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CCP-AK-INL-600

Central Characterization Project
Acceptable Knowledge Summary Report
For

REMOTE-HANDLED TRANSURANIC DEBRIS WASTE FROM EXPERIMENTAL BREEDER REACTOR AT THE IDAHO NATIONAL LABORATORY

Waste Stream
ID-EBR-S5000

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
AFCI	Advanced Fuel Cycle Initiative
AK	Acceptable Knowledge
ANL-W	Argonne National Laboratory – West
CCP	Central Characterization Project
CFR	Code of Federal Regulations
CH	contact-handled
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	data quality objective
EBR	Experimental Breeder Reactor
EPA	U. S. Environmental Protection Agency
FCF	Fuel Conditioning Facility
FCF	Fuel Cycle Facility
FDP	Fluorinel Dissolution Process
FFTF	Fast Flux Test Facility
FMF	Fuel Manufacturing Facility
HFEF	Hot Fuel Examination Facility
HWN	Hazardous Waste Number
IFR	Integral Fast Reactor
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
ISC	Interim Storage Container
IWTS	Integrated Waste Tracking System
L&O	Laboratory and Office
LMFBR	Liquid Metal Fast Breeder Reactor
LWA	*The Waste Isolation Pilot Plant Land Withdrawal Act*
m^3	cubic meters
MFC	Materials and Fuels Complex
mrem/hr	millirem per hour
MSDS	Material Safety Data Sheets
NaK	potassium-sodium eutectic
nCi/g	nanocuries per gram
NU	natural uranium
NWCF	New Waste Calcining Facility
NWPA	*Nuclear Waste Policy Act of 1982*
PCB	polychlorinated biphenyl
PVC	polyvinyl chloride
QA	Quality Assurance
QAO	quality assurance objective
RCRA	Resource Conservation and Recovery Act
Rem/hr	rems per hour
RH	remote-handled
RH TRUCON	RH TRU Waste Content Code

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

RSWF	Radioactive Scrap and Waste Facility
RTR	real-time radiography
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
TBD	To Be Determined
TREAT	Transient Reactor Test Facility
TRU	transuranic
U	uranium
VE	visual examination
WAC	Waste Acceptance Criteria
WCPIP	Remote-Handled TRU Waste Characterization Program Implementation Plan
WIPP	Waste Isolation Pilot Plant
WIPP-WAC	*Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*
WIPP-WAP	*Waste Isolation Pilot Plant Hazardous Waste Facility Permit*, Attachments B-B6, *Waste Analysis Plan*
WMP	Waste Material Parameter
ZPPR	Zero Power Physics Reactor

1.0 EXECUTIVE SUMMARY

This Acceptable Knowledge (AK) Summary Report has been prepared for the Central Characterization Project (CCP) for remote-handled (RH) transuranic (TRU) waste stored at the Materials and Fuels Complex (MFC), formerly Argonne National Laboratory-West (ANL-W) and part of the Idaho National Laboratory (INL). The waste described in this report was historically generated from decommissioning the Experimental Breeder Reactor-1 (EBR-I), in Building EBR-601. The waste is currently stored at the MFC Radioactive Scrap and Waste Facility (RSWF) pending repackaging at the Idaho Nuclear Technology and Engineering Center (INTEC). This report was prepared in accordance with Attachment