault-type rooms were converted to backlog residue storage rooms in 1986 (DOE, 1994) and are currently used as SNM storage rooms (Weaver, 1994).

3.4.1.3 Pyrochemical Processing

Pyrochemical processing began in 1981 and ceased in 1988. The pyrochemical area consisted of Rooms 3305, 3303 (tank vault), 3301 and 3315 (EG&G, 1992a). Pyrochemical processes consisted of a variety of operations which were used to recover and purify plutonium metal from plutonium oxide, scrap, turnings, site returns or other impure plutonium. Some of the operations which were planned for Building 371 included reduction operations, direct oxide reduction operations, electrorefining and MSE activities (EG&G, 1990). (These processes are described in more detail in Section 9.4.2.6, which describes full-scale recovery operations conducted in Building 776.) The system contained a series of gloveboxes and control rooms. The majority of the pyrochemical processes functioned very well and exceeded the design capacity with the exception of electrorefining. (Weaver, 1994).

The electrorefining process produced high purity electrorefined plutonium metal from impure metal for use in the War Reserve (WR) manufacturing/production areas. In August 1981, four tilt-pour electrorefining furnaces began operation in Building 371. Equipment and operational problems showed low process yields averaging 64 percent as well as periodic contamination with tungsten and tantalum. In May 1987, the tilt-pour electrorefining process was shut down, and Building 771 assumed the electrorefining responsibility using stationary furnaces in June of 1988 (Crisler, 1992).

3.4.1.4 Nitric Acid Recovery

A nitric acid recovery process was established in Rooms 3573, 3571, and 3517. The system consisted of tanks, gloveboxes and evaporator and distillation columns that were used to purify the large quantity of nitric acid used in the metal recovery process (EG&G, 1992a). The system experienced significant equipment problems and was not very successful. One of the problems associated with the system was that it over-purified the acid above reagent grade. The pure nitric acid interfered with proper functioning of equipment in the building (Weaver, 1994).

3.4.1.5 Dicesium Hexachloroplutonate (DCHP) Preparation

DCHP preparation took place in Glovebox 37, Room 3305, for the purpose of converting plutonium oxide to the reagent salt DCHP. The DCHP was used as the oxidant in the pyrochemical MSE recovery process in Building 776 for extraction of americium from site-return metal (Crisler, 1992). DCHP production in Building 371 began in 1989 using non-specification grade plutonium oxide as the source of plutonium (Crisler, 1992) and ceased operation in 1990 (EG&G, 1993b).

The DCHP preparation process involved two major steps: (1) oxide dissolution and (2) precipitation and drying (EG&G, 1990). The *oxide dissolution* step involved dissolving plutonium oxide in hydrochloric acid and calcium fluoride. The resulting slurry was then filtered, separating the undissolved solids from the solution. The *precipitation and drying* step mixed the filtrate with cesium chloride in hydrochloric acid and sodium nitrate to precipitate DCHP, which was the reagent used in Building 776 plutonium recovery operations. The DCHP was removed from the solution by filtration and dried in an oven, or muffle furnace, before transfer to Building 776 for use (EG&G, 1990; Crisler, 1992) or to Room 3305 in Building 371 for storage (EG&G, 1992a).

The process contained a system for treatment of off-gases vented from the various reaction vessels. Oxide dissolution filtration off-gas, DCHP filtration off-gas and muffle furnace off-gas were all initially routed into a trap flask. They were then passed to a caustic flask where potassium hydroxide was added and the gases were eventually discharged through a vacuum pump and treated in the caustic treatment process (EG&G, 1993a). The undissolved plutonium oxide solids from the oxide dissolution step were either recycled through dissolution or removed from the glovebox for storage (EG&G, 1993a).

3.4.2 SNM AND WASTE STORAGE AND HANDLING

Currently, the main function of Building 371 is waste and SNM storage and transfer and handling, including repacking operations. In addition, two incinerators are also located in Building 371, but they operated only briefly in trial runs and never became fully operational.

3.4.2.1 Waste and SNM Storage and Transfer

The majority of Building 371 is currently used for handling and storing SNM and wastes. The building has a stacker-retriever system consisting of a central storage vault which houses both radioactive and non-radioactive metal and/or residues in closed containers awaiting processing, packaging or shipment. The central storage vault is connected to a 4-stage HEPA filtration system. In addition, in-process tanks are also used for storage (EG&G, 1990). Wastes stored in the building may be categorized as transuranic waste, transuranic-mixed waste, low-level waste and low-level mixed waste (EG&G, 1992). Table 3-1 identifies areas of Building 371 used for storage.

TABLE 3-1
STORAGE AREAS IN BUILDING 371

Location	Area	Operation ¹
Ground Floor	7,000 ft ²	Drum Storage
	2,200 ft ²	Analytical & Standards Laboratories
	4,600 ft ²	Materials storage vault
	36,700 ft ²	Process/Storage areas
Basement Floor	8,200 ft ²	Material Storage (Inert environment)
	8,200 ft ²	Process/Storage areas
Sub-basement	8,200 ft ²	Material Storage (Inert environment)
	4,700 ft ²	Process/Storage area
Total Process/Storage Areas	82,500 ft²	

¹Areas designated process/storage no longer have active material processing capabilities and are currently used to store drums from across the plant site.

The largest single storage area in the building is the plutonium storage vault which is constructed of concrete and steel and is inerted with a nitrogen atmosphere. The plutonium is stored in segregated, closed stainless steel containers. The majority of the other rooms in the building are also currently used for drum storage of SNM, TRU wastes and residues (Weaver, 1994; EG&G, 1992). For example, Room 3420 is used as a backlog storage area for transuranic waste contaminated with small quantities of carbon tetrachloride, 1,1,1-trichloroethane and toluene (Rockwell, 1989). Several areas in the building identified as canyons, which were originally designed to support SNM material processing, now act as storage areas. Many of these canyons are contaminated. Gloveboxes store plutonium solutions in unvented plastic bottles. This

practice is of concern because plastic bottles tend to deteriorate with time when in contact with nitric or hydrochloric acid and radiation fields. However, these bottles are periodically inspected and vented. Other storage concerns include the decomposition of packaging material surrounding plutonium metal, plutonium oxides and residue salts which contain high gamma counts. The packaging is subject to radiolytic deterioration, which generates hydrogen gas, as well as deterioration from elevated temperatures (EG&G, 1992a).

Other materials stored in the building include hydrochloric acid, ammonium nitrate, caustic solution and acidic plutonium nitrate solution. Two bermed tanks on the north side of Building 371 store nitric acid and potassium hydroxide for use in Building 371/374 (EG&G, 1992a).

Also related to waste handling and storage operations are the repacking operations, located in Gloveboxes 1, 2, and 3 in Rooms 3206 and 3602. Residues and wastes are re-packed for off-site shipment to other DOE facilities or for on-site storage. Residues that are repacked include oxides, incinerator ash, molten salt, electrorefining salt, cell cleanout and anode heels (EG&G, 1993a).

3.4.2.2 Incineration

Two rotary kiln incinerators were located in Building 371, but were only used for test runs (Hudson, 1991). The purpose of one of the incinerators was to reduce the large quantity of Low Specific Activity (LSA) combustible material, which was contaminated with only small amounts of actinides, into a product which could be further processed to recover actinides (Crisler, 1992). These materials typically included office waste from buildings within the Protected Area. The other incinerator was designed to burn high specific activity (HSA) waste including plutonium-contaminated combustibles generated in plutonium-handling buildings (Weaver, 1994). Decontamination and Decommissioning (D&D) of the existing equipment in the incinerator area was completed in 1988 as part of the Plutonium Recovery Operational Verification Exercise (PROVE) (EG&G, 1992a). This D&D took place only on the ground floor, not in the basement and sub-basement areas (Weaver, 1994).

3.4.3 SUPPORT OPERATIONS

Support operations active in Building 371 include laboratories, maintenance activities and utilities.

3.4.3.1 Laboratories

Building 371 houses plutonium analytical laboratories and a chemical standards laboratory which support operations throughout the plant site.

The plutonium analytical laboratories located in Rooms 3412 and 3179 serve Buildings 371 and 374, act as backup labs for the Building 771 analytical lab and provide analytical support to the entire plant site (EG&G, 1992; ChemRisk, 1992). The majority of the work at this laboratory consists of total alpha and beta counts along with radiochemical analysis for specific isotopes in liquid and solid samples (EG&G, 1993b). The alpha and beta analyses serve as screens to identify highly radioactive samples which are unsuitable for detailed analysis in Building 881. X-ray emission, spectroscopy and ignitability tests are also performed. Prior to analysis, the samples are dissolved in nitric, hydrofluoric and/or hydrochloric acids. If samples are expected to contain americium, they are mixed with tri-n-octylphosphine oxide (TOPO) extract (EG&G, 1993a). Cyclohexane, chloroform and potassium chromate are also documented as being used in this lab (ChemRisk, 1992).

The chemical standards laboratory, located in Room 3408, prepares both non-destructive assay (NDA) and destructive assay standards for various user groups at the plant and inspects standards used in the field. Most laboratory operations take place in gloveboxes. NDA standards are prepared from plutonium, americium and uranium oxides and metals (including beryllium) for a wide range of NDA instrumentation (EG&G, 1993; Mahaffey, 1993). Destructive assay standards are prepared from plutonium, americium, uranium, strontium, and yttrium solutions. Other chemicals used in the laboratory for various operations include nitric, hydrochloric and hydrofluoric acids, and potassium pyrosulfate (EG&G, 1993a).

3.4.3.2 Maintenance

Building 371 houses several maintenance shops for service of process and building equipment in Building 371 and Building 374. These shops include machine, electrical, carpenter, sheet metal, pipe and paint shops (EG&G, 1993a).

The machine shop is located in Room 3157 and repairs and produces metal parts for basic process maintenance systems. Process equipment includes lathes, mills and drills. Some of this machinery requires the use of TrimSol in water as a coolant (EG&G, 1993a).

The electrical shop is located in Room 3159 and repairs and calibrates electrical components and equipment. Repair work requires the use of wire pulling lubricant, contact lubricant, contact cleaner and other electrical supplies. Small amounts of hydrochloric acid and plating solution are used in the cleaning and repair of conductivity cells. Lead-acid and nickel-cadmium batteries may also be changed out in this room (EG&G, 1993a).

The carpenter shop is located at the east end of Dock 5. It assembles and repairs wooden items. Chemicals used include carpenter's glue and Silicone 732 as a sealant (EG&G, 1993a).

The sheet metal and pipe shop is located in Room 3148 and produces sheet metal products and repairs piping in Buildings 371 and 374. Chemicals used in this process include acetylene, oxygen and/or argon gas, commercial cleaners, petroleum solvents (mainly Isopar-L), cutting oil and tap oil (EG&G, 1993a).

The paint shop is located in Room 3160 and paints building and process equipment from Buildings 371 and 374. The shop uses both latex and oil-based paints and uses water and mineral spirits, respectively, to thin these paints (EG&G, 1993a).

3.4.3.3 Utilities

Special utility systems present in Building 371 include a process vacuum system, a process vent scrubber, a utility scrubber system, caustic treatment and an emergency generator.

The process vacuum system is located in Rooms 2317 and 2319 and provides negative pressure at the vacuum header for various process uses. Equipment includes vacuum headers, liquid traps, vacuum pumps, caustic pumps, heat exchangers and mist separator tanks. Vacuum Header A serves areas where nitric acid or caustic are present. Vacuum Header B serves areas where chloride is present. The headers terminate in liquid traps, which feed the liquid to the caustic treatment process (EG&G, 1993a).

The process vent scrubber is located in Rooms 1105 and 2319 and has not operated since approximately 1989. When operational, it removed acid vapors and entrained liquids from the process vent header streams connected to the Building 371 tanks. Chemicals used in this process included blowdown solution consisting of water and potassium hydroxide with a pH of 10 (EG&G, 1993a).

The utility scrubber system is located in Rooms 1105, 1210, 2319 and 2217. It removes acid vapors and entrained liquids from the feed air streams connected to the process vacuum, process vent scrubber (prior to 1989) and the transuranic handling area exhaust air from ventilation systems. Chemicals used in this scrubber system include a scrubber solution comprised of water and sodium hydroxide solution at a pH of 10. Potassium hydroxide is also added to the solution when the pH falls to a specified level (EG&G, 1993a).

Caustic treatment, located in Rooms 1115 and 1117, precipitates and filters plutonium from various feed solutions. Solutions to be filtered are received from the utility scrubbers, process vacuum separators, process vent scrubber and criticality drain tanks. Solutions are pumped from two tanks through an in-line mixer, heat exchangers, sock filter banks and into the two other tanks. Caustic (potassium hydroxide) solution is added upstream of the mixer as needed to raise the solution pH above 10. Plutonium, americium and other metal ions precipitate and are trapped by the sock filters. Room 1125 is planned to become part of this system (EG&G, 1993a). A new caustic waste treatment system is being installed in Rooms 1103 and 115T to replace the original system (Weaver, 1994).

The emergency diesel generator is housed in Room 3583 and provides an emergency power supply to equipment and machinery in Building 371. Waste generated by this generator includes used engine oil, used oil filters, diesel fuel filters, air filters, Kimwipes, Oil Dri and ethylene glycol. Lead-acid storage batteries are used to start the generator (EG&G, 1993a).

3.5 CURRENT CONTAMINATION STATUS

The current contamination status of Building 371 is such that close to 50 percent of the process area requires respiratory protection for access. After cessation of aqueous processing operations, attempts were made to quantify the plutonium remaining in the process equipment, piping, tanks, canyons and floors. Approximately 50 percent of the plutonium recovery process area is expected to be radioactively contaminated. Gamma scanning measurements have identified some plutonium holdup in the pyrochemical furnaces. Areas used for storage of radioactive wastes may also be contaminated (EG&G, 1992a).

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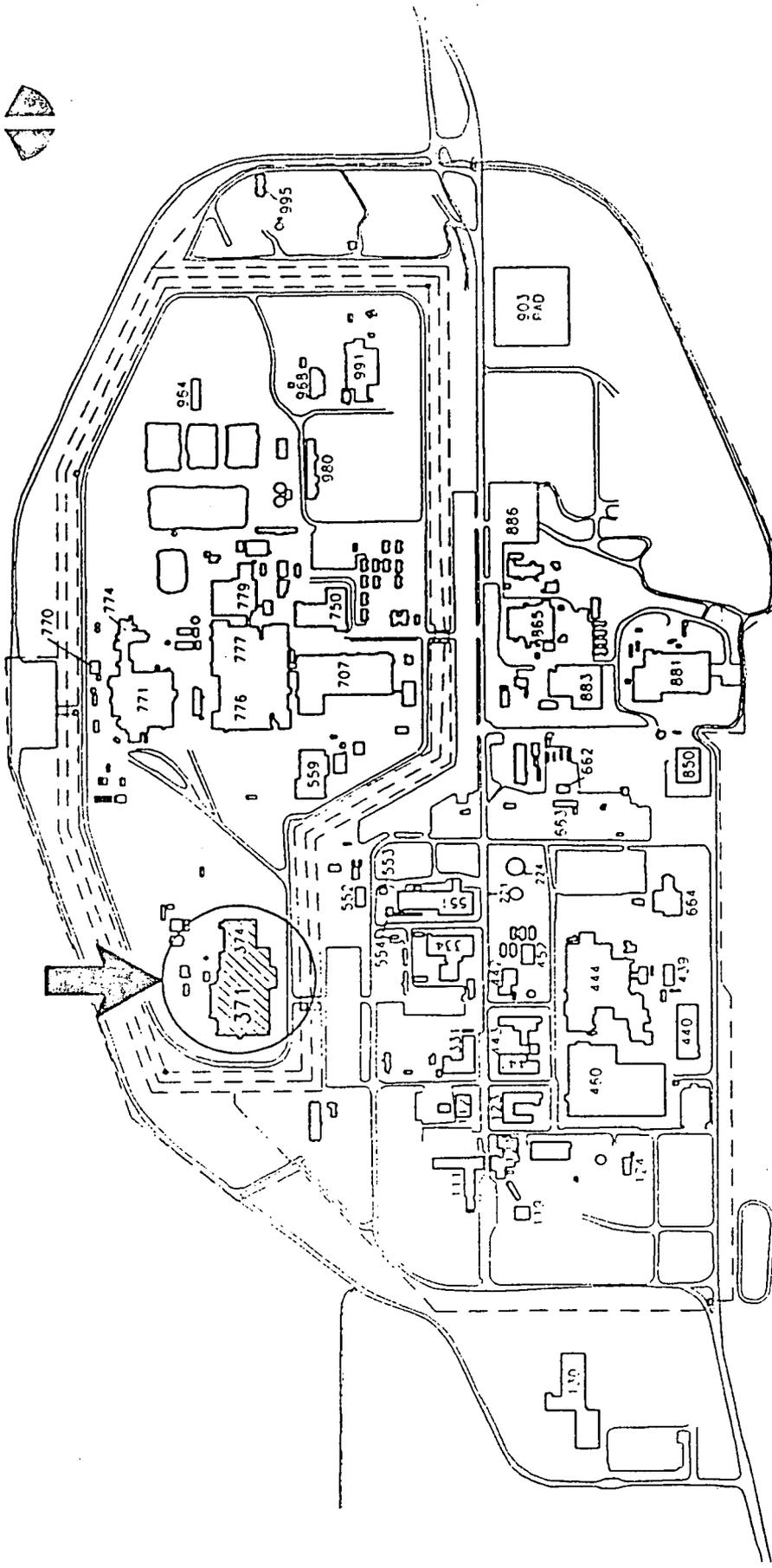


FIGURE 3-1
BUILDING 371

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO
BY
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700

PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	JUNE 8, 1994	SCALE	1" = 800'

4.0 OPERATIONAL HISTORY OF BUILDING 444

4.1 INTRODUCTION

Building 444 was a multi-purpose manufacturing facility with an emphasis on manufacturing depleted uranium and beryllium components (DOE, 1992; EG&G, 1991). War Reserve and special order parts were cast, fabricated, assembled and inspected. Depleted uranium, depleted uranium alloys and beryllium were the main metals used in parts manufactured in the building although copper, stainless steel, aluminum, titanium, nickel, gold, silver and magnesium were also used in some parts or as coating or alloy materials (EG&G, 1991).

Building 444 was one of the first buildings constructed on plant site and was built for the purpose of casting and fabricating depleted uranium components. Beginning in 1953, depleted uranium was both cast and machined in Building 444, which was also known as the "A Plant" (EG&G, 1993). Changing needs led to additional processing of depleted uranium components. Building 883 was built in 1957 to fill the need for additional fabrication (rolling and forming) operations that could not be supported by Building 444. The process then changed to casting the ingots in Building 444 and transferring them to Building 883 to be heated, rolled into sheets, cut into blanks and formed into the required shape. The shaped pieces were then shipped back to Building 444 for final machining (Barrick, 1991; ChemRisk, 1992; Campbell, 1986). These operations remained the same for approximately 35 years (ChemRisk, 1992; Campbell, 1986).

Although research and development (R&D) scale beryllium operations took place in Building 444 shortly after it became operational (Campbell, 1986; Hill, 1994), full-scale beryllium fabrication (machining) operations did not begin in the building until 1958 (Hill, 1994; EG&G, 1993). In 1962, the beryllium "wrought process" was developed and Building 444 began casting beryllium ingots, and sending the ingots to Buildings 881 and 883 for canning, rolling, cutting and shaping operations. The shaped parts were then returned to Building 444 for final machining. These operations continued until 1975 when beryllium began being supplied in the form of blanks from an offsite contractor, eliminating the casting portion of the operation (EG&G, 1993). Machining of beryllium in Building 444 continued until recent production curtailment.

4.2 HISTORICAL TIMELINE

- 1951 Construction began on Building 444 as one of the first buildings on plant site along with Buildings 771 and 881 (Buffer, 1993).
- 1953 Depleted uranium casting and machining began in Building 444 (ChemRisk, 1992; DOE, 1992).
- 1954 On September 3, a distillation process began operation in Building 444 for disposal of waste machine coolant (Rains and Hawley, 1955).
- 1955 Radiography vaults were added to Building 444 (Buffer, 1993).
- 1957 Building 445 was added to store and cut graphite, steel and plastics used in the Building 444 graphite mold production processes (ChemRisk, 1992).
- 1958 Beryllium machining operations began in Building 444. The building exhaust system and High Efficiency Particulate Air (HEPA) filtration system were installed to accommodate beryllium operations (ChemRisk, 1992).
- early-1960s Beryllium "wrought" process was used beginning in approximately 1962. (This process is described in Section 4.4.1.2.)
- 1964 The first upgrade to the exhaust system for the beryllium machining area was installed in the basement. It included a large aerotech unit designed to serve all beryllium machines (Reyland and Rogers, 1964).
- 1970 Several fires involving depleted uranium occurred. As a result, non-plutonium areas on plant were inspected for fire hazard (Jianetti, et al., 1970).
- 1974 The beryllium exhaust system was upgraded for the second time (EG&G, 1993).
- 1975 The beryllium "wrought" process was discontinued and replaced by purchase of sintered blanks from outside suppliers (ChemRisk, 1992).

- 1981 Production plating lab operations began (ChemRisk, 1992).
- 1985 Erbium nitrate began being used as a coating for graphite molds used in foundry operations. This material replaced calcium fluoride which had only allowed use of the mold for two or three runs (Buffer, 1993).
- 1986 The exhaust filter system for beryllium machining areas received a third upgrade (EG&G, 1993).
- 1987 Titanium stripping operations began (ChemRisk, 1992).
- 1989 The uranium foundry was shut down (ChemRisk, 1992). In an unrelated event, a plating bath tank overflowed, releasing chromic acid to a footing drain beneath the building (Buffer, 1993).
- 1990 On May 22, a fire in the coatings room of the production plating lab (Room 345) caused damages estimated at \$250,000 and resulted in shut down of the production plating lab (ChemRisk, 1992). No known releases to the environment occurred (Buffer, 1993).
- 1992-1994 The majority of the processes housed in Building 444 ceased operation (EG&G, 1994).

4.3 PHYSICAL BUILDING DESCRIPTION

Building 444 is located in the southwestern portion of Rocky Flats Plant (RFP) outside of the Protected Area (Figure 4-1). The building is a reinforced concrete structure containing a partial basement, a main floor and mezzanine in the eastern portion of the building and only a main floor in the western portion of the building (EG&G, 1991). The building houses a cafeteria in Room 125 and contains several locker rooms which include beryllium locker rooms, rest rooms and/or showers in Rooms 103C, 106C, 108, 108B, 112 and 115 (Hill, 1994; Mahaffey, 1993). Support buildings physically connected to Building 444 include Buildings 445, 450 and 455. Building 445 is used to cut and store graphite, steel and plastics (EG&G, 1991). Building 450 houses the exhaust filter plenum and exhaust fans which handle a significant portion of air exhausted from Building 444. Building 455 houses the exterior exhaust filter plenum

serving the Production Plating Laboratory in Building 444 (ChemRisk, 1992). With the exception of the beryllium machining area (Napple, 1994), there are no air locks in Building 444 because it was not generally considered to handle plutonium or enriched uranium (Johnson, 1991; Simmons, 1991).

During the operational history of Building 444, the beryllium area underwent three ventilation upgrades in 1964, 1974 and 1986 (EG&G, 1993). When beryllium manufacturing began in 1958, the ventilation system consisted of Aero-Tech cyclone separator units placed at each machine to filter the air at the point of operation. The Aero-Tech units exhausted to the main building exhaust serving the uranium operations. This system was updated in 1964 by installing a central Aero-Tech unit in the basement of the building that was connected to the main building exhaust. The new system was arranged so that each machine's local ventilation extended through the floor to a drop box which collected the heavier debris. The air then passed through the central plenum to a cyclone separator and then through a single bank of HEPA filters prior to reaching the building's filter units (ChemRisk, 1992; DOE, 1984).

In 1974, the centralized beryllium aerotech system was replaced by an overhead duct system which led to an external chip cyclone and HEPA filtration unit. In 1986, the HEPA filters were upgraded to include two stages of HEPA filtration. The new system in Building 444 included two types of conveyance systems: (1) a "low vacuum" local exhaust system to carry the fine particulates and (2) a "high vacuum" local exhaust to carry the heavier particulates. Each subsystem had its own cyclone separator, which was then connected to its own HEPA filtration unit (ChemRisk, 1992).

4.4 DESCRIPTION OF OPERATIONS

The production operations in Building 444 were conducted to support War Reserve, special order and manufacturing development work. Weapon components were fabricated from various materials such as depleted uranium, beryllium, stainless steel, aluminum and various exotic materials (EG&G, 1993). Operations in Building 444 included casting, fabrication, assembly, inspection and testing, coating and plating, special projects and support operations. With the exception of the beryllium wrought process (described in Section 4.4.1.2), the majority of these operations remained approximately the same until recent production curtailment. For this reason, historical and recent operations are discussed as a whole in the following sections. As of March 1994, the majority of Building 444 manufacturing operations have been curtailed and a final

decision on the future of building operations is still pending. Operations are expected to continue at a very reduced level until a decision is reached (EG&G, 1993).

4.4.1 CASTING

Casting operations conducted in Building 444 took place in the foundry in Rooms 201 and 205 upstairs, and in Rooms 109 and 117A on the main floor (EG&G, 1991; EG&G, 1994; Hill, 1994).

4.4.1.1 Uranium Casting

The foundry cast ingots from virgin depleted uranium, scrap depleted uranium, depleted uranium alloys, silver, aluminum and copper (EG&G, 1991; EG&G, 1994). The metals were placed in crucibles, loaded into one of eight induction furnaces and melted in a vacuum atmosphere. Induction-casting used radio frequency energy to melt the metal, which was then poured into graphite molds to form ingots. Both molds and crucibles were brushed with a mold coating consisting of yttrium oxide and sodium methyl cellulose prior to use. Wastes associated with these processes included vacuum pump oil used in the house vacuum system, non-hazardous batteries, uranium oxide residue (skull) and waste light metals such as aluminum and steel (EG&G, 1994). The graphite molds were sent to mold cleaning where residual metal, powdered graphite and yttrium residue were removed (EG&G, 1991). The graphite dust was disposed of in the landfill (Hornbacher, 1994).

4.4.1.2 Beryllium Casting (Wrought Process)

Through R&D work at RFP and other DOE facilities, the "wrought" beryllium process was developed in approximately 1962 (Hill, 1994; Link, 1994). This process was tied to development of the ability to cast beryllium forms. It involved casting beryllium ingots, sawing the ingots, canning them in stainless steel, rolling them into sheets and cutting the cans. The beryllium ingots were very brittle, and in order to roll them, they had to be encased in stainless steel and heated to a temperature ranging from 900 to 1,000°C (Link, 1994). After the stainless steel can was removed, the beryllium sheet was then cut into shapes, pressed and machined (Campbell, 1986). This process was split between Buildings 444, 881 and 883. Building 444 cast the ingots, Building 881 canned the ingots in stainless steel, and Building 883 rolled the cans, acid etched the beryllium

sheets and pressed the beryllium sheets into shapes. These shapes were then sent back to Building 444 for machining (Hill, 1994; Hornbacher, 1994).

In 1975, the beryllium production method changed again. At this time, the wrought process was abandoned for the molding of parts from sintered (pressed powder) blanks received from outside suppliers; therefore, the beryllium foundry operations ceased (Hill, 1994). By 1980, the foundry had been cleaned up of beryllium; however, the furnaces used in the wrought process remained and were used for depleted uranium casting (ChemRisk, 1992; Link, 1994). Beryllium machining operations outside of the foundry continued until 1993 (EG&G, 1993).

4.4.2 FABRICATION

Fabrication operations conducted in Building 444 included depleted uranium machining and beryllium machining.

4.4.2.1 Depleted Uranium Machining (active)

Metal parts consisting of depleted uranium, depleted uranium alloy and depleted uranium with trace amounts of iron, silica, titanium, aluminum and stainless steel are cut in the depleted uranium machining process in Room 101. Machining operations include turning, facing, boring, milling, and sawing using lathes, saws, milling equipment and other conventional machine tools (EG&G, 1994; EG&G, 1991). Due to the pyrophoric nature of depleted uranium, significant quantities of machining coolant are used during machining to reduce fire risk. Originally, coolants used in depleted uranium machining included Cimcool, which was an oil in water emulsion, and Texaco CX, which was a petroleum based water soluble coolant (Rains and Hawley, 1955; Cichorz, 1970). In more recent operations, the water-based coolant Trim Sol has been used during machining (EG&G, 1991).

After machining, coolants are cleaned off of the machined parts. During the majority of the plant's history, considerable quantities of the solvent perchloroethylene (PCE) were used to clean the parts (Hill, 1994; Barrick, 1991; Campbell, 1986). Later, PCE was replaced with Freon TF and 1,1,1-trichloroethane (1,1,1-TCA) (Rockwell, 1988). In more recent years, non-chlorinated solvents including Trim Rinse detergent, Oakite 162 cleaner and deionized water have been used to clean the machined parts (EG&G, 1991). After the part is cleaned, it is coated with other materials and assembled.

When uranium machining operations began in Building 444, the original plan for machine coolant was continuous filtering and usage of the machine coolants; however, once active production began, it was determined that these coolants eventually soured and required disposal. Neither CimCool nor Texaco CX could be processed in the Waste Disposal Plant. By February 1954, approximately 14,000 gallons of sour coolant contaminated with 300 parts per million uranium were stored in the building awaiting disposal. In an effort to find a means of reducing waste oil volume, research was conducted which identified evaporation as an effective means and a pilot-scale 55-gallon drum evaporator was established. The resulting condensate was released to the process waste treatment system in Building 774 (Hornbacher, 1994) and the still bottoms were "drummed and buried through normal disposal channels" (Rains & Hawley, 1955; Cichorz, 1970). In addition to burial, these still bottoms were also burned in outdoor burning pits and stored at the 903 Pad (Putzier, 1970). In the late 1970s or early 1980s, this system was replaced with a centrifuge system which removed particulates from the Trim Sol machine coolant and allowed reuse of the coolant (Idecker, 1994; EG&G, 1991).

Disposal of waste depleted uranium chips also became a significant problem at RFP in the early 1950s because of the safety hazards associated with transporting highly pyrophoric depleted uranium chips (Putzier, 1970). Various disposal locations of wastes from Building 444 during the mid-1950s to mid-1960s included burial in Trench T-1 and burial in the Mound area (Putzier, 1970; Butler, 1962; Strangfeld, 1993; Young, 1991). In 1956, the chip roaster began operation in Building 447. Coolant-coated lathe turnings and chips of depleted uranium and other uranium alloys and composites were then collected in 55-gallon drums and sent to Building 447 to be oxidized and packaged for off-site disposal. The chip roaster has remained in operation to the present day with the exception of 1959-1961 (see Section 5.4.4 for more detail). In the late 1980s, turnings and chips mixed with depleted uranium were sent to the chip cementation process to be cemented, packaged and shipped off-site for disposal (EG&G, 1991; Idecker, 1994).

In 1970, several uranium-related fires occurred in the uranium machining area. A thorough investigation was conducted and it was determined that the fires were initiated by finely divided metal powder. The presence of nitrite in intimate contact with the burning metal powder initiated a violent exothermic reaction not characteristic of uranium metal fires. The nitrite originated from the coolant system which employed an aqueous mixture of triethanolamine, fatty acid soap and sodium nitrite (a rust preventative common to commercial water-base coolants) (Jiannetti, et al., 1970).

4.4.2.2 Beryllium Machining

Beryllium machining began in 1958 (Hill, 1994; Swenson, 1994). During 1958 to 1962, beryllium material was received from off-site vendors. These vendor-supplied components were heat-treated and then machined into required dimensions in the southeast corner of Building 444 in Room 106. Beryllium machining operations later expanded into Rooms 109A and 107 (Hill, 1994). From 1962 to 1975 beryllium sheets underwent the wrought process (as described in Section 4.4.1.1) on plant site and beryllium shapes were sent from Building 883 to Building 444 for final machining. After 1975, sintered blanks supplied by off-site vendors were machined in Building 444 until 1993 (Hill, 1994; EG&G, 1993).

Machining processes involved sawing, milling, drilling and lathe operations followed by polishing and abrading operations, if needed. Components containing beryllium were also returned to the machining area for dismantling. Over the years, machining included work on beryllium castings, wrought pressings, sintered forms and bar stock. Beryllium was machined dry without coolants or lubricants; however, the lathes required lubricating oil, which sometimes accumulated on the machine and became mixed with beryllium chips (Reyland and Rogers, 1964). Beryllium parts were cleaned in an ultrasonic cleaner and/or with small quantities of deionized water and Oakite to remove the residue that resulted from machining (EG&G, 1991; EG&G, 1994).

The machining area was an enclosed shop with an independent ventilation/exhaust system due to the health risk associated with machining beryllium (EG&G, 1993). The machining process generated beryllium chips and dust which were vacuumed from the immediate work area by two vacuum systems. These systems picked up beryllium chips as they were created and conveyed them in an air stream to a cyclone separator. After traveling through the cyclone separator to remove the chips, the air was exhausted through a filter plenum to the atmosphere (Yoder, 1978).

In 1976, the upstairs beryllium machining area was scrubbed with PCE (Cichorz, 1976). The frequency of this cleaning operation is not known.

4.4.3 ASSEMBLY

Parts received at the welding process from other processes underwent one or more welding or brazing operations. Materials welded included beryllium parts, depleted uranium and other source materials (EG&G, 1994). Cleaning, welding, brazing, etching and coating activities associated

with part assembly were recently suspended, and minimal activity is expected in the future (EG&G, 1993). These operations were located in Rooms 101, T101A, 104, 104A and 109A (EG&G, 1994).

Assembly Cleaning. Assembly cleaning took place in both Buildings 444 and 447. Cleaning was performed by both building crews which moved parts back and forth through a doorway which divided the two buildings. Cleaning was performed prior to welding, brazing and coating of parts, which consisted of uranium, beryllium and stainless steel (from Building 460). In recent operations, Oakite, deionized water, isopropyl alcohol and ethyl alcohol were used to clean the parts. The parts were then sent to welding, brazing and coating of parts and finally to leak checking/proof testing or inspection. Cleaning activities were located in Rooms 109A and 104 (EG&G, 1994).

Assembly Welding and Brazing. Welding processes were composed of a number of operations conducted in Rooms 101, T101A, 104, 104A and 109A. These processes included tungsten inert gas (TIG) welding, electron beam welding, TIG crimp welding, electron bombardment and vacuum furnace brazing, and titanium vapor deposition coating. Parts received from other processes underwent one or more welding or brazing operations as required by design agency specifications or internal instructions. The electron beam welder joined beryllium with other parts and was equipped with a filter to capture beryllium dust. The brazing operations were performed in Rooms 104 and 109A and used rings and wires of various filler metals and an appropriate flux to join like and unlike metals. Vacuum brazing was performed in a furnace chamber and electron bombardment brazing used a bell jar and vacuum pump arrangement. Alcohol, acetone, Noxon metal polish, sandpaper and wipes were used to prepare surfaces and filler materials. The brazing operations required helium and argon gas and freon (compound not specified), which was used in the electron bombardment cooling system (EG&G, 1994).

Assembly Etching. Assembly etching was performed prior to assembly coating. Uranium parts were acid etched using an ultrasonic etching bath with a solution of nitric acid, hydrogen peroxide and deionized water (EG&G, 1994).

Assembly Coating. Assembly coating involved applying a silver coating to the uranium parts using a hot-hollow cathode chamber. Titanium coatings were applied using a vacuum coating chamber (EG&G, 1991).

4.4.4 TESTING AND INSPECTION (active)

Testing and inspection activities conducted in Building 444 include assembly testing, non-destructive testing (NDT) and product inspection.

Assembly Testing. Assembly testing is performed in Rooms 104, 104B, and T101A and consists of a variety of operations that determine product integrity and conformance to design specifications. Parts may be subjected to one or more tests or procedures, including leak and pressure tests, weight determination, crimping or swaging, and electromarking. Chemicals involved may include acetone, ethyl and isopropyl alcohols, molybdenum lubricants or etching (calcium nitrate) solution. Process gases include helium, argon and nitrogen. Other waste materials include waste vacuum oil, compressor oil and hydraulic fluid (EG&G, 1994; EG&G, 1991).

Non-destructive Testing (NDT). NDT includes the following types of operations: radiography, dye penetrant testing, weight and density testing, eddy current and beta back-scattering (EG&G, 1994; EG&G, 1991). Tested parts from Building 444 may be composed of stainless steel, beryllium, vanadium, monel, titanium or depleted uranium. Materials/chemicals involved in the testing include silver, developer/fixer, penetrant oil and chromium (EG&G, 1994).

Product Inspection. Product inspection takes place in module labs contained in Rooms 101A through 101F in the Radiological Control Area (RCA) and involves determining machined parts' dimensions and conformance to specifications. Tools from the tool grind process are inspected in Room 700D. Equipment includes dimensioning instruments, visual comparators and hand gauges. Most products are made of stainless steel, beryllium or depleted uranium, although other metals may be used. Parts which contain oil residue from machining are wiped clean with a Precision Wipe moistened with isopropyl alcohol. Very small quantities of light oil, waxes, detergents, casting and molding material, and Dykem and Dykem remover are used (EG&G, 1994). Historically, parts in the building were cleaned with trichloromethane and Freon 113 rather than isopropyl alcohol (EG&G, 1993).

4.4.5 COATING AND PLATING

Coating and plating operations were performed on non-nuclear parts such as stainless steel and copper. These operations are not part of the flow of the casting, fabrication and assembly of

depleted uranium and beryllium parts produced in Building 444; however, these operations were not considered to be special projects or R&D operations. These operations were suspended in 1993 (EG&G, 1993).

Coating. During the coating process in Room 137, non-nuclear parts from Production Control in Building 460 were coated with erbium oxide. Prior to coating, the parts were grit blasted, ultrasonically cleaned in deionized water, rinsed in deionized water to remove the grit and placed in a drying booth to remove excess moisture from the part. The parts were then coated with erbium nitrate in a paint booth and placed in a drying oven. Dried parts were then heat treated in one of five furnaces to decompose the erbium nitrate to erbium oxide. Repeated spray coating and heating cycles were conducted if required. Parts were inspected and any residual spray was removed using a silicon oxide grit blast (EG&G, 1994; EG&G, 1991).

Production Plating. Production plating activities were located in Room 212 (EG&G, 1993). War Reserve and special order parts fabricated from copper, steel and stainless steel were etched and plated on a bench-scale level. Plating and/or etching parts made of these materials required different solutions which were stored in five tanks. Tanks containing plating solutions included a silver plating tank, a sulfuric acid etch bath tank, a nickel-plating tank, an alkaline cleaner tank and an electroless nickel-plating tank. After parts were plated, they were rinsed in one of several rinse tanks. The rinsate used for gold-plated parts contained cyanide. Other rinse tanks contained Oakite and Turco 4215, an acid-plating solution rinse. Spent potassium/gold/cyanide plating solution was generated in this process (EG&G, 1994). Other chemicals used included ammonium hydroxide, hydrochloric acid, Mac Stop 9554, which is 60% toluene and xylene, and nickel chloride (EG&G, 1991).

4.4.6 SPECIAL PROJECTS

4.4.6.1 Historical Special Projects

A number of special projects were historically conducted in Building 444 in support of R&D. Only limited information is publicly available on these projects. The following list briefly highlights some of the known special projects historically conducted in Building 444:

- Around 1961-1963, lithium salts were machined using a process similar to that used in uranium machining (ChemRisk, 1992).

- In 1967-1968, Building 444 supported the Zero Power Plutonium Reactor (ZPPR) project. ZPPR elements were made by first alloying uranium and molybdenum in Building 444 and then sending the components to Building 771 to be alloyed with plutonium by casting. The alloy plates were then clad in stainless steel envelopes in Building 776/777 and sealed with a weldment (ChemRisk, 1992).
- During 1968-1972, tetrabromoethylene was used for float/sink tests in conjunction with R&D beryllium work (Crisler, 1991; Andrews, 1994).
- Cadmium was rolled and formed in R&D operations and generally treated like beryllium (Link, 1991).

4.4.6.2 Recent Special Projects

Recent special projects conducted in Building 444 were conducted in the R&D plating lab, and the metallurgy lab.

R&D Plating Lab (inactive). The R&D plating lab was located in Room 245 and consisted of five lines including a cyanide line, three acid lines and a bench-top line where various chemicals such as anodizing dyes were made up. Room 245 was stripped of these five lines including decontamination and disassembly of bench-top and tanks, supporting vent systems, drains and associated plumbing (EG&G, 1994).

- Line 1, the cyanide line, was destroyed by fire in 1990. It originally consisted of nine tanks built into a bench-top and one stand-alone tank. The tanks contained chemicals used for copper plating, gold plating and cadmium plating. Spillage drained to the permitted storage tank via the floor drain (EG&G, 1994).
- Line 2 was an acid line consisting of 12 tanks built into a bench-top. A floor drain shared with lines 3 and 4 ran the length to the bench-top. Line 2 was the primary line used for plating-metals including chrome, nickel, and copper. Various tanks held etch baths of hydrochloric acid, sulfuric acid and Oakite 12 with possible traces of trichloroethane (TCA) or Turco (EG&G, 1994).

- Line 3 contained seven tanks. These tanks contained Alodine water bath, chromate conversion baths, anodizing baths, electropolish chemicals, Oakite Superust stripper, a caustic solution and dye baths (EG&G, 1994).
- Line 4 was also an acid line and consisted of eight tanks built into a bench-top. A floor drain ran the length of the line. Tank contents included a heated sealing bath, a dye bath, a plating bath containing 50 percent nitric acid, a silver stripping tank containing nitric acid, Oakite 160 used to etch parts and Turco 4215 used to clean parts. Silver coated parts originated from the production coating process and may also have contained some uranium. Parts were rinsed between baths and rinse water drained via the sink drain or floor drain to permitted storage tanks (T-1 or T-2) (EG&G, 1994).
- Line 5 was a bench-top line where various chemicals such as anodizing dyes were made-up. The line included a vapor degreaser and fume hood. The fume hood performed nickel stripping or plating of various metals. The vapor degreaser contained 1,1,1-TCA and was used to clean parts coming into the lab. Plating solutions and acid wastes were also generated by this process (EG&G, 1994).

Metallurgy Laboratory (inactive). A small metallurgy laboratory was originally located in Building 444, possibly in Room 115 or 117 (Hill, 1994). No additional information is known about this lab.

4.4.7 SUPPORT OPERATIONS

Support operations conducted in Building 444 include foundry and assembly support operations, tool manufacturing, several laboratories, a uranium storage area, and utilities and maintenance operations.

4.4.7.1 Foundry and Assembly (Coatings) Support

Operations conducted in support of foundry and assembly coating operations included graphite mold preparation, mold cleaning and titanium stripping operations. These operations were recently suspended (EG&G, 1994).

Graphite Mold Preparation (Carbon Shop). Graphite mold preparation operations consisted of: (1) saw-cutting bulk graphite into appropriate sizes for machining; and (2) machining graphite into molds used in foundries and pyrochemical operations throughout RFP (EG&G, 1991). These operations were carried out in Room 116 of Building 444 and involved storage of graphite in Building 445 (Hill, 1994). The graphite molds prepared in Building 444 served the casting needs of the entire RFP (Lombardi, 1994).

Mold Cleaning. Room 211 was used for the purpose of cleaning the graphite molds used in the Building 444 foundry. Uranium and/or other metals and yttrium coating residue were manually cleaned from the molds with wire brushes and other hand tools (EG&G, 1994; EG&G, 1991). The robot crucible cleaner was also located in Room 211. The crucibles were cleaned on a turntable where the robot arm of the crucible cleaner cleaned the inside with a wire brush. Residual material in the mold after ingot removal included yttrium oxide, depleted uranium oxide, graphite and trace quantities of iron, silica and other cast metals (EG&G, 1991).

Titanium Stripping. Titanium stripping activities were located in Room 203 and involved cleaning stainless steel and ceramic fixtures used during titanium coating. During titanium coating, stainless steel and ceramic rings and fixtures used to hold War Reserve parts would incidentally become coated with titanium. The titanium coating was stripped off of these rings by immersion in an acid solution of ammonium bifluoride, fluosilicic acid, nitric acid and deionized water (EG&G, 1994).

4.4.7.2 Tool Manufacturing (active)

Building 444 houses a variety of processes used to manufacture tools for use throughout the plant. These processes include heat treatment, electric discharge machining, tool grinding, and tool and gauge machining.

Heat Treatment. This primary purpose of the heat treatment process is to harden tool steel. In addition some production parts from Buildings 460 and 444 and tools from the tool and gauge shop are annealed, drawn, seasoned, provided with stress relief, brazed and subjected to grit blasting. Materials treated are limited to tool steel, high alloy and other carbon steels--no radioactive materials are allowed in this area. Four heat treating furnaces are used to heat the parts and tools to high temperatures and the parts are then placed in oil quenching baths to cool the parts. Parts are then seasoned by freezing the parts in a freezer and then heating the part in

one of the furnaces (EG&G, 1993; EG&G, 1991). After the process is completed, the tool and parts are cleaned using isopropyl alcohol (EG&G, 1991).

Electric Discharge Machining. The electric discharge machining process in Room 180 makes tools, fixtures and dies for plant operations. Process equipment includes three electric discharge machines. Dielectric fluid in at least two of the machines is BP Dielectric 200 fluid, which is a kerosene-based oil (EG&G, 1991; EG&G, 1994).

Tool Grinding. The tool grinding process is located in Rooms 113, 117 and 118 and involves machining raw materials into tools used in Buildings 444, 460 and 707. Process equipment includes grinders, mills and a lathe. Carbide steel, high speed steel and, occasionally, tungsten electrodes are machined into tools. Chemicals used include oil and water-based coolants, isopropyl alcohol, electronic discharge machine oil and olive oil (EG&G, 1994).

Tool and Gauge Machining. The tool and gauge machining process is located in Rooms 101E, 148, 148A, 151 and 180. Process metals are machined into tools and gauges using a variety of equipment including grinders, mills, lathes and borers. Stainless steel, copper, lead and aluminum are machined into tools and gauges to be used in various production processes. Machined tools are cleaned with isopropyl alcohol and sent to heat treatment for processing or to tool and gauge inspection. Water-based coolant is used on the equipment to cool the parts being produced and to aid in cutting. Other inputs in the process include lubricants, WD-40, etching acids, drilling and tapping fluid, isopropyl alcohol, glues, vacuum grease, epoxies and acrylics (EG&G, 1994). This tool and gauge shop supplied tools and gauges for the entire RFP (Grooms, 1994).

4.4.7.3 Laboratories

Several laboratory or laboratory-type activities are currently active in Building 444. These include the calibration laboratory, the environmental technology laboratory and the beryllium counting process.

The calibration laboratory is located in Room 181 and provides dimensional inspection and calibration of tools, fixtures and gauges used throughout the plant. Chemicals used include basic cleaning supplies (EG&G, 1994).

The environmental technology laboratory is located in Rooms 212A and 212 North and dilutes and extracts chemicals in support of the toxicity characteristic leaching procedure (TCLP) analyses conducted in Building 881. Chemicals used include nitric, acetic and hydrochloric acids (EG&G, 1994).

The beryllium counter process is located in Room 14 and is part of beryllium contamination control. Equipment used in this process includes crucibles, the beryllium counter and a ventilation hood. Samples of beryllium from Rooms 106, 107 and other areas in Building 444 and throughout the plant site are collected in the form of "smears" on surfaces using Watman or paper filters. The samples are taken to Room 14 for determination of the beryllium content (EG&G, 1991; EG&G, 1994).

4.4.7.4 Uranium Storage Area (active)

Rooms 202 and 204 store depleted uranium ingots, feed material and packaged scrap uranium material from Buildings 444 and 883 (EG&G, 1991; EG&G, 1994).

4.4.7.5 Salt Casting

The salt casting process was located in Room 203 until its recent suspension (EG&G, 1994). The purpose of the process was to form salt cakes for use in the plutonium recovery process. Sodium chloride, potassium chloride, calcium chloride or a mixture of salts were cast into salt cakes for use in the plutonium recovery processes including direct oxide reduction and electrorefining (EG&G, 1994). The salt was placed in crucibles, heated in a furnace and then poured into a mold. The salt cakes were then removed from the mold, placed in cans and stored until needed for use in Buildings 771 and 776/777 (EG&G, 1994; EG&G, 1991).

4.4.7.6 Utilities and Maintenance

Utilities (active). Building 444 contains utilities including heating, ventilation and air conditioning (HVAC), air compressors and a steam heating system. A process cooling water system is used to provide cooling for various pieces of equipment including lathes, milling machines and drills. Chemicals involved in the cooling system include a rust inhibitor, Nalco 2536, which consists of borate, silicate, nitrate and nitrate, and HTH or calcium hypochlorite. Chlorine bleach and/or Nalco 2826 may also be used (EG&G, 1994).

The process waste collection and filtration system is located in the basement and collects and filters liquid waste from various processes in the building including the utilities' ground water sumps tanks, the Kinny vacuum pumps, machines in Rooms 101, 125 and 148A, process area sinks and the building janitor's closets. Wastes potentially include uranium-238, oil, Trim Sol, Oakite and Mariko detergent (EG&G, 1994). As of 1986, four free-standing tanks were present in Room 9A in the basement of the building. Two 400-gallon tanks were used to collect acid wastes and two 450-gallon tanks were used to collect cyanide waste. The acid waste tanks received both acid rinse water and caustic (Oakite) rinse water. Two 3,500-gallon tanks were located in Room 1 of the basement and were used to collect process waste from other operations in the building. None of the waste from metal operations or the coating lab were routed to these tanks (Weston, 1986).

Maintenance (active). Maintenance activities include lubrication and pipe, paint, sheet metal, carpentry, machine, and electrical shops. Chemicals involved in lubrication activities include lubricants and used oil. Materials used in the pipe shop include PVC cleaner and cement, denatured alcohol, acetone, molybdenum disulfide (Moly dee), Loctite 27, water soluble dyes, oil absorbents, oil, refrigerants (freons), antifreeze and welding gases (argon, oxygen, acetylene). Materials used in the paint shop include various paints (oil base, epoxy, latex spray), solvents, thinner and strippers. Materials used in the sheet metal shop include nickel-cadmium and alkaline batteries, metal stock, fiberglass stock, lead sheeting, tape, solder/flux, argon gas, adhesives including carboline and 3M, welding rods, neoprene rubber stock, silicon rubber calk, isopropanol and cutting oil. Materials used in the carpentry shop include chloroform, adhesives and caulking materials, glaze and surface cleaners. Materials used in the machine shop include various metals and plastics; lubricants including grease, WD-40, transmission fluid, light oil, hydraulic oil; Dykem remover; solvents including Norpar, alcohol, acetone, and Mariko; and tapping compound. Materials used in the electrical shop include Wakefield Thermal compound, lead-acid batteries, sealed lead-acid batteries, gel-cell batteries, nickel-cadmium batteries, lithium batteries, alkaline batteries, high-voltage oil, contact cleaner, tuner bath, circuit cooler, solder, various light bulbs and lamps, cable lubricant, copper wire and alcohol (EG&G, 1994).

4.5 CURRENT CONTAMINATION STATUS

The current contamination status of Building 444 has not been thoroughly assessed at this time. Because the building is known to have handled beryllium, depleted uranium and various solvents, some contamination is likely to be present.

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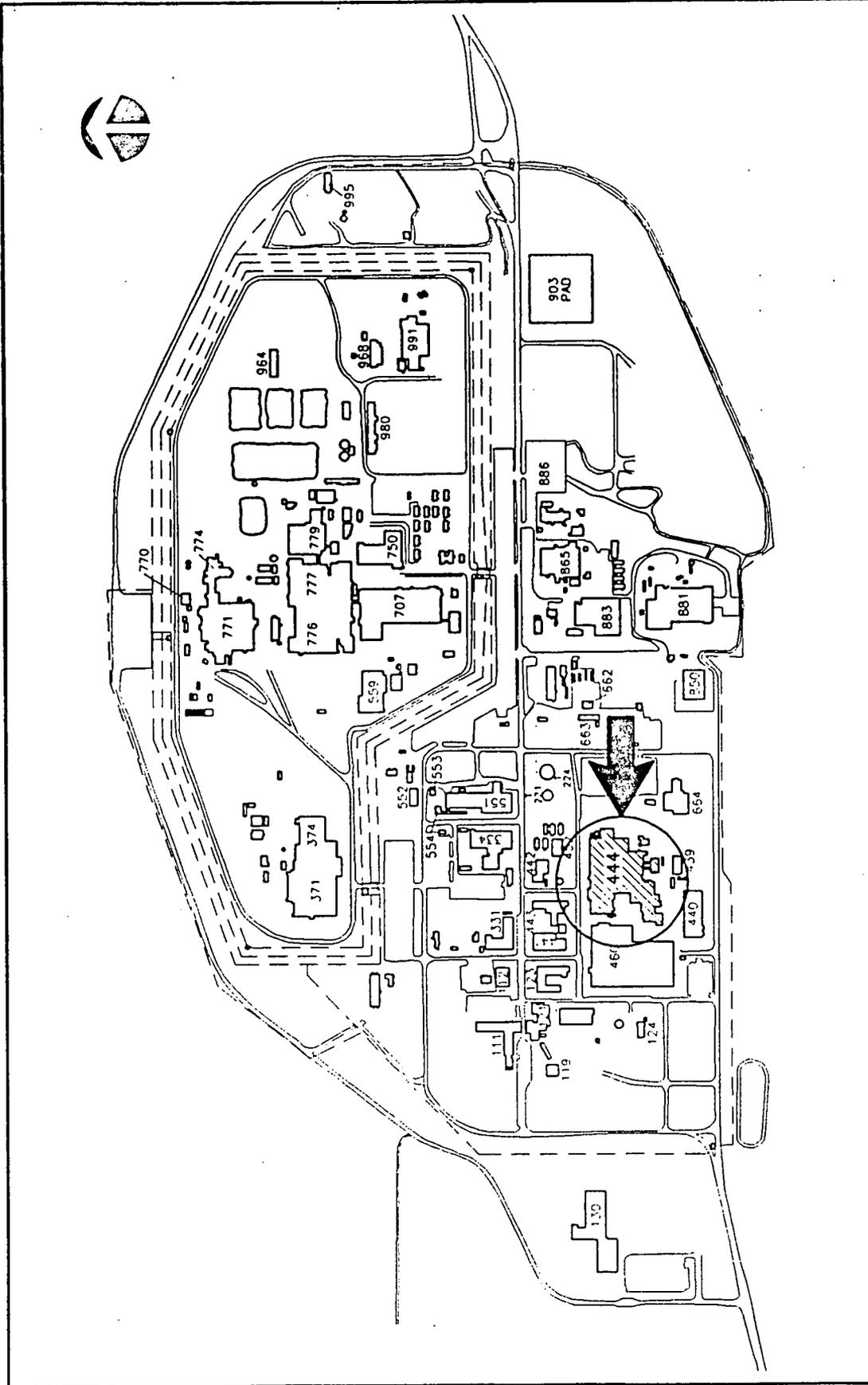


FIGURE 4-1
BUILDING 444

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 GOLDEN, COLORADO

BY
WRIGHT WATER ENGINEERS, INC.
 2490 W. 25TH AVE., SUITE 100A
 DENVER, CO 80211 (303)480-1700

PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

5.0 OPERATIONAL HISTORY OF BUILDING 447

5.1 INTRODUCTION

Operations in Building 447 began in 1956 for the purpose of supporting Building 444 manufacturing operations. Building 447 housed both assembly-related processes and waste-related processes. War reserve and special order parts were assembled, inspected, packaged and shipped from this building. Metals parts manufactured or processed in Building 447 consisted of depleted uranium, uranium alloys, beryllium, niobium, vanadium, stainless steel, aluminum, copper and brass (enriched uranium and plutonium were not handled in this building). Parts and assemblies were received from Buildings 444, 460, 865, and 883 for processing. Depleted uranium and beryllium chips and turnings from machine operations in those buildings were sent to Building 447 for waste processing. The depleted uranium metal turnings were cleaned, oxidized in the chip roaster, packaged and shipped off-site for disposal or recovery. Beryllium chips and turnings or metal contaminated with beryllium were cemented, packaged and shipped off-site for disposal (DOE, 1992; EG&G, 1990). Following the 1989 production curtailment, the majority of Building 447's manufacturing and waste operations were curtailed, and a final decision on the future of the building is still pending. Only the chip roaster and building support operations currently remain active in this building (EG&G, 1993).

5.2 HISTORICAL TIMELINE

- 1955 Construction of Building 447 began as part of Part IV plant expansion for the purpose of adding manufacturing space to Building 444. Building 447's primary purpose was to anneal depleted uranium parts in heat treatment furnaces (Buffer, 1993; EG&G, 1993).
- 1956 Construction was completed for Building 447 (Buffer, 1993). The original chip roaster began operations (Rockwell, 1988).
- 1962 Building 448 was added on to Building 447 to house Production Control for the 444 Complex (EG&G, 1993)

- 1960s (late) Full scale use of the vacuum arc furnace began in the late 1960s. This furnace allowed efficient alloying of depleted uranium with materials such as zirconium and niobium (EG&G, 1993).
- 1983 A new filter system was constructed for Building 447 (ChemRisk, 1992).
- 1986-87 A new chip roaster was planned and constructed but never became operational due to flooding and other problems (Rockwell, 1988).
- 1993-94 Assembly activities including cleaning, leak testing, heat treatment and welding ceased; waste-related activities including composite chip cementation and drum cleaning also ceased (EG&G, 1994).

5.3 PHYSICAL BUILDING DESCRIPTION

Building 447 is located in the south-western area of Rocky Flats Plant (RFP) and is physically connected to the southwest corner of Building 444 (Figure 5-1). Building 447 consists of a one-story steel structure with a mezzanine and partial basement on the west side. Although some of the operations of this building take place under a vacuum system, the building does not contain gloveboxes and air locks because it does not handle enriched uranium and plutonium. Most of the building's exhaust air is discharged into a filter plenum with the exception of the port on the electron beam welder chamber. During cleanup operations following beryllium welding, this chamber vents to the beryllium exhaust plenum in Building 444. In addition to typical utilities, the building is equipped with a process wastewater drain and helium gas (EG&G, 1990).

Buildings associated with Building 447 include Building 451, which houses the exhaust filter plenum and exhaust fans servicing Buildings 447 and 448. Building 448 is used for storage, receiving and shipping of parts and materials associated with Building 447 operations (EG&G, 1990).

5.4 DESCRIPTION OF OPERATIONS

Although the original purpose of Building 447 was to provide additional manufacturing space for Building 444, one of its major functions became waste treatment as a result of disposal and

transportation problems associated with highly pyrophoric uranium chips (Langell, 1961; Putzier, 1970). Operations for Building 447 are described in three categories below: (1) assembly operations; (2) inspection; (3) waste handling operations; and (4) building support operations including maintenance and utilities. Of these, only the chip roaster and maintenance operations remain active as of June, 1994. The remainder of the activities described in this section have either recently ceased operations or are effectively inactive because overall plant operations are conducted at a very reduced level.

5.4.1 ASSEMBLY

War Reserve and special order parts produced in Buildings 444 and 447 were cleaned and assembled if needed in Building 447 prior to shipping. Prior to production curtailment, the major assembly-related operations in Building 447 included: (1) electron beam welding; (2) electrochemical milling; (3) heat treatment; (4) vacuum arc melt furnace operations; and (5) parts and assembly cleaning (EG&G, 1994; EG&G, 1990). These activities have decreased significantly or been completely suspended due to the reduction in manufacturing (E&G, 1993).

Electron Beam Welding. Electron beam welding involved welding vanadium, beryllium, aluminum, depleted uranium, stainless steel and War Reserve production and special order assemblies in Room 406 (EG&G, 1993; Mahaffey, 1993). These operations were conducted inside a vacuum chamber which connected to the Building 451 exhaust filter plenum. After beryllium welding, the chamber was vented to the beryllium exhaust plenum in Building 444 (ChemRisk, 1992). Chemicals used in various aspects of this operation include Noxon metal polish for finishing part surfaces and Oakite and ethyl alcohol for cleaning the welding chamber and surfaces (EG&G, 1990).

Electrochemical Milling Operations. The electrochemical milling machine was used for a variety of production and special order jobs, mainly on parts fabricated from stainless steel. However, some work involved milling tungsten, brass, copper, aluminum, beryllium and depleted uranium (EG&G, 1990). These operations were performed in an enclosed chamber in Room 407 using aqueous electro-chemical processing (ChemRisk, 1992; Mahaffey, 1993). Chemicals involved include a solution of sodium nitrate or occasionally solutions of sodium chloride or sodium carbonate. By-products of the machining process were hydrogen gas and metal hydroxides (EG&G, 1990).

Heat Treatment Operations. Three heat treating vacuum furnaces provided treatment for uranium, beryllium and vanadium parts which required vacuum heat treatment to relieve internal stresses and "work hardening" induced by machining processes. The only chemical used in the process was ethyl alcohol to clean the vacuum door seals (EG&G, 1990). These operations were located in Room 403 (Mahaffey, 1993). A still was also present for a period of time in the southeast corner of the room, but the exact purpose of the still is unknown (Hill, 1994). Heat treatment operations were recently suspended (EG&G, 1994).

Vacuum Arc Melt Furnaces. Two vacuum arc melt furnaces existed in Building 447 (Sunniwick, 1994). The original furnace was moved to Room 420 in the late 1960s after Metallurgical and Development Operations ceased in Building 331 (Hill, 1994). This furnace was used to melt material for casting consumable electrodes in 6-inch and 8-inch diameter copper molds. The metals melted include depleted uranium and depleted uranium-niobium alloy (EG&G, 1990). Metal melting operations were performed inside a vacuum chamber which vented to the Building 447 exhaust system, which in turn vented to the Building 451 exhaust plenum (ChemRisk, 1992). This system operated until operations ceased in 1989. In 1985, a new vacuum arc melt furnace with increased capacity was installed. Although test runs using steel as a test material were conducted, the furnace never came on line due to changes in the production schedule (Sunniwick, 1994).

Parts and Assembly Cleaning Operations. Parts and assembly cleaning operations were conducted on War Reserve and special order parts produced in manufacturing Buildings 444, 447 and 460 prior to assembly, after assembly, or prior to shipping (EG&G, 1990). Cleaning operations occurred several times during the assembly process (Shields, 1994).

Originally, cleaning operations took place in Rooms 406 and 409 and involved aqueous detergent cleaning of beryllium metal and binary alloy and tube washing (Dow, 1974). A new aqueous cleaning system was installed in Room 406A in the mid-1980s. This system conducted the final cleaning process on all War Reserve production parts fabricated in Building 444. This cleaning system involved ultrasonic cleaning in Oakite NST detergent followed by cascading rinses of deionized water (Rockwell, 1985). In recent years, the parts may also have been cleaned with an ultrasonic Freon 113 vapor degreasing bath (EG&G, 1990). These operations have decreased significantly due to manufacturing reductions. Freon 113 is no longer used in this building (EG&G, 1993).

During assembly, beryllium parts were tabbed with an epoxy adhesive. Acetone was used for spot cleaning beryllium parts during the adhesive tabbing operation in Room 406 (Dow, 1974).

5.4.2 INSPECTION

Inspection operations occurred as an integral part of assembly operations. Inspection operations included non-destructive testing and material analysis. In addition, some parts inspection operations were located in Room 407 of Building 447 at one time (Hill, 1994).

Non-Destructive Testing Operations. These operations consisted of tensile testing, ultrasonic testing and acoustic emissions testing and were conducted in Room 420 (EG&G, 1990; Mahaffey, 1993). Parts tested were fabricated from stainless steel, beryllium and depleted uranium and produced in Buildings 444 and 460. Tensile testing was used to determine component material stress and strain data. Ultrasonic testing was used to check the quality of brazed joints. An ultrasonic pulse was used to detect voids and other defects in the brazed portion of the part of assembly. Acoustic emissions testing involved subjecting parts or assemblies to an acoustic force to determine the integrity of brazed joints. Petroleum jelly was used in acoustic testing and removed using Freon 113 solvent (EG&G, 1990). These operations have decreased significantly due to manufacturing reductions. Freon 113 is no longer used in this building (EG&G, 1993).

Material Analysis. Material analysis pressure tests consisted of performing leak tests on War Reserve stainless steel, beryllium and depleted uranium assemblies received from Buildings 444 and 447. These items were cleaned using ethyl alcohol. After cleaning, the part or assembly was placed in a vacuum chamber and tested with helium at the required pressure (EG&G, 1990). This process was recently suspended (EG&G, 1994).

5.4.3 SPECIAL PROJECTS

Miscellaneous beryllium operations were conducted in Room 404 of Building 447 at one time (Mahaffey, 1993; Hill, 1994). These operations included a grit blast machine as well as a lapping machine. These operations were eventually moved to the Protected Area (PA) (Hill, 1994).

5.4.4 WASTE HANDLING

Waste treatment and handling operations in Building 447 include oxidation of depleted uranium chips from Buildings 444, 883 and 865 in the "chip roaster," composite waste chip cementation, drum cleaning, and low-level waste packaging and handling (EG&G, 1994; EG&G, 1990). Of these three operations, only the chip roaster remains active as of June 1994.

5.4.4.1 "Chip Roaster"

The chip roaster, sometimes referred to as the chip incinerator or the ore roaster, was used to oxidize depleted uranium chips so that these wastes could be safely transported for off-site disposal. The chip roaster began operation in 1956 and operated consistently with the exception of 1959 through 1961 (Rockwell, 1988). During those years, the chip roaster was relocated from Room 409 to Room 502 on the mezzanine in Building 447. A new air filtration system was also added at this time; however, the air filtration system did not function properly. This resulted in an eight month halt in using the roaster until the problem could be corrected (Bassler, 1960; Rockwell, 1988). During this time period, floor sweepings of material were stored in drums outside of Building 447 until chip roasting operations resumed (Bassler, 1960). In April 1961, it was recommended that twenty-seven 55-gallon drums and sixteen 30-gallon drums of discarded depleted uranium stored in the west yard of Building 447 be disposed of by on-site burial. The material in the drums consisted of 5,472 kilograms of tuballoy in the form of saw chips and floor sweepings, plus foreign matter and coolant (Bassler, 1961). These drums of depleted uranium chips may have been disposed of in trenches on plant-site although the exact fate of the drums is unknown (Hillsley, 1983; Putzier, 1970).

During the 1980s, it was determined that the chip roasting was considered to be incidental thermal treatment of Resource Conservation Recovery Act (RCRA) waste because the chips being roasted had low levels of RCRA-regulated solvents in the cooling oils coating them; therefore, the chip roaster required a RCRA permit (Rockwell, 1988). In 1986-87, a new chip roaster was planned which would comply with RCRA regulations for hazardous waste incinerators. Although construction of the chip roaster began, it never became operational due to flooding of the Building 447 basement in 1987 in addition to other problems. During this period, a steam cleaning process was developed which removed the RCRA-regulated waste solvents Freon TF and 1,1,1-trichloroethane from the chips prior to oxidation. At that time, it was decided to close the

original unit with regard to treatment of hazardous waste and reopen this unit as a non-RCRA-regulated unit (Rockwell, 1988).

Currently, the chip roaster operation involves Rooms 31, 32 and 502 and processes depleted uranium chips from machining processes in Buildings 444, 865 and 883 (EG&G, 1994). As of June 1994, the chip roaster operations were limited and focused on cleanup of machining areas and some backlog of depleted uranium chips. Since the elimination of chlorinated solvent usage, the chips are now coated in coolants such as Das Cool-521 or Trim Sol (EG&G, 1994; EG&G, 1990). The chips are steam cleaned and allowed to drain while still in the drum. The drainage is released to the process drain and subsequently placed in 55 gallon drums. The chips are then placed in the chip roaster where they are converted to oxide. Chip roaster exhaust is vented to the building plenum after passing through a heat exchanger. When oxidation is complete, the uranium oxide is collected in a 30-gallon drum, properly packaged and sent to low-level waste storage (EG&G, 1990).

5.4.4.2 Composite Waste Chip Cementation

This process prepared metal chips or turnings from various machine operations in Building 444 and other manufacturing buildings for low-level hazardous waste disposal. These chips and turnings consisted of depleted uranium, stainless steel and aluminum coated with small amounts of TrimSol machine coolant, machine cutting oil and Freon 113. Cementation operations took place in Room 502 and involved mixing turnings with Portland cement, sand and water (EG&G, 1990; Mahaffey, 1993). A layer of pure cement was placed in an unlined 55-gallon drum followed by a layer of cemented turnings (EG&G, 1990). These drums were then stored in Room 501 (EG&G, 1994). This operation was suspended in 1993 (EG&G, 1993).

5.4.4.3 Drum Cleaning Operations and Handling and Packaging Low-level Waste

The area immediately near the shipping dock for Building 447 was used for drum storage, cleaning and transfer operations. This area included both Room 31 and the shipping dock (Hill, 1994). Any potential external contamination on shipping drums was removed by steam cleaning before the drums were allowed to leave the building. The solution used in the steam cleaning was a mixture of water and Mariko, a non-hazardous commercial cleaning detergent. Handling and packaging operations involved placing previously sealed low-level radioactive waste drums into shipping containers (EG&G, 1990). This process was suspended in 1994 (EG&G, 1994).

5.4.5

SUPPORT OPERATIONS

Process support systems include a heating, venting and air conditioning (HVAC) system, process waste collection and filtration system and a process cooling water system (EG&G, 1994; EG&G, 1990). Because the HVAC system is a typical industrial HVAC system, it is not discussed below.

Process Waste Collection and Filtration. Liquid waste from the groundwater sump, the janitors' closet sinks, the building process sink, the uranium chip rinse drain, the deionized water drain, the elevator pit line and various processes in Building 447 is collected and filtered in the basement of Building 447. Waste is discharged to the sanitary sewer, to the Building 774 waste collection system, or to Building 444, depending on the waste's origin and contents (EG&G, 1990; Hornbacher, 1994). The liquid waste is mostly water but it may also contain small amount of uranium-238 or some Mariko and oil from the drum cleaning process in Room 501. During active production, liquid waste collected by the process waste system included trace contaminants of beryllium, depleted uranium, Trim Sol machine coolant, Mariko detergent and Oakite cleaner (EG&G, 1990). Although Freon 113 is not currently used in this process, it was actively used in the past and may be present in older wastes (EG&G, 1990).

Process Cooling Water System. During active production, the process cooling water system provided cooling water to various pieces of equipment including lathes, milling machines, and drills. Chemicals involved include chlorine bleach, calcium hypochlorite, Nalco 2826 (to kill bacteria and algae) and Nalco 2536, which is a rust inhibitor consisting of borate, silicate, nitrate and nitrate (EG&G, 1994; EG&G, 1990). Nalco 2826 is still used in the HVAC system.

Maintenance. Building 447 maintenance operations involve routine building and equipment maintenance and repair. Some of these activities include cleaning, welding, painting and grinding (EG&G, 1993).

5.5 CURRENT CONTAMINATION STATUS

The current contamination status of Building 447 has not been thoroughly assessed at this time because production has only recently diminished in this building. Areas of the building known to have processed beryllium which may potentially contain beryllium contamination include Rooms 403, 404, 406, 406B, 407, 420, 501 and 502 (Mahaffey, 1993).

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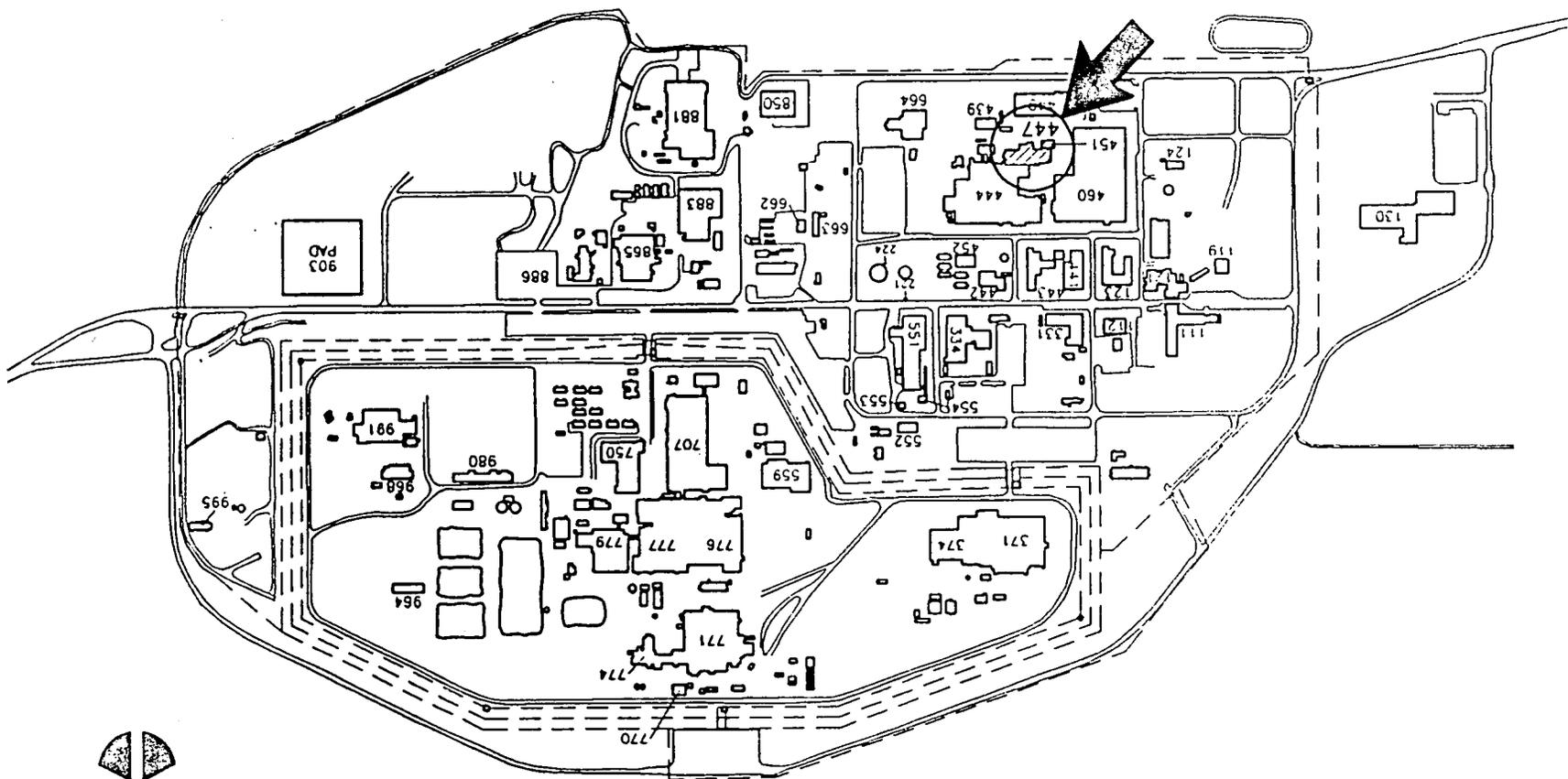
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**FIGURE 5-1
BUILDING 447**

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO
BY
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700

DATE	NOV. 28, 1994	SCALE	1" = 900'
DRAWN BY	KAL	APPROVED	-
DESIGN BY	JKC	CHECKED	JKC
PROJ. NO.	931-082.000	DWG. NO.	-



6.0 OPERATIONAL HISTORY OF BUILDING 460

6.1 INTRODUCTION

Building 460 was placed into service in 1984 for the production of non-nuclear weapons components. Building 460 assumed the stainless steel operations which were conducted in Building 881 from 1966 to 1984 and some non-nuclear metal working operations from Building 444 (ChemRisk, 1991). The major activities performed in this building include fabrication, assembly, and testing of stainless steel components such as reservoirs, tubes and non-fissile pit components. These components are associated with the tritium "reservoir-to-pit" delivery system which boosted the yield of the explosion produced by the weapon (ChemRisk, 1991). In addition to stainless steel, parts may also be manufactured from aluminum, vanadium, copper, gold, silver, magnesium, titanium, Teflon and other plastics (EG&G, 1991).

6.2 HISTORICAL TIMELINE

- 1984 Building 460 was constructed for the production of non-nuclear War Reserve and special order parts and assemblies. The building was designed to consolidate all non-nuclear manufacturing at Rocky Flats Plant (RFP) into one facility (Buffer, 1993). The stainless steel operations in the building were transferred from Building 881 (ChemRisk, 1992)
- 1985 The first tool-made samples were produced in May and the building was described as the most modern non-nuclear manufacturing building in the DOE weapons complex. On September 30, the building became fully operational (Buffer, 1993). The Automated Machining Cell (AMC) was completed to increase efficiency and safety of parts production (Buffer, 1993).
- early 1990s The use of chlorinated solvents in Building 460 was eliminated as part of a plant-wide effort to reduce chlorinated solvent usage (ChemRisk, 1992).
- 1994 Building 460 is currently used as a stainless steel manufacturing facility (EG&G, 1993b).

6.3 PHYSICAL BUILDING DESCRIPTION

Building 460 is a modern non-nuclear manufacturing facility located in the southwest portion of the plant site (Figure 6-1). The building contains a total area of 230,000 square feet split between the first floor and a mezzanine. The first floor is used primarily for manufacturing and contains 150,000 square feet. A second floor mezzanine houses offices and a cafeteria and contains approximately 80,000 square feet. The building is constructed of single-gabled, multi-span rigid-framed steel with concrete floors. Utilities include steam, raw and potable water, electricity, and instrument and process plant air. Building 462 is a cooling tower which provides cooling process water for both supply and return. Building 460 does not have a negative air pressure system since it is a non-nuclear building. Liquid wastes are collected in sump tanks, filtered and sampled prior to transfer to Building 374 for waste processing (EG&G, 1993a).

6.4 DESCRIPTION OF OPERATIONS

Building 460 is one of the few buildings on-site whose historical operations coincide with its current operations. Since operations began in April 1985, stainless steel has been the primary material handled. The building is not known to have processed special nuclear material, depleted uranium or beryllium. No major modifications have been made to the building structure since it was commissioned and all systems are currently operational (EG&G, 1993a). The only major difference in historical and current operations is the elimination of chlorinated solvent usage in Building 460 in the early 1990s (ChemRisk, 1992). Building 460's mission is expected to continue at a reduced level until operations are transferred to Allied Signal in Kansas City, Missouri, by the end of fiscal year 1995 (EG&G, 1993b). Building 460 is currently in operation as a stainless steel manufacturing facility and houses various fabrication, assembly, inspection, special projects and support operations.

6.4.1 FABRICATION

Fabrication of stainless steel and other non-nuclear metal parts includes mechanical machining, electrochemical machining and grinding, electric discharge machining and crush grinding.

Mechanical Machining. Mechanical machining of stainless steel parts takes place in Room 134 and consists of production machining and hardware machining. Production machining includes

the production of War Reserve parts from stainless steel, vanadium, copper, tantalum and aluminum. Operations involve turning, facing, boring, drilling, milling, sawing and other metal altering activities (EG&G, 1991). Hardware machining involves finishing stock metal parts with lathes, milling machines, a drill press, horizontal and vertical saws, centerless and bench grinders, and belt sanders. Stock metal parts consist of stainless steel, copper, aluminum and vanadium and are purchased from off-site vendors and sent to this shop for machining. Machined parts are then sent to cleaning operations (EG&G, 1994).

TrimSol or Das Cool-521, which are water-based machine coolants, and Transultex A, a petroleum-based machine cutting oil and machine coolant, are used for machining operations. DoAll Steel Ink aerosol and Dykem Steel Blue DX-100 are used for marking parts. Dykem Remover and Thinner are used to remove marking compounds. Moly-Dee Tapping Fluid, a heavy petroleum oil, is used for some machining operations. Parts are cleaned using ethyl alcohol, isopropyl alcohol and De-Solv-It, a commercial cleaner (EG&G, 1991). In early manufacturing operations, freon (compound unspecified) and trichloroethylene (TCE) were used as solvents to clean parts (Ideker, 1994).

Electrochemical Machining and Grinding. Electrochemical machining equipment includes seven electrochemical machines, an electrochemical grinder, and twelve electrolyte solution holding/preparation tanks. Electrochemical machining operations are located in Room 141 and are used for a variety of production and special order jobs. Most of the work is performed on parts fabricated from stainless steel. Some work involves milling tungsten, brass, copper and aluminum. Electrochemical energy is used to rapidly oxidize the metal. The process includes an electrolyte feed system, a clarifier/flocculator and a filter press to remove metal oxide sludge. The electrolyte solution, consisting of sodium nitrate and water, is contained in Tank T-7. A sodium hydroxide solution is held in Tank T-8 and is used to maintain the neutral pH of the electrolyte. Tank T-11 holds Aqua-Flor flocculent that is added to the electrolyte solution to enhance solid formation. The sludge solution from the clarifier/flocculator is held in three tanks prior to passing through the filter press. The filter press removes most of the remaining electrolyte from the sludge. This electrolyte is contained in Tank T-12. Dewatered sludge with trace amounts of chromium from stainless steel is sent off-site for disposal. The electrolyte is reused, the machined parts are washed with water, and the wastewater is discharged to the building process wastewater collection system (EG&G, 1991).

An electrochemical grinder and a grit blaster are used in electrochemical grinding operations located in Room 141A. The grinding wheel serves as a conducting electrode and removes most of the metal by an electrochemical reaction. The electrochemical grinder has a 50-gallon tank that holds the sodium nitrate electrolyte. The grit blaster is used for part surface cleaning and uses aluminum oxide grit as the abrasive (EG&G, 1991; EG&G, 1994). After grinding, the stainless steel parts are rinsed in a sink in Room 141A (EG&G, 1994).

Electric Discharge Machining. Electric discharge machining of stainless steel, aluminum, copper, and tool-steel parts takes place in Room 141. An electric arc is established between the part and the electrode using either BP Dielectric 200, which is a non-conductive oil comprised of isoparaffinic hydrocarbons, or deionized water as the dielectric fluid (EG&G, 1994; EG&G, 1991). The shape of the electrode configures the part using the spark from the electrode to remove metal from the part and reproduce an accurately positioned hole (Weston, 1986). There are five different types of electronic discharge machines which incorporate electrodes of copper, brass, graphite or copper-tungsten (EG&G, 1994; EG&G, 1991). After machining, the part is cleaned with freon (compound not specified) and kimwipes (Weston, 1986).

Crush Grinding. The crush grinder process grinds and shapes stainless steel parts in Room 142. Process equipment includes two crush grinders, a filtering system for each crush grinder and a static collector for each crush grinder. Cooling oil is used during the crush grinding process and the part is cleaned with isopropyl alcohol before transfer to another process (EG&G, 1994). The cooling oil consists of either Sunquench 1021 or Mistlube 24, which are non-volatile paraffinic distillates (EG&G, 1991).

6.4.2 ASSEMBLY

Assembly operations involve a combination of machining, joining, grit blasting and cleaning operations.

Assembly Machining. This process involves finishing stainless steel subassemblies in the high bay area of Room 134 (EG&G, 1994). Only stainless steel is machined in this area. Several lathes, a milling machine and a drill press are used for assembly machining operations (EG&G, 1991). The same coolants and oils used for mechanical machining during fabrication are also used for assembly machining.

Joining. Joining or welding of parts takes place in Rooms 122A and C, 132, 132B, 132C and 135. Welding fixtures are composed of copper-beryllium, aluminum, copper and brass. Each welding unit has its own glycol-based cooling system and filter. Gas tungsten welding uses copper thoriate-tungsten electrodes, Noxon metal polish and a roughing pump. Ninety-nine percent argon is used as an inert atmosphere. Brazing operations use gold, silver and copper as brazing materials. The high voltage transformers used with electron beam welders are cooled and insulated by Exxon Univolt 60 transformer oil. The electron beam welder is cleaned with Noxon metal polish, isopropyl alcohol and Spec wipes (EG&G, 1994).

Grit Blasting. Room 135B contains grit blasting facilities and is used for surface finishing and parts cleaning. Aluminum oxide (190 grit) is used in grit blasting; however, this process is not currently in use (EG&G, 1994).

Cleaning. A variety of cleaning processes are employed which can be categorized as acid, aqueous, final and copper cleaning.

Acid cleaning is used for outer and internal surfaces of the parts. The acid cleaning automated line (A-line) in Room 156 cleans the outer surfaces of stainless steel and vanadium parts and assemblies from various production areas. The A-Line consists of an Oakite wash, several deionized water rinses, a nitric acid rinse, a Turco Nitric Nitradd wash and a drying process using nitrogen gas. The acid cleaning (internal line) process in Room 156C cleans the internal portion of War Reserve parts and assemblies made of stainless steel, aluminum and copper using chemicals similar to the A-line (EG&G, 1991; EG&G, 1994).

The aqueous cleaning process in Room 157 consists of a series of wash and rinse tanks, sprays and exhaust hoods used for cleaning War Reserve parts and assemblies. The parts and assemblies are fabricated from stainless steel, aluminum and copper. They are cleaned with Oakite and deionized water (EG&G, 1991). Prior to 1993, Cee Bee silicone remover, which contains 20% methylene chloride and 10% toluene, and 1,1,1-trichloroethane were used during assembly cleaning processes (EG&G, 1993b; EG&G, 1994).

The final cleaning process is located in Room 156B and provides the final internal and external cleaning of part assemblies. Five rinse solutions are used which consist of Oakite, deionized water or isopropyl alcohol rinse (EG&G, 1994).

Copper cleaning in Room 158A consists of an acid wash with Globrite and several stages of rinse. Waste Globrite from copper cleaning, as well as acid-contaminated waste water from sprays and rinses, are discharged to Sump Pit 4 in Room 156C. The copper cleaning process is operated less than six times a year because the copper part the line was primarily designed to clean has been canceled (EG&G, 1994).

6.4.3 INSPECTION

Quality control testing of machined parts is required before the parts can be used for other processes. Parts are passed through production cell tests, assembly testing, non-destructive testing and product inspection.

Production Cell Tests. Eight test cells located in Rooms 115A through 115H are used to conduct quality control testing of parts. A production test cell consists of a chamber, two liquid nitrogen cold traps, two diffusion pumps, two roughing pumps and two holding pumps. Helium and argon are used to pressurize the part during leak- and pressure-testing. Flaws in the part are detected if helium or argon leaks through the part into the test cell. Isopropyl alcohol is used for cleaning. DDO-19 diffusion pump oil is used in the pumps and Apiezon vacuum grease is used to lubricate O-ring seals (EG&G, 1991; EG&G, 1994).

Assembly Testing. Leak and pressure tests take place in Rooms 121, 122B and 123 for the purpose of testing assembled parts. In Room 121, parts from various processes are tested either with leak detectors or a "D" tester. The three leak detectors each have two vacuum pumps and one diffusion pump. Liquid nitrogen is used in the cold trap of each leak detector, and helium is used to check for leaks. Maintenance uses acetone for cleaning the cold traps. The "D" tester is used to check firing characteristics of actuator-driven valves containing class "C" explosives. Molykote is used for torquing operations. Product testing is located in Room 122B and uses an environmental chamber to test parts at extreme temperature conditions under pressure. Liquid nitrogen is used for refrigeration and the chamber is pressurized with compressed helium. Room 123 is reserved for miscellaneous flow and backfill tests. A drying oven was being used to remove air from epoxy, but it is no longer in operation (EG&G, 1994). DDO-19 diffusion pump oil is used in these operations (EG&G, 1991).

Non-destructive Testing. These activities take place in Rooms 151A through 151S and include ultrasonic testing, holographic pressure testing, radiographic testing and dye penetrant testing (EG&G, 1994).

Ultrasonic testing is used to detect voids and other defects in the welded joints of parts and subassemblies. This procedure uses water and an ultrasonic pulse (EG&G, 1994).

Holographic pressure testing is used to test parts and subassemblies for distortion under pressure in a test cell. Compressed argon is applied to the tested item. A holographic plate records the expansion or contraction of the tested item using an Argon Class IV laser. The exposed plate is processed using Kodak fixer and developer. Polaroid photography is used to provide an additional record of the processed holographic plates (EG&G, 1994).

Radiographic testing uses X-rays to detect internal flaws in parts and subassemblies such as cracks, lack of fusion and inclusions. Processing equipment includes X-ray generators, generator cooling systems, special lead-lined exposure cells, solution batching and film processing. Lead is used for film identification lettering, X-ray intensifier screens and X-ray backscatter shielding. Isopropyl alcohol is used for cleaning parts after testing (EG&G, 1991). Chemicals associated with radiography include the silver halide emulsion on the film and processing solutions. Prior to chlorinated solvent elimination, the cleaner/remover SKC-NF/ZC-7B, which contains 95 percent 1,1,1-trichloroethane, was used in the radiography process (EG&G, 1993b). Bio-perg is added to the processor's rinse water to kill bacteria. Process solutions generated include spent X-ray starter and developer, emulsifier and penetrant developer and rinse water. These fluids are gravity-drained and pumped into Sump Pit 2 (EG&G, 1994).

Dye penetrant testing detects surface cracks, laps and other defects in War Reserve parts and subassemblies. The part or subassembly is dipped in a dye penetrant oil then immersed in an emulsion bath. The bath removes the dye penetrant oil from the surface of the part. The part is then dipped in a developer solution which draws the oil that penetrated into cracks or voids to the surface. When the part is exposed to ultraviolet light, the surface defects are then revealed (EG&G, 1991).

Product Inspection. Product inspection in Room 163 provides Quality Assurance (QA) support for the building. Parts manufactured in the building or purchased off-site are cleaned with isopropyl alcohol, and prior to chlorinated solvent elimination, 1,1,1-trichloroethane (EG&G,

1992; EG&G, 1994). The parts are then sent to non-dimensional inspection which uses sweep gauges, optical comparators, bore scopes and bench inspection. Bench plates are cleaned with isopropyl alcohol. Some parts are coated with Nye watch oil, inspected and cleaned again with isopropyl alcohol (or 1,1,1-trichloroethane prior to 1992). In special cases, replica castings are made of the part and dimensional measurements are made. RTV 21 silicone compound is used as a casting media using Nuocure 28 as a catalyst (EG&G, 1991).

6.4.4 SPECIAL PROJECTS

Special projects conducted in Building 460 include research and development (R&D) on prototype fixtures and parts and materials development activities.

R&D. R&D takes place in Rooms 118A and 118B. The R&D shop in Room 118A performs prototype checkout of fixtures and parts. Equipment includes an ultrasonic cleaner and a Dremel motor tool. Metal parts consisting of aluminum, stainless steel, copper and brass are leak-tested using compressed air or helium and argon gases. Denatured alcohol or an Oakite-based ultrasonic cleaner is used to clean parts before, during or after testing. The R&D Shop in Room 118B is responsible for soft tooling parts, primarily those composed of aluminum. Process equipment includes a Well Index Milling Machine, a surface grinder and a Hardinge lathe. The Hardinge lathe uses Waylube, Regal and Slide Way oil as lubricating agents, and the milling machine uses hydraulic oil and transmission fluid. Dykem bluer is brushed on metal parts to leave a film for making a scribe to cut metal. Das Cool-521 coolant is used on both machines (EG&G, 1994).

Materials Development Laboratory. This laboratory conducts quality assurance testing of various rinses used in parts cleaning. Metal parts received from Building 460 production areas are analytically cleaned with carbon tetrachloride, isopropyl alcohol and water. Samples of the rinse solutions are sent to Building 881 for testing (EG&G, 1991).

6.4.5 SUPPORT OPERATIONS

Various support operations housed in Building 460 include machining and gauging, production control, product definition, deionized water production, test cell compression, laboratories, maintenance and utilities.

Machining and Gauging. These operations produce soft tooling parts, usually made from aluminum. Non-production prototype parts are also made from aluminum, copper, stainless steel, brass, Teflon and other plastics. Process equipment consists of a milling machine, a surface grinder and a lathe. Mariko detergent, isopropyl alcohol and De-Solv-It are used to remove oils and other residue from parts. Dykem Blue DX-100 and Dykem Remover and Thinner 138 are used for labelling parts. Cutting oil is used for tapping operations (EG&G, 1991).

Production Control - Electroetching and Laser Marking. The Electroetch process uses an electronic stenciling method to serialize steel War Reserve parts in Room 161 or 134. The electroetching solution consists of calcium nitrate (EG&G, 1994). Other parts may be marked using a laser beam (EG&G, 1991).

Product Definition. Product definition activities are conducted in Rooms 225 and 231 and include developing, reproducing, updating and storing drawings for War Reserve items manufactured at RFP. Processing equipment includes cameras, a plotter and a blueline printing machine. Developer and fixer solutions are used for developing and processing film, microfilm, photographs and viewgraphs. A toner and plotter paper are used in the plotter. Anhydrous ammonia is used as a developing agent for the ozalid printing paper processed in the blueline printing machine (EG&G, 1991; EG&G, 1994).

Deionized Water Production. The deionized water production facility in Building 460 provides purified deionized water for production cleaning operations. Potable water is treated by the following processes: (1) filtration; (2) reverse osmosis (RO); (3) anion exchange; and (4) ultraviolet sterilization. Feed water for the RO unit is chemically treated with sodium metabisulfate and Flocon 100 antiscalant. The RO feed water is pumped through a multimedia filter, a carbon filter and an ultra-prefilter before passing through ion exchange columns, a woven cloth final filter and into a deionized water storage tank. The deionized water is sterilized with ultraviolet light before it is used in assembly cleaning (EG&G, 1991).

Test Cell Compression. The test cell compression area provides high pressure helium gas (3,000 to 60,000 pounds per square inch gage [psig]) for various pressure test applications. Helium is delivered to a first-stage compressor from outside storage tanks and then delivered to either a 30,000 or 60,000 psig compressor. This activity takes place in Room 115J (EG&G, 1994; EG&G, 1991).

Laboratories. In addition to the Materials Development Laboratory, Building 460 houses a Calibration Laboratory and a Metallurgical Laboratory. The Calibration Laboratory is located in Rooms 120D and 120E and is responsible for dimensional, physical, electronic and electro-optical calibrations. Process equipment includes a Brooks Volume Prover, Moore Universal Measuring Machines, optical comparators, linear micrometers, surface plates and various measurement standards. Chemicals involved include ethyl alcohol and other basic cleaning supplies (EG&G, 1994).

The Metallurgical Laboratory is located in Room 135 and provides quality assurance for welding operations in Building 460. Process equipment includes metal cutters, grinders, etchers and polishers, and photography equipment. Chemicals used include kerosene, cooling oils, diamond paste polishing solution and oxalic acid. Polaroid film coating pads and packs, Isocut fluid and TrimSol are also used (EG&G, 1994).

Maintenance. Maintenance operations include tool control and upkeep, an electric shop, a machine shop, a paint shop, a pipe shop, a carpenter shop, a sheet metal shop, test cell maintenance, a lubricating oil storage area and a coolant recycle area (EG&G, 1991). These maintenance operations service Buildings 439, 440, 444, 445, 447, 449, 865 and 883 (Nichols, 1994). All waste generated in these processes is returned to Building 460 (EG&G, 1994).

Tool Control cleans and maintains tools and gauges stored in the tool crib. Rust preventatives are used as needed (EG&G, 1991).

The electric shop services electronic equipment related to Buildings 439, 440 and 460. Lead acid batteries are maintained and changed. Contact cleaner, tuner bath and circuit cooler compounds are used for equipment maintenance (EG&G, 1991).

The machine shop services and repairs production and utilities machinery and equipment related to the building. The shop includes two lathes, two milling machines, a pedestal grinder, a surface grinder, a drill press and a vapor degreaser/parts cleaner. TrimSol coolant is used for machining operations. Norpar 12, a petroleum based solvent, is used for cleaning parts and equipment during servicing. Isopropyl alcohol and acetone are used for general machine shop cleaning operations. Lead oxide is used for refinishing metal surfaces. Various lubricating oils and greases are used to service building equipment (EG&G, 1991).

The paint shop operations provide painting services for the entire building. Spray painting, except from aerosol cans, is not permitted inside the building. Various types of paint, paint thinner, paint stripper and tint are stored. Paint types include oil-based epoxy and water-based latex paints (EG&G, 1991).

The pipe shop installs and services all piping systems associated with the building. Shop equipment consists of an electric pipe threader, a band saw, two welding stations that include argon tungsten inert gas welders, oxyacetylene welding and cutting equipment, and supporting hand tools. Metal surfaces are cleaned with isopropyl alcohol and acetone prior to welding. Pipe shop power equipment uses Mobil Vactra 2 lubricating equipment, hydraulic oil and TrimSol machine coolant. Racon 12 refrigerant is used to service refrigeration equipment (EG&G, 1991).

The carpenter shop provides carpentry services for the building and other RFP areas. The only chemical of interest used in this shop is chloroform, which is used to fuse plexiglass (EG&G, 1991).

The sheet metal shop provides sheet metal fabrication, installation, replacement and routine maintenance services for the entire building. Isopropyl alcohol is used to clean metal surfaces (EG&G, 1991).

Test cell maintenance operations are no longer in operation as of March 1994 (EG&G, 1994). These operations provided special maintenance services such as cleaning, piping and electrical maintenance for test cell equipment including the following: (1) test chambers; (2) high pressure gas compressors, lines and controls; (3) vacuum pumps; (4) diffusion pumps; and (5) other test cell components. Chemicals used include isopropyl alcohol for cleaning, contact cleaner, tuner bath and circuit cooler (EG&G, 1991).

Lubricating oil storage in Room 140A is used exclusively for storage of oils, greases, cutting oils, solvents, hydraulic fluids and similar materials for Buildings 460, 439 and 440. These materials are stored in 55-gallon drums (EG&G, 1991; EG&G, 1994).

The coolant recycle area is used to purify used TrimSol, a water-based machine coolant. This coolant is used in many machining operations such as lathes, milling machines, drill presses and grinders. During machining, the coolant becomes contaminated with other oils, water and fine metal particles. A centrifuge is used to remove these contaminants, permitting the TrimSol to

be recycled and reused. The centrifuge uses Westfalia separator oil, a low viscosity premium oil, for high-speed applications (EG&G, 1991).

Utilities. Utilities in Building 460 include the following systems: (1) HVAC; (2) process cooling water; (3) process wastewater collection and filtration; (4) compressed air; (5) potable water; (6) sanitary drain; (7) hot water; (8) steam supply; (9) steam condensate return; and (10) electrical power (EG&G, 1991). Only the process cooling water and process wastewater collection and filtration systems are discussed below.

The process cooling water system consists of both an open loop and a closed-loop system interconnected by a heat exchanger. Nalco 2536 is added to the water to prevent rust build-up, and Nalco 2826 is added to the cooling water for algae control. Sodium hypochlorite and Vitrafor are used interchangeably as fungicides and biocides (EG&G, 1991).

The process wastewater collection and filtration system is housed in Room 140 and filters solids from liquid waste before transfer to Building 374 for treatment. Process equipment includes sumps and holding tanks and a roll table filtration unit (EG&G, 1994). Process wastes are collected in one of four sump tanks as described below:

- Sump Tank 1, located in Room 141B, collects mainly aqueous wastes from the electrochemical machining process. This rinse water contains sodium nitrate, nitric acid or sodium hydroxide. Waste water from the air compressor is also collected in Sump Tank 1 (EG&G, 1994).
- Sump Tank 2, located in Room 151, contains rinse water wastes from the Non-destructive Testing Process. The rinse water contains developer, fixer, emulsifiers and dye penetrants (EG&G, 1994).
- Sump Tank 3, located in Room 156, collects rinse water from the "A-line" cleaning processes occurring in other parts of the building. The water contains some nitric acid and Nitradd (EG&G, 1994).
- Sump Tank 4, located in Room 156C, collects wastes from the copper cleaning and passivator system. This waste is mainly rinse water with some nitric acid, Nitradd and Globrite (phosphoric acid and glacial acetic acid) (EG&G, 1994).

Rooms 118 and 135a contain sump pumps which pump waste from the metallography lab and the materials development lab directly to Tank 3. This waste consists of water and oxalic acid from metallurgy cleaning (EG&G, 1994).

The contents of the sump tanks are pumped into a collection tank in Room 140. Liquids from the collection tank are passed through a roll filter table unit and rolls of filter paper are used to remove any remaining solids from the liquids prior to transfer to Sump Tank 5. Sump Tank 5 filtered water is pumped to either Process Waste Tank 1 or 2, depending on which tank has available space. All processes in Room 140 are conducted in a spill pit to facilitate cleanup (EG&G, 1994). The process wastewater potentially contains toxic and hazardous chemicals including acids and various metals (chrome, nickel, etc.) (EG&G, 1991).

6.5 CURRENT CONTAMINATION STATUS

The current contamination status of Building 460 is not currently known. Radionuclide contamination within the building is not expected since the building is considered to be a non-nuclear facility.

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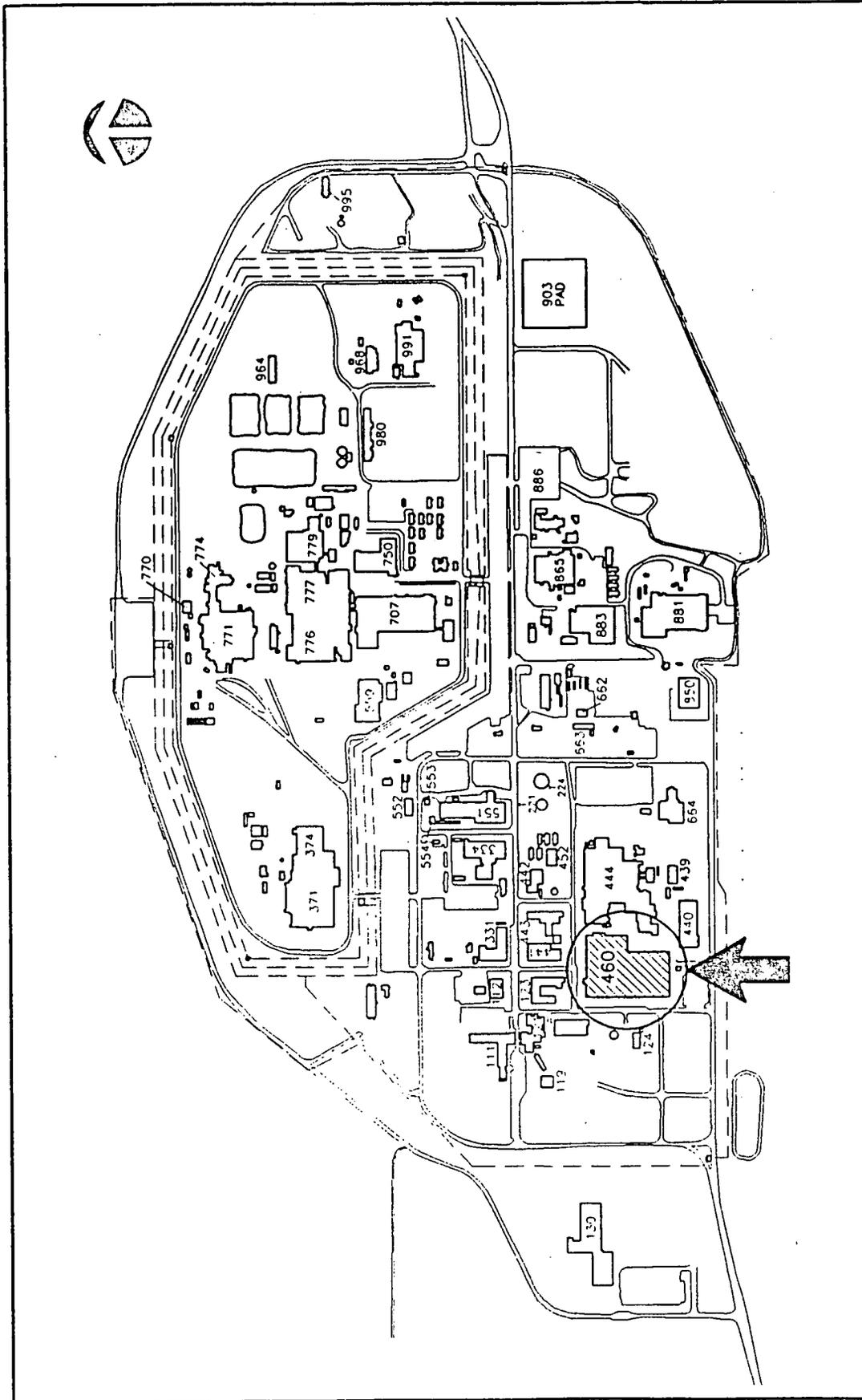


FIGURE 6-1
BUILDING 460

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 GOLDEN, COLORADO

BY
WRIGHT WATER ENGINEERS, INC.
 2490 W. 26TH AVE. SUITE 100A
 DENVER, CO 80211 (303)480-1700

PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

7.0 OPERATIONAL HISTORY OF BUILDING 707

7.1 INTRODUCTION

Construction of Building 707 began in 1967 to support production of the Part V weapons design that could not be fully accommodated by existing capabilities in Building 776/777. However, as a result of the 1969 fire in Building 776/777, Building 707 acquired additional plutonium foundry, casting and machining functions that were moved from Building 776/777 (ChemRisk, 1992; EG&G, 1992). Further, an addition to Building 707 (referred to as Building 707A or the Building 707 Annex) was constructed to accommodate all of the Building 776/777 operations that needed to be moved to Building 707 (EG&G, 1990).

Plutonium manufacturing operations began on May 25, 1970 (Buffer, 1993). Between 1970 and 1989, Building 707 provided metallurgical support for plutonium and was involved in final product assembly. Plutonium metal was first cast into ingots in the foundry. The ingots were then rolled and formed prior to being machined, cleaned and assembled in various areas within the building. Upon completion of Building 707, the majority of plutonium pit assembly operations were moved from Building 777 (ChemRisk, 1992; Dingman, 1994). Operations involving radioactive and fissile material (except storage facilities and limited laboratory activities) were discontinued in November 1989 (EG&G, 1992). As of 1992, certain non-production operations had resumed in Building 707, but no future weapons production is anticipated (EG&G, 1994; EG&G, 1992).

7.2 HISTORICAL TIMELINE

- 1967 Construction of Building 707 began (EG&G, 1992).
- 1970 The first plutonium operations in Building 707 began on May 25 (Buffer, 1993). Operations focused on casting and fabrication of plutonium components and final assembly of the plutonium pit.
- 1971 The Building 707 Annex (sometimes referred to as Building 707A) was constructed to accommodate operations moved from Building 777 as a result of the 1969 fire (EG&G, 1990).

- 1971 The X-Y retriever used for handling and storing plutonium began operation in the spring (Buffer, 1993).
- 1989 Operations (production and assembly) involving radioactive materials ceased in November (EG&G, 1992).
- 1992 Operations including thermal stabilization of residue materials, removal of oxides and packaging for storage began.

7.3 PHYSICAL BUILDING DESCRIPTION

The building is located in the north-central section of Rocky Flats Plant (RFP), within the Protected Area (PA) and just south of Building 776/777 (Figure 7-1). Building 707 is a two-story building with a single-story section on the east side. The two-story portion is 74,240 square feet per floor while the single-story section is 18,560 square feet. There is a small basement under Module C with an area of 1,000 square feet. The 707 Annex is a two-story free-standing structure with 13,100 square feet per floor (EG&G, 1992).

The main floor of the building is compartmentalized into eight modules (Modules A through H) which contain one or more of the primary production operations. There are two additional modules referred to as Modules J and K within the 707 Annex. During its years of operation, no significant changes were made to the building design (Slaybaugh, 1991).

Air filtration, ventilation and dehumidification are provided to the modules and gloveboxes by utilities equipment located on the second floor of Buildings 707 and 708. There are two inert atmosphere systems for special enclosures within Building 707. These systems maintain a dry, inert atmosphere of nitrogen and less than 5 percent oxygen. System 1 provides the atmosphere within the gloveboxes in Modules A, B, and C while system 2 provides the same function for equipment in Modules J and K and the storage area in Module K. Each system includes four-stage HEPA filter exhaust plenum with a standby filter interconnected to the two (EG&G, 1990).

The air pressure in the building becomes progressively more negative from office areas to production areas and to gloveboxes. This provides contamination control by directing air flow through designated emission control devices. The building is equipped with airlocks which

separate plutonium production and handling areas (the modules) from office and general support areas. Air exhausted to the outside is first drawn into nine plenums by 18 parallel-mounted fans (EG&G, 1990). The Building 707 exhaust stacks are equipped with 4-stage HEPA filter plenums (Slaybaugh, 1991; Koffer, 1994).

7.4 DESCRIPTION OF OPERATIONS

Operations in Building 707 can be divided into two categories: (1) plutonium fabrication operations which occurred between 1970 and 1989, and (2) recent operations since production curtailment in 1989.

7.4.1 PLUTONIUM FABRICATION OPERATIONS (1970-1989)

Construction of Building 707 began in 1967 with plutonium operations actually commencing on May 25, 1970 (Buffer, 1993). The building was originally intended to support production of the Part V plutonium weapon design but took over many of the Part IV operations from Building 776/777 after the 1969 fire. When operations were moved from Building 777, they were not changed significantly. Detailed descriptions of the casting, fabrication and assembly process operations are described in the following sections.

7.4.1.1 CASTING OPERATIONS

In general, casting operations focused on production of feed ingots and production ingots. Feed ingots were produced by blending plutonium from various sources including scrap, briquettes, buttons from the Building 771 recovery operations, and/or rejected parts. A portion of the feed ingot was then tested for purity in Building 559 and its composition catalogued. Final gallium-stabilized War Reserve ingots were then produced by blending feed ingots of known purity and composition (Dingman, 1994). Most of the casting occurred in Rooms 145 in Module K and Room 140 in Module J, although some also took place in Room 100 of Module A. Differences in the processes employed in each module are described below.

7.4.1.1.1 Module K Casting

In the Module K casting process, metal was weighed, placed into tantalum crucibles and melted in the casting furnaces. Molten metal was poured into erbium oxide coated stainless steel molds

to form ingots. Although four furnaces were present in Module K (Lombardi, 1994), only two furnaces were used during routine operations for casting (EG&G, 1990). Rejected ingots from casting in Modules A, J and K were cut with a shear press within a glovebox and returned to the X-Y Retriever for storage (EG&G, 1990).

During routine operations, carbon tetrachloride was used at an approximate rate of one gallon per month for cleaning inside the gloveboxes. During inventories, an estimated 40 gallons of carbon tetrachloride were used to clean the gloveboxes and shuttle area to the X-Y Retriever. There were generally six inventories per year (EG&G, 1990).

Another significant use of chemicals occurred during testing of the tantalum crucibles for cracks and leaks. In this operation, any suspect crucible was filled with freon (compound unspecified) and the crucible was inspected for leakage. This method of testing was discontinued in the mid-1980s due to problems encountered with de-halogenation of the freon (Lombardi, 1994).

7.4.1.1.2 Module J Casting Operations

The casting operation in Module J differed from that in Modules A and K in that the starting materials included plutonium buttons, plutonium scrap such as machine turnings, briquettes and scrap from the rolling and forming operations, as well as plutonium feed ingots. Most of the gloveboxes in Module J contained casting furnaces, although only four were generally used during routine operations (EG&G, 1990).

Plutonium was placed inside tantalum crucibles and heated inside the furnace vessel. The bottom-pour furnaces used reusable tantalum rods to release the molten metal into stainless steel molds. The tilt-pour furnaces used reusable tantalum funnels to divert the molten metal into graphite molds. The molds were used until their coatings were worn off and then were discarded. Carbon tetrachloride was used to clean the gloveboxes (EG&G, 1990).

Other gloveboxes were used for sampling ingots, cleaning graphite and steel molds and for plutonium oxidation. Carbon tetrachloride usage for Module J operations was estimated to be the same as for the previously described Module K operations (EG&G, 1990).

7.4.1.1.3 **Module A Casting Operations**

Limited casting of plutonium into feed or production ingots took place in the furnaces located in Room 100 (EG&G, 1990; EG&G, 1994; Dingman, 1994). Graphite molds, delivered from the Building 444 carbon shop, were prepared in a fume hood with a spray application coating of a water-based calcium fluoride solution (Lombardi, 1994). The ingots were placed in tantalum crucibles and melted in one of four electric induction furnaces. The metal was poured through a funnel into the graphite molds which were then allowed to cool. Crucibles and funnels were scraped clean and reused until worn. Graphite molds were recoated with calcium fluoride and reused (EG&G, 1990).

During routine operations, approximately one gallon per month of carbon tetrachloride was used to clean the interior glovebox walls. However, during each of six annual inventories, approximately 40 gallons of carbon tetrachloride were used to thoroughly clean the furnaces. Use of freon for leak testing of tantalum crucibles also occurred until the mid-1980s (Lombardi, 1994).

7.4.1.2 **FABRICATION OPERATIONS**

After casting, the molded parts underwent a series of fabrication steps to produce the required final shape. These included rolling, forming, thermal treatment, and final machining.

7.4.1.2.1 **Rolling, Forming and Thermal Treatment**

Rolling, forming and thermal treatment of plutonium production ingots occurred in Module B. Production ingots were rolled until a specified thickness was obtained. Oil was used in rolling, and rags and carbon tetrachloride were used to clean the rollers. The rolled ingots were moved to another glovebox where shapes were cut out of the sheet in a blanking press. Scraps left from cutting were cut into smaller pieces in the same glovebox, placed in a container and sent to the briquetting process in Module C. The cut blanks were sent to adjacent gloveboxes for thermal treatment (annealing and homogenizing). Following thermal treatment, the blanks were formed into hemishells in a hydroform press. Oil was used as a lubricant to facilitate forming (EG&G, 1990; Dingman, 1994).

After forming, the parts were annealed, cleaned and measured on a density balance. Cleaning took place using carbon tetrachloride in a small bath tank (Lombardi, 1994). Carbon tetrachloride was used at a rate of approximately three gallons per day (EG&G, 1990). The density balance consisted of a 55-gallon drum filled with Freon 113, which was used due to its density and thermal characteristics (Lombardi, 1994). A percentage of the parts were selected for further quality assurance evaluation (EG&G, 1990).

7.4.1.2.2 Final Machining Operations

Module C performed final machining operations on the bulk of plutonium parts used for weapons production. The various gloveboxes within Module C contained lathes, mills, a drillbox and a high-precision drill press. Machining operations used cutting oil (the long straight chain hydrocarbon, Texaco 634 (Lombardi, 1994)) as a coolant which was pumped into a tank adjacent to each machine. The oil was then pumped through a filter, used to cool the cutting process equipment, and recycled to the tank. Spent oil was pumped from the tank, through two filters, and to the C-pit. Machining generated plutonium fines and chips were collected in cans at each machine (EG&G, 1990).

After machining, parts were weighed in a density balance. The density balance measured the density of a part by reference to the density of Freon 113. Parts were suspended while a 15-gallon tank filled with Freon 113 was lifted until the parts were submerged. The parts were then allowed to drip and dry by evaporation (EG&G, 1990). The Freon 113 tank was changed out every two months or when the Freon 113 became visibly dirty. Approximately 1.5 gallons per day of make-up Freon 113 were added to the tank to compensate for evaporative losses (EG&G, 1990).

After the part was machined, carbon tetrachloride was spray applied to remove gross quantities of machine oil from the part, the drill chuck and gloves. Additional degreasing of the part was performed with a spray of fresh solvent prior to placing the part on the carrier for transfer (Hobbs and Swan, 1983). Carbon tetrachloride was also used to clean the gloveboxes during inventories. The oil sumps were emptied and the glovebox interiors washed to remove remaining oil and residual chips (Hobbs and Swan, 1983).

The solvent cleaning operations drained into an oil sump and thus became intermingled with the used coolant oil. This intermingled waste stream was pumped from the tank, through two filters

for removal of plutonium fines, and then to the C Pit for disposal (Lombardi, 1994). The used oil filters were changed during inventories. An estimated 3,400 gallons per year of carbon tetrachloride were used in the machining operations (EG&G, 1990). The plutonium fines were periodically collected and sent to the oxidation process. Larger turnings from the machining operations were cleaned and sent to briquetting (Dingman, 1994).

7.4.1.3 ASSEMBLY

Machined parts went through a series of cleaning and assembly steps to produce the final plutonium pit. The steps varied depending on the design of the pit (i.e., whether it was a Part IV or Part V design) but were usually iterative. Some of the parts received from other buildings on plant site required cleaning prior to being incorporated into the pit assembly. As examples, beryllium parts from Building 444 were coated and therefore did not require cleaning. Vanadium parts, however, were uncoated and had to be cleaned in Building 707 (Dingman, 1994).

Pre-Assembly Cleaning Operations. In Module D, plutonium parts were inspected and marked with a serial number prior to cleaning in an ultrasonic cleaner. Trichloroethylene (TCE) was used for cleaning up until about 1972, at which time RFP switched to trichloroethane (TCA) (Dingman, 1991; Hornbacher, 1994). Parts were also cleaned in Module E using a vapor-degreaser-ultrasonic cleaner combination and a single ultrasonic cleaner (EG&G, 1990; Hobbs, 1970). After cleaning, the parts were wrapped in aluminum foil (EG&G, 1990).

In both the ultrasonic and vapor wash tanks, the TCA was changed based on weekly sample results that indicated the solvent contained too much plutonium or water. Ful-Flo filters purified the spent TCA discharged from the wash basins before being piped to a sump tank (V-100) in the C-Pit. When this tank was full, the contents were pumped to a tank in Building 777 and then piped to Building 774 for waste treatment (EG&G, 1990).

Subassembly of Plutonium Parts. Plutonium parts were welded with electron beam welders in gloveboxes housed in Module E. The area to be welded was first treated with Scotch-brite and cleaned with TCA. The welders used machine oil, which was changed periodically and discarded. The parts were then checked for leaks in a procedure using liquid nitrogen. The parts underwent the same three steps again (i.e., washing, welding and leak detection). Parts were also repeatedly wire brushed to remove oxides (EG&G, 1990; Dingman, 1994).

Outershell Assembly. Rooms 125 and 125A in Module F were used for the assembly "Superdry" process in which an outer metal casing was welded onto the plutonium subassembly using a pigma or electron beam welder. Aluminum foil wrapped plutonium parts were unwrapped and cleaned using wipes and TCA or sometimes ethyl alcohol (Crisler and Dingman, 1991; EG&G, 1990). The parts were assembled, welded and sent for acceptance testing. TCA and ethyl alcohol were used at rates of approximately one gallon per month and one-half gallon per month, respectively (EG&G, 1990). Some parts were sent on to Room 126 in Module F to have the interior evacuated on a vacuum pump-down table. This evacuation process occurred repeatedly after various steps (Dingman, 1994).

Electron Bombardment Brazing. Brazing was a process in which two metals were joined using a nonferrous alloy that melted at a lower temperature than the metals being joined. An electrical filament, connected to a high-voltage power source, was used to melt the alloy. Plutonium parts encased in other metals were brazed in a glass bell jar in Room 130 of Module G. Prior to brazing, parts were cleaned with acetone. Estimates of acetone use rates were one-half gallon three gallons per year (EG&G, 1990; Crisler and Dingman, 1993; Dingman, 1994).

During brazing, waste material was deposited on the walls of the bell jar and a metal cleaner was used with an abrasive pad to clean the jar. Bell jars were cleaned a final time using Kimwipes and acetone or TCA. These materials were mixed with floor-dry for disposal (EG&G, 1990).

High Pressure Assembly. Module H included a high pressure assembly process where parts comprised of various metals including beryllium, plutonium and uranium were bonded together as part of the Part V weapon design (Dingman, 1994). The component was then cleaned in Module H with TCA and cheesecloth (EG&G, 1990; Mahaffey, 1993).

7.4.1.4 DISASSEMBLY

Rejected aluminum, stainless steel and beryllium parts were disassembled in Module G using machining operations (EG&G, 1990; Dingman, 1994). The process used two lathes inside "B-boxes" (similar to lab hoods) and a milling machine. Light oil was used for equipment lubrication. Small amounts of Freon 113 and distilled water were used for cooling and lubrication during machining of the beryllium parts. Approximately one gallon of Freon 113 was used per year (EG&G, 1990).

7.4.1.5 INSPECTION AND TESTING

Parts were tested and inspected after each operation. The following subprocess related to checking the integrity of welding complemented the welding and cleaning steps:

Radiography - Module E. Radiography involved the x-ray examination of plutonium parts to identify structural flaws. Parts were transferred to a glovebox in Room 167 of Module E and then transferred to Room 169, where they were x-rayed. Room 173 was the darkroom for x-ray image development for this process. When plutonium operations ceased, the used fixer was being sent to Building 774 for silver recovery. The used developer was washed down the process drain, pumped to Room 173, and then pumped to Building 374 for treatment. Radiography also used several other rooms for storage of drums and radiographic film (EG&G, 1990). Approximately 20 gallons of the fixer solution were used per week. TCA was also used in this process at a rate of 2 gallons per year (EG&G, 1990).

Eddy Current Testing - Module E. Eddy current testing on plutonium parts was conducted in Module E to check the depth of weld penetration. Approximately 2 gallons of TCA were used per year to clean the gloveboxes during inventories (EG&G, 1990).

Weld Scanners and Fluorescent Penetrant Operations. These operations, housed in Module E, used an ultrasonic scanner, a weld scanner and a fluorescent penetration station for qualifying welds, although the weld scanner was not typically used. The penetrant station was located under a hood and was used to detect minute cracks or voids in parts. Following application of the dye to a part, it was allowed to sit for ten minutes before being cleaned with TCA. TCA was used at a rate of approximately 40 gallons per year (EG&G, 1990).

Leak Testing. Leak testing was conducted on stainless steel and beryllium parts in Room 126 of Module F (EG&G, 1990; Mahaffey, 1993; Dingman, 1994). Each part was placed on one of ten pump-down tables and a vacuum was exerted on the part to check for leaks and to remove any moisture. Electro-etch was used to mark any pits or imperfections in the part. Electro-etch was the only chemical used in this process (EG&G, 1990).

Ultrasonic Scanning, Weld Scanning, and Fluorescent Dye Penetration. Ultrasonic scanning, weld scanning and fluorescent dye penetration also took place in Module G as quality control measures for detection of flaws in plutonium parts. An ultrasonic scanner was used to take

readings on a part immersed in deionized water. Spent water was pumped to process waste. Fluorescent dye was applied to the part and the part was then cleaned with TCA and viewed under a black light. An estimated two gallons per month of acetone and TCA were used. Developer was also used in this process (EG&G, 1990).

Pressure testing. Pressure testing occurred in Room 131B of Module G to test the integrity of the interior of various assemblies (Dingman, 1994). The parts were tested using high purity helium as an inert pressurization gas. Following testing, the gas was recycled and the parts were sent to material analysis or back to assembly. The gas compressors used oil as a lubricant. The oil was stored in tanks near the compressors. Potassium hydroxide was also used in the compressors and was collected in an adjacent caustic storage cabinet. TCA was used infrequently at a rate of less than one-half gallon per year (EG&G, 1990).

Destructive Testing. Destructive testing of parts occurred in Module A. Parts and metal were weighed in a glovebox while coring on a variety of metal parts, including plutonium and beryllium, was performed in another. All lathing and milling functions, both of which used Freon 113 and oil, were performed inside gloveboxes. It was estimated that less than one gallon of Freon 113 was used per week (EG&G, 1990; Mahaffey, 1993; Dingman, 1994)

A band saw and coring machine were operated on a non-routine basis approximately once every one or two months. These machines were operated dry, so some particulates were generated. All other material processing in Module A was done using oil or Freon 113, so no particulate emissions occurred (EG&G, 1990).

Inspection. Inspection activities took place in Modules C and D of Building 707. Operations in these modules involved dimensional non-destructive testing of parts and assemblies. Various metal gauges, micarta rings, and optical- and computer-assisted instruments were used to inspect and measure part dimensions. Due to the sensitivity of instrumentation, the parts were periodically cleaned with carbon tetrachloride. During 1989, 15 gallons of carbon tetrachloride were used in inspection operations in Module D and 24 liters were used in Module C (EG&G, 1990).

7.4.1.6 RECOVERY

Plutonium recovery operations were limited to recycling of relatively pure materials through oxidation of metal fines and briquetting metal scraps.

Plutonium Oxidation. In a glovebox in Module K, carbon tetrachloride was used to remove oil from metal fines generated from various machining operations. These fines then underwent plutonium oxidation to convert pyrophoric plutonium residues to non-pyrophoric plutonium oxide (PuO_2) in a glovebox in Module J. The operation was carried out in a stainless steel container atop an electric hot plate which was located inside a glovebox. The oxide material was then sorted and stored in cans and eventually sent on to the Building 771 recovery operations (EG&G, 1990; Dingman; 1994).

The oxidation process took place in the presence of carbon tetrachloride which was used heavily as a degreaser. In 1983, a reaction between carbon tetrachloride and burning plutonium fines caused an explosion within the oxidation glovebox (Hobbs and Swan, 1983)

Briquetting of Scraps - Module C. Briquetting involved cleaning and pressing metal turnings from the Module C machining process and metal scrap from Module B scrap cutters. The scrap plutonium metal from Module B and plutonium machine turnings from Module C were placed in perforated metal baskets. The baskets were dipped into a series of five carbon tetrachloride baths. Each bath was a steel tank which contained approximately four gallons of solvent. After cleaning, the scraps and turnings were air-dried and then pressed into pucks with a hydraulic press (EG&G, 1990).

The solvent baths were changed-out after approximately 30 basket dips. All five baths were changed at one time. The used carbon tetrachloride was passed through two Ful-Flo filters for removal of plutonium fines. Ful-flo filters are spun polypropylene cartridge filters used to filter solids from the cleaning solutions. Filtered carbon tetrachloride was then piped directly to pencil tanks in the C-pit prior to being sent to Building 774 for treatment and off-site disposal as a solid (EG&G, 1990).

7.4.1.7 SOLVENT AND WASTE HANDLING

Building 707 handled large quantities of Freon 113, TCA, and machining oil. Each of these compounds was stored prior to use in large tanks located on the second floor of the building. Process waste was collected in tanks located in the basement. These systems are described below.

Feed Tanks. A 500-gallon Freon 113 tank (V-32) and three TCA feed tanks (V-36A, B and C) located in Room 200 provided solvents to Buildings 707 and 777. A carbon tetrachloride feed tank for these buildings was located and remains north and outside of Building 707 (EG&G, 1990). At one point in time, a 200-gallon carbon tetrachloride day tank was housed inside the building (Crocker, 1991). The total amount of Freon 113 used in Building 707 ranged from 800 to 990 gallons per year. Each TCA feed tank had a capacity of 200 gallons. The total purchase of TCA for Buildings 707 and 777 in 1989 was 2,450 gallons. Equal use of each tank was assumed, so approximately 817 gallons per year was the total throughput for each tank (EG&G, 1990).

Waste Tanks and the C-pit. Waste tanks containing these spent solvents were located in the C-pit, which is a partial basement under Module C. The pit contained two storage tanks for commingled carbon tetrachloride, oil and Freon 113. It also contained 16 pencil tanks for carbon tetrachloride, a glovebox for a Ful-Flo filtration system and a large storage tank for TCA. Waste carbon tetrachloride from machining processes was pumped through Ful-Flo filters, located with each machining process, to the 16 pencil tanks in the C-pit. It was then pumped through the filtration system to a holding tank where it was sampled for nuclear materials. Following sampling, the waste was transferred to Building 774 for waste treatment. Machining oil, used as a coolant during machining processes, Freon 113 from density balances and spindle oil from calibration of sight gauges were also collected in the carbon tetrachloride system (EG&G, 1990).

Waste TCA from ultrasonic cleaners in the building was collected in a sump tank (V-100). When this tank was full, the TCA was pumped to a tank in Building 777 and then piped to Building 774 for waste treatment (EG&G, 1990).

The TCA waste tank throughput for 1989 was equivalent to the amount of TCA emptied or flushed from the five degreaser systems in Modules D, E and G a minimum of six times, or 723 gallons per year (EG&G, 1990).

7.4.1.8 STORAGE

Various locations in Building 707 were used to store nuclear and non-nuclear materials. Materials stored included raw materials needed for casting, feed ingots, products cast within the building, and finished components awaiting assembly or transfer to Building 991 for eventual off-site shipment.

X-Y Retriever. The Module K X-Y retriever, which began operation in 1971 (Buffer, 1993), was used to store and retrieve plutonium metal for distribution to other processes in Building 707. Operators retrieved an appropriate quantity of plutonium from the retriever then conveyed it to the X-Y shuttle area where it was cut and weighed. The metal was then conveyed to Modules A, J or K for casting, or Module B for rolling and forming.

Module J Vaults. Rooms 141 and 142 in Module J were called the J vault and were used for storage of oxides, plutonium buttons received from Savannah River, and to some extent, from Building 771 molten salt extraction (MSE) operations (Dingman, 1994).

Production Control Operation. The main function of the Production Control group was scheduling and tracking all activities associated with the assembly of weapons components produced at RFP. Nuclear and non-nuclear materials were received, inventoried and placed into storage in Building 707. Shipping and receiving was located in Room 184 (Mahaffey, 1993), and Rooms 183 and 184 in the corridor outside the modules were also used for packaging and storage (Dingman, 1994).

Production Control was responsible for maintaining inventory/accountability records for all materials received and shipped from Building 707. Part of this task involved etching serial numbers on parts using a grit blaster (EG&G, 1990). Following grit blasting, the parts were cleaned with TCA. One dip tank was used prior to final inspection. The tank was kept covered when not in use to prevent evaporation of TCA. The tank held approximately four gallons of TCA. Approximately one-half to one gallon of TCA per week of tank use was added to the tank to make up for losses. The tank was drained during the Christmas shutdown and the six annual inventory periods (EG&G, 1990). The TCA in the tank was changed frequently to ensure efficient cleaning. It was changed when it became visibly dirty or when sampling indicated that fresh TCA was needed. Used TCA was pumped through Ful-Flo filters to the collection tanks located in the C-pit (EG&G, 1990).

7.4.1.9 SUPPORT OPERATIONS

Support activities active during the production period included a calibration laboratory, calorimetry operations, and utilities and maintenance.

Calibration Laboratory - Modules D and G. The Calibration Laboratory, located in Rooms 133 and 133A of Module G, calibrated gauges from various locations in Building 707. In addition, three gloveboxes in Module D were used for storage and dimensional measurements of gauges. Lint-free rags were used with ethyl alcohol to clean the gauges before precision measurements were made. These cloths were dried and disposed with dry combustible waste. All gauges were returned to the users after calibration (EG&G, 1990).

Calorimetric Assay - Module G. Calorimetric assays were historically performed and continue to be performed in Room 130B of Module G (EG&G, 1994). Calorimetry is the process by which radioactivity is measured and isotopic contents of a package are determined. Plutonium metal fines and chips from other processes in Building 707 were assayed for radioactivity using calorimetry techniques and gamma spectroscopic analysis. The plutonium was kept in stainless steel cans which were placed in air or water baths to regulate temperature. The heat produced by the air/water can system was measured and related directly to the alpha activity in the can. The cans were then placed under a high purity germanium detector for measurement of the relative amounts of plutonium, americium, uranium and neptunium in the can. After measurement, the cans were returned to Module J for storage. Water used for cleaning and liquid nitrogen in the laboratory evaporated to the room air (EG&G, 1990).

Utilities and Maintenance. Six Freon 12 tanks, located on the second floor of Building 707, were used for the heating, ventilation and air conditioning (HVAC) system (EG&G, 1990). The Maintenance group performed a variety of support functions in both process and non-process areas of Building 707. Batteries, lightbulbs, insulation and lubricating oils, as well as broken or cracked leaded glass and plexiglass from gloveboxes, were changed out and replaced by this group on an as-needed basis. The cleaning of compressors was performed with isopropyl alcohol (Crisler and Dingman, 1993).

7.4.2 RECENT OPERATIONS (1989-PRESENT)

After plutonium operations were shut down in November of 1989, Building 707 was classified as a Production Contingency Facility, meaning it was to be maintained in a condition to allow restart of production operations if national security requirements mandated such action (EG&G, 1992). In 1992, however, the plant mission was changed and all future weapons production was cancelled.

The current and anticipated future activities in Building 707 are to provide brushing of oxides from stored items and thermal stabilization of radioactive residue materials. The source of the residue is from previous production activities or oxides from current brushing. Other activities involve maintaining building safety envelopes. The detailed status of the various operations and Modules is discussed below.

7.4.2.1 WASTE HANDLING

Building 707 is involved in stabilizing residues containing plutonium and the decontamination of gloveboxes formerly used for plutonium operations. These operations are discussed below.

7.4.2.1.1 Thermal Stabilization

With the change in plant mission, the casting furnaces in Modules A, J, and K in Building 707 are no longer used to cast plutonium ingots, although the equipment for these functions still remain. Current operations in these areas include unpackaging, weighing, brushing and inspecting of various parts or materials, maintenance of various equipment within the process area, thermal stabilization, can-sealing and activities to maintain the "safety envelope" of process areas (EG&G, 1994).

Miscellaneous pyrophoric plutonium residues such as metal scrapings and fines and materials contaminated with plutonium such as insulation, combustibles, turnings, tools and glass are conveyed to Building 707 from other buildings and from within Building 707. If necessary, oxide is removed from the material with a brush. The oxide itself is stored in stainless steel cans. Pre-sampling of the material to be stabilized is conducted in approved gloveboxes in Modules A, J or K before the thermal stabilization process can be performed. Samples are transferred to

Building 559 for analysis and thermal stabilization does not begin until analytical results are available.

Containers of material to be thermally stabilized are transferred into either the Glovebox J-25 oxidation vessel or Glovebox J-60 oxidation furnace. The material in the container is weighed and stabilized in small batches. These materials are placed in a stainless steel pan, steel crucible or graphite crucible and heated to convert plutonium metal to plutonium oxide. The residue remaining in the pan after burning is carefully screened to remove plutonium oxide from the non-plutonium material. The stabilized plutonium oxide is placed in a stainless steel storage container until the container is filled. Towels are used for glovebox cleaning. Gloves, cans, plastic, tape, glass and tools are used for handling materials (EG&G, 1994).

Samples are obtained from each container of stabilized plutonium oxide and stored in an approved glovebox for eventual analysis in Building 559. The sampled containers of stabilized plutonium are bagged out of the gloveboxes and moved to Building 771 for calorimetry operations (EG&G, 1994). Glovebox J-65 is used to seal cans of oxide (A-65 is a backup). Can sealing provides an airtight shipping container for material destined for long-term storage in Building 371 or an off-site location (EG&G, 1994).

When graphite molds are no longer usable for stabilization, they are placed in a 55-gallon graphite drum. Other line-generated plastics, metal, combustibles, glovebox HEPA filters, glass and furnace insulation are placed in the appropriate 55-gallon drum. Line-generated leaded glovebox gloves and floor stripping waste are drummed and then deposited in a 90-day accumulation area. Non-line-generated combustibles, plastics and light metal are placed in the appropriate 55-gallon drum. Glovebox and furnace exhausts are vented to the building filter plenum system (EG&G, 1994).

7.4.2.1.2 Decontamination and Decommissioning

Modules B through H are for the most part idle. However, activities occur within the modules related to the maintenance of safety systems and the implementation of Decontamination and Decommissioning (D&D) programs. Safety systems activities include the performance of various surveillance, radiological surveys, maintaining glovebox integrity and glovebox systems decontamination. D&D activities are the removal or disposal of excess chemicals, repackaging of waste drums or crates, management of building waste, general housekeeping within the

modules. Other D&D activities will be determined as D&D objectives are defined. If repackaging of a drum or crate is required as a result of a packaging deficiency, it is repackaged in the C-cell in Module B.

7.4.2.2 STORAGE

Nuclear and non-nuclear components and materials for use in Buildings 707, 776 and 777 continue to be received, stored, and inventoried in Room 184 by the Nuclear Material Handling and Packaging Group. Incoming parts and materials are stored or transferred to the thermal stabilization areas. Radioactive sealed source standards are transferred to Nondestructive Assay (NDA). Module K still houses the X-Y Retriever where plutonium metal is stored and distributed to other processes in the building. The X-Y Shuttle Area in Module K is generally used for unpackaging of materials that do not require a glovebox environment.

Materials handled within Building 707 are sent to Nuclear Material Handling and Packaging for storage or preparation and packaging for shipment on-site or off-site. Packing materials such as drums, fixtures, insulation, cushioning and replacement hardware are ordered as needed from the Building 991 product warehouse. Preparation may require cleaning of the product with Alconox or Mariko cleaner or water and Kimwipes to reduce the level of removable surface contamination (alpha) to less than 20 disintegrations per minute. Packing materials are examined for integrity and discarded if defective. Reusable containers and packing materials are monitored for surface contamination, cleaned to less than 20 disintegrations per minute, if necessary, and stored or shipped to Building 991. Packages are typically sealed with a copper cup seal or other tamper-indicating device (EG&G, 1994).

Dry combustibles, Kimwipes with Mariko or Alconox residues and plastic bags and vinyl tape are collected in the appropriate 55-gallon drums in Room 184. Light metal wastes, such as used copper cup seals, aluminum foil and defective hardware are accumulated and taken to a designated drum in the Module K foundry (EG&G, 1994).

7.4.2.3 SUPPORT OPERATIONS

Support operations include laboratories for calorimetric assays, mass spectrometry of gases and calibration of equipment. In addition, the building retains utilities and maintenance functions.

Calorimetric Assay - Module G. Calorimetric and gamma spectroscopic analyses continue to be performed in Module G to non-destructively determine the abundance of select radionuclides in an assortment of matrices. The compounds of interest are plutonium, americium, uranium and neptunium in matrices which include metal, fines, chips, oxides, duct samples, colloids and liquids from a variety of processes (EG&G, 1994).

Assayed materials, including plutonium metal, fines, chips and plutonium oxide are returned to the originator in entirety. The metal cases are placed in a 55-gallon drum for light metal. Lead bricks and cadmium sheets used to shield the samples and detectors from interferences are not normally discarded (EG&G, 1994).

Calibration Laboratory - Module G. The Calibration Laboratory calibrates measurement and test equipment from various non-glovebox operations in the Protected Area. Types of measurement and test equipment used by the Calibration Laboratory include electrical, electronic, mechanical and physical precision standards. Measurement and test equipment may require in-place calibration at the user's site if the system is not mobile. When the calibration is completed, documentation of the calibration is generated, certification labels are affixed to the equipment and the equipment is returned to the user (EG&G, 1994).

The equipment is cleaned before being brought to the Calibration Laboratory. The Calibration Laboratory cleans its own equipment using approved wipes. Some standards use alkaline, nickel-cadmium or mercury batteries for a source of power (EG&G, 1994).

Mass Spectrometry - Module F. The mass spectrometry laboratory analyzes gases for various programs at RFP. The process is located in Room 127, Module F. Process equipment includes vacuum generators and mass spectrometers. The primary purpose of the laboratory is to perform analyses in support of the Waste Isolation Pilot Plant Program, Stockpile Laboratory Test, New Materials Laboratory Test, Phase 7 retirements and shelf-study programs. Gas analyses are performed upon request in support of Research and Development activities and for other groups. Gas samples are received in stainless steel canisters and bottles. The sample is analyzed and the sample container is returned if reusable. Unusable containers are discarded as non-line metal waste. Vacuum pump oil is periodically replaced in the vacuum generators. Wipes are used to clean up any excess oil on the equipment (EG&G, 1994).

Utilities and Maintenance. Utilities personnel maintain and operate the heating, air supply, air filtering, air conditioning, water supply and power systems associated with Building 707. These systems include process water, an air supply plenum and an exhaust air plenum.

Maintenance personnel are responsible for maintaining electrical systems, lighting systems, gloveboxes, vacuum pumps, diffusion pumps, insulation and equipment fabrication, repairs and service. Maintenance operates two electrical shops. Process equipment includes a lightbulb crusher, two drills, two grinders, a band saw and a pipe threader.

Miscellaneous electrical work and electrical support work is conducted in Room 186 in Module G. The room contains a drill and a grinder. Electrical work requires the use of spray cleaners, sealers, joining compound, soldering flux, methanol and, occasionally, Kimwipes to clean electrical devices. Another electrical shop is located on the second floor of Building 707 in Room 223. It contains a drill, a grinder, a band saw and a pipe threader. Dry-Rite oil is used with this machinery (EG&G, 1994).

Maintenance personnel replace spent lead-acid batteries used for the emergency lighting system with new Gel-Cel batteries. Gel-Cel and mercury batteries used in the uninterrupted power supply system and dry cell and nickel-cadmium batteries used in some small equipment are also replaced as needed. Burned-out fluorescent lightbulbs are collected and crushed in a small device mounted on the top of a 55-gallon drum. Polychlorinated biphenyls (PCB) ballasts are replaced in light fixtures with non-PCB ballasts.

Solid waste is collected in drums and handled as nonhazardous or hazardous appropriate. For example, PCB ballasts are placed in a designated Toxic Substances Control Act (TSCA) 55-gallon drum. Used Gel-Cel and lead acid batteries are radiologically surveyed and collected for recycle. Dry cell batteries are placed in 55-gallon drums in the Radioactive Materials Management Area. Nickel/cadmium and mercury batteries are radiologically surveyed and collected in a 90-day accumulation area on Building 778's south dock (EG&G, 1994).

7.5 CURRENT CONTAMINATION STATUS

Building 707 is moderately to highly contaminated with plutonium and some enriched uranium. There is also some beryllium contamination in the building. Asbestos exists on the second floor

in Building 707 at 57 locations in three rooms as insulation on steam lines, chilled water lines and domestic hot water pipes (EG&G, 1992).

As of 1992, 82 drums or boxes of radioactive waste were stored in Building 707. Forty-two were low-level waste and forty were TRU-waste. This number is expected to vary as additional waste is generated by maintenance activities (EG&G, 1992). Forty-three drums of radioactive residue was stored in Building 707 as of 1992. This material was scheduled to be processed in Building 771 to recover the plutonium content (EG&G, 1992).

Radiologically, much of the removable contamination in Building 707 has been removed. Some contamination remains under the vacuum pumps of the casting furnaces in Modules A, J and K due to contaminated oil. The inside of all of the gloveboxes in Building 707 are radioactively contaminated. All fixed or non-removable contamination has been covered or painted over. Radiation emanates from the SNM storage areas, the waste drums and crates, the residue drums, the exhaust ducts and several of the gloveboxes (EG&G, 1992).

The two large C-Pit tanks and 16 pencil tanks once used for storage of commingled waste carbon tetrachloride and machine oil and waste TCA are operationally empty and the lines in and out of the C-Pit process are locked and tagged out (EG&G, 1994).

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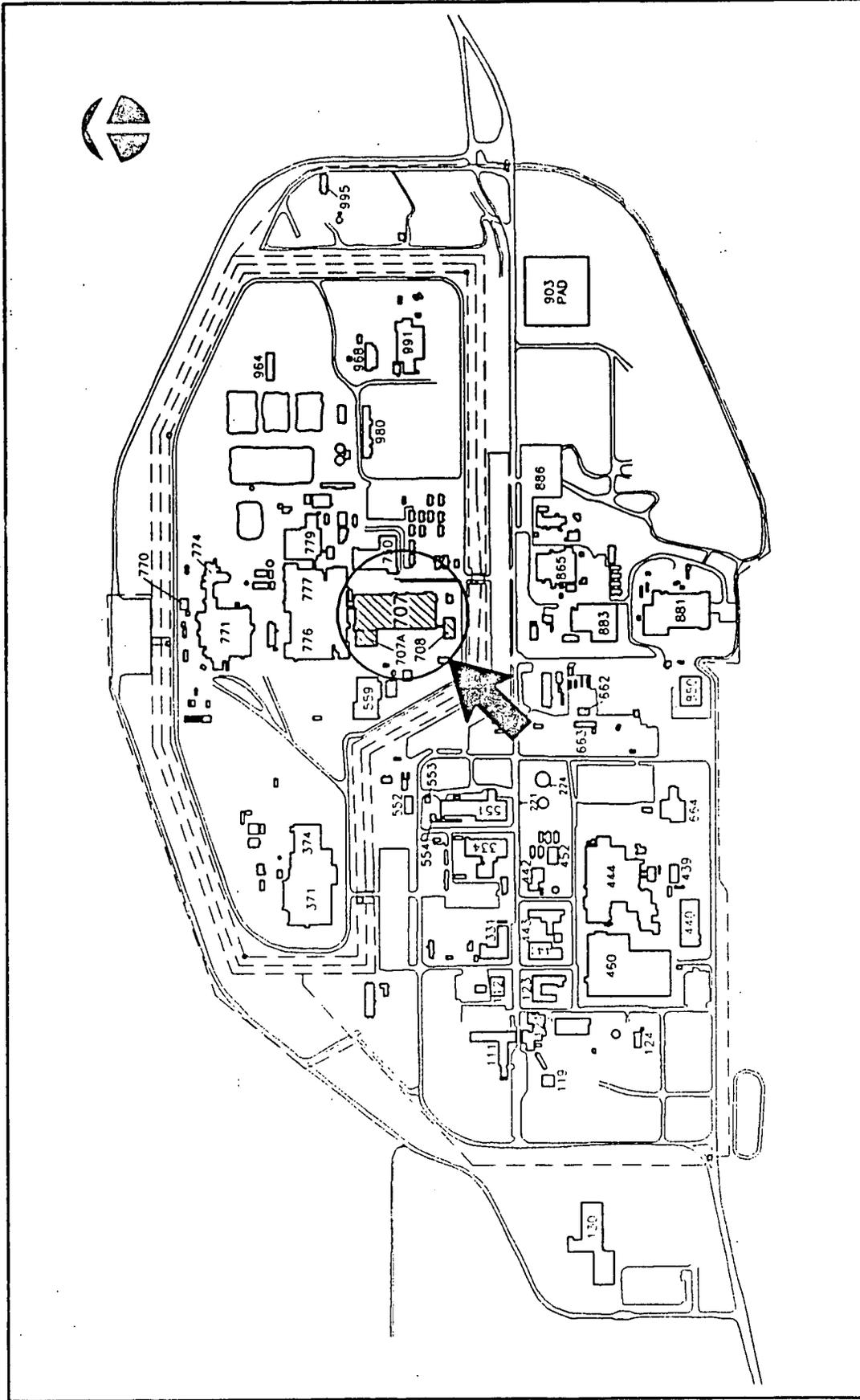
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FIGURES



**FIGURE 7-1
BUILDING 707**

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 GOLDEN, COLORADO
 BY
WRIGHT WATER ENGINEERS, INC.
 2490 W. 26TH AVE., SUITE 100A
 DENVER, CO 80211 (303)480-1700

PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

8.0 OPERATIONAL HISTORY OF BUILDING 771

8.1 INTRODUCTION

Building 771 was one of the first four major buildings to be constructed and placed in operation at the Rocky Flats Plant (RFP). For the first few years of RFP operation, Building 771 was the primary facility for plutonium operations. These operations included production of plutonium parts and recovery of plutonium from recycled materials and residues. The final product of this recovery operation was high-purity plutonium metal for use in casting and manufacturing operations (Crisler, 1992).

By the mid-1950s, it was clear that the space within Building 771 was inadequate to support all plutonium operations needed at RFP. This decision was partly prompted by the need to support a new weapons design which required more plutonium than the original weapons. Further, the plutonium shapes in this new weapon required more machining to achieve the necessary specifications. In addition, increased plutonium recovery operations were expected, partly due to the new weapons design. This expansion was known as the Part IV expansion, and included two major production buildings to support plutonium casting and fabrication operations. These buildings are now known as Buildings 776 and 777.

Plutonium part production in Buildings 776/777 began in 1957 when these buildings became operative although much of the production and fabrication equipment for plutonium remained in Building 771. In this manner "backup" plutonium production capabilities existed at RFP (Strangfeld, 1993). From 1957 onward the mission of Building 771 focused primarily on plutonium recovery.

The operations occurring within Building 771 prior to the 1989 shut-down included: (1) the chemical and physical operations for recovering and refining plutonium metal; (2) plutonium chemistry and metallurgical research operations; and (3) radiochemical analytical laboratory operations (EG&G, 1991). The storage of plutonium within the building has also been an essential feature of the building's activities since operations began.

This facility was placed in a curtailed mode of operation in November 1989 due to operational safety concerns. This curtailed mode of operation includes maintenance of the safety envelope

but no processing operations. Since January 1992, Building 771 has been in preparation for decontamination and decommissioning activities (Chew and Associates, 1992).

8.2 HISTORICAL TIMELINE

- 1951 Construction began on Building 771 in November (Buffer, 1993).
- 1952 Building 771 was occupied (Buffer, 1993).
- 1953 The first operations began in Building 771 in July (Epp, et al., 1957a)
- 1957 On September 11, a major industrial fire involving plutonium occurred within Building 771 (ChemRisk, 1992).
- 1958 A plutonium recovery incinerator began operation within Building 771 (Buffer, 1993).
- 1959 The solvent extraction process for plutonium recovery was replaced with the anion exchange process for plutonium recovery (Crisler, 1992).
- 1963/64 During this time period, the building was expanded to increase production. This expansion included the construction of new offices on the eastern portion of the northern wall of the building to accommodate a conference room, a new cafeteria, expansion of process operations into Room 114, and conversion of the original laundry area in Room 124 into additional locker room space (Chew and Associates, 1992). The addition containing the new offices, conference room and new cafeteria is known as Building 771A (EG&G, 1991).

Most of the expanded process operations in Room 114 had previously occurred in Room 149 of Building 771, although at a reduced scale. The new lines in Room 114 consisted of an americium recovery line, dissolution lines, filtrate recovery operations, batching operations, calcination operations, and fluorination operations (Weaver, 1994b).

- 1967 An office expansion was added to the western portion of the northern wall of the building (Chew and Associates, 1992). This addition is known as Building 771B (EG&G, 1991).
- 1970 Construction of a concrete block addition to the west side of the building for consolidation of all the maintenance, pipe, sheet metal and painting activities was completed (Chew and Associates, 1992).
- 1971 Construction of a drum-handling facility joining Building 771 to Building 774 was completed (Chew and Associates, 1992). This drum-handling facility is known as Building 771C or the Building 771 Annex (EG&G, 1991).
- 1974 The plenum system was upgraded (Crisler, 1992).
- 1979 Building 771 was shut down (Crisler, 1992) because Building 371 operations were expected to fulfill the plutonium recovery need of the RFP. Safety and cleanup operations for Building 771 began (Crisler, 1992).
- 1980 Operations restarted within Building 771 (Crisler, 1992) due to Building 371 material accountability problems.
- 1984 A plenum upgrade/replacement occurred (Crisler, 1992).
- 1986 Hydrofluorination upgrades began (Crisler, 1992), but these upgrades were never finished.
- 1989 Plutonium operations in Building 771 shut down in November as part of an overall plutonium operations shut down ordered by DOE.

8.3 PHYSICAL BUILDING DESCRIPTION

Building 771 is currently a one and two story structural-frame building of reinforced concrete construction and covers an area of approximately 300 feet by 260 feet. The second floor area dimensions are approximately 280 feet by 200 feet. The second floor area houses the ventilation equipment, chemical make-up operations, and miscellaneous storage facilities (Crisler, 1992).

The original Building 771 was a two-story, reinforced concrete structure partially buried in a hillside in the north-central part of the plant site (Figure 8-1). Except for the exposed north wall, the sides of the building are only slightly above the finished grade of the hill (EG&G, 1991).

Buildings 771A, 771B and 771C are major additions that were made to the original Building 771. Currently, Building 771A, located on the eastern portion of the north side of Building 771, contains a cafeteria and offices. Building 771B includes additional offices and is also located on the north side of Building 771. Production operations have never been conducted in Buildings 771A and 771B. Building 771C, commonly referred to as the Building 771 Annex, is on the east side of Building 771 and currently contains the shipping, receiving and drum radiological counting area. Other additions have been made to Building 771, but these additions have not been given building numbers. These additions include a loading dock and the maintenance shop (EG&G, 1991). For the purposes of this document, the term "Building 771" is considered to include references to Buildings 771A, 771B, 771C and other additions to the building.

Plutonium is handled in most of the Building 771 operations. These operations are conducted within gloveboxes for primary containment of the radioactive materials. The design of the ventilation system further provides for air flow from areas where plutonium is not handled ("cold areas") to areas where plutonium is handled ("hot areas"). This is accomplished, in part, by supplying air to the cold areas and exhausting air from the hot areas (Crisler, 1991). Room air is drawn into gloveboxes through high efficiency particulate air (HEPA) filters (EG&G, 1991). Air exits the gloveboxes through the following: (1) a HEPA filter; (2) a booster exhaust plenum provided with a minimum of four stages of HEPA filtration; and (3) the main exhaust plenum which is provided with two additional stages of HEPA filtration (Crisler, 1992).

Building 771 does not have a separate process air vent system that specifically handles fumes from the chemical process area. However, individual fume scrubbers are typically used where acids or other noxious fumes require neutralization. Most of the operations involving heated acids are provided with a condenser unit near the operations in addition to offgas treatment with a fume scrubber. The condenser unit typically consisted of a heat exchanger chilled by a countercurrent flow of water. The water is chilled, providing for condensation of a majority of the acid entrained in the exhaust stream (EG&G, 1991).

A large fume scrubber is used to draw acid fumes from dissolver pots, evaporators, calciners, and vacuum systems. This large fume scrubber consisted of two packed media scrubbing towers in series, in which the acid-laden air is contacted by refrigerated potassium hydroxide passing counter to the air flow. Potassium hydroxide is collected in sumps at the bottom of the towers and recirculated through chillers and back to the top of the towers (EG&G, 1991).

8.4 DESCRIPTION OF OPERATIONS

The description of operations for Building 771 is divided into three sections: (1) historical operations (1952-1957), (2) recovery operations (1952 - 1989), and (3) support operations. Historical operations include the original mission of Building 771 as the sole plutonium processing facility at the RFP. Plutonium and americium recovery operations from the opening of the building to the 1989 production curtailment are discussed in detail in Section 8.4.2 of this report. These operations are discussed in detail because they were the major operations within Building 771 during most of its active production period. The discussion in the support operations section focuses on several laboratories which operated in the building. Additional information regarding many of the unit operations described in the following sections can be found in the "Plutonium Processing Materials Data Book" (Thompson, 1972).

8.4.1 HISTORICAL OPERATIONS (1953 - 1957)

Building 771 was originally constructed as a totally self-contained plutonium fabrication and reprocessing facility. For the period of May 1953 until 1957, when Building 776/777 entered operation, Building 771 was the plutonium handling facility for the RFP. During this time period the building housed the following plutonium part production-related activities: casting, fabrication (machining), coating, inspection, and testing, recovery operations, storage of plutonium metal, various laboratories, and other support operations (Chew and Associates, 1992; Strangfeld, 1993). The plutonium-related operations in Building 771 were arrayed along the southern hallway of the first floor of Building 771. Plutonium manufacturing operations were located on the south side of the south hallway while plutonium recovery operations were located on the north side of the south hallway. Only limited information is available on the original casting, fabrication, and other support activities that took place in Building 771. That information is presented below.

- Casting operations were conducted in the foundry in Room 182 (Chew and Associates, 1992).
- Plutonium machining facilities were located in the eastern portion of Room 182 (Chew and Associates, 1992; Strangfeld, 1993).
- Plutonium reprocessing operations were located in the east and west chemical glovebox lines located in Rooms 146 and 148, respectively. A process control room was located in Room 147, and a recovery process area in Room 149. Room 149 accommodated residue recovery using dissolution and a solvent extraction process (Chew and Associates, 1992). Details of the recovery process are discussed in detail in Section 8.4.2. These operations remained largely the same during active operations in Building 771.
- Radiography was located in Room 184.
- Plutonium metal was stored in Rooms 187 and 188 (Chew and Associates, 1992).
- Chemistry and Metallurgy Development Laboratories were located in rooms that are currently designated 172, 174, 175, 176, 178, 179, and 180 (Chew and Associates, 1992).
- Analytical Support Laboratories were located in the building in rooms that are now designated 151, 152, 153, and 157, as well as Rooms 154 through 156, and Rooms 158 through 169 (Chew and Associates, 1992).
- Laundry facilities were located in the northwest corner of the building in an area that is now part of Room 123 (the locker room). The laundry was located in roughly the northeast corner of the current locker room (Chew and Associates, 1992).
- Maintenance shops are known to have existed during this time, but their exact location is not currently known (Chew and Associates, 1992).

- Locker rooms were located in the general location of the current locker rooms for the building, but the original locker rooms were smaller and occupied only the northwestern one-third of the current area (Chew and Associates, 1992)

Offices, a cafeteria, a tool room, and a stock room were located in areas currently occupied by Rooms 101, 102, 106, 114, 120, 122, 127, 133, 135, and 141 through 144 (Chew and Associates, 1992).

Many of the plutonium operations were moved to Buildings 776/777 in 1957. On September 11 and 12, 1957, a fire occurred that caused considerable damage to Building 771 and considerable radiological contamination of areas inside and outside of the building. Although this was a serious fire, no injuries were reported (Epp, et al, 1957a), and the fire debris was cleaned up by 1958 (Barrick, 1989). Because of the damage caused to Building 771, and due to the impending completion of Buildings 776/777, some of the plutonium production operations started in Buildings 776/777 immediately following the Building 771 fire (Epp, et al, 1957a).

8.4.2 RECOVERY (1953-1989)

Plutonium and americium recovery operations were conducted in Building 771. The following discussion primarily addresses plutonium recovery operations because the majority of the building was dedicated to this operation after 1957.

8.4.2.1 Plutonium Recovery Operations

The overall process and chemistry of plutonium recovery at RFP remained largely unchanged since plutonium recovery operations began in Building 771 (Crisler, 1992). However, a number of the individual unit operations were significantly changed. Also, the floor space and equipment devoted to plutonium recovery in Building 771 was considerably increased.

Plutonium recovery operations in Building 771 were originally conducted in a batch fashion which consisted of simple manually operated equipment. At that time, batch operations were sufficient because little scrap was generated by the limited plutonium casting and machining operations. Similarly, site returns of retired or out-of-specification nuclear weapons or nuclear weapons components were minimal. Continuously operating and automatic control systems were

later introduced to increase the recovery capacity of the facility and to decrease radiation exposure of operating personnel.

The following discussion begins with the residue preparation process which prepares feed for the dissolution operations and flows through dissolution and leaching, ion exchange and conversion to metal. Other recovery related operations including plutonium oxidation and incineration are then discussed.

8.4.2.1.1 Residue Preparation

Plutonium residues that underwent dissolution typically consisted of internally generated plutonium including scrap metal, plutonium residues associated with process-generated materials, and skull oxide from foundry operations (Crisler, 1992). Plutonium scrap metal was typically oxidized prior to dissolution operations (See Section 8.4.2.15). Some processing of plutonium-bearing liquids that originated at other DOE facilities was also performed in the 1950s. A brief discussion of these plutonium-bearing liquid feeds is provided below.

The first plutonium-bearing solutions were received from the Hanford Plant in Richland, Washington in 1953 (Crisler, 1992). Shipments of liquid plutonium solutions from Hanford were discontinued in 1959 (Crisler, 1992). After this time, other DOE facilities shipped solid plutonium materials, typically plutonium oxide, to RFP.

Until 1962, one of the feeds for dissolution operations was plutonium metal from foundry operations. This metal, which was called casting skull, had varying amounts of surface oxidation. Its reaction with the nitric acid was erratic, varying from slow to violent. In 1962, the operation was modified to eliminate this unpredictable behavior. Starting at this time the metal was completely oxidized prior to dissolution. This change also eliminated problems related with the storage of pyrophoric metal since the metal was oxidized as quickly as possible (Crisler, 1992).

Crushing and Grinding. Sand, slag, and crucible residues generated from the plutonium reduction process at RFP were reprocessed for plutonium recovery. These materials were primarily composed of calcium fluoride and calcium, along with traces of magnesium oxide, plutonium tetrafluoride, plutonium dioxide, and varying amounts of plutonium metal beads. The materials were broken into small pieces in a jaw crusher and then ground to a fine powder in a hammer mill. A disc-type grinder was also sometimes used for size reduction operations.

Following these operations, the sand, slag and crucible was in a form suitable for feed to the dissolution process.

Glovebox HEPA Filter Processing. Prior to discharge to the Building 771 plenum system, glovebox exhausts passed through HEPA filters installed at the glovebox. During active production when HEPA filters were changed out, the plutonium particulates on the used filter were knocked off by tapping the filter on the floor of the glovebox. The plutonium was then recovered and reprocessed. The used filter was disassembled to separate the wooden frame from the filter medium. The wood was discarded and the filter medium was held for further processing (EG&G, 1991).

8.4.2.1.2 Residue Dissolution and Leaching

Dissolution. Prior to 1965, dissolution was a batch-type operation performed in Room 149 in beakers of 2- to 4-liter capacity, which were heated by electric immersion heaters. The mixture of nitric acid and plutonium residues was agitated by the boiling action caused by the heater, an air sparge, mechanical agitation or a combination of these methods (Crisler, 1992). Typical residue feeds to dissolution consisted of sand, slag and crucible, graphite, plutonium fluoride, and feed heels.

In addition to being very labor intensive, the beaker method had other significant problems. The fumes from the many dissolution beakers corroded the electric heater connections and presented problems for the glovebox air-handling and filtration systems. The efficiency of dissolution was poor, primarily because of incomplete suspension of the solids in the acid solution. This type of dissolution was later used only for special materials or for systems with a low throughput (Crisler, 1992).

To improve dissolution, the batch pots were replaced in 1965 with a system of continuous cascade dissolvers (1965-1971). Additional space was also devoted to dissolution at about this time with the expansion of dissolution operations into Room 114 as well as Room 149. The continuous cascade dissolver system consisted of air-sparged dissolver vessels in series, overflowing by gravity from one to the other. The feed mechanism was a laboratory-sized vibratory feeder. Serious problems existed with this cascade system. The suspension of solids was incomplete. A buildup of solids, termed "heel," would slowly fill the vessels, rendering them inoperable. In order to achieve even minimal solid suspension, high air flow rates were required.

This caused the glovebox ventilation system to be overwhelmed. In addition, the vibratory feeders were subjected to transient equipment vibrations and fed erratically. This required that they be continuously monitored. These deficiencies led to the design of the air-lift with screw feeder dissolvers which were in use from 1971 to the end of process operations in 1989 (Crisler, 1992).

The first set of air-lift dissolvers was installed in 1971 and continued in use until 1989. High-level feeds consisted of various types of plutonium oxide and oxide heels. Incinerator ash and ash heel feeds were processed through the late 1970s, but because of off-gas silicon dioxide plugging problems, process-scale ash dissolution operations were discontinued and ash stockpiled since that time (Crisler, 1992). However, pilot-scale work was conducted in the 1980s to try to find a solution to the off-gas silica dioxide plugging problem (Weaver, 1994a).

In recent operations, both plutonium oxide and plutonium-bearing residues were processed in dissolution lines containing a series of air-lift screw feeder dissolver vessels. Plutonium-bearing residues normally processed included impure oxide, impure fluoride, impure green cake, oxide heel, sand, slag, and crucible (EG&G, 1991). These materials were fed into the first dissolver at a controlled rate by a special screw feeder. Nitric acid, aluminum nitrate, calcium fluoride and water were also fed into the first dissolver at a controlled rate. The solution in the cascade dissolvers was heated to approximately 100° C by internal steam coils. The slurry overflowed (cascaded) from the first to the last dissolver in the set. From the last dissolver, the slurry overflowed to a filter, which separated the undissolved solids from the solution (EG&G, 1991). Agitation within the dissolvers was accomplished by internal air lifts which helped to keep the solids in suspension (Crisler, 1992).

Laboratory Residue Processing. Laboratory residue solutions were transferred to plutonium recovery in 4-liter bottles. These solutions contained plutonium from samples sent to analytical laboratories mixed with chemicals used in the analyses. These solutions contained complexing agents that adversely affected waste treatment processes and chloride ions that could be detrimental to process equipment. These residues were introduced directly into the recovery process by controlled blending of the laboratory residue with the feed to the cation exchange process. In the ion exchange process, chloride ions were separated from the solutions and the solutions go through normal plutonium recovery operations (EG&G, 1991).

Oralloy Leaching. This operation was transferred to Building 771 in approximately 1964 from Building 881 and took place in Room 174 area (Weaver, 1994). Oralloy materials consisted of enriched uranium. Oralloy residues were processed by selectively leaching pieces of scrap metal in a spray dissolver to allow oralloy metal to be recycled directly to the Oak Ridge, Tennessee DOE facilities without being subjected to chemical recovery. A mixture of sulfuric acid and nitric acid was used as the leaching solution to remove contamination present in the oralloy residues. Dissolved uranium and plutonium from the leaching process were ultimately precipitated from the solution and further processed in the special recovery area, Room 146 (EG&G, 1991). The uranium and plutonium present in the leaching solution were precipitated by sparging gaseous ammonia through the solution. The ammonia raised the pH of the solution, causing oxides of uranium and plutonium to precipitate.

Part V Leach Process. Part V Leach operations took place in Room 114. Special material residues, called Part V residues, were processed separately from the other plutonium residues. This process consisted of selectively leaching large pieces of scrap metal in a spray dissolver to remove impurities from the plutonium metal so that it could be recycled directly to MSE without going through chemical recovery (EG&G, 1991). A mixture of sulfuric and nitric acid was used as the leaching solution. The solution from the leaching operation was sent to ion exchange (EG&G, 1991).

8.4.2.1.3 Ion Exchange

The ion exchange process purified and concentrated plutonium-bearing solutions to make them acceptable as feed for the conversion to metal process. The solutions resulted from (1) residue dissolution and leaching processes, (2) solution recycle from conversion to metal processes, and (3) solutions transferred from laboratories (EG&G, 1991).

Ion exchange equipment consisted of two separate gloveboxes and sets of tanks. These two systems were identified as the recycle recovery systems. Solutions were adjusted as batches to a set acid normality using nitric acid. Ferrous sulfamate and aluminum nitrate were added to adjust the valence of plutonium and to complex any fluoride present from the dissolution operation. The adjusted solution was pumped through sets of three columns in series containing nitrate-form resin. The plutonium was retained on the resin and the plutonium-depleted solution (ion column effluent) was collected for shipment to Liquid Waste Treatment Operations in another building. The columns were washed and eluted with nitric acid. The eluate was

) transferred to the feed preparation process for conversion to metal. Ion columns were reconditioned for the next loading using a nitric acid wash. It was necessary to recycle some solution from the initial part of the elution and reconditioning steps. A separate set of cation exchange columns was used to remove chloride from laboratory residue solutions. The chloride waste solution was transferred to Liquid Waste Treatment Operations (EG&G, 1991).

This process replaced the historical solvent extraction process located in Room 149 which utilized tributyl phosphate (TBP) in a batch process (Crisler, 1992; Chew and Associates, 1992). This original batch solvent extraction process had been replaced by a small, continuous mixer-settler system in 1954, and the entire solvent extraction process was replaced in 1959 by the ion exchange system (Crisler, 1992).

8.4.2.1.4 Conversion to Metal

The operations associated with converting liquid feed solutions to plutonium metal included feed evaporation, batching, peroxide precipitation, calcination, hydrofluorination, reduction and button breakout. These processes are described below.

Feed Evaporation. This process was used to concentrate plutonium solutions originating from previous operations. Concentration of these solutions was necessary in order to have an acceptable plutonium concentration in the feed. Solutions selected to be concentrated were analyzed for plutonium concentration, normality, and iron concentration. From these data, the optimum degree of evaporation was determined. The solution was concentrated in a steam-heated, natural-convection evaporator. The concentrated solution, called "bottoms," was transferred as a batch to tanks prior to use in the batching operation (EG&G, 1991).

Feed evaporation was added to plutonium recovery operations in 1964. Prior to 1964, high-level plutonium solutions from dissolution were mixed with low-level solutions from anion exchange or diluted with nitric acid to obtain the desired precipitation feed concentration (Crisler, 1992; Weaver, 1994b).

In 1964, a feed evaporation unit began operations in Room 114 utilizing a single steam chest, thermosiphon-type evaporator in a semi-batch mode of operation. This system remained in operation until August 1988, when a new double-chest thermosiphon evaporator was installed along with a new controller unit. Prior to the installation of the new evaporator, the only changes

to the single-chest unit were upgrading of methods to calculate the amount of liquid to be boiled down (Crisler, 1992).

Batching. This process remained relatively unchanged after the batching line was moved from Room 149 to Room 114 in 1964 (Crisler, 1992; Weaver, 1994b). Relatively pure plutonium nitrate solutions received from oxide dissolution, ion exchange and feed evaporation were blended and adjusted to the proper pH and plutonium concentration before transfer to the peroxide precipitation process. Feed for this process was prepared in batches by blending the available solutions in the proper ratios in two tanks (EG&G, 1991). Sulfuric acid was also added to aid crystal growth in peroxide precipitation. Batches were mixed by circulation with a pump or by air sparging. The batch was sampled and analyzed for normality, impurities, and plutonium concentration. If the batched feed was within the prescribed concentration limits, it was transferred to the feed holding tank. If it was not, adjustments were calculated and solutions were added as needed (EG&G, 1991).

Peroxide Precipitation. The peroxide precipitation process converted the plutonium in solution to a solid form. The original precipitator for use in peroxide precipitation was made of a plastic or lucite material and had a volume of 5 to 8 liters, and was located in Room 149. The vessel contained both an agitator and a slinger plate used to distribute peroxide evenly into the vessel. Cooling coils along the vessel walls maintained a temperature of approximately 4°C during precipitation. A total of four precipitations were completed each day (Crisler, 1992).

For precipitation, hydrogen peroxide was added at a varying rate over the course of approximately one hour. The slurry was then allowed to digest. After digestion, the precipitate was pulled by vacuum through a dip tub in the precipitator vessel to a filter "G" boat. The filter boat was made of platinum-lined monel with a sintered-platinum fritter filter. The filtered precipitate was washed with water, then allowed to air dry. The precipitate was then transferred to a "G" furnace station where it was dried overnight. The dried precipitate cake was fluorinated the next day with anhydrous hydrogen fluoride gas. Peroxide remaining in the filtrate was destroyed with sodium hydroxide. During this period, the precipitate cake often decomposed while in the drying cycle (Crisler, 1992).

Starting in 1954, the precipitate cake was washed with denatured alcohol, eliminating plutonium peroxide decomposition. A major problem at this time was the reaction of hydrogen fluoride and

alcohol within the "G" furnace. An incident occurred in which the furnace pressurized and blew oxide out into the room. The use of alcohol was then terminated (Crisler, 1992).

On June 14, 1957, an explosion during the peroxide digestion cycle blew out the front panel of the glovebox. The primary cause of the incident was the catalytic decomposition of hydrogen peroxide. Shortly after, 35 weight percent hydrogen peroxide replaced the 50 weight percent hydrogen peroxide that had been used earlier. This method was used until the development of the continuous plutonium peroxide precipitation process in the 1960s (Crisler, 1992).

The entire continuous precipitation method was moved to Room 114 in 1964. The basic design remained similar to the methods used in Room 149. Major differences included the addition of a third digester. At about this same time, a calcination step, as opposed to the drying step identified above, was initiated (Crisler, 1992).

In recent operations, the feed solution and hydrogen peroxide were fed into a refrigerated, stirred reactor called a digester. Precipitation occurred and crystal growth began. The plutonium peroxide slurry cascaded through the digesters and into the rotary drum filter basin. A vacuum applied to the filter caused the plutonium peroxide to collect on the rotating filter drum surface. The plutonium peroxide cake which collected on the rotary drum filter, was automatically sliced off the filter wheel, collected in containers and transferred to the calciner (EG&G, 1991).

Filtrate was collected in a set of two receivers. The filtrate was fed to a steam-heated evaporator for conversion of the residual hydrogen peroxide into water and for concentration of the solution. This evaporation unit was referred to as the peroxide kill evaporator. The evaporator distillate was held for shipment to Liquid Waste Treatment Operations. Concentrated evaporator bottoms were transferred to tanks for sampling and analysis prior to transfer to anion exchange (Weaver, 1994b).

Calcination. The calcination process converted plutonium peroxide to plutonium oxide and drove out residual water and nitric acid, leaving a dry, powdered product. This process took place in an electrically heated rotary-tube furnace. The plutonium peroxide cake was fed into the heated tube by a feed auger drawing from a feed hopper. As material passed through the tube, it was dried by a counter-current flow of air that swept the acid fumes and some light particles into a solids scrubber (EG&G, 1991).

The solids scrubber used circulating nitric acid as the scrubbing solution. The calciner tube atmosphere was at a negative pressure compared to the glovebox. The solids scrubber solution dissolved most of the trapped solids. The solution was filtered and transferred to anion exchange. The dried plutonium oxide was collected, screened, weighed into batches, and transferred to hydrofluorination. The off-gas from the nitric acid scrubbing operation was passed through six HEPA filters in series (EG&G, 1991).

Hydrofluorination. Hydrofluorination was first conducted in Room 146 and 149 of 771. Originally, a batch of precipitated plutonium peroxide was filtered, calcined and hydrofluorinated using the same platinum-lined boat. Continuous peroxide precipitation and calcination were added in 1958, but the G-furnaces and platinum-lined boats continued to be used for hydrofluorination until a continuous hydrofluorinator was installed in 1964. A new continuous rotary hydrofluorinator, glovebox and support equipment were installed in 1980-1981 (Crisler, 1992).

In recent operations, plutonium oxide was converted to plutonium tetrafluoride in a continuous rotary-tube hydrofluorinator with a screwfeeder supply for the plutonium oxide feed. Plutonium tetrafluoride was formed by counter-current contact with hydrogen fluoride gas inside the rotating tube. The tube had three separate temperature zones for efficient production of plutonium tetrafluoride and for the removal of impurities such as sulfur from the feed. The plutonium tetrafluoride product was collected, weighed, and transferred in batches to the reduction process (EG&G, 1991).

Reduction and Button Breakout. This process consisted of placing plutonium tetrafluoride in a magnesium oxide crucible, which was surrounded with magnesium oxide sand. A 30 percent excess of the stoichiometric equivalent of calcium was added to the crucible. Initiators were also placed in the crucible which was inerted with argon, sealed, and heated in a reduction vessel. This process was conducted in an inert, nitrogen-filled glovebox for fire protection. The initiator, which was made of potassium iodate, magnesium metal, and sodium peroxide, started an exothermic reaction at approximately 150° C. Temperatures in the crucible rose to approximately 2,000° C. During the reaction, the magnesium oxide sand acted as a heat sink, protecting the glovebox from temperature and pressure spikes (EG&G, 1991). In this reaction, pure plutonium metal buttons were formed.

After cooling, the crucible was opened and the plutonium button removed. The slag left in the crucible and the crucible were recycled through brushing/grinding and transferred to the dissolution process for plutonium recovery as sand, slag and crucible material (EG&G, 1991). The sand, slag, and crucible material included calcium fluoride and calcium, along with traces of magnesium oxide, plutonium tetrafluoride, plutonium dioxide, and varying amounts of plutonium metal beads.

The reduction operations remained largely unchanged since metal reduction operations began at RFP, with the exception of the introduction of initiators in 1972/1973 and increasing plutonium charges being introduced to the reduction vessel (Crisler, 1992).

8.4.2.1.5 Plutonium Oxidation

Plutonium oxidation converted pure plutonium metal, which was pyrophoric, to a more stable plutonium oxide. The plutonium oxide was then used as a feed to the dissolution operation. The source of plutonium for oxidation was solid pieces, such as buttons from recovery, flashing from button breakout, and drill shavings from button sampling. Oxidation of the metal was conducted in tantalum metal pans on electrically heated hot plates in a glovebox dedicated to this purpose (EG&G, 1991).

8.4.2.1.6 Incineration

Large quantities of combustible residues contaminated with small amounts of actinides, primarily plutonium and americium, were generated when RFP produced nuclear weapons components. One method to allow for recovery of plutonium from these materials was to reduce the amount of combustible bulk by incineration. Actinide contaminants remained in the ash, resulting in an ash having a plutonium concentration ranging from 5 to 10 weight percent. This ash was then sent to dissolution for subsequent recovery of the plutonium (Crisler, 1992). The incinerator was constructed in Room 149 (Chew and Associates, 1992) and became operational in 1957 or 1958 (Chew and Associates, 1992; Buffer, 1993).

Combustibles to be used as feed to the incineration process were stored in 55-gallon drums. The contents of one drum was emptied into the incinerator-sorting portion of the glovebox. Contents of the drum were searched for glass, metal and any other items which would not burn or would cause a hazard in the combustion chamber (Crisler, 1992).

The incinerator was comprised of three chambers: a firebox (with approximate dimensions of 2 feet by 2 feet by 3 feet) where combustibles were initially introduced to the system and burned, a main burner chamber where ashes which fell through the firebox grate continued to burn, and an afterburner section (Crisler, 1992). The offgases from the incinerator were treated through an extensive off-gas scrubbing and filtration system to minimize releases to the environment.

8.4.2.2 Americium Recovery

Plutonium-241, constituting less than one weight percent of the RFP plutonium stream, undergoes decay to americium-241. Equipment for removal and concentration of americium from plutonium solutions was installed in Room 149 in 1957 (ChemRisk, 1992; Chew and Associates, 1992).

Feed for the americium recovery process prior to 1967 originated from the plutonium recovery precipitation filtrate stream, which was stored in a set of tanks external to the gloveboxes. The filtrate from plutonium recovery operations was concentrated by evaporation, the bulk of the plutonium removed by anion exchange, and the americium recovered and purified by a thiocyanate ion-exchange process (Crisler, 1992). Pencil tanks for storage of americium solutions were also located in Room 149, with an americium nitrate solution tank located outside the building to the north (Chew and Associates, 1992).

In 1967, a molten salt extraction (MSE) process was developed to extract americium directly from aged plutonium metal. This MSE process took place in Building 776. Due to the new MSE process, the americium concentration in the plutonium-peroxide filtrate decreased. MSE residues were the only source of recoverable americium after 1968. After dissolution, actinides in the MSE residues were separated from the chloride salt matrix with a potassium hydroxide precipitation step. This precipitation step was later replaced by a cation exchange process (Crisler, 1992).

The americium purified at RFP was sold by DOE for use in commercial applications such as a medical diagnostic tracer and for smoke detector ionization sources. However, the demand for americium dropped off in the late 1970s, making purification and sale of the material uneconomical (ChemRisk, 1992). Americium was declared a waste by DOE in 1986 and no emphasis was placed on the recovery of americium after this date (Crisler, 1992).

8.4.3 SUPPORT OPERATIONS

The major support operations conducted in Building 771 included several laboratories and shipping and counting operations which are described below.

8.4.3.1 Chemical Technology

Plutonium chemistry technology in Building 771 supported and developed improved methods for recovering, separating, and purifying actinides from acidic streams (EG&G, 1991).

Chemical research and development for actinide element separation and purification was conducted on laboratory-scale, pilot-scale, and production-scale equipment. Projects were conducted for the purpose of testing and gathering basic information. In addition to providing services for production at RFP, work was done in job lots for other DOE facilities, design agencies, and governmental departments (EG&G, 1991).

One of the primary operations studied by this laboratory was dissolution. Thus, nitric acid use by this laboratory was high, but use of other compounds was on an extremely limited basis.

8.4.3.2 Plutonium Metallurgy Research

The plutonium metallurgy group of Building 771 assisted in the development of processes that required metallurgical production of materials and related manufacturing techniques. Plutonium metallurgy operations consisted of casting, heat-treating, rolling, forming, forging, sizing, and swaging. Supporting operations included metallography, X-ray diffraction, tensile testing, density measurements, and powder metallurgy (EG&G, 1991).

All plutonium metallurgy operations were conducted in gloveboxes. In recent years, the primary emphasis was on plutonium casting operations. Castings were made in ceramic-lined metal molds or ceramic-lined graphite molds (EG&G, 1991).

8.4.3.3 Plutonium Operations Support Laboratory

Liquid and solid samples were received by or prepared in the Building 771 analytical laboratory. Samples were analyzed for plutonium, americium, uranium, neptunium, and other radioactive

isotopes (EG&G, 1991). Small liquid samples and sludges were prepared for analysis in "B" boxes that could be opened to the room. Sample analysis involved the use of hydrochloric acid, nitrous oxide and hexane in some cases (EG&G, 1991).

8.4.3.4 Shipping and Counting

Shipping, receiving, and measurement of the amount of radioactivity (counting) of containerized materials entering or exiting Building 771 were performed in Building 771C. Building 771C was separated from the remainder of Building 771 by an airlock. Typical operations in Building 771C included temporary storage of materials in containers and counting of individual containers for activity prior to transfer into or out of Building 771. Containers remained closed while in temporary storage, and counting was a non-destructive, non-intrusive activity (EG&G, 1991).

8.5 CURRENT CONTAMINATION STATUS

Building 771 is considered hazardous due to the existence of quantities of Special Nuclear Material (SNM) in storage and due to plutonium contamination present in the building (EG&G, 1992a).

Sources of radiation exposure in Building 771 are plutonium and uranium solutions in tanks and bottles; plutonium metal, oxides, and fluorides in vaults; and other residues stored in drums. Exposure levels in the vaults are up to 15 millirem per hour. The average exposure level for chemical operators during curtailment has been 150 - 160 millirem per year (EG&G, 1992a).

Some Building 771 process areas are contaminated with plutonium, ranging from less than 200 disintegrations per minute per 100 square centimeters, to in excess of 1,000,000 disintegrations per minute per 100 square centimeters. The latter is the limit of the detection instruments used by the Radiation Protection Technologists (RPTs) (EG&G, 1992a).

Room 141, an old pump room, is the most heavily contaminated area. The pumps, which were not housed in gloveboxes, were used to transfer plutonium nitrate solutions. The solution leaked and the acidic solution contaminated, corroded, and diffused into the concrete floor (EG&G, 1992a).

Many contamination incidents have occurred in the process areas during the 40 years of processing and storage of plutonium solutions and solids. Decontamination of the working areas was accomplished to the extent possible at the time of the incidents. Contamination which could not be removed was painted over. Thus, there can be contamination within the layers of paint (EG&G, 1992a).

Hazardous wastes present within Building 771 include mixed low-level radioactive and hazardous waste, mixed transuranic and hazardous waste, as well as straight hazardous waste. There are also approximately 72 tanks containing hazardous or mixed radioactive and hazardous waste (EG&G, 1992a).

Building 771 also has appreciable amounts of asbestos insulation, but this material has been identified and wrapped in plastic to await decontamination and decommissioning efforts (EG&G, 1992a).

Because the 1989 curtailment status was initially expected to last for a short period of time, plutonium bearing residues and process operations were stabilized only for short term storage and long term actions were not taken. During the 1989 to 1992 curtailment period, multiple assessments of the building equipment and infrastructure resulted in a decision that the plutonium recovery operations would not resume within this building. At this time, the specific schedules and details concerning the type and magnitude of future operations within Building 771 are not well defined (EG&G, 1992).

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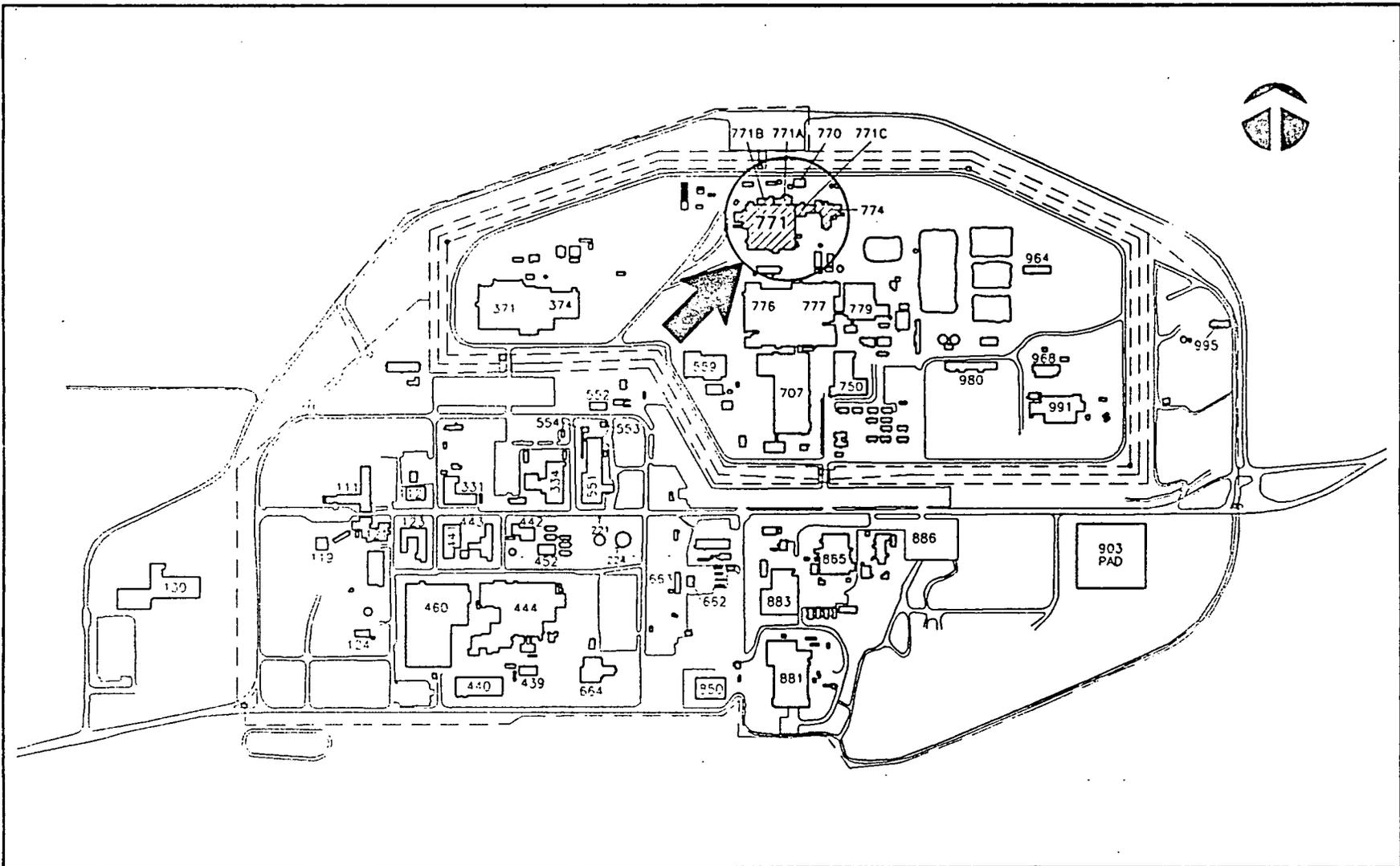
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PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO
BY
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700

FIGURE 8-1
BUILDING 771

9.0 OPERATIONAL HISTORY OF BUILDING 776/777

9.1 INTRODUCTION

Building 776/777 began operations in 1957 and has undergone several major production changes since that time. These can be divided into three time periods: pre-1969 fire, post-1969 fire to the 1989 production curtailment, and current operations.

Until the 1957 fire in Building 771, the plutonium foundry, fabrication and assembly operations at RFP were housed in Building 771. Beginning in 1958 and continuing through 1969, Building 776 was the main manufacturing facility for plutonium weapons components and housed a plutonium foundry and fabrication operations. Building 777's main function was assembly of parts.

After a major fire in Building 776/777 in 1969, the majority of the foundry and fabrication operations were transferred to Building 707. After several months of clean-up following the fire, limited production operations were resumed in Building 776/777 (EG&G, 1990); however, the main focus of the building turned towards waste and residue handling, disassembly of site returns and special projects. Processes conducted in Building 776 included size reduction, advanced size reduction, pyrochemistry, coatings operations and test runs with a fluidized bed unit (EG&G, 1990). Building 777 operations included machining, product assembly and disassembly functions, testing and inspection, special weapons projects and support operations such as laboratories (EG&G, 1990).

Current operations in Building 776/777 have been vastly reduced compared to operations prior to the 1989 production curtailment. Current operations in Building 776 include waste handling and maintenance activities. Building 777's current activities include a Tritium Surveillance Laboratory and container repacking operations. In addition, nuclear material and waste are currently being stored in the building (EG&G, 1993; EG&G, 1992).

9.2 HISTORICAL TIMELINE

1957 Construction of Building 776/777 was completed (Buffer, 1993). The purpose of Building 776 was plutonium components manufacturing, and the purpose of

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- Building 777 was assembly and inspection of the pit for the Part IV weapon design, which used plutonium and other metal components (ChemRisk, 1992).
- 1957-1969 Building 776 was the major user of carbon tetrachloride, and Building 777 was the major user of trichloroethylene (TCE) at Rocky Flats Plant (RFP) (ChemRisk, 1992).
- 1958 The first significant machining of plutonium began. This process used Shell Vitrea cutting oil followed by a washing with carbon tetrachloride (ChemRisk, 1992).
- 1961 The concrete block wall between Buildings 776 and 777 was removed to accommodate additional equipment (USAEC, 1969).
- 1963-1964 Building 777 switched from using isopropyl alcohol in cleaning activities to using TCE (Dingman, 1991). Perchloroethylene (PCE) was also replaced with TCE at this time (Hornbacher, 1994b).
- 1964 The "Campbell incident" occurred involving an explosion between plutonium and carbon tetrachloride in Building 776 during a briquetting operation. This incident resulted in research and development (R&D) projects that examined the interaction of plutonium with a variety of solvents (ChemRisk, 1992).
- 1965 The "glovebox drain line fire" occurred during maintenance on a plugged oil coolant drain line in Building 776/777. The fire was attributed to spontaneous combustion of plutonium chips. The fire spread contamination inside of the building (Buffer, 1993).
- 1966 The canteen, locker room and laundry were relocated to another building in order to provide more operating space in Building 776 (USAEC, 1969).
- 1966 Glovebox 134-24, located in the North Foundry Line in Building 776, was modified to increase storage capacity and to reduce handling damage to heat sensors (USAEC, 1969).

- 1967 The Part V expansion program began. Project goals included rearrangement and expansion of production foundries and installation of additional equipment for fabrication and connecting conveyor lines (USAEC, 1969).
- 1967-68 Actions to reduce penetrating radiation exposure levels to employees were undertaken. These involved installing additional shielding to glovebox systems in Building 776/777. Materials installed included lead, leaded glass, and Benelex and Plexiglas of various thicknesses on the gloveboxes and conveyor lines (USAEC, 1969).
- 1969 A major fire occurred in Building 776/777 on May 11, 1969. This fire released as much as 210 μ Ci of plutonium to the atmosphere with significant property loss. The fire resulted in new safety procedures, including sprinklers, more fire walls and operational modifications such as performance of some plutonium work in inert atmospheres (Buffer, 1993; USDOE, 1980).
- 1969 Waste operations began in Building 776, originally initiated for the purpose of disposing of the 1969 fire contaminated material (EG&G, 1992).
- 1970 Pyrochemistry operations used for plutonium recovery began in Building 776 and continued until 1989 (EG&G, 1992).
- 1971 Clean-up activities for the 1969 fire were completed on October 18 (Buffer, 1993).
- 1972 Plutonium fabrication operations in Building 776 were transferred to Building 707. Building 776 was converted to a waste storage and size reduction facility (ChemRisk, 1992). TCE was replaced with trichloroethane (TCA) (Hornbacher, 1994b).
- Mid-1970s Tritium gettering of site return parts began in Building 777 (Dingman, 1991).
- 1979 The fluidized bed unit (FBU) made its first 108-hour burn of "non-line," low-level transuranic (TRU) wastes (Buffer, 1993).

- 1983 Construction of the Advanced Size Reduction Facility (ASRF) in Building 776 began (Buffer, 1993).
- 1986 The ASRF became operational (Buffer, 1993).
- 1988 The "Hot Laundry" facility began operation in Building 777. Its purpose was to launder radionuclide-contaminated clothing separately from non-contaminated plant laundry for the purposes of decontamination (Buffer, 1993).
- 1989 Plutonium production operations ceased in November (EG&G, 1990).
- 1994 The Supercompactor and Repackaging Facility (SARF) became operational on May 9. Its goal was to reduce up to 80 percent of the volume of TRU waste stored and shipped from RFP (EG&G, 1994).

9.3 PHYSICAL BUILDING DESCRIPTION

The Building 776/777 complex is located in the north-central portion of the plant site (Figure 9-1). Buildings 776 and 777 share a common wall, utilities and maintenance. The building has a structural steel frame, the majority of which has been covered with heat shielding materials. All floors in the building are cast-in-place reinforced concrete slabs. The main floor has an area of 135,000 square feet. Metal facilities occupy 62,000 square feet and waste handling occupies 63,000 square feet. The second floor contains 88,000 square feet and is almost exclusively occupied by utilities. There are two sub-basement areas: a four-bay area of approximately 1,600 square feet and an elevator pit area which is adjacent to the tunnel connecting Buildings 776 and 771.

Building 776/777 contains an extensive glovebox network that historically supported various plutonium production operations. Prior to the 1969 fire, the majority of the building space was in one large open room. Since that time, the building has been compartmentalized into several areas separated by physical barriers to confine any radioactive material releases. The western portion of the building was equipped with storage vaults for plutonium buttons. These vaults are still in use. The northwest corner of the building stored plutonium in cans (Boss, 1994). A ventilation system of negative pressure is used to keep areas of least contamination from becoming contaminated by areas of higher contamination. The building is equipped with a series of High Efficiency Particulate Air (HEPA) filters to control air emissions to the environment (EG&G, 1992).

A laundry facility in Building 777 was used to wash worker protective clothing and respirators with measurable radioactivity levels of 250 to 20,000 counts per minute (EG&G, 1990). Laundry facilities are no longer operational in this building (EG&G, 1993b).

Utilities are shared between Buildings 776 and 777. These include supply and control of potable water, eye wash and emergency body showers, cooling water, sanitary sewage, building heating and air conditioning, glovebox and vacuum air supply, emergency electrical power and compressed air (EG&G, 1990). In addition, the building had an air drying system that contained Kathene as the drying agent. The Kathene solution was treated with a chromium anti-microbial additive. This air drying system ceased operations in the early 1990s (Bouwer, 1994). The building also has a liquid nitrogen tank system that is used as a secondary source of high purity nitrogen for the glovebox inert atmosphere system. The process drains in the buildings are no longer usable and are filled with concrete. Instead, the liquid waste is collected in sumps and is transferred to tanks and disposed of through liquid waste processing in Building 374 (EG&G, 1992; Bouwer, 1994).

9.4 DESCRIPTION OF OPERATIONS

The operational history of Building 776/777 is organized according to three distinct time periods: from 1957 to the 1969 fire, post-1969 fire to 1989 operations curtailment and current operations since 1989.

9.4.1 OPERATIONS FROM 1957 TO THE 1969 FIRE

In 1957, a change in the weapon concept occurred which resulted in an increase in plutonium relative to uranium content. In addition, different shapes of plutonium with closer dimensional tolerances were also required. Thus, more rolling, forming and machining of plutonium was required than in the earlier years of production. As a result of these changes and an increased workload, the Building 776/777 complex was constructed for plutonium casting, fabrication, assembly and quality assurance testing. Building 776's main purpose was the casting and fabrication of plutonium parts, and Building 777's main purpose was assembly of parts and some disassembly of site-return parts (ChemRisk, 1992; USAEC, 1969; Hornbacher, 1994b). Four principal glovebox systems existed in Building 776/777 during 1957 to 1969. These included the North Foundry Line, the South Foundry Line, the Center Line, and the North-South-East Machining Line. All production operations were carried out in gloveboxes which were interconnected by a series of conveyors. The conveyor system was an overhead chain link conveyor on which materials were moved between gloveboxes. In addition, conveyors served

the North and South Briquetting Presses and provided a way to return scrap or machining chips to the casting furnaces (USAEC, 1969).

9.4.1.1 CASTING

The original foundry was located in the southwest corner of Building 776 in the approximate area of the current Room 134. The foundry contained 16 furnaces which were crowded into the room (Lombardi and Campbell, 1994). Foundry operations cast plutonium either as ingots suitable for rolling and further wrought processing or into shapes amenable to direct machining operations. Foundry operations also included collecting, reprocessing and remelting of machine turnings and solid scrap. Additional responsibilities included preparation and transfer of samples to the analytical laboratory, operation of a molten salt extraction (MSE) facility and filtration of waste machining oil and turning degreasing solvent (USAEC, 1969).

Foundry equipment consisted of two nearly identical glovebox lines which handled plutonium: the North and South Foundry Lines. Eight furnaces were located on each line. Six of those on the North Line were used for alloyed War Reserve ingot production, one was used to make feed ingots from alloyed turnings, and one was used to burn skull-lid material from the tantalum-ware used in the casting furnaces. Two of the furnaces of the South Line produced alloyed feed ingots from buttons, two produced classified feed ingots, and two were used for alloyed classified feed ingots or to cast the plutonium from units that were returned from the stockpile. One furnace was used exclusively for casting special alloy parts and one was assigned to R&D work (USAEC, 1969).

The foundry received many materials as feed sources. These included fresh reactor feed in the form of buttons from Savannah River and Hanford, buttons of reprocessed RFP residue materials from Building 771, scraps, turnings, stockpile return parts and residues (USAEC, 1969). Button processing took place in the South Line and involved casting all buttons into feed ingots and blending them to produce War Reserve, special job order or preproduction ingots. A large part of the low-ameridium fresh feed material went into the alloyed preproduction ingots which were stored in Building 991 in preparation for Part V production requirements (USAEC, 1969).

9.4.1.2 FABRICATION

Fabrication operations involved either direct machining of ingots or cast shapes produced in the foundry or conducting a wrought process which further prepared the ingot for machining operations (USAEC, 1969). The wrought process involved rolling ingots into sheets and cutting them into circle blanks to be passed through the Center Line for pressing. The pressed blanks

were then annealed in furnaces prior to machining. Machining operations involved taking cast or wrought parts and performing a sequence of operations including debrimming or removing sprues, contouring, drilling and milling. Machining operations took place on the North-South-East Line (USAEC, 1969).

In 1958, oil was added to the plutonium machining process to enable more rapid machining with less chance of spontaneous combustion. In very early operations, Shell Vitrea cutting oil was used followed by a washing with PCE. Shortly thereafter, PCE was replaced with carbon tetrachloride because PCE caused degradation of the gloves in the gloveboxes and created a gummy residue which interfered with inventory control (Strangfeld, 1994; USAEC, 1969). Later, the Shell Vitrea oil was replaced with Texaco Regal oil because it was less costly (Strangfeld, 1994). Building 776 housed a centralized oil collection system. The oil was filtered and used filters were sent to Building 771 for plutonium recovery. Disposal of the waste oil after approximately 1966 was accomplished through a solidification process in Building 774. However, prior to the operation of the Building 774 solidification process, disposal of the plutonium-contaminated waste oil was a significant problem. The generation of this waste, and the lack of an acceptable treatment system, resulted in the outdoor storage of these waste oils at the "903 Pad" (Putzier, 1970).

9.4.1.3 ASSEMBLY AND TESTING

Assembly operations were located in Building 777 and involved assembling various pit components. The units primarily contained nuclear materials such as plutonium and uranium, however, non-nuclear materials such as steel, beryllium, copper, monel and silver were also assembled. Prior to assembly, all components were thoroughly cleaned with ethyl alcohol or acetone and inspected (Strangfeld, 1994). Assembly activities included drilling, welding, brazing, turning and polishing (USAEC, 1969; ChemRisk, 1992). After assembly, completed units were packed and shipped off-site or to Building 991 for final processing, storage and shipping (USAEC, 1969).

Prior to the introduction of ultrasonic cleaning units in approximately 1960-1961, the plutonium parts were cleaned by dipping them in tanks of TCE (Crisler and Dingman, 1993). Cleaned parts were then moved to the superdry room in the down-draft assembly area where the parts were welded together. Welded assemblies were then baked, filled and sealed, leak-tested, weighed and tested by non-destructive testing. All assemblies were then radiographed, dimensionally inspected, sampled and finally packaged. Similar operations took place for non-nuclear assemblies (USAEC, 1969).

The assembly process for plutonium parts after approximately 1960-1961 involved washing the parts in an ultrasonic cleaning unit using Alk-Tri-grade TCE followed by a visual inspection for physical damage. The cleaned parts were then wrapped in aluminum foil and moved to the assembly glovebox storage area. Plutonium parts were rewashed using the ultrasonic vapor-degreaser system, again using TCE (USAEC, 1969).

Special assembly operations included the Zero Power Plutonium Reactor (ZPPR) project. This project involved assembly and welding of stainless steel to plutonium-molybdenum-uranium alloy plates (ChemRisk, 1992). Other special assembly operations included assembly of special order pits and parts which were tested at the Nevada Test Site (Hornbacher, 1994b).

9.4.1.4 DISASSEMBLY

Disassembly operations were also conducted in the Building 777 assembly area. The first site-return work performed in Building 777 took place in 1958 (Dingman, 1994). Increased site-return disassembly activities began in the late 1960s as old weapon designs were retired and disassembled to recover valuable materials (Hornbacher, 1994b; USAEC, 1969). After disassembly, parts were inspected for unusual conditions and segregated according to material type. Plutonium materials were returned to the Building 776 foundry where they were cast into feed ingots. Depending on assay specifications, the ingot was then sent to the MSE facility for americium removal. Otherwise, the ingot was sent to Building 771 for chemical purification and returned to the foundry as a fresh button. Enriched uranium parts were shipped to Building 881 for recovery, and depleted uranium and inert components were packaged for disposal at off-site disposal sites (USAEC, 1969).

9.4.1.5 RECOVERY

Several recovery operations were conducted in conjunction with fabrication operations in Building 776. These focused on processing plutonium scrap, turnings and residues.

Alloyed scrap from rejected parts, Center Line scrap, other classified scrap, and alloyed turnings were degreased with carbon tetrachloride, briquetted and recast directly into ingots (USAEC, 1969; Lombardi and Campbell, 1994). The briquetting operations were conducted on the North and South Briquetting Presses which were located towards the center of Building 776/777. These briquetting presses were located in gloveboxes which ran east-west. Briquetting presses took machine turnings and scrap plutonium which had been degreased with carbon tetrachloride and pressed the metal into a hockey-puck type shape. The presses located in the gloveboxes were

hydrostatic presses (Boss, 1994). In addition, Building 776 contained an isostatic press located outside of the glovebox line which utilized oil for pressing (Lombardi and Campbell, 1994).

Various operations in Building 776 produced residue material that was reprocessed and recovered (USAEC, 1969). In some cases, dirty materials were oxidized in furnaces or hot-plates to convert plutonium to an oxide form which could be recovered by dissolution in Building 771 (Weaver, 1994).

9.4.2 OPERATIONS FROM THE 1969 FIRE TO 1989 PRODUCTION CURTAILMENT

On May 11, 1969, a major fire in Building 776/777 resulted in relocation of some of the foundry, fabrication and assembly operations into Building 707 (Hornbacher, 1994a). Cleanup of areas following the fire resulted in the disposal of some equipment including the hydroform press, the briquetting presses, the rolling mill, casting furnaces and gloveboxes associated with this equipment (Dingman, 1994). As a result of the fire, additional walls were constructed within Building 776/777 for better fire safety (Hornbacher, 1994a). After the fire, the major production operations in the building were reduced to machining operations on the South Line in Building 776, and disassembly of site returns and assembly operations in Building 777. Special order and R&D work became more common than the pre-fire War Reserve production (Dingman, 1994). In Building 776, the empty spaces resulting from the fire were mostly filled with waste-related operations which focused on waste reduction (Hornbacher, 1994a). Other operations conducted in the complex included plutonium recovery operations in Building 776 and support operations such as storage and laboratory work in both buildings. These operations continued until production curtailment in 1989 (EG&G, 1993b).

9.4.2.1 CASTING

After the 1969 fire, Building 776 casting operations ceased, its casting furnaces were removed, and its casting operations were assumed by Building 707 (Dingman, 1994; Bouwer, 1994). The spaces within the foundry area were largely replaced by waste-related operations

9.4.2.2 FABRICATION

Parts cast in the Building 707 foundry were machined in Rooms 131 and 134A in Building 777. Equipment used was contained in eleven gloveboxes and included a dry lathe, eight oil-cooled lathes, a five-axes mill and a jig borer. Prior to machining, parts were cleaned with carbon tetrachloride and Freon 113. After machining, the parts were sent for further processing and the

remaining scrap metal was returned to the briquetting process located in the South Foundry Line (EG&G, 1990). This process is no longer in operation (EG&G, 1993b).

In addition, shortly after the fire, the South Machining Line in Building 776 resumed operations which focused on special order work and one War Reserve program (Dingman, 1994).

9.4.2.3 ASSEMBLY

After the fire, the main source of parts to be assembled in Building 777 changed from Building 776 to Building 707 (Dingman, 1994). Rooms 430, 432, 432B, 433, and 440 were down draft rooms used for assembly and cleaning activities. These "superdry rooms" were virtually moisture-free and enclosed in an airlock chamber. The rooms were connected to a glovebox and received parts which had passed through electron beam welding and non-destructive testing. In Glovebox 465 in Room 430, inspected parts from Building 777 were cleaned in a 10-gallon TCA bath to remove oil, grime and dirt. Next, the ultrasonic vapor degreaser, which was also located in Room 430, used a 90-gallon TCA bath split into two compartments to further clean the parts. After rinsing, the part was placed on a down draft table and the TCA was evaporated and the parts were assembled and cleaned with lint-free wipes and TCA or ethyl alcohol. The parts were then sent to the superdry electron beam welding unit in Building 707 (EG&G, 1990). When the TCA baths used for cleaning became dirty, they were piped directly to the Building 777 waste TCA collection system (EG&G, 1990). The TCA used in these baths replaced the TCE cleaning system which was used prior to 1972. This change was made in response to the 1972 Clean Air Act in order to reduce hydrocarbon emissions (Hornbacher, 1994b).

An additional ultrasonic cleaning system was located in Room 440 and operated similarly to the system in Room 430, except it cleaned metal filters from Module H in Building 707 (EG&G, 1990).

9.4.2.4 DISASSEMBLY

Disassembly operations in Building 777 continued from the late 1960s throughout the 1970s and 1980s. These operations involved the disassembly of site return plutonium parts for further processing in the MSE operation on the Building 776 side. Two lathes inside gloveboxes in Room 430 were used to disassemble parts. One lathe was used for beryllium components and the other was used for aluminum and stainless steel components. For some parts, the outer portion of the part would be partially cut outside of the glovebox and then disassembled within the glovebox (Hornbacher, 1994b). Following disassembly, the plutonium parts were transferred to the MSE process. Ethyl alcohol and 1,1,1-TCA were used in small quantities to clean parts

in this operation (EG&G, 1990). In addition to the site return disassembly operations, samples from the weapons stockpile were also disassembled as part of quality assurance/quality control (QA/QC) operations (Hornbacher, 1994b).

Because tritium was generated from the disassembly of some types of contaminated parts, a tritium gettering system was installed. This system removed tritium from gas sampling and glovebox exhaust by converting it to tritiated water and desiccating the air stream. The tritium gettering process has not been used since approximately 1988 (EG&G, 1990).

9.4.2.5 INSPECTION AND TESTING

Pre-assembly testing of the plutonium parts and inspection of assembled components were conducted in Building 777 until production curtailment (EG&G, 1993b). These activities included non-destructive testing, inspection and density balance operations. Component integrity testing was also conducted on non-production parts.

Non-destructive Testing (NDT). NDT included radiography and weighing. Radiography used X-rays to examine plutonium parts for structural flaws. Freon 12 was used in one type of X-ray device, and sulfur hexafluoride was used in another type of X-ray device. The X-ray development process used fixer solution which was sent to Building 774 for silver recovery after use. Developer was also used and washed down the process drain after use. Small quantities of TCA were used for general cleaning purposes. Weighing activities involved cleaning parts with TCA and then weighing them in a glovebox on a gram balance (EG&G, 1990). NDT is no longer conducted in this building (EG&G, 1993b).

Inspection. Inspection activities took place in Rooms 130 and 430 and involved dimensional non-destructive testing of parts and assemblies. Part surfaces were cleaned with carbon tetrachloride and Freon 113 on abrasive pads. Oil was sometimes applied to the part surface for testing and then was removed using Freon 113 (EG&G, 1990).

Density Balance Operations. The density of plutonium metal parts was determined by immersing the part into a 15-gallon Freon 113 bath and measuring the density relative to Freon 113. These activities were conducted in a nitrogen inerted glovebox. Provided that the part was determined to have the proper density, it was sent on for further processing (EG&G, 1990).

Component Integrity Testing (Nuclear Assembly Technology). Rooms 445, 453, 454, 459, 459A and 460 were used to conduct component integrity testing. This process involved stress, vibration, strain, tensile strength and gravity force analyses. Gloveboxes 494, 495, 499, 500, 501

and 502 were located in the process area. Process equipment consisted of pressure chambers, tensile testers, welders, an environmental chamber, a gravity-inducing machine and vibration and shaker machines (EG&G, 1993). Small amounts of aqueous detergent sprays were used for general cleaning (EG&G, 1990).

9.4.2.6 RECOVERY

The main recovery operations in the building were briquetting and pyrochemistry operations located in Room 154 in Building 776. The major pyrochemical processes for recovery of site return materials and scraps were molten salt extraction (MSE) and electrorefining. Prior to undergoing MSE or electrorefining, the plutonium components from retired weapons were reduced in size using a pneumatic sizer (EG&G, 1990; EG&G, 1993). Other recovery operations were used to recover plutonium residues and oxides. These included direct oxide reduction (DOR) and the salt scrub process. All of these operations ceased by 1989 (Bouwer, 1994).

Briquetting. Post-fire briquetting operations involved the pressing of plutonium metal machine turnings into pucks using a hydraulic press. The turnings were first conveyed to Room 131 in Building 777 where they were cleaned in perforated metal baskets which were dipped into a series of four identical carbon tetrachloride baths. The scraps were then air-dried and pressed into pucks which were conveyed to the foundry in Building 707. The carbon tetrachloride baths were changed frequently. Waste bath solutions potentially contained Freon 113 and machining oils (EG&G, 1990). These were eventually disposed of in liquid waste processing in Building 774 (Bouwer, 1994). These operations ceased with production curtailment, but the process equipment remains in the building (EG&G, 1993b; Bouwer, 1994).

MSE. The purpose of the MSE process was to remove americium contamination from site return plutonium metal parts. Six furnaces dedicated to MSE were installed in the building in 1972 (McKaig et al., 1983). The process involved placing the plutonium metal in an argon-inerted crucible with an oxidant salt and a solvent salt in an electrically heated furnace. Beginning in approximately 1986/1987, dicesium hexachloroplutonate (DCHP) was used as the oxidant salt and calcium chloride was used as the solvent salt. The process produced a purified plutonium "button" and a contaminated chloride salt. Americium chloride and plutonium chloride were removed from the contaminated chloride salts in the salt scrub process (EG&G, 1990; EG&G, 1993). The plutonium button was sampled for purity, and if it was pure enough, it was sent to Building 707; otherwise, it was sent through electrorefining as an additional purification step (Dingman, 1994).

Electrorefining. In the early 1960's, an in situ electrorefining process was developed in which non-specification plutonium metal was electrorefined to produce purified plutonium (III). A production-scale electrorefining facility consisting of six furnaces was established in Building 776 in 1966 (McKaig et al., 1983; Crisler, 1992). In late 1970, electrorefining was discontinued because 70 to 75 percent plutonium yields from the process were deemed unacceptable compared to the aqueous process in Building 771 which could produce 90 to 95 percent yields. However, electrorefining research continued and resulted in the development of the tilt-pour furnace which was placed in Building 371. In May 1987, the tilt-pour electrorefining furnace was shut down in Building 371, and the decision was made to implement an electrorefining production with stationary furnaces in Building 776. Electrorefining activities resumed in Building 776 in 1988 (Crisler, 1992). The electrorefining process at that time involved purifying non-specification plutonium metal by placing the metal in a magnesium oxide crucible with magnesium chloride, sodium chloride and potassium chloride. The crucible was placed in an electric furnace and a cathode and anode/stirrer were added to create a reaction which resulted in salts, anode heel and plutonium metal (EG&G, 1990). The anode alloy subprocess combined the anode heel from electrorefining with aluminum to produce an alloy that was suitable for recovery at the Savannah River site. Anode alloy used the same furnaces as MSE (EG&G, 1993).

Salt Scrub Process. This process concentrated actinide metals into a metal alloy from residue salts such as those produced in the MSE process. The resulting metal alloy was suitable for recovery at the Savannah River site. The salt scrub was performed in the same furnaces as MSE in Gloveboxes 496 and 503. The salt scrub process was first conducted in Building 776 in 1976 using a magnesium/zinc extractant in a tilt-pour furnace (Crisler, 1992). Later, two other salt scrub processes were used. In the first process, aluminum and magnesium were used as the alloying agent and the reductant, respectively. In the second process, gallium was used as the alloying agent and calcium was used as the reductant (EG&G, 1990; EG&G, 1993).

Direct Oxide Reduction. DOR research at RFP began in 1967 with pilot-scale operations conducted from 1981 through 1983. In 1983, the process began being used on a production-scale basis in Building 776 (Crisler, 1992). DOR produced plutonium metal from plutonium oxide without aqueous processing. It eliminated the potentially high radiation exposure step of hydrofluorination that occurred in Building 771. It involved batch processing plutonium oxide feed through a high temperature calciner to remove moisture and drive off volatiles. The charge consisted of plutonium oxide, calcium metal and cast calcium chloride salt (EG&G, 1993; Crisler, 1992). The resulting plutonium button was sampled for purity. If it was pure, it was sent to Building 707, if not, it was sent to electrorefining for additional refining (Dingman, 1994). The residual calcium salts were sampled for plutonium and stored for possible aqueous recovery (Crisler, 1992).

9.4.2.7 WASTE HANDLING

Waste handling operations included collection of waste solvents such as carbon tetrachloride and TCA and reduction of wastes.

Carbon Tetrachloride System. This system was located in Glovebox 207-642 in Rooms 131 and 134A of Building 776. Its purpose was to collect, filter and distribute waste carbon tetrachloride for eventual treatment. Carbon tetrachloride was used to clean machine turnings in the briquetting process and in several machining operations in Building 777. In addition, fluids such as Freon TF from the density balance, coolant oil, vacuum pump oil and sight gauge oil were put into this system. Waste carbon tetrachloride was collected in a series of five pencil (small diameter) tanks. When the tanks were full, the carbon tetrachloride was pumped through the Ful-flo filtration system to a large storage tank. The liquid was then pumped through another filtration unit and sampled to ensure that the sample was below the radioactive discard limit and then transferred to Building 774 for waste treatment (EG&G, 1990; EG&G, 1993).

TCA Collection and Filter System. The TCA collection and filtration system was located in Room 430 and collected TCA from various storage systems in Buildings 707, 776 and 777 and stored it in Tank T-1. Tank T-1 was sampled regularly for plutonium, americium and uranium. If it was below the transfer limit, it was pumped to Tank T-2. Otherwise, it was circulated through a filter system and sent back to Tank T-1. The wastes were then pumped to the Building 774 waste treatment system (EG&G, 1990). Tanks and associated piping are scheduled for Resource Conservation Recovery Act (RCRA) closure and the tanks are operationally empty at this time (EG&G, 1993).

Baler. The low-level waste baler was located in Room 144 of Building 776 and was used to reduce the volume of low-level combustible waste. The baler was a hydraulic, single chamber, downstroke press with a compressive force of 50 tons, equipped with a hydraulic bale eject system. Combustible waste forms were unpacked from drums, fed into the baler and compressed into a cardboard box lined with plastic and layered with Oil Dri to absorb any free liquid. The box was then strapped shut and transferred to a wooden crate for low-level waste disposal. The process reduced the volume of waste by a ratio of 5:1, increasing the capacity for on-site waste storage.

Although the baler is not currently in use, there is a possibility that it may be used at some time in the future for low-level and low-level mixed combustible waste, provided that the appropriate RCRA permit is obtained (EG&G, 1990; Aguilar, 1994). If used for low-level mixed

combustible waste, the baled waste would be classified as hazardous due to solvent contamination and/or the presence of lead-lined gloves present in low-level mixed waste (EG&G, 1990).

Advanced Size Reduction Facility (ASRF). This facility in Building 776 was used to disassemble or cut plutonium-contaminated gloveboxes and miscellaneous large equipment down to a size that was easily packaged in approved waste containers. The ASRF process consisted of five subprocesses enclosed in one glovebox in Room 134. These included an air-locked manual disassembly area, a remote disassembly area, a cutting area, a steam cleaning area and a packaging area (EG&G, 1993). The ASRF produced TRU, TRU-mixed, low-level and low-level mixed wastes (EG&G, 1990). This facility has not been operational since production curtailment but may operate again in the future (Bouwer, 1994). Other size reduction operations conducted in Building 776 during this time are still operating and are described in Section 9.4.3.1.

Fluidized Bed Unit (FBU). Building 776 housed both a pilot-scale FBU in Room 135 and a full-scale, two-story, 3,000 square-foot FBU in Room 118 (Bouwer, 1994; Aguilar, 1994; EG&G, 1993). The FBU system design involved a series of shredding and sorting processes prior to screw-feeding shredded waste into a primary reactor. The fluidized bed material in the reactor consisted of heated sodium carbonate granules and an oxidation catalyst comprised of aluminum oxide and chromium oxide. These materials were fluidized by a flow of compressed air and nitrogen gas. In addition to solid waste, liquid waste could also be fed into the unit. All emissions from the unit passed through an afterburner, a cyclone separator and a bank of HEPA prefilters and filters (EG&G, 1990; EG&G, 1992).

Development of the FBU began in 1975 and involved a bench-scale unit followed by installation of a pilot-scale unit which underwent testing through approximately 1981 (Aguilar, 1994). On May 19, 1981, a trial burn of one gallon of polychlorinated biphenyls (PCBs) mixed with four gallons of kerosene was conducted in the pilot-scale unit and considered to be a success (Buffer, 1993; Aguilar, 1994). In 1978, the full-scale FBU, or demonstration unit, came on line for testing. EPA-approved test burns were conducted in this unit from 1979-1988 on both liquid and solid waste forms. The trial-basis operations burned non-line combustibles, office trash, crankcase oil and compressor oils (EG&G, 1993). Material from the test burns remains in the feed tanks to those units (EG&G, 1992). Although the full-scale unit was designed and built for thermal treatment of low level radioactive and hazardous mixed solid and liquid waste, the unit never gained operational status due to difficulties with the RCRA permitting process (Aguilar, 1994; EG&G, 1993). The FBU has not been tested or otherwise operated since 1988 (EG&G, 1993).

9.4.2.8 SPECIAL PROJECTS

After the 1969 fire, Building 776/777 production-related activities generally shifted from full-scale War Reserve production activities to special order work and R&D activities. Available information on special projects in the complex includes: coatings operations in Building 776, coatings operations in Building 777, "special weapons projects" in Building 777 and joining operations in Building 777. These operations are described below.

Coatings in Building 776. The coatings facility in Building 776 was an R&D operation which began operation in the 1970s (EG&G, 1990; Crisler and Dingman, 1993). Functions included the evaluation and development of chemical coatings for a variety of ceramic and metal substrates (EG&G, 1990). The coating materials included rare earth oxides and nitrates, especially erbium nitrate (Dingman, 1994). Other materials used for coating included chromates, manganese and stainless steel. Nearly all elements in the periodic table were candidates for coating materials. The substrates to which the coatings were applied were roughened or abraded using glass beads or aluminum oxide grit. They may also have been etched with any or all of the common mineral acids. Typical substrates included magnesium oxide, aluminum and numerous other metals. A curing furnace was used in the experimental process. Erbium nitrate was used to coat molds which were placed in the electric furnace (EG&G, 1990).

Coatings in Building 777. This coatings facility was a research facility for the development of substrates to be coated with plutonium (EG&G, 1990; Crisler, 1991). This process occurred in gloveboxes with nitrogen-inerted atmospheres in Rooms 437 and 463. Substrates were first etched with sulfamic acid and cleaned with wire brushes. The substrates were then grit-blasted and cleaned with a combination of vapor degreaser and ultrasonic cleaner, which contained TCA, to remove oils. The TCA in the degreaser was changed out when it became visibly dirty or contaminated with waste and during bimonthly inventories. Freon 113 and ethyl alcohol were also used for cleaning the substrates (EG&G, 1990).

Special Weapons Projects. This operation involved R&D in Building 777 for fabricating classified parts and fitting specialty parts and material. Surveillance parts were also disassembled for analytical testing. Cleaning of parts involved ultrasonic cleaning with TCA and some cleaning with ethyl alcohol. Some machining, which used cutting oils, was performed in a glovebox (EG&G, 1993b).

Joining. The joining process was located in Rooms 418, 430 and 475 of Building 777 and involved a variety of R&D-scale welding and cutting operations on non-plutonium metal parts. The process received aluminum, titanium, depleted uranium, vanadium and stainless steel parts

from machining operations in the 400-, 700-, and 800-series buildings. During the most recent operations, the process used two laser welders and one electron beam welder (EG&G, 1993b). Prior to those operations, an additional electron beam welder and a pressurized inert gas metal arc (Pigma) welder were also used (EG&G, 1990; EG&G, 1993). The two laser welders included a Neodymium-Yttrium Aluminum Garnet (Nd-YAG) laser and a carbon dioxide laser. The Nd-YAG laser used argon, helium, oxygen and nitrogen gases for cutting and welding non-nuclear metal parts. The carbon dioxide laser welded non-production parts using compressed gases. The electron beam welding involved fusion welding in a vacuum chamber in a glovebox; these units were used only a few times per year (EG&G, 1990). Most of the welding processes used acetone, ethyl alcohol and isopropyl alcohol for cleaning purposes. Welding processes are no longer active in Building 777 (Bouwer, 1994).

9.4.2.9 SUPPORT OPERATIONS

Support operations included a Calibration Laboratory and a Plutonium Metallography Laboratory. The Calibration Laboratory calibrated gauges from around the plant site but is no longer operational (EG&G, 1990; EG&G, 1993). The Plutonium Metallography Laboratory was used to prepare and examine metal specimens. Specimens were cut, embedded in plastic, ground and polished. Specimens could also be etched or electropolished. Evaluations were performed by optical microscopy and hardness testing. Diamond polishing paste, which was thinned with kerosene, was used during the process and was then removed with wipes. Ethyl alcohol was used to clean samples prior to analysis. The cutting agent 1,1,1-TCA was used for grinding with carbide grit. The electrolyte solution used in the electronic etching process was neutralized with sodium hydroxide prior to disposal or further plutonium recovery processing in Building 771 (EG&G, 1990). The plutonium metallography laboratories are no longer in operation (EG&G, 1993b).

9.4.3 CURRENT BUILDING OPERATIONS DESCRIPTION (1989-1994)

Currently, the Building 776/777 facility is used for waste handling and several support operations. Waste handling operations including size reduction, supercompaction and low specific activity counters (LOSAC) in Building 776. Support activities including general maintenance in Building 776, and a Tritium Surveillance laboratory and container repacking in Building 777.

9.4.3.1 WASTE HANDLING

Current waste handling operations conducted in Building 776 focus on volume reduction and proper control of activity levels in waste drums. These activities include size reduction, supercompaction and drum activity counting.

Size Reduction Vault. The size reduction vault in Room 146 is used to repackage drums and crates containing mostly metal, lead, filters, Raschig rings and combustibles. These materials potentially contain radioactive contamination from several processes within the Protected Area (PA). The low-level, non-hazardous wastes are sent to Building 664 for storage and eventual shipment off-site. TRU, TRU-mixed and low-level mixed wastes are stored on-site awaiting an approved off-site disposal (EG&G, 1990; EG&G, 1993). Gas samples from wastes are also collected in this air-locked vault (Bouwer, 1994).

Supercompactor and Repackaging Facility (SARF). The SARF, located in Room 134, sorts and compacts transuranic, low-level and mixed wastes. It began full-scale operation on May 9, 1994 (EG&G, 1994). The wastes processed may originate in any RFP building which generates radioactive and mixed waste (EG&G, 1993). The purpose of the operation is to reduce the volume of waste as much as 75 percent to better use storage space at RFP prior to waste shipment for permanent disposal (EG&G, 1994).

Low Specific Activity Counter (LOSAC). Assay machines are located in Room 134 and are used to count activity levels of drums of low level waste and light weight drums. In Room 159, a HEPA LOSAC counts the activity level of HEPA filters. (Bouwer, 1994).

9.4.3.2 SUPPORT OPERATIONS

Various support operations currently conducted in the complex include the Tritium Surveillance Laboratory and container repacking activities in Building 777 and maintenance activities housed in Building 776.

Tritium Surveillance Laboratory. The Tritium Surveillance Laboratory in Building 777 is used for analysis of solid, liquid and gas samples from throughout the plant site for tritium content. This laboratory uses Rooms 429, 431 and 431A. The laboratory also analyzes gas samples which do not require tritium content determination. The process involves sample dissolution, filtration and radioactivity counting. Process equipment includes a mass spectrometer and a liquid scintillation counter. Chemicals used in these processes may include nitric acid, sodium

hydroxide, potassium permanganate and Opti-Fluor scintillation cocktail. Following analysis, Micro-Cel E is added to eliminate all free liquids in samples (EG&G, 1993).

Container Repacking. In this process, shipping containers from Building 991 are repacked to meet current packaging requirements of the DOT (EG&G, 1993). This process is located in Rooms 462 and 465 of Building 777.

Maintenance. Maintenance activities located in Building 776 include preventive maintenance, paint, carpenter, machine, sheet metal, pipe and general area maintenance shops (Weston, 1986; EG&G, 1993). Preventive maintenance is based in Room 154 and includes primarily changing oil in pumps and other equipment and replacing batteries (EG&G, 1993).

9.5 CURRENT CONTAMINATION STATUS

Building 776/777 is currently considered to be a high hazard facility due to the large amounts of plutonium and uranium metal and plutonium oxides and residues stored in the building. Radiation hazards include the Special Nuclear Material (SNM) storage vaults, small specific areas in some gloveboxes and associated duct-work and FBU ash storage areas (EG&G, 1992).

As of 1992, the building contained 31 RCRA tanks (including raschig ring, pencil and annular), 55 room storage sites, 1 FBU, 8 gloveboxes, 8 vaults, 1 baler, 1 washer, 1 open top collection pan and 3 fenced areas (EG&G, 1992). The building also housed a chemical material inventory of approximately 1,500 individual chemical containers. This inventory was typical of an industrial metal processing facility and included solvents (halogenated and non-halogenated), corrosives, oils and lubricants, and laboratory reagents and standards. Most of the materials were present in quantities of 10 gallons or less. The inventory included 257 containers between 10 and 55 gallons, with most of those materials used to support utility and maintenance operations in the building (EG&G, 1992). In addition, five pencil tanks that historically stored a mixture of machining oil contaminated with plutonium, carbon tetrachloride and freon (compound unspecified) were recently drained (Bouwer, 1994). The remainder of the 2,659 drums of stored material included transuranic, low-level mixed, transuranic mixed and low-level wastes in addition to low-mixed and non-mixed residues and non-fully characterized waste (EG&G, 1992).

Contamination hazards in the building include both loose and fixed contamination, much of which resulted from the 1969 plutonium fire. Despite extensive decontamination efforts, approximately 75 percent of the building and equipment surfaces have fixed contamination in localized areas. Levels of contamination may exceed 10^6 disintegrations per minute per 100 square centimeters in localized areas. The fixed contamination has in most cases been controlled by paint or other

fixatives. Contamination of the original roof of the building has been contained by the addition of a false roof over the facility (EG&G, 1992; EG&G, 1992b).

Soil contamination underneath the building is expected from at least three sources. Water was used to control and extinguish the 1969 fire and is believed to have seeped through cracks and seams in the concrete slab floor. Secondly, at least three pieces of contaminated equipment were placed in a below-grade heavy machinery pit in the basement of the building and encapsulated in concrete as an acceptable method of disposal during the decontamination of the building following the fire. The largest pour of concrete consisted of approximately 280 cubic yards of concrete and burial depths in the machinery pit may be as much as 35 feet. Finally, seasonal fluctuations in groundwater result in seepage of groundwater into at least one contaminated metal press pit and one sub-basement (EG&G, 1992; EG&G, 1992b; DOE, 1994).

Finally, the building is known to have asbestos insulation in numerous locations as well as in the Transite siding that constitutes the outer skin of the facility. The extent and condition of the asbestos has not been fully characterized (EG&G, 1992; USAEC, 1969).

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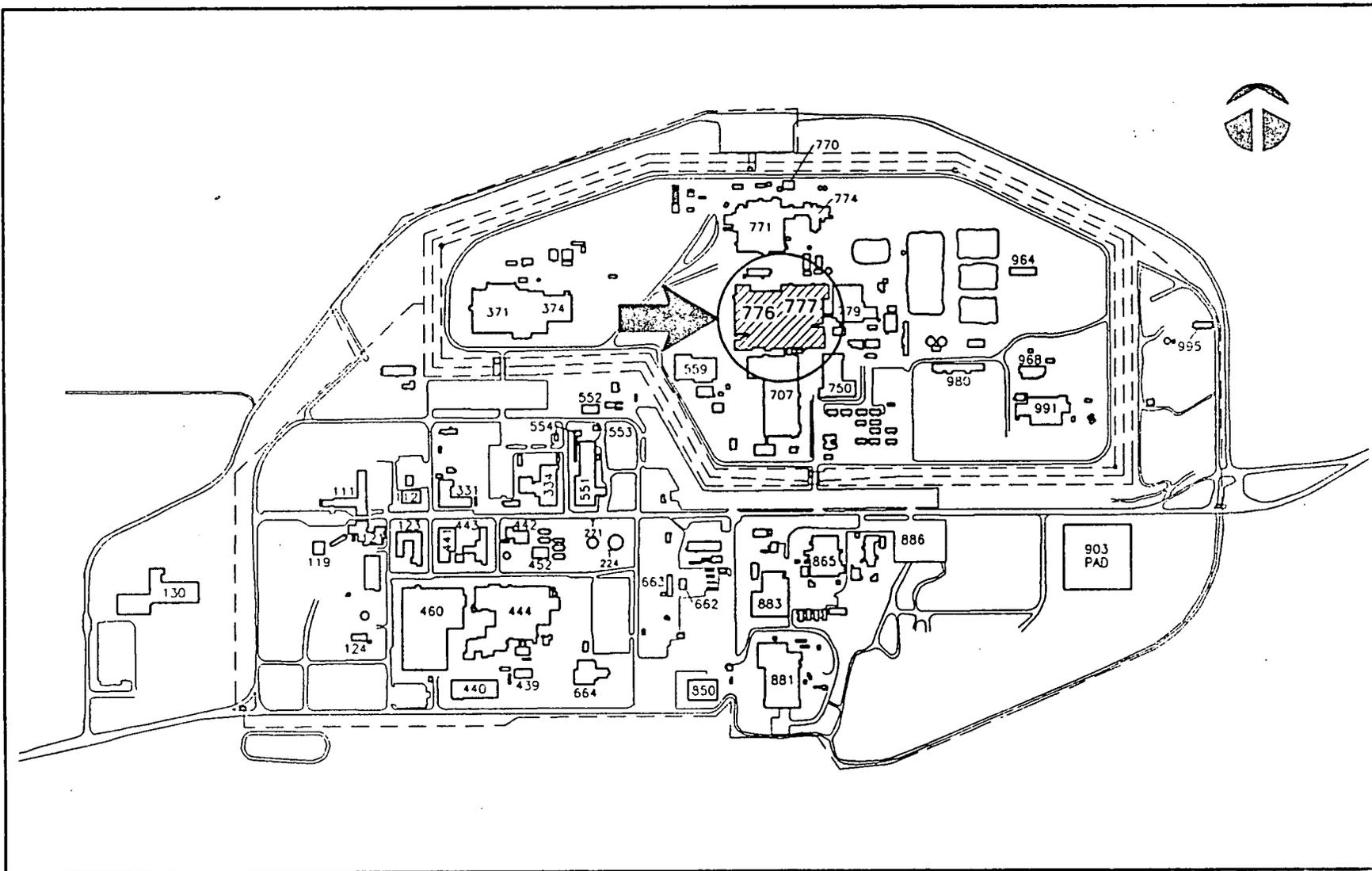
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FIGURES



<p>PROJ. NO. 931-082.000 DWG. NO. -</p> <p>DESIGN BY JKC CHECKED JKC</p> <p>DRAWN BY KAL APPROVED -</p> <p>DATE NOV. 28, 1994 SCALE 1" = 90'</p>				<p>PREPARED FOR U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT GOLDEN, COLORADO</p> <p>BY WRIGHT WATER ENGINEERS, INC. 2490 W. 26TH AVE. SUITE 100A DENVER, CO 80211 (303)480-1700</p>	<p>FIGURE 9-1 BUILDING 776/777</p>
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10.0 OPERATIONAL HISTORY OF BUILDING 881

10.1 INTRODUCTION

During the early 1950s, the United States adopted a nuclear weapons defense duality policy which called for at least two installations to have the capability to produce any of the nuclear components for the national stockpile. The Rocky Flats Plant (RFP) Building 881 was selected, along with the Oak Ridge Y-12 plant, to fabricate weapon parts from enriched uranium (also known as Orallo) (Crisler, 1992; ChemRisk, 1992). Building 881, originally called the "B Plant," was the fourth building at the Rocky Flats Plant (RFP) to come on line. Operations producing uranium components began in the summer of 1952 (Kelchner et al., 1994). A chemical facility in Building 881 which complemented the manufacturing operations, recycled metal from fabrication and foundry residues (Heberlein, 1994; Kelchner et al., 1994; Crisler, 1991). The specific process operations involved in the fabrication of uranium components included heating and casting of parts, parts shaping and forming, machining, assembly and uranium recovery (ChemRisk, 1992).

Enriched uranium fabrication operations were moved to Oak Ridge between 1964-1966 when the United States Atomic Energy Commission (USAEC) adopted a single mission policy and made the production of plutonium components the focus of operations at RFP (Kelchner et al., 1994; Crisler, 1992). At this time and until 1984, Building 881 housed the manufacturing process for precision stainless steel parts which were used in the plutonium-based weapon (ChemRisk, 1992; Hebert, 1991; Jackson, 1991; Kelchner, 1991). In 1984, the stainless steel operations were moved to Building 460 (ChemRisk, 1992). After stainless steel manufacturing was moved out of Building 881, the building expanded its role as a multipurpose facility for research and development (R&D), analytical, support, and administrative and computer functions (EG&G, 1991; EG&G, 1994).

10.2 HISTORICAL TIMELINE

- 1951 Construction of Building 881 began in December (Buffer, 1993).

- 1952 In April, the first operations began on regular production materials (Buffer, 1993).

- 1953 In the summer of 1953, fabrication of weapon parts from enriched uranium began. The specific operations included casting, rolling, forming and cleaning of uranium parts (Kelchner et al., 1994; Putzier, 1982). The original building contained a foundry, analytical laboratory, machine shop, steam plant and laundry. Several months after production began, uranium recovery operations came on-line (Kelchner et al., 1994).
- 1955 In September, construction began on an L-shaped annex to the northeast corner of Building 881 which was designed primarily as a machining facility to support the new weapon design which was part of the Part IV expansion (Buffer, 1993; ChemRisk, 1992; Hunter, 1990).
- 1958 Operation of a solvent still to recycle spent solvents and oils began and continued until 1962 (Kelchner, 1991).
- 1964 Uranium operations began to shut down. (Kelchner et al., 1994)
- 1965 An announcement was made in January that all enriched uranium work would be transferred to Oak Ridge (Buffer, 1993).
- 1966 Most uranium production and recovery operations had ceased except for some continued recovery of site returns from Oak Ridge (ChemRisk, 1992; Kelchner et al., 1994).
- 1966 Stainless steel fabrication operations began (Morrison, 1991; ChemRisk, 1992; Kelchner et al., 1994).
- 1967 Beryllium sealing operations began. Beryllium ingots received from Building 444 were placed into stainless steel canisters which were sent on to be rolled in Building 883 (Hill, 1994).
- 1967 On December 1, J-line stainless steel activities were acquired when Dow officially took over those operations at the Albuquerque plant a year after it had been announced that work would be done under contract with DOW (Buffer, 1993).

- 1968 By July, all stainless steel operations had been transferred from Albuquerque to Building 881 (Ideker, 1994).
- Late 1960s Preliminary decontamination of the outside ventilation grills and inside ventilation ducts was conducted (Aldrich, 1991).
- Mid-1970s Uranium recovery operations on parts received from Oak Ridge were discontinued (Ideker, 1994a).
- 1983 to 1985 Stainless steel operations moved to Building 460 (DOE, 1992, ChemRisk, 1992; Hunter, 1990; Hebert, 1991; Ideker, 1991).
- Mid-1980s Building 881's primary functions became research and development, administrative and computer support, and laboratory support.
- 1987 The analytical lab in Building 881 expanded to support plantwide waste characterization activities (Hunter, 1994).

10.3 PHYSICAL BUILDING DESCRIPTION

Building 881 is a three-story reinforced concrete structure, built mostly below ground (EG&G, 1992). It is located in the southern portion of RFP, outside the protected area and just south of Building 883 (Figure 10-1). The northwest corner of the second floor of Building 881 is connected by a tunnel to the southwest basement corner of Building 883. The tunnel was originally used to convey enriched uranium parts and other materials between the two buildings (EG&G, 1992). An addition referred to as the Building 881 Annex was built onto the north side of the building in 1957.

Many of the rooms in Building 881 have been partitioned since the building was first operated. The total floor area of 245,160 square feet is broken down as follows:

- First Floor - 86,300 square feet;
- First Floor Mezzanine - 6,000 square feet;
- Second Floor - 121,460 square feet;

- Second Floor Mezzanine - 13,530 square feet; and
- Basement - 17,870 square feet (EG&G, 1992).

During the period of uranium and stainless steel production, most of the production related operations occurred on the second floor. The floors in most of the process areas were surfaced with stainless steel sheeting with welded seams to contain spills and facilitate cleaning (ChemRisk, 1992; Heberlein, 1994; Kelchner et al., 1994). Support functions such as laboratories, utilities and maintenance were located on the first floor and basement.

Building 881 has several support buildings which support its operations. These are Building 887, Building 890, Building 881F and Building 881G. Building 887 houses 4 process waste steel tanks, 2 process waste pumps, and 2 filter tanks. The building also serves as a RCRA storage area. Building 890 was originally the process cooling tower but is now used as a utility work and storage area. Building 881F is a steel structure located on the roof of Building 881 and houses the ventilation system. It was constructed in the mid-1980s to replace the old filter plenum. Building 881G is a cement block structure constructed in 1989 to provide emergency generator power to Building 881 (EG&G, 1992).

To minimize the release of radioactivity, all uranium manufacturing and laboratory operations were vented through a main plenum equipped with high efficiency particulate air (HEPA) filtration (ChemRisk, 1992; Kelchner, 1991). A new exhaust air filter plenum with two stages of HEPA filters was constructed on the roof of the building in the mid 1980s, replacing the original plenum system which was decontaminated and removed (EG&G, 1991).

10.4 DESCRIPTION OF OPERATIONS

Building 881 operations can be divided into three categories representing three distinct primary functions for the building. These are (1) enriched uranium manufacturing and recovery which occurred between 1953 and 1966; (2) stainless steel operations which took place between 1966 and 1984; and lastly (3) recent activities that have taken place in the building since manufacturing operations were phased out. Recent activities include provision of plant-wide administrative, computer and analytical support and conduct of a variety of R&D projects.

10.4.1 ENRICHED URANIUM MANUFACTURING AND RECOVERY (1953-1966)

In December, 1951, construction began on the four original buildings which comprised RFP, including Building 881 (Buffer, 1993). Starting in the summer of 1953, Building 881 housed the plant's only enriched uranium (also called "Oralloy") components manufacturing and recovery operations (ChemRisk, 1992; Heberlein, 1994; Kelchner et al., 1994; Crisler, 1991). Along with the primary casting, machining and chemical recovery operations, the first floor and basement of the original Building 881 contained a laundry, an analytical laboratory to support manufacturing, and utility and maintenance functions (Hunter, 1990; Kelchner et al., 1994; ChemRisk, 1992).

The primary operations were divided into three areas: (1) fabrication support which included the foundry (for casting of shapes and ingots), machining and inspection; (2) metal product support which included recovery of relatively pure materials; and (3) salvage support which handled recovery of solutions and solid residues with a relatively low uranium content (Kelchner et al., 1994).

In 1964, enriched uranium operations began phasing out of Building 881 when DOE adopted a single mission policy and decided to consolidate enriched uranium activities at Oak Ridge (ChemRisk, 1992; Jackson, 1991; Hoffman, 1991; Hebert, 1991; Kelchner et al., 1994). In January of 1965, a plantwide announcement was made that all enriched uranium work would be transferred to Oak Ridge (Buffer, 1993). By 1966, most of the operations had ceased, the salvage and recovery processes being the last to shut down (Kelchner et al., 1994).

The detailed processes involved in the manufacturing and recovery operations as well as some of the ancillary activities are discussed in the following subsections.

10.4.1.1 CASTING

For the first few months of production, Oak Ridge sent uranium castings that went directly to the machining operations to be shaped. The first raw material used in production came from Oak Ridge in the form of hockey puck-sized "buttons" of pure metal (ChemRisk, 1992; Kelchner et al., 1994). Smaller quantities of other forms of uranium such as uranyl nitrate and alloy scraps were also provided (ChemRisk, 1992). RFP-produced uranium buttons were soon added to the feed material once recovery operations were fully established in Building 881.

Casting operations began with two furnaces located in Room 242, but as production increased, four additional furnaces were added in Room 249 (Kelchner et al., 1994; EG&G, 1992). Crucibles used in the casting process were made from magnesium oxide until about 1958 or 1959 when the building switched to using graphite crucibles supplied by the Building 444 carbon shop. These graphite crucibles could be reused approximately 25 times prior to disposal. To start the casting process, uranium metal was placed in a crucible and then heated in one of the six bottom-pouring induction furnaces. Molten uranium was then poured into graphite molds to produce the desired shape (Kelchner et al., 1994).

To support production of the original weapon concept, uranium was cast into spherical shapes that were sent directly to machining (Putzier, 1982; Kelchner et al., 1994). When the weapon concept changed to using hollow components in 1957 (also referred to as the Phase IV operations), the pieces were cast into slabs or ingots which could then be fabricated (rolled, formed and machined) into the precise shapes required. Many of these additional machining operations, including rolling, forming and computer controlled turning, took place in two newly constructed areas, Building 883 or the 881 annex (ChemRisk, 1992; Kelchner et al., 1994; Hunter 1990). No chemicals were known to be used in the foundry operations (DOE, 1994; Kelchner et al., 1994).

10.4.1.2 FABRICATION

Fabrication operations were housed in Rooms 245 through 247 and were performed in the open rather than in enclosed gloveboxes like the plutonium operations (Kelchner et al., 1994; Morrison, 1991). Between 1952 and 1957, milling machines and lathes were used to shape the first weapon design. In 1957, tape-controlled turning machines were added to provide additional precision work for the hollow component design. Machining was conducted with Shell Vitrea oil as a coolant that was circulated by a centralized system operated in Room 304 (Morrison, 1991; Kelchner, et al., 1994). Some waste oil was burned and some was drummed and sent to the mound area and later moved to the 903 Pad drum storage area (ChemRisk, 1992).

After machining, the parts were cleaned by dipping them into tanks containing PCE and allowing them to drip dry. Each machine had a dedicated dip tank that was changed out when impurities warranted (Kelchner et al., 1994).

10.4.1.3 INSPECTION AND TESTING

After cleaning, the parts were sent to inspection and testing located in the northeast corner of the building. Nondestructive testing using radiography was performed in Room 255 and was eventually expanded to parts of Room 276 (Kelchner et al., 1994).

10.4.1.4 ENRICHED URANIUM RECOVERY

The uranium recovery operations in Building 881 began approximately two to three months after primary fabrication operations began (Kelchner et al., 1994). They were modelled after the processes developed at Los Alamos and Oak Ridge during World War II and were similar to the 1950s plutonium recovery process that employed solvent extraction (Crisler, 1992; ChemRisk, 1992; Kelchner et al., 1994). Several different recovery operations were employed depending on the type of starting material; however, in most instances recovery processes involved operations to solubilize uranium from the various residues and to convert the uranium from a liquid to a solid oxide, and then to a metal (Crisler, 1992).

Uranium recovery involved "fast" and "slow" processes. The slow process handled relatively impure materials with low concentrations of enriched uranium by placing them through nitric acid leaching, followed by solvent extraction. Fast recycle used conversion and reduction steps to produce a pure uranium button. The fast recycle process also handled materials that were relatively pure, including uranyl nitrate. Recovery of these materials involved some of the same steps as the slow side, except the solvent extraction step was skipped (Kelchner, 1991; Kelchner et al., 1994). The specific processes involved in recovery are discussed in detail below.

10.4.1.4.1 Fast Side Recovery of Relatively Pure Materials

Materials such as chips from machining operations and black skull oxide that accumulated in the foundry crucibles contained a high percentage of enriched uranium that could be processed relatively simply back into a pure uranium button. Some of the important processing steps are described in the following text.

Oxidation and Dissolution. Chips and skull oxide were burned to form an uranium oxide (U_3O_8) and then transferred to Room 257 for dissolution in small batches of concentrated nitric acid (Kelchner et al., 1994). Room 257 (which at the time also included what is currently

designated as Room 272) housed three rows of controlled hoods known as "B-boxes." The B-boxes operated with high air velocities at the opening to ensure that vapors were contained within the hood (Heberlein, 1994).

Precipitation and Calcination. The uranyl nitrate solutions resulting from nitric acid dissolution were filtered into a 4-liter beaker. A 30 percent solution of hydrogen peroxide and malonic and citric acid were added to form a uranium peroxide precipitate ($\text{UO}_4 \cdot 2 \text{H}_2\text{O}$). The precipitate was referred to as "yellow cake" because of its characteristic color. The yellow cake was then filtered and the liquid filtrate was returned to dissolution. The filter cake was placed into a boat-shaped container and heated in a muffle furnace to produce orange uranium oxide (UO_3). The dissolution, precipitation and calcination processes which were originally performed as batch operations were changed to continuous operations as these were developed in the late 1950s and early 1960s (Crisler, 1992; Kelchner et al., 1994).

Conversion and Reduction. The orange oxide from the calcination step was transferred to the stainless steel-floored Room 266 for conversion to uranium tetrafluoride, or green salt. The orange oxide was placed into Monel (Copper-Nickel alloy) boats and heated for two hours in a tube furnace to convert the UO_3 to UO_2 . Anhydrous hydrogen fluoride was then added under constant temperature conditions which converted the oxide to the green salt (Crisler, 1992; Kelchner et al., 1994; Heberlein, 1994).

Final Reduction. The green salt was transferred to Room 264 for the final reduction to uranium metal which was performed in a sealed metal bomb reactor. The uranium tetrafluoride was homogenized in a blender and placed into a magnesium oxide ceramic liner in the reactor with elemental iodine and calcium. The reactor lid was sealed and the reactor was purged with argon gas and then heated. While molten, the metal separated from the calcium and fluoride/calcium iodide slag and collected as a button at the bottom of the reactor (Crisler, 1992; Kelchner et al., 1994; Heberlein, 1994). Building 881 operations began with production of buttons approximately 3 kilograms in size, but process improvements were able to produce buttons up to 15 kilograms in size in later years (Kelchner et al., 1994).

Off-gas from the reduction went through a potassium hydroxide scrubber and then through the building's main sodium hydroxide scrubber that handled off-gas from all of the chemical operations (Kelchner et al., 1994). Like the preceding recovery steps, the conversion and reduction processes which were originally performed as batch operations were changed to

) continuous operations as these were developed in the late 1950s and early 1960s (Crisler, 1992; Kelchner et al., 1994).

10.4.1.4.2 Slow Side Recovery of Impure Residues

Impure materials such as slag, sand and crucibles from the foundry operations, and residues from the incinerator (See Section 10.4.2.5) were handled through a series of operations designated as slow side recovery or salvage operations.

Dissolution. The impure materials to be recovered were crushed into pea-sized feed in a rod mill located in the southwest corner of Room 235. The crushed feed was placed into one of six 300-gallon or three 30-gallon steam-jacketed dissolving tanks. Concentrated nitric acid was metered into the tanks which were heated to promote dissolution. The resulting solution was then filtered through a plate and frame press with the filter mud being recycled to dissolution and the liquid going on to solvent extraction (Kelchner et al., 1994). One kilogram of residue material produced approximately 7.5 liters of solution (Crisler, 1992).

Solvent Extraction. The low-concentration solutions from dissolution filtration operations were concentrated through use of two large solvent extraction columns operated in sequence. The columns were three stories tall and originated in the pit located in the Building 881 basement. The uranium containing nitrate solution was adjusted to a specific gravity of 1.38 through addition of nitrate salts and fed into the top of the column. Dibutylcarbitol (a high molecular weight ether with a specific gravity of 0.9) was pulsed into the bottom. The uranium was then extracted into the carbitol phase. The aqueous phase from which the uranium was extracted, referred to as primary raffinate, was left with less than 1 parts per million uranium (Crisler, 1992; Kelchner et al., 1994). Originally this waste was solidified in concrete, but as production and volume increased it was sent to the Solar Evaporation Ponds (Kelchner et al., 1994).

The primary column extraction produced a solution with a uranium concentration of about 5 to 10 grams/liter. This solution was sent to one of 12 Eastman Kodak (EK) evaporators to be concentrated to 20-30 grams/liter (Crisler, 1992; Kelchner et al., 1994). The uranium solution was then pumped into the bottom of the secondary carbitol extraction column where high purity solutions containing 90 grams/liter uranium were produced (Crisler, 1992; Kelchner et al., 1994). This solution was then sent to be precipitated with hydrogen peroxide and further processed, as

discussed in Sections 10.4.2.2 and 10.4.2.3. The dibutyl carbitol was recycled within the columns with only a small loss to the aqueous phase (Kelchner et al., 1994).

10.4.1.4.3 Incineration of Combustible Residues

Six 3-foot diameter incinerators operated in Room 233 for the disposal and recovery of combustible waste produced during operation. Material handled in the incinerators included kimwipes and cheesecloth used to wipe up drips and minor spills, wood, cardboard and some air filters. Material to be burned was placed inside a stainless steel wire mesh basket which fit into the cavity, leaving a two-inch air space between it and the wall. The fine white ash residual was then sent to the slow side recovery process (Kelchner et al., 1994). The off gas went to a slightly basic water scrubber followed by a spray caustic tower scrubber. The exhaust was then sent through the main building plenum (Kelchner, 1991; Kelchner et al., 1994).

10.4.1.4.4 Recovery of Site Returns

Starting some time after 1960 (Heberlein, 1994), Building 881 housed chemical recovery operations for returned or rejected enriched uranium weapon parts. In what was referred to as the oralloy leaching or OY leach process, uranium parts to be recycled were first subjected to a hot nitric acid spray to remove residual surface plutonium contamination. Some amount of uranium was also removed by this acid leaching (Hunter, 1990; Boss, 1991; ChemRisk, 1992). Acid solutions generated were collected and evaporated. The concentrate was then precipitated with ammonia gas, calcined to a dry oxide and analyzed for plutonium. Oxides were sent to Building 771 for recovery of plutonium. After leaching, the decontaminated uranium parts were broken up in a press in preparation for further salvage (Putzier, 1992). The uranium leaching process was originally located in Room 226 (EG&G, 1992; Putzier, 1992) and then moved to Room 257 (Kelchner et al., 1994). OY leaching was moved from Building 881 to Building 777 sometime between 1973 to 1975 (Ideker, 1994). Recovery processes may have continued using nitric acid to leach beryllium from aluminum hemishells (Hill, 1994).

10.4.1.4.5 Briquetting

Starting in about 1956, some of the relatively pure uranium scraps from machining were cleaned with TCE and PCE, pressed into briquettes and reintroduced into the casting furnace without

further processing. The briquetting press was located in Room 242 (Morrison, 1991; Kelchner et al., 1994).

10.4.1.4.6 Recovery of Uranium Fines from the Oil Coolant System

During the semi-annual inventories, coolant was drained from the machining operation system. The lines were pumped full of nitric acid to dissolve kilogram amounts of uranium fines that accumulated. This solution was then sent to recovery in the solvent extraction columns. The coolant lines were reconditioned by pumping PCE through the lines. Coolant system filters were also periodically sent to slow side recovery of for recovery of uranium fines by burning the filters in the incinerators and processing the ash (Kelchner et al., 1994).

10.4.1.5 SPECIAL PROJECTS (1953-1966)

Building 881 was involved in numerous special projects ranging from ongoing R&D to one-time operations. It is important to note that the operations discussed below may not represent all activities but only those for which information was documented and available.

Tracer Components. Some radionuclide tracers consisting of neptunium, curium, and cerium were used in Building 881 (ChemRisk, 1992). Also, some of the first neptunium processing occurred in Building 881 (Conner, 1991). The tracers were blended with standard component materials so that the uniformity of the weapon components could be evaluated based on the distribution of the tracers (ChemRisk, 1992). Thorium-containing components were manufactured as a short duration project that occurred in the late 1950s to early 1960s. Most of the thorium was returned to Savannah River or Oak Ridge for recovery (Morrison, 1991).

Every effort was made to keep the tracer material separate from the regular production material in Building 881. Special operations were established to recover these constituents or they were sent off-site (to other DOE facilities) for recovery (Martella, 1991; Hoffman, 1991; Morrison, 1991). Room 152 was often used for dissolution and preliminary recovery of small quantity or specialized waste streams (Kelchner et al., 1994).

Another material which was handled in Building 881 in the mid-1960s was curium-244. Curium-244 is an alpha emitter with a high specific activity, relatively short half life and a relatively high rate of spontaneous fission. Three grams of this material were converted from oxide into curium

metal in a glovebox operation (Putzier, 1982). More details on this operation are contained in report RFP-811 "Glove Box Handling of Gram-Quantities of Curium-244 at Rocky Flats."

Uranium-233 Processing. In the mid-1960s, approximately 20 kilograms of uranium-233 were handled in Building 881 for two distinct projects (Putzier, 1982; Kelchner et al., 1994; Morrison, 1991). Uranium-233 is a fissionable material that contains some fraction of uranium-232, a short half-life isotope with energetic gamma-radiating daughter products, including thorium-228. The material used in Building 881 was received from Oak Ridge and contained approximately 40 parts per million of uranium-232. Naturally occurring thorium was used as a carrier to carry down unwanted thorium-228 in what was called a thorium strike. The material was reduced to a metal before fabrication work was performed (Putzier, 1982). The thorium strike was performed in Building 771 after which the material was transferred to Building 881 for further processing. The material was cast in the G casting furnace in Building 881 and machined in a lathe that was isolated from the rest of the oil cooling system (Kelchner et al., 1994). The operations involving uranium-233 were carefully controlled to reduce the probability of radiation exposure to workers (Putzier, 1982).

Lithium Fabrication. Some special order work involved lithium metal with a total of about 10 to 15 kilograms being handled (Hoffman, 1991). The lithium was usually pressed and machined in Building 777 but was handled in Building 881 in approximately 1966 (Kelchner et al., 1994). The material was malleable like lead and did not need to be cast in the foundry (Hoffman, 1991).

Recovery of Fuel Rods. A special recovery project involved dissolving rejected beryllium-coated uranium fuel rods. Several thousand rods were handled (Morrison, 1991).

Distillation. Solvent stills designed to recycle spent solvents, oils and mixtures of the two were also operated in Building 881 from about 1958 to 1962 (Kelchner, 1991). The "heels" of the stills were scrubbed with nitric acid to reclaim the uranium and then were discarded. Only about 10 percent of the distilled solvent was accepted for reuse. In addition, a mercury recovery still was operated in Building 881 for non-plutonium contaminated mercury which was generated from vacuum pumps (Strangfeld, 1993; Horbacher, 1994).

Cadmium Plating of Uranium Parts. Room 253 housed an operation to coat enriched uranium artillery pieces with cadmium. The pieces were then machined in Room 253 (Kelchner et al., 1994).

10.4.1.6 SUPPORT OPERATIONS

The main support operations related to uranium operations involved laboratories that were located on the first floor, primarily in Rooms 137 and 101. Room 101 was a wet chemistry lab and Room 137 was used for emission spectroscopy (Kelcher et al., 1994).

10.4.2 STAINLESS STEEL OPERATIONS (1966-1984)

On January 16, 1967, it was announced that RFP would assume an expanded role in the atomic weapons program that would stem in part from the liquidation of stainless steel contracts with American Car and Foundry in Albuquerque (Buffer, 1993). A year later, on December 1, 1967, the J-line stainless steel activities were acquired by DOW and by July of 1968 all stainless steel work had been transferred to Building 881 (Ideker, 1994). Between 1968 and 1985 Building 881 was involved in stainless steel parts fabrication and testing. The stainless steel operations were transferred to Building 460 between 1983 to 1985, where they remain today (DOE, 1992, ChemRisk, 1992; Hunter, 1990; Hebert, 1991; Ideker, 1991). The operations were moved along with some of the Building 444 operations to Building 460 which is often referred to as consolidated manufacturing (ChemRisk, 1992).

10.4.2.1 STAINLESS STEEL FABRICATION

A significant portion of the stainless steel work was fabrication of tritium reservoirs that were external to the plutonium pit. These containers hold a certain amount of tritium gas which was introduced into the pit just prior to detonation to boost the yield of the explosion. Other stainless steel work included fabrication of the tubes and fasteners associated with the tritium reservoir-to-pit delivery system (ChemRisk, 1992).

Building 881 was not changed much to accommodate the stainless steel operations (Ideker, 1994). Stainless steel was purchased as bar stock from an off-site source (Morrison, 1991). Parts were machined in Rooms 244, 245, and 296 using a water soluble oil. After machining, parts were cleaned in freon (compound unspecified), nitric acid, Nitradd and TCE using two vapor degreasers and an ultrasonic cleaning unit. Approximately 50 gallons of TCE per month were used in the operations (Ideker, 1991; Ideker, 1994; Goad, 1974). According to a 1974 report, steps were being taken at that time to eliminate TCE use by converting to an Oakite aqueous detergent (Goad, 1974).

In October 1967, operations began sealing beryllium ingots into stainless steel containers. The ingots were cast in Building 444, sent to Building 881 for sealing and then sent to Building 883 for rolling and forming (Hill, 1994).

10.4.2.2 INSPECTION, TESTING AND ASSEMBLY

After machining and cleaning operations, the stainless steel parts were then inspected, x-rayed, and welded as part of assembly (Ideker, 1994). Various assembly operations consisted of clinching pressure fittings, tube bending, wire winding, solid film applications, fixture assembly, vacuum bakeout, resin molding and adhesive assembly (Goad, 1974).

Final cleaning of parts took place using solvents such as caustic and acidic solutions followed by an aqueous rinse. A mechanical automated wash line was located in Room 238. Parts to be washed were placed in special racks on the wash line and sequentially dipped and rinsed in tanks of hot acid, caustic or cleaning solutions, and then rinsed. The parts were carried in the racks by a chain driven mechanism. Tube and chamber passivation and cleaning was performed using a special aqueous acid Nitradd system in a ventilated hood (Goad, 1974).

10.4.2.3 SPECIAL PROJECTS (1966-1984)

Building 881 was also involved in special projects including R&D. To the extent information was available on these projects, they are discussed below.

Inertial Fusion. Building 881 was involved in "inertial fusion" activities to machine specialty microparts for weapons and energy generation research. There were four operational components to the inertial fusion project as follows: (1) machining of small parts for subsequent gold plating, (2) gold plating, (3) assembly of microscopic parts, and (4) some large machining operations (ChemRisk, 1992; EG&G, 1991). This operation took place in Rooms 283 and 143 (EG&G, 1992) and was discontinued in December 1993 (EG&G, 1994). Small quantities of encapsulated tritium were contained in the components machined as part of this project (EG&G, 1992). Chemicals such as lubricating oil, Freon 12, Freon 113, ethyl alcohol, epoxy glues and cutting fluids were used in the process (EG&G, 1991).

Tantalum Special Order Work. The brew furnace in Building 881 was the only furnace at RFP that could generate the required high temperatures for brazing and heat treating the tantalum special order components that were produced in Building 865 (EG&G, 1992).

Special Weapons Project Group. The Special Weapons Projects Group developed engineering prototypes and full-scale models for military training. Three-dimensional cutaway models were produced to display the internal workings or determine dimensions of various devices manufactured at RFP. A dedicated machine shop fabricated the materials and used materials such as lubricants, cutting oils, and epoxy (ChemRisk, 1992; EG&G, 1991). This process was deleted in January, 1994 (EG&G, 1994).

Corrosion Testing. A corrosion testing laboratory began operation sometime prior to 1978 and is still operating (Hilbig, 1994). It is, therefore, discussed under recent operations.

10.4.3 RECENT OPERATIONS (1984-PRESENT)

Once stainless steel manufacturing was moved out of Building 881, the building became a multipurpose facility for R&D, computer support, analytical support and administrative functions (EG&G, 1991; EG&G, 1994). Building 881 is now designated as a file support facility that provides infrastructure for RFP (EG&G, 1992). Building 881 currently houses the plant's Central Computer Facility, the General Chemistry Laboratory and administrative functions.

10.4.3.1 NON-NUCLEAR METAL FABRICATION

Non-nuclear joining, located in Room 317, consists of brazing together nonradioactive metals such as stainless steel, vanadium, beryllium, and copper. The metal parts are cleaned prior to brazing with a variety of solvents (typically acetone or alcohols) or acids. After neutralization, aqueous wastes are washed down the process drain while nonhazardous solid wastes are sent to the RFP landfill (EG&G, 1994).

10.4.3.2 SPECIAL PROJECTS

R&D projects include corrosion testing, polymer solidification development, and wastewater treatability studies. Details on these operations follow.

Corrosion Testing (active). The materials and surface technology group operates a corrosion testing laboratory in Rooms 265, 267 and 282. The group conducts chemical and mechanical tests of raw and finished parts for compatibility with chemicals. It is an R&D process that conducts non-routine tests on a variety of materials and, therefore, produces highly variable and intermittent waste streams. A variety of solvents, acids, brine, oil and other chemicals can be used. Aqueous wastes are washed down the process drain with solid wastes are drummed and disposed of as hazardous or non-hazardous waste depending on content (EG&G, 1994; EG&G, 1991).

Instrumentation and Special Projects (active). The Instrumentation and Special Projects Group (ISP) is one of thirteen groups in the Technology Department. The primary functions of the ISP, which is housed in Rooms 233 and 245, include evaluation and implementation of physical and real-time chemical analysis instrumentation, development of other automated equipment, and process simulation and control system development. The ISP uses various instrumentation and a physical and chemical laboratory. Chemicals typically used include common lab reagents, trichloroethane, calcium fluoride, and carbon tetrachloride. After neutralization, aqueous wastes are washed down the process drain (EG&G, 1994).

Polymer Solidification Development (active). Room 296 houses the research effort on processes to encapsulate surrogate waste forms in thermoplastic thermosetting polymers. Hazardous samples from this project are drummed and sent to satellite collection areas (EG&G, 1994).

Wastewater Treatability Studies (active). Wastewater treatability tests are performed by the Waste Chemistry Group (ChemRisk, 1992) in Rooms 264 and 299 to test the ability of processes to precipitate low-level transuranic compounds. Acids and bases are used to adjust pH, and various oxidizing and reducing agents and precipitants are used in the treatment. Non-hazardous waste is placed in low-level waste drums and process water is discharge to the process drain (EG&G, 1994).

10.4.3.3 STORAGE

Rooms 297 and 144 are used to store low-level radioactive waste drums (EG&G, 1992). Room 165 is also a drum storage area with a capacity of five 55-gallon drums. In the past it was used

for storage of maintenance waste that contained hazardous and possible low-level radioactive wastes (DOE, 1988).

10.4.3.4 GENERAL PLANT OR BUILDING SUPPORT

The General Chemistry Laboratory in Building 881 conducts analyses to determine chemical composition of, or presence of, impurities or hazardous substances in process wastes, surface waters or products from vendors. Records management and storage maintains records and shreds unwanted documents. Other facilities include fabrication shops, maintenance and utilities (DOE, 1992; EG&G, 1994).

Health Physics Instrumentation (active). Located in Room 114J, this unit maintains all hand probe and hand/foot probes throughout RFP. Used mylar film and tape is placed in a low-level waste drum and nonhazardous waste is sent to the RFP landfill (EG&G, 1994).

Micrographics. Room 115 is used for document maintenance, including microfilming of documents. The only chemicals used are fixer, developer, and cleaning solutions (EG&G, 1994).

Records Maintenance. Over 2.5 million documents are stored in two separate vaults in Building 881. These documents consist of radiographic film that is potentially radioactively contaminated and contains a substantial amount of silver in the emulsion. There are 300 60-pound boxes of film in Vault Room 246 and 1,500 similar boxes in Vault Room 17 (EG&G, 1992).

Maintenance and Utilities. The utilities group in Building 881 provides building utilities for the all of 800 Area buildings including power supply and emergency power generation, chilled and domestic water supply, and plenum scrubbers for the buildings. Maintenance provides routine maintenance services throughout the building and generally for the other 800 Area buildings. A wide variety of routine chemicals are used, and wastes are generated such as freon (compound unspecified), lubricating oil, paint, paint thinner, acetylene, 1,1,1-trichloroethane, ballasts containing PCBs, and fluorescent lightbulbs. Waste streams generated within Radiation Control Areas are considered low-level waste and are secured in controlled storage areas (EG&G, 1994).

General Chemistry Lab. The majority of the process functions in Building 881 support the General Chemistry Laboratory. Laboratory analytical operations conducted in Building 881

include atomic absorption spectroscopy, inductively coupled plasma and direct current plasma emission spectroscopy, various chemical analyses, x-ray spectroscopy, furnace combustion analyses, semivolatile chemical analyses, ion chromatography, gas chromatography/mass spectrometry, radiochemistry, various organic chemical analyses, ion chromatography, anion and cation analyses, water analyses, and waste stream characterization analyses (EG&G, 1991; ChemRisk, 1992). Table 10-1 summarizes the analytical processes employed, the chemicals used, the wastes generated and the method(s) of disposal.

10.5 CURRENT CONTAMINATION STATUS

Between the time that the uranium activities were phased out and the building was converted to other uses, the outside ventilation grills and inside ventilation ducts of the annex were decontaminated as far as personnel could reach without actually entering the ducts (Hunter, 1990). During the early 1980s, gloveboxes that had been used for uranium processing were still being removed from the building (Aldrich, 1991).

On January 11, 1990, during routine inspection of the filter plenums in the 881 Annex duct work, elevated concentrations of uranium and plutonium were found on the downstream side of filters in the north half of the plenum. It was ascertained that the contamination reached the downstream side as a result of disturbance of residual duct work contamination which occurred during a scheduled filter change in December, 1989 (Hunter, 1990). Some senior employees on plant site indicate that plutonium may have been machined in the Building 881 Annex to the original building as part of an experimental program. However, no specific data or historical record can be found to substantiate the use of plutonium in this way (Hunter, 1990). A more likely source was from the OY leaching process for site returns that occurred prior to 1968 (Kelchner et al., 1994). As discussed, the operations in Building 881 involved leaching of uranium parts that contained some plutonium residues (Boss, 1991; Hunter, 1990). Another source stated that Building 881 was involved in processing plutonium-contaminated beryllium (EG&G, 1992). Others thought it may have been the result of analytical work with samples that may have had plutonium on them (Kelchner, 1991).

Most of the removable contamination in the open areas of Building 881 has already been removed or painted over. The building has numerous covered/closed areas with some degree of past contamination (i.e., plutonium or uranium) in ducts, under floors, behind walls, in pipes, etc. Levels of contamination are not presently known and have not been surveyed to determine

associated counts. Undocumented estimates are that as much as 5 kilograms of enriched uranium may be scattered throughout the building's duct work. Surveys and analyses must be done to determine levels and types (alpha, beta, gamma, etc.) of contamination. Completion of a thorough survey of the building is estimated to take three months. It has also been estimated that removal of all smearable contamination within Building 881 will require six people for two years. This radioactive clean-up is independent of the duct remediation work (EG&G, 1992).

Along with the duct and plenum contamination, the following additional areas of concern have been identified in the *1992 Mission Transition Program Management Plan* (EG&G, 1992):

1. Roof leakage - possible leaching of contamination.
2. Fire sprinkler system contains unknown types and amounts of radioactive contamination and needs to be removed.
3. Room 10 - cooling water tank is posted "Internal Contamination," and the floor beneath tank has up to 500 counts per minute fixed contamination (non-smearable) by Ludlum 12-1A.
4. Room 15 - the house vacuum pump liquid drain trap, the old process waste lines from the wet laboratories that were located upstairs, and the exhaust ducts are posted "Internal Contamination." The floor beneath the vacuum pump drain trap which is sealed with plastic and tape, has 25,000 counts per minute fixed contamination. The floor in front of the door to Room 15A has up to 500 counts per minute fixed contamination that has been painted. Finally, trenches that contain lead bricks covered with deck plate were used to house radioactive sources. The contamination in these trenches cannot be surveyed.
5. Room 15A - the air chase to the old plenum is contaminated and posted "Caution - Contact Radiation Protection Before Entering."
6. Room 21 - the house vacuum pumps are internally contaminated. Some are posted and some are not. Up to 1,000 counts per minute fixed contamination on the floor surrounding the pumps and 250 counts per minute fixed contamination is present on process waste drain in floor.

7. Room 122A - 500 counts per minute fixed contamination exists in front of the door to the high voltage enclosure.
8. Room 144 - the south end of the former plenum has various levels of fixed contamination.
9. Room 165 - two counting devices from the general laboratories are present, each containing a radium-226 source.
10. Room 114A - contains caustic scrubber, elevated levels of removable and fixed contamination. It is posted as "Contamination Area" and is locked.
11. Room 115 - formerly used to house ion columns that were three-stories tall. The columns have been known to break in the past, resulting in area contamination. The room has been decontaminated and there is no removable contamination present. However, residual fixed contamination exists at levels of up to 2,500 counts per minute on the floors and up to 4,000 counts per minute on the grill of the upright exhaust duct.
12. Room 243 - up to 500 counts per minute fixed contamination on floor by the hydrofluoric acid scrubber.
13. Room 266 - formerly uranium leach area, floor below tile is contaminated.
14. Room 265A - fixed contamination on walls and duct work is sealed with paint, levels unknown.
15. Room 245 - deck plate covering floor was allegedly put in place to cover elevated levels of contamination from enriched uranium.
16. Rooms 242, 309 - formerly housed foundry casting furnaces. Unknown levels of fixed contamination may be present in the cavities created by furnace removal.

17. Room 110 - the floor of this room covers elevated levels of contamination caused by leaking process waste lines from the old laundry that was located in Building 881.
18. Room 114L - floor by the hydrofluoric acid scrubber has 250 counts per minute fixed contamination.
19. Room 149 (elevator, main hallway) - rails entering the elevator and the elevator pit have various levels of fixed contamination. The conduits leading to electrical junction boxes and areas behind electrical panels have various levels of fixed and removable contamination. It is suspected that the floor beneath the tile in the main hallway (279) has various levels of fixed and possibly removable contamination (EG&G, 1992).

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TABLES

**TABLE 10-1
SUMMARY OF ANALYTICAL LABORATORY PROCESSES CONDUCTED IN BUILDING 881**

Process Name and Description	Room Location	Chemicals Used ⁽¹⁾	Wastes Generated and Disposal Method(s)
Atomic Absorption - metal analysis via flame, furnace, and cold vapor atomic absorption instruments	137, 139	Common lab reagents Potassium persulfate, potassium permanganate and hydroylamine hydrochloride	Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
X-ray Spectroscopy - analysis of metals, powders, salts, paint chips, and soils via energy dispersive and wavelength dispersive spectroscopy	137, 137A	Common lab reagents	Solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites Unused samples - returned to generator
Emission Spectroscopy - analysis of beryllium and other special metals	127A, 130, 131, 131B, 137	Common lab reagents Carbon tetrachloride, photographic fixer and developer	Processed non-hazardous samples, solid waste samples and solid waste - drummed in low-level containers or, if hazardous, sent to satellite collection sites Acids and carbon tetrachloride - complete evaporation Unused Beryllium - returned to Building 444 for reprocessing Unused samples - returned to generator
Ion Chromatography - analysis of rinse water samples from Building 460 for fluoride, nitrate, phosphate, sulfate, and chloride	254	Common lab reagents	Most aqueous wastes - rinsed into process drain Metal coupons - returned to generator Solid waste - drummed in low-level containers or, if hazardous, sent to satellite collection sites

TABLE 10-1
(Page 2 of 5)

Process Name and Description	Room Location	Chemicals Used ⁽¹⁾	Wastes Generated and Disposal Method(s)
Semivolatile Organics Preparation - solid and aqueous sample preparation via chemical extraction	255	Common lab reagents Methylene chloride, isopropanol and dimethyldichlorosilane	Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Sulfide and Cyanide Preparation and Analysis- solid and liquid sample preparation for analysis of total or amenable cyanide or cyanide or sulfide reactivity	137	Common lab reagents Iodine, sodium thiosulfate, salicylic acid, potassium iodate, silver nitrate, bismuth nitrate, sulfamic acid, cyanide standards, and sulfide standards	Unused samples - returned to generator Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Toxicity Characteristic Leaching Procedure - solid sample preparation via leaching	137	Common lab reagents	Unused samples - returned to generator Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Chemicals Certification - analysis of cleaning bath samples from Building 460 and chemicals purchased off-site via titrametric tests	137	Nitric/Nitradd solutions and common lab reagents	Aqueous wastes - rinsed into process drain Solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Ion Chromatography for Waters - analysis of surface water, wastewater, and deionized water	276	Common lab reagents	Aqueous wastes - rinsed into process drain Solid wastes - drummed in low-level containers and sent to satellite collection site

TABLE 10-1
(Page 3 of 5)

Wastes Generated and Disposal Method(s)	Chemicals Used ⁽¹⁾	Room Location	Process Name and Description
Excess salts and aqueous wastes - rinsed into process drain Solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites	Carbon tetrachloride, chloroform, 1,1,1-trichloroethane, potassium bromide	137, 224, 255	Infrared Analysis - analysis of unknown liquids and solids
Aqueous wastes - rinsed into process drain Solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites	Common lab reagents		Combustion Analysis - analysis of pure and alloyed refractory metals
Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites	Common lab reagents	131, 131D, 137	Plasma Spectroscopy - analysis of metals, plating bath solutions, J-line solutions, waters and wastes via three types of plasma spectrometers
Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites	Common lab reagents	266	Fingerprinting and Semiquantitative Analysis - analysis of liquids for characteristic hazards
Aqueous wastes - rinsed into process drain Solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites	Common lab reagents	276	Technicon Analyses - analysis of water samples for ammonia, cyanide, nitrate, and nitrite
Aqueous wastes - rinsed into process drain Solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites	Common lab reagents COD Digestion reagents	276	Water Laboratory Analyses - analysis of wastewater samples for typical NPDES parameters

TABLE 10-1
(Page 4 of 5)

Process Name and Description	Room Location	Chemicals Used ⁽¹⁾	Wastes Generated and Disposal Method(s)
Gross Alpha/Beta - analysis of liquid and solid samples for gross alpha and beta via gas-proportional counter instruments	137, 266, 266D, 272	Common lab reagents Reagents containing Plutonium-239, Sr-90, and Am-241	Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Tritium Analyses - analysis of liquid and soil samples for tritium using liquid scintillation counters	266, 266D, 272	Common lab reagents Scintillation Cocktail	Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Isotopic Analyses - analysis of liquid and solid samples for uranium, plutonium and americium	266, 266D, 272	Common lab reagents Radioactive standards	Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites
Gas Chromatography - analysis of analytical gases for impurities, nonradioactive environmental samples for PCBs	266, 254,	Carrier gases (argon, helium, oxygen) Common lab reagents	PCB contaminated materials - placed in black and yellow drums and sent to a TSCA storage area Unused samples - returned to generator Most aqueous wastes - rinsed into process drain Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites

TABLE 10-1
(Page 5 of 5)

Process Name and Description	Room Location	Chemicals Used ⁽¹⁾	Wastes Generated and Disposal Method(s)
Gas Chromatography/Mass Spectroscopy - analysis of environmental and RCRA TCLP samples from outside the Protected Area	127C, 245	Common lab reagents	<p>Unused samples - returned to generator</p> <p>Most aqueous wastes - rinsed into process drain</p> <p>Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites</p>
Water Analysis for Oil and Grease and Phenols - analysis of waters from outside the Protected Area	137	Freon, copper sulfate, phosphoric acid, ammonium chloride, ammonium hydroxide, amino-antipyridine, potassium ferricyanide, and chloroform	<p>Unused samples - returned to generator</p> <p>Most aqueous wastes - rinsed into process drain</p> <p>Some aqueous and solid wastes - drummed in low-level containers or, if hazardous, sent to satellite collection sites</p>

*Common lab reagents may include the following: Acetone, nitric acid, hydrochloric acid, hydrofluoric acid, hydrogen peroxide, ethanol, methanol, sulfuric acid, sodium carbonate, sodium bicarbonate, sulfuric acid, sodium fluoride, sodium chloride, potassium dihydrogen phosphate, potassium nitrate, potassium bromide. These components are used and stored in several liter quantities (EG&G, 1994; EG&G, 1992).

Sources: EG&G, 1994 and EG&G, 1991

931-0821000cb.881.Tab

FIGURES

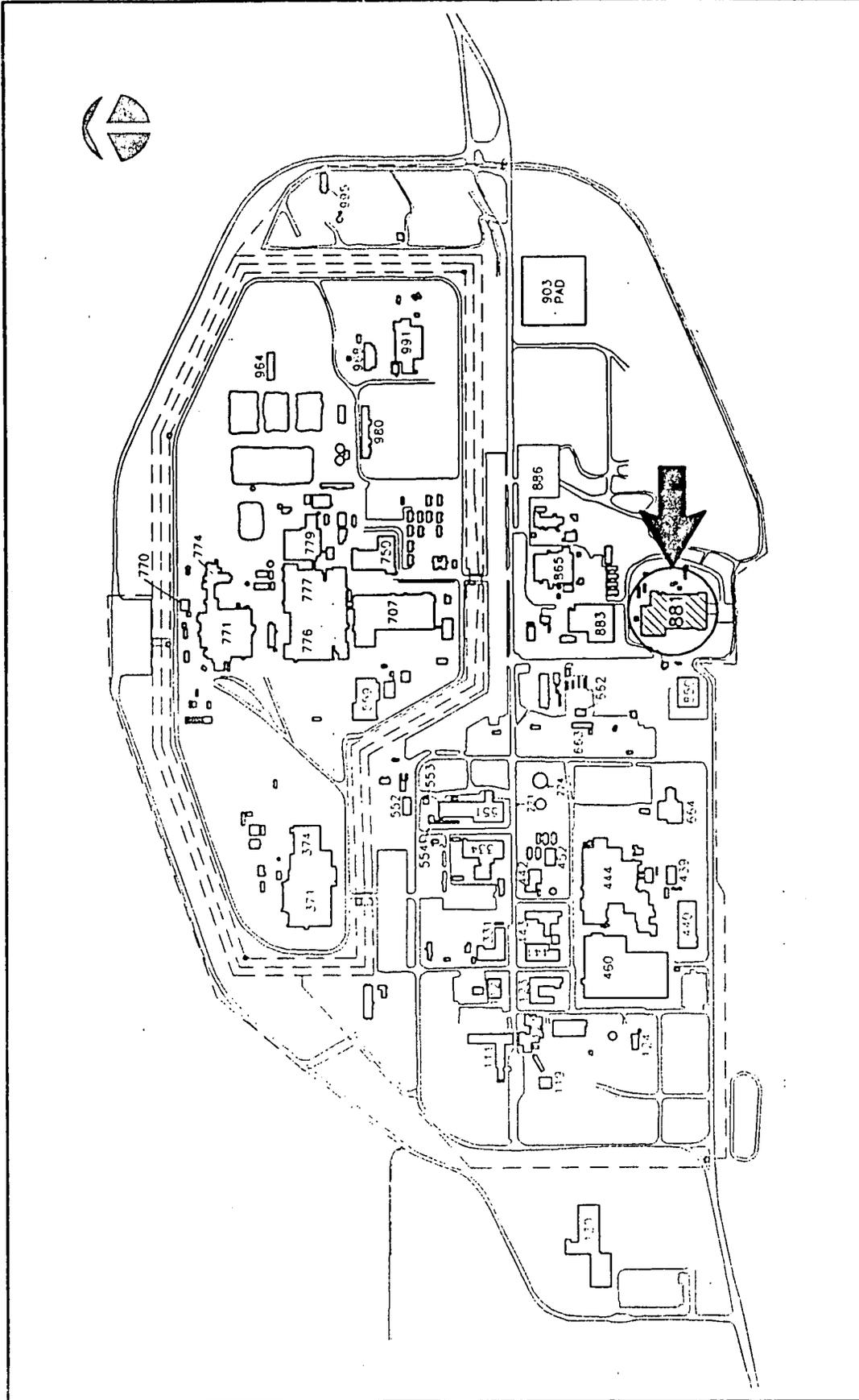


FIGURE 10-1
BUILDING 881

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 GOLDEN, COLORADO
 BY
WRIGHT WATER ENGINEERS, INC.
 2490 W. 26TH AVE., SUITE 100A
 DENVER, CO 80211 (303)480-1700

PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

11.0 OPERATIONAL HISTORY OF BUILDING 883

11.1 BUILDING DESCRIPTION

Building 883 was constructed in 1957 as part of the Part IV plant expansion. It was constructed to assist with fabrication of enriched and depleted uranium parts used in weapon design supported by the Part IV expansion (ChemRisk, 1992; Putzier, 1982). The scaled hollow shape of the components in the new weapon design required a significant amount of rolling and forming of both types of uranium. Space in existing Building 881 (involved in enriched uranium parts manufacturing) and Building 444 (involved in depleted uranium parts manufacturing) became limited. Building 883 was therefore constructed to handle some of the uranium rolling and forming operations (ChemRisk, 1992; Kelchner et al., 1994). Process operations conducted in Building 883 included cleaning and heating materials prior to shaping, rolling the metal into sheets, cutting of blanks, forming into required shapes, and cleaning after shaping.

Enriched uranium operations in Building 883 were discontinued between 1964-1966 when all enriched uranium work was moved to Oak Ridge in support of DOE's single mission concept (Kelchner et al., 1994; Buffer, 1993; ChemRisk, 1992). This single mission concept allowed Rocky Flats Plant (RFP) to focus on plutonium based weapons (ChemRisk, 1992). The enriched uranium side of Building 883 remained idle while the rest of the building continued to handle depleted uranium along with other non-fissile metals such as beryllium, tungsten, stainless steel, aluminum and vanadium, which were also used in plutonium weapon production (EG&G, 1991; Kelchner et al., 1994).

A major addition to Building 883 was completed in 1985 to support manufacturing of armor plates containing depleted uranium for the M1A1 tank. Handling of non-radioactive metals has continued even after the cessation of plutonium weapons production in November of 1989 and the change in plant mission in 1992. The building still houses many of the same physical operations for forming metal shapes as it did when it began uranium machining operations (EG&G, 1991).

11.2 HISTORICAL TIMELINE

- 1957 Building 883 was constructed for the purpose of fabricating (heating, rolling and cutting) enriched and depleted uranium into required shapes. Depleted uranium was handled in the "A" side of Building 883 (Side A), while enriched uranium was handled in the "B" side of Building 883 (Side B) (ChemRisk, 1992; Jackson, 1991). Other metals such as aluminum, titanium, tantalum, stainless steel and occasionally cadmium, were also machined on Side A (Kelchner et al., 1994; Clark, 1991).
- 1962 Beryllium rolling began in Side A (Kelchner et al., 1994).
- 1964-1966 The enriched uranium operations were transferred to Oak Ridge (Kelchner et al., 1994; ChemRisk, 1992) and Side B remained idle until 1977.
- mid-1970s Most beryllium machining operations ceased (Jackson, 1991).
- 1977 Manufacturing of calorimeter plates using depleted uranium began (Clark, 1991).
- 1983 Construction was initiated on a "C" side addition (Side C) to house armor plate manufacturing for the M1A1 tank. Pilot-Scale manufacturing of the plate took place (ChemRisk, 1992).
- 1985 Construction of Side C was completed and full-scale manufacture of armor plates using depleted uranium for the M1A1 tank began (ChemRisk, 1992; Clark, 1991).
- 1985-1986 The use of trichloroethylene (TCE) and perchloroethylene (PCE) as solvents was discontinued, and they were replaced by Oakite (Clark, 1991).
- mid-1980s Manufacturing of calorimeter plates using depleted uranium ceased (ChemRisk, 1992; Clark, 1991).
- mid-1980s The remaining beryllium operations ceased (Hill, 1994; EG&G, 1993).

11.3 PHYSICAL BUILDING DESCRIPTION

Building 883 is a two-story, steel-framed building located in the south-central portion of the plant site outside the Protected Area (PA) (Figure 11-1). It is south of Central Avenue and just north of Building 881 and is connected to Building 881 by a tunnel. The tunnel connects the northwest corner of the second floor of Building 881 to the southwest corner basement of Building 883 (EG&G, 1991; EG&G, 1992). Building 883 has a partial basement and a small second floor on the north and south ends. The exhaust plenum and particulate emission controls for Building 883's heating, ventilation and air conditioning (HVAC) system are housed in a separate support building, Building 879 (EG&G, 1991). Another support building, Building 827, contains the emergency generator for Buildings 883, 865, 875, and 889.

The building consists of 76,500 square feet of space, most of which is taken up by a high bay metal working facility containing large equipment. Within the manufacturing area, there are three long narrow areas designated as the "A," "B," and "C" sides. As of 1993, the A and B sides each contain a large rolling mill and support machinery while some of the equipment has been removed from the C side (EG&G, 1993). Offices are located on the south side of both the first and second floors.

The building air system is a single-pass non-recirculating system. Air is drawn in through five different inlets, where it is pre-filtered. The building air is exhausted through three sets of filter plenums. Each set consists of a metal de-mister or pre-filter and two stages of HEPA filters. Most of the air is exhausted through Building 879, the filter plenum building. No processes other than air filtration are conducted in Building 879. A smaller amount of air is also discharged through a plenum in Room 139 of Building 883. A portion of the exhaust air passing through the Room 139 plenum is treated by a scrubber to remove nitric acid fumes before entering the filter plenum (EG&G, 1991).

11.4 DESCRIPTION OF OPERATIONS

Operations in Building 883 can be divided into two distinct time periods. These are (1) historic operations which took place between the buildings construction in 1957 and 1989; and (2) recent operations that have occurred since plutonium production was shut down in 1989.

11.4.1 HISTORIC OPERATIONS (1957-1989)

The operations that occurred in Building 883 historically were uranium fabrication, beryllium fabrication, and a series of special projects involving various metal working. These are described below.

11.4.1.1 ENRICHED AND DEPLETED URANIUM FABRICATION

Building 883 began operation in 1957 as an enriched and depleted uranium fabrication facility (ChemRisk, 1992). The building was designed with two functional areas or sides to prevent cross contamination of the radioactive enriched uranium with the non-fissile depleted uranium. Side A handled depleted uranium, and Side B handled enriched uranium (ChemRisk, 1992; Clark 1991; Kelchner et al., 1994). Depleted uranium was cast in Building 444 and sent to Side A to be heated and rolled into sheets from which blanks of the required shape were cut. The shaped pieces were then sent back to Building 444 for final turning, trimming and polishing (ChemRisk, 1992). Side A also periodically handled other non-radioactive metals such as beryllium, tungsten, stainless steel, aluminum, and vanadium which also went into plutonium weapon production (EG&G, 1991; Kelchner et al., 1994). (Beryllium operations are discussed in Section 11.4.1.2.) Enriched uranium parts were sent to Side B from the casting operations in Building 881 and were sent back to Building 881 for final processing (Kelchner et al., 1994).

Metal ingots received from either Building 881 or Building 444 were placed in a furnace or eutectic salt bath to make the metal suitably malleable for rolling. The ingots were then rolled into sheets and annealed in a second salt bath (Kelchner et al., 1994). The sludge comprised of spent salt and uranium oxide was drummed and sent to Building 664 (Weston, 1986). The rolled sheets were then cleaned in a bath of TCE or PCE (Clark, 1991; Kelchner et al., 1994). A roller leveler was used to flatten the cleaned sheets which were then cut into circular shapes. The near final shaped "hats" were then formed using a Marform press process that employed a cylindrical press of solid rubber that behaved like a fluid under pressure. The parts were generally recleaned in a PCE bath, and in some instances, in a vapor degreaser. The presses were periodically cleaned with PCE which was drummed for disposal (Kelchner et al., 1994).

A house vacuum system operated on Side B to collect enriched uranium fines which were sent to Building 881 for recovery. The vacuum system was designed with a cloth filter bag which captured the fines. In addition, the molten salt baths were pumped out annually to recover metal

finer that had accumulated in the bottom. Other waste streams from enriched uranium work were sent to the enriched uranium recovery operations in Building 881 (Kelchner et al., 1994).

Beginning in 1964, enriched uranium work was curtailed in Buildings 881 and 883 as the work was moved to Oak Ridge (ChemRisk, 1992; Jackson, 1991; Kelchner et al., 1994). In January 1965, a plantwide announcement was made that all enriched uranium operations would be transferred to Oak Ridge (Buffer, 1993); therefore, there was no longer a need for enriched uranium rolling and forming in Side B. Side B remained idle for a period of about 17 years after enriched uranium operations were removed (Kelchner et al., 1994).

11.4.1.2 BERYLLIUM FABRICATION (1962-mid-1980s)

In approximately 1962, beryllium-forming operations began in Side A and operated until the mid-1980s (Hill, 1994; Kelchner et al., 1994). Nine-inch by nine-inch beryllium ingots, which were cast in Building 444 and placed into stainless steel "cans" in Building 881, were heated, rolled into sheets and then cut out of the stainless steel forms. During this time period, the southwest corner of the building housed a beryllium grinding room that included an etching bath (Clark, 1991). The sheets were acid etched using nitric or hydrofluoric acid to remove any micro-cracks and to reduce the thickness. Originally, etching occurred in heated dip tanks, which were later replaced by a spray tank (Hornbacher, 1994). Sheets were then heat-treated in either the acid and/or eutectic salt baths and pressed into the desired shape in Building 883. The beryllium shapes were then returned to Building 444 for further machining (Hill, 1994; Jackson, 1991). Another beryllium part was made using a process in which the beryllium was rolled without the use of a stainless steel outer shell. This process occurred until the mid-1970s (Jackson, 1991).

11.4.1.3 WASTE HANDLING

Building 883 housed a process waste collection system which collected liquid wastes such as machine oils, coolants, and quench water from the various processes in Building 883. The system consisted of process drains and seven tanks (ranging in size from 350 to 750 gallons) located in Room 1. The system collected liquids from quench tanks in Rooms 102, 105, and 109 and from the process drains in the janitor's closets. Spent nitric acid from acid cleaning of metal parts was also collected (Weston, 1986). Treatment of the wastes generated in Building 883 did not take place in the building, however, drains were fitted with screens to catch large solids. Water from

the portable quench tanks entered the system via a process waste drain in Room 109 (EG&G, 1991).

In addition, Room 104 contained a drum accumulation area for 30- to 55-gallon drums containing waste oils, solvents, uranium, beryllium, and 1,1,1-trichloroethane (DOE, 1988).

11.4.1.4 SPECIAL PROJECTS (1970s-1980s)

A series of special order projects took place in Building 883 throughout the late 1970s and the first half of the 1980s. These are as follows:

- Starting in 1977, thousands of depleted uranium calorimeter plates were manufactured and rolled in Side A (Clark, 1991; Kelchner et al., 1994).
- Cadmium was infrequently rolled and formed (Clark, 1991; Link, 1991).
- In 1983, pilot-scale operations began for the manufacture of armor plates for the M1A1 tank in which depleted uranium was used (ChemRisk, 1992). Also in 1983 construction began on Side C to Building 881 which was used for full-scale production of the armor plates. Full-scale operations began in both Sides B and C in 1985 and hundreds of tons of depleted uranium were processed over the life of the project (Kelchner et al., 1994; Clark, 1991; ChemRisk, 1992).

11.4.1.5 CHEMICAL USAGE (1957-1988)

Between 1957-1988 the metal pressing and forming processes conducted in Building 883 used the following chemicals: PCE, TCE, freon (compound unspecified), a 50 percent nitric acid aqueous solution (for pickling uranium), and chlorofluorocarbons (CFCs). The use of CFCs was discontinued in 1988, while PCE and TCE were replaced with water and Oakite in 1985 or 1986 (ChemRisk, 1992; Clark, 1991). In the past, one of the large metal presses was filled with oil containing polychlorinated biphenyls (PCBs). The oil was drained from the press and taken to the PCB storage area (Weston, 1986).

11.4.2 RECENT OPERATIONS (1989-Present)

Although the primary mission of the plant was curtailed in 1989 when plutonium operations ceased, Building 883 has continued to be involved in non-fissile metal (stainless steel, aluminum, depleted uranium, tantalum, and titanium) fabrication. In 1993, Building 883 was used for three purposes: (1) rolling and pressing of classified blanks for pit contingency (war reserve) and special order work; (2) bending large tubes for W84 body parts; and (3) swaging reservoir stems to meet production requirements (EG&G, 1993). The rolling and pressing operations have changed little from those employed when the building first opened. In addition to these fabrication operations, some special projects and support operations are also active.

11.4.2.1 FABRICATION

Fabrication operations include rolling, shearing, blanking and trepanning, preheating and forming, heat treating, cleaning and grit blasting. All of these processes are active with the exception of shearing and grit blasting, which were discontinued in 1993.

Rolling Process. Rolling occurs in Rooms 105, 112, and 138. Metal ingots consisting of stainless steel, aluminum, tantalum, titanium, and depleted uranium are heated in a furnace, or in the case of uranium, in a eutectic salt bath. As previously discussed, uranium oxide sludge and sludges generated by the quench system are drummed and sent to Building 664. After softening, the ingots are rolled in one of three rolling machines which are lubricated with non-hazardous, water soluble rolling oil (EG&G, 1991; EG&G, 1994). After rolling, the metals are cooled with a water quench system either by air, a water quench system or tool quench. The quench water is filtered and then recycled. Liquid waste is transferred via drum to Building 374 for processing (EG&G, 1991).

Shearing (discontinued). Stainless steel, titanium, depleted uranium, and aluminum sheet metal were mechanically cut with equipment into smaller pieces before being shaped. For the most part, the guillotine action of the equipment *did not* produce fine particulate or other waste material (EG&G, 1991). This process was discontinued in 1993 (EG&G, 1994).

Blanking and Trepanning. After rolling, some metal sheets of uranium, stainless steel, or aluminum are blanked or trepanned in Rooms 105 and 109. Blanking consists of punch pressing a circular shape using a hydraulic press and blanking die, whereas trepanning consists of cutting

a shape using a lathe. The only chemical used in the process is cutting oil (Trim Sol coolant) that is passed over the lathe through a recirculating system. Used coolant is placed in a drum and sent to Building 794. Wastes produced are metal scraps, including uranium turnings and chips, which are sent to the chip roaster in Building 447. Non-uranium metal scrap is sent to Building 664 (EG&G, 1991; EG&G, 1994).

Preheating and Forming. Forming takes place in Rooms 102, 104, 105, and 109 and involves pressing metal blanks into specific shapes following the rolling process. Sometimes the process involves heating the metal with either a torch or in a hot oil bath. Scrap uranium is sent to Building 444 for reprocessing and vanadium is drummed and sent to an off-site recycler. Other metal scrap is drummed in low-level waste drums and sent to Building 664. Chemicals used in the process are non-toxic cleaning fluids (Mariko and De-Solv-It), oil, and machining fluids. Along with the scrap metal, the only wastes produced are hot dye lubricant and wax which are vaporized into the exhaust system, cleaning fluids which are collected in low-level waste drums, and used oil which is also drummed (EG&G, 1991; EG&G, 1994).

Heat Treating. Heat treating occurs in Rooms 102, 104, and 105 and uses high temperatures to anneal metal parts. Solid metal parts consisting of depleted uranium, uranium alloy, stainless steel, aluminum, or tantalum are placed into one of six enclosed and liquid cooled furnaces or into one of four salt baths. As of 1994, only one of the eutectic baths was operational (EG&G, 1994). The salt bath contains sodium, lithium, and potassium carbonates. After heating or bathing, the parts are cooled by water, air or press quenches housed in portable tanks. An oil bath consisting of Dow Corning 550 fluid is occasionally used to cool parts (EG&G, 1991). Wastes produced include argon gas, which is processed in the vent system, and uranium oxide dust and sludge, which are drummed and stored in Building 883 (EG&G, 1991; EG&G, 1994).

Cleaning. Cleaning takes place in Rooms 102, 105, 108, 109, 138, and 139, subsequent to the various forming operations. Cleaning solutions used are nitric acid (only for uranium), De-Solv-It, Mariko, Oakite and Ox-Out, although nitric acid was discontinued sometime between 1991 and 1994 (EG&G, 1994). Cleaning rags and other wet combustible waste are placed in low level waste drums while spent Ox-Out solution is drummed and sent to Building 374 for analysis (EG&G, 1991; EG&G, 1994).

Nitric acid cleaning was performed inside an enclosure to control fumes. The process occurred in a double-walled, stainless steel tank located in Room 138. According to the 1991 Air

Pollution Emission Notice (APEN), nitric acid was used at a rate of 50 pounds per year. Parts were cleaned by dipping in nitric acid followed by dipping or spraying with water (EG&G, 1991). Ox-Out contains 20 percent nitric acid and cleaning with this product occurs in Room 105 by dipping the parts in a 55-gallon drum of the solution followed by dipping in water (EG&G, 1991).

Grit Blasting (discontinued). Grit blasting consisted of cleaning a part inside of a closed container using a stream of high-velocity air mixed with an aluminum oxide blasting grit. The particulate generated was collected in a cyclone separator and was subsequently filtered through disposable cloth filters (EG&G, 1991). This process was discontinued in 1993 (EG&G, 1994).

11.4.2.2 SPECIAL PROJECTS

A research decontamination booth was constructed in Side B in the early 1990s and was used to evaluate the effectiveness of a vendor-owned carbon dioxide pellet blaster for removing radioactive contamination (EG&G, 1993). This work has been discontinued (EG&G, 1994).

11.4.2.3 SUPPORT OPERATIONS

Support operations include a stepoff pad, general maintenance, and utilities. The stepoff pad is located in Room 101 and produces wastes such as used protective clothing and smear paper associated with radiation monitoring. The maintenance and utility functions use chemicals and generate chemical waste such as lubricating oil, bearing grease, ethylene glycol, HTH algae inhibitor, Nalco corrosion inhibitor, paints, adhesives, lead-acid batteries, spent florescent light bulbs, ballasts with PCBs and asbestos insulation (EG&G, 1994).

11.5 CURRENT CONTAMINATION STATUS

Since beryllium operations ceased in the mid-1980s, the building has undergone extensive decontamination (ChemRisk, 1991). No additional information is currently known on the contamination status of Building 883.

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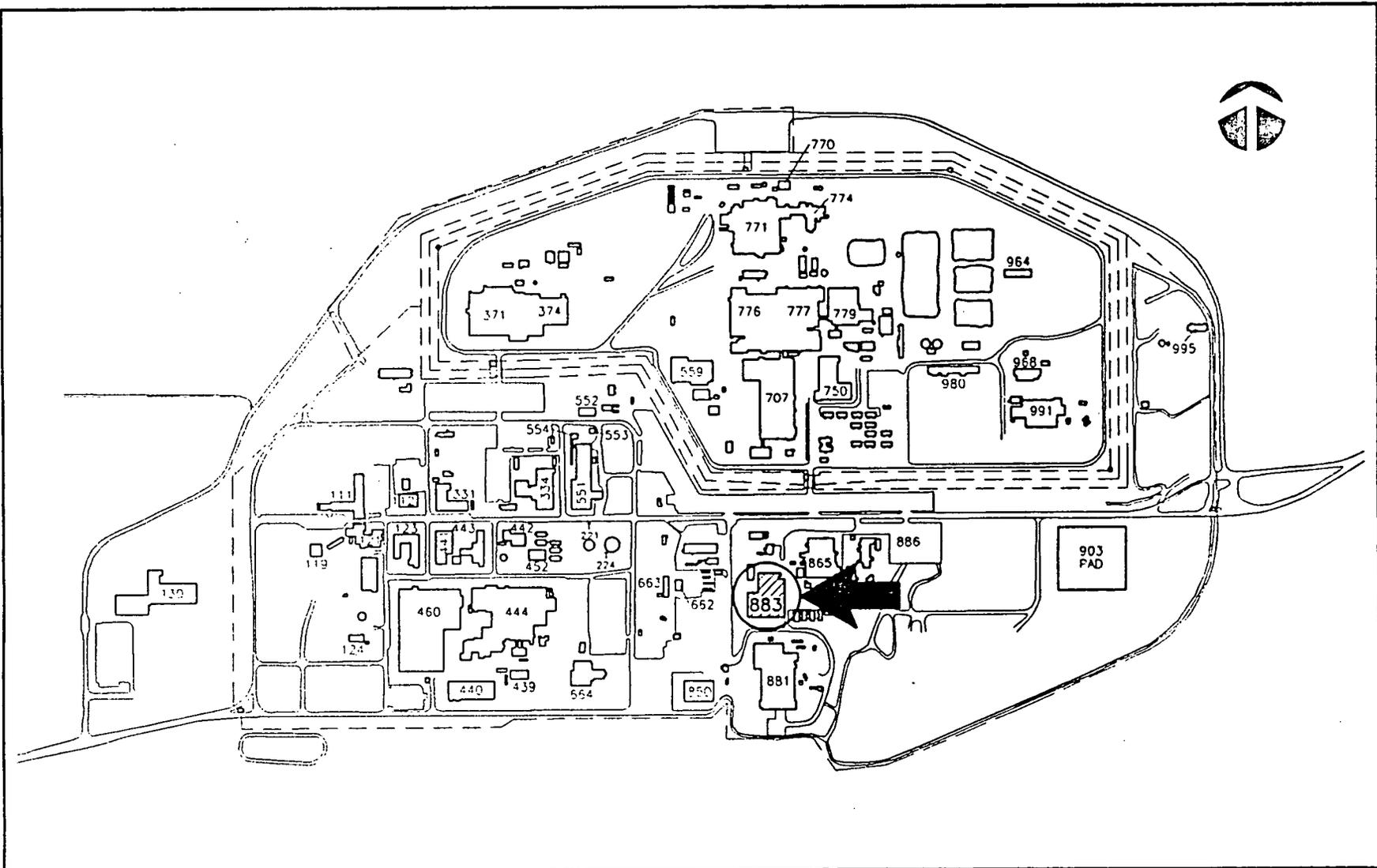
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FIGURES



PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO
BY
WRIGHT WATER ENGINEERS, INC.
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**FIGURE 11-1
BUILDING 883**

12.0 OPERATIONAL HISTORY OF BUILDING 991

12.1 INTRODUCTION

Building 991 was one of the four original buildings at the Rocky Flats Plant (RFP) and was constructed between 1951 and 1952 (Buffer, 1993). At that time, Building 991 was designated as the "D" Plant and was used for shipping and receiving, and for final assembly of weapon components received from on-site fabrication operations and from Oak Ridge and Hanford (EG&G, 1992; ChemRisk, 1992). Building 991 also served RFP's administrative functions until Building 111 was completed (Wilson, 1994). In 1957, production began on a new weapon design, referred to as the Part IV design. Because of the new design, final pit assembly took place in newly constructed Building 777 (ChemRisk, 1992; Getman, 1994). It is believed that assembly of the older uranium based weapon continued in Building 991 until approximately 1960 (Getman, 1994). However, after 1957, the mission of Building 991 became increasingly one of a shipping, receiving and storage facility. The types of materials handled by this facility included special nuclear material (SNM, which is defined as fissile, concentrated radioactive material), classified materials, and other metal components. As of 1994, this building has the only shipping/receiving dock at RFP with the capability of handling off-site shipments of SNM and classified materials (EG&G, 1992; Wilson, 1994; Riddle, 1994).

12.2 HISTORICAL TIMELINE

- 1951 Ground breaking occurred on July 10 for Building 991 which was the first permanent building at RFP (Buffer, 1993).
- 1952 Operations began on regular production materials in April (Buffer, 1993). Building 991's main function was assembly and shipping and receiving of final components produced at RFP, Hanford and Oak Ridge (EG&G, 1992; ChemRisk, 1992).
- 1953 The first products were completed and shipped off-site in April (Buffer, 1993).

- 1957 Most assembly operations were curtailed as RFP began producing and assembling the Part IV weapon design in Building 777. Assembly of stockpiled uranium based pits continued in Building 991 until approximately 1960 (Getman, 1994).
- Early 1960s A limited number of plutonium pits were assembled in Building 991 (Getman, 1994).
- 1964 A beryllium coating operation began in a research laboratory in Building 991 (Hill, 1994).
- Mid-1970s Research and development (R&D) operations moved from the building (EG&G, 1992). Some of these operations were transferred to Building 705 (Hill, 1994).
- 1976 The beryllium coating operation ceased in Building 991 and was transferred to Building 705 (Hill, 1994).

12.3 PHYSICAL BUILDING DESCRIPTION

Building 991 is located on the east side of the developed portion of RFP within the Protected Area (PA) (Figure 12-1). The building is the center of the 991 complex which includes a series of four underground storage vaults connected by tunnels referred to as Building 996, Building 997, Building 998, and Building 999 (DOE, 1992; EG&G, 1992). Building 991 encompasses 37,880 square feet on a first floor and basement. The four underground vaults have a total area of 20,940 square feet (Wilson, 1994). The Building 991 tunnels and vaults are maintained at a slight negative pressure by the building heating, ventilating and air conditioning (HVAC) system (EG&G, 1992; Getman, 1994). The north half of the building was used for shipping, receiving and storage of classified and SNM, laboratories and the protected area alarm maintenance. The south side is occupied by offices (Wilson, 1994).

12.4 DESCRIPTION OF OPERATIONS

Building 991 operations are categorized into two major time periods delineated by the curtailment of weapons production in 1989. Historic (or pre-1989) operations, followed by recent operations are described below. Because 991 was constructed mainly to support shipments of nuclear

materials, the description of operations is rather limited as compared to the manufacturing buildings.

12.4.1 HISTORIC OPERATIONS (1952-1989)

Building 991 was the first building to be completed at RFP and was designed to be the shipping and receiving, and final assembly building (ChemRisk, 1992; Putzier, 1982; EG&G, 1992; Buffer, 1993). Plutonium, enriched uranium and depleted uranium components which were fabricated on-site and components from Hanford and Oak Ridge were assembled into final products, inspected and tested, and then placed back in storage prior to off-site shipment. A few special projects were also conducted in this building.

12.4.1.1 FINAL ASSEMBLY (1952-1960)

Final assembly of the early concept design products was a relatively simple operation. A small amount of solvent was used for one last wipe-down of the components and finished product (ChemRisk, 1992). Solvents typically used in assembly were trichloroethylene (TCE) and acetone (Crisler and Dingman, 1993). Assembly took place in an open room rather than in enclosed gloveboxes or B-boxes because all of the radioactive components were coated in nickel or encased in plastic (Getman, 1994).

A change in the weapon design produced at RFP occurred in the late 1950s. This change required a shift in the relative amount of materials used in the pit and the amount of machining and handling of the materials. Along with this change in design, the assembly operation became more involved and required tighter controls. Assembly of the new design, therefore, took place in Building 777 which became operational in 1957 and was designed specifically to support the Part IV weapon. Assembly operations for stockpiled components for the older weapon design are believed to have continued in Building 991 until about 1960 (Getman, 1994; Dingman, 1994). A limited number of the plutonium based pits were also assembled in Building 991 in the early 1960's.

12.4.1.2 SHIPPING AND RECEIVING (1952-1989)

From RFP's earliest operation until weapon production was cancelled in 1989, Building 991 served as a shipping and receiving facility for incoming and outgoing SNM and as a storage

facility for some of those materials (DOE, 1992; EG&G, 1992). Until the mid-1980s, materials were shipped and received from the eastern dock area, Room 166 (Getman, 1994). Most shipments of product were sent by rail until the mid-1970s when specially designed tractor trailers referred to as Safe Secure Transports (SSTs) were designed and employed. These SSTs were used for shipment of final product by roadway. The west dock was added in the mid-1980s to provide a covered shipping area specifically designed for the SSTs (Getman, 1994). Transport of SNM was moved out of Building 991 for a period of about six months in 1975 or 1976. During this time period, shipping occurred from Building 439/440. Shipping was moved back to Building 991 because of security concerns (Getman, 1994).

SNM to be shipped off-site such as finished plutonium pits was packaged in elaborate containers specially designed to ensure safe transport. Much of the area on the first floor was devoted to storage of packaging materials and containers. The inner surface of some containers were coated with material such as lead or cadmium (Getman, 1994).

Incoming materials were generally not unpacked (Getman, 1994). However, site-return pits were unpacked, tested via radiography (X-ray) to determine and verify contents, re-packaged, and shipped to Building 777 for disassembly (Riddle, 1994).

12.4.1.3 FINISHED MACHINE PARTS INSPECTION AND TESTING

Building 991 was used to test the quality of non-nuclear raw materials and parts fabricated by off-site vendors. The building also inventoried and stored these parts for future use. Building 991 took over this operation from Building 881 sometime in the 1970s. The building received thousands of parts and materials that were purchased off-site that needed to be tested to ensure that they were weapons quality. A metallography lab was operated as part of this function. Parts were periodically cleaned with Oakite after testing. In the late 1980s, the handling of non-classified materials was moved to Buildings 130 and 460. Materials ready for assembly were sent directly to Building 460 (Getman, 1994).

12.4.1.4 SPECIAL PROJECTS (1960s to mid-1970s)

A number of research and development projects occurred in Building 991 throughout its operation, although information regarding them is limited. In the 1960s and until sometime in 1970, the southwest corner of Building 991 housed large fish tanks for radiation studies (Getman,

1994). A small beryllium coating process operated in the building between July 1964 and September 1976. This operation was subsequently moved to Building 705 (Hill, 1994; Wilson, 1994). An explosives forming project occupied the building between 1966 to 1974 (Wilson, 1994). Most special projects and research and development operations had been moved out of the building by 1974 to 1976, leaving shipping, receiving and storage as the primary functions (EG&G, 1992; Wilson, 1994).

12.4.2 RECENT OPERATIONS

Currently, Building 991 is used for off-site shipping of various components, assemblies, and other materials associated with past weapons and/or plutonium metal production. Building 991 also houses non-destructive testing operations, a metallography laboratory and other support operations (DOE, 1992). Radioactive and non-radioactive raw materials, non-design agency special order items, packaging items, components, and samples are also stored in the 991 Vaults (EG&G, 1992). These recent operations are described below.

12.4.2.1 SHIPPING AND RECEIVING (1952-1989)

Building 991 is the point of departure for all off-site shipments of radioactive material. Building 991 receives materials from other buildings at RFP and prepares them for off-site shipment. All non-nuclear and nuclear materials sent to Building 991 are handled in Rooms 170 (the shipping dock) and 134 (Wilson, 1994). Production Quality Control is responsible for tracking all incoming and outgoing shipments.

Primary materials handled include 55-gallon and 30-gallon drums of uranium and plutonium parts from off- and on-site (EG&G, 1994). The outside of the drums received at the dock is checked for contamination and, if radiation levels exceed a threshold limit, the drums are cleaned with Triple C Cleaner and Kimwipes. Materials received at the dock are then transferred to the storage vault awaiting final disposition. Prior to shipment from Building 991, drums are rechecked for contamination. Room 134 is also used to repair fixtures that hold parts securely in the drums (EG&G, 1994).

Chemical products used in these functions are Triple C Cleaner, glue, paint, Lubribrand A, batteries, sodium bicarbonate and Oil-dri. The primary waste material produced is plutonium- and uranium-contaminated Kimwipes (EG&G, 1994).

12.4.2.2 INSPECTION AND TESTING

Non-destructive testing (NDT) operations including radiography, ultrasonic analysis and dye penetrant testing occur in Rooms 160 through 165. Major pieces of equipment used are a fixed X-ray machine, a portable X-ray machine and a gamma ray source of iridium-192 and depleted uranium shielding. Major chemicals used are ultrasonic coupling gel, developer solutions and cleaner, photographic fixer, film, dye penetrant and dye penetrant cleaner (EG&G, 1994; Riddle, 1994).

NDT has many boxes of used radiographic film stored in Vault 158. The film is potentially radioactively-contaminated and contains a substantial amount of silver emulsion (EG&G, 1992).

12.4.2.3 STORAGE (1952-1989)

In 1992, Building 991 had two 90-day accumulation areas and seven satellite storage areas for the storage of Resource Conservation and Recovery Act (RCRA) regulated waste. In 1994, only one 90-day accumulation area and six satellite storage areas are located in the building (Wilson, 1994). Building 991 currently stores thousands of drums and cartons containing non-fissile, scrap beryllium, some of which was received from Pantex. Under the *Draft 1992 Mission Transition Program Management Plan*, this classified beryllium scrap was planned to be sent off-site for processing into unclassified ingots and the scrap disassembly operations were to be moved to Pantex or Oak Ridge (EG&G, 1992).

12.4.2.4 SPECIAL PROJECTS

The non-plutonium physical metallurgy process located in Room 155 is an R&D operation dedicated to electron beam analysis of non-plutonium metal samples. The room is also used for experiments to determine alternative solvents to replace carbon tetrachloride. Chemicals used are predominantly in support of the alternative solvent program and include diglyme bis (2-methoxyethyl) ether, methyl acetoacetate, diacetone, 2-butoxyethanol, hexanol, butyl lactate, hexane, dodecane, 3-methylecyclohexanol, 140-66 solvent, octanol and tetradecane. Other chemicals include machining oil, 2,2,2-trifluoroethanol, trifluoroacetic anhydride and ethyl acetate (EG&G, 1994).

12.4.2.5 SUPPORT OPERATIONS

Support operations include laboratories, utilities, and maintenance operations.

Metallography Lab. The metallography lab is located in Rooms 109, 110 and 111 and analyzes non-radioactive metal and non-metal samples to support weapons development, shipping container design and waste management. Major chemicals used are isopropyl alcohol, alumina or silicon carbide grinding paper, diamond paste or other nonhazardous polishing solutions, etching solutions such as oxalic, nitric, hydrochloric and phosphoric acid, and Trim Sol cutting oil. In addition to these chemicals, wastes generated include metal cutting fines from sample preparation (EG&G, 1992; EG&G, 1994).

Module Lab. The module lab in Room 143 supports the inspection of glovebox gloves and air-breathing garments (EG&G, 1992).

Maintenance Alarms. Rooms 140 and 141 are used for the repair and maintenance of alarm equipment used throughout the Protected Area. Chemicals used include adhesives, alcohol, solvents, nickel-cadmium and lead-acid batteries and sodium bicarbonate (EG&G, 1994).

Utilities and Maintenance. The Utilities Group, located in Rooms 130 and 137, operates the building ventilation system. The Maintenance Group provides routine maintenance services throughout the building. A wide variety of routine chemicals are used including Freon 12 or Freon 22 for the refrigeration unit, lubricating oil, ballasts containing polychlorinated biphenyls (PCBs), paint and fluorescent light bulbs (EG&G, 1994).

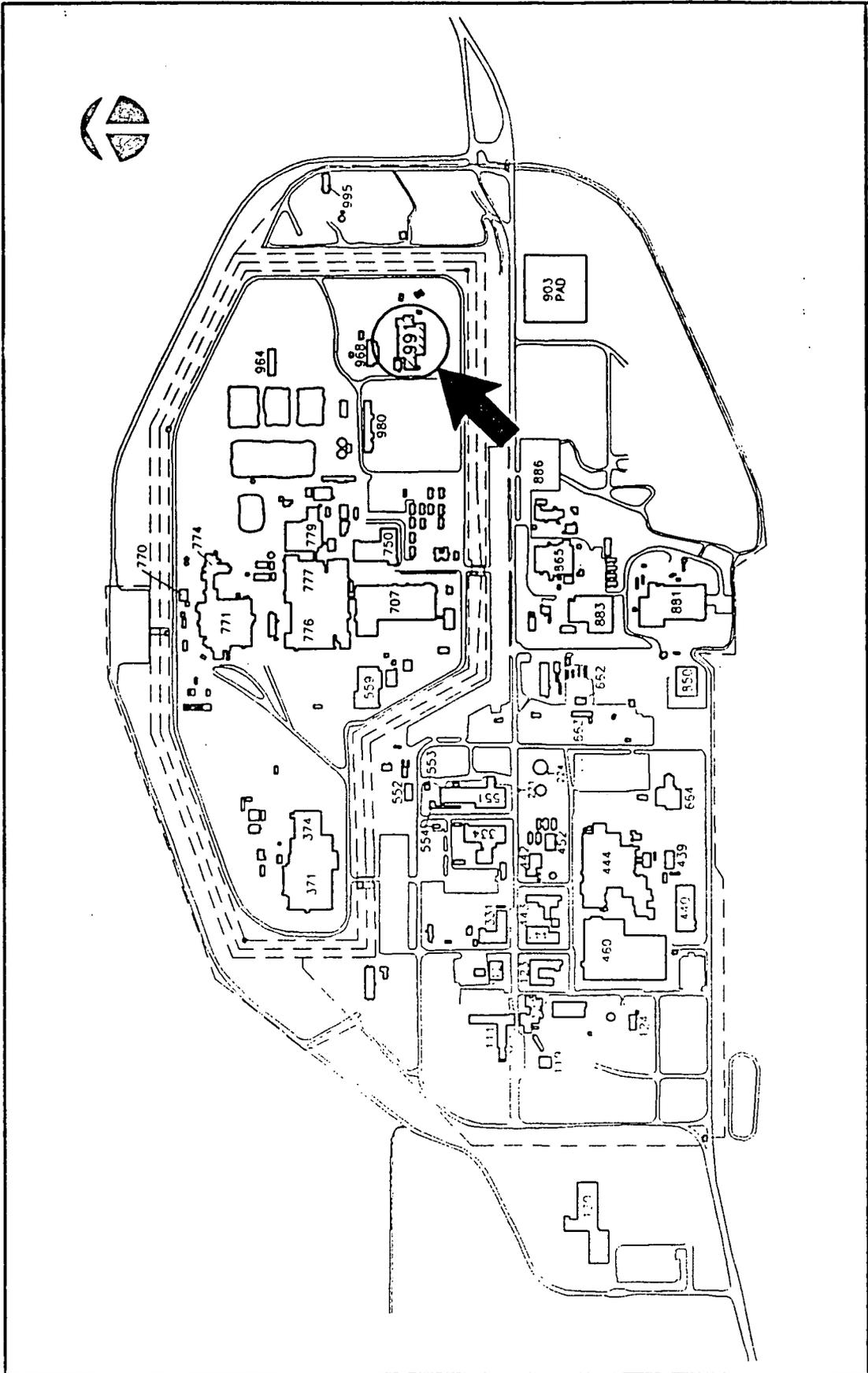
12.5 CURRENT CONTAMINATION STATUS OF BUILDING 991

A Final Hazard Assessment has been completed for Building 991 which addresses surface contamination, radiation, airborne and general hazards. There are no reported contamination levels outside of regulatory guidelines, and no decontamination is required in Building 991 for its continued use. There are no other general hazards which pose an unusual risk, although the Building 991 complex has been designated as an Individual Hazardous Substance Site (IHSS) (EG&G, 1992).

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**FIGURE 12-1
BUILDING 991**

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 GOLDEN, COLORADO
 BY
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PROJ. NO.	931-082.000	DWG. NO.	-
DESIGN BY	JKC	CHECKED	JKC
DRAWN BY	KAL	APPROVED	-
DATE	NOV. 28, 1994	SCALE	1" = 900'

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FIGURES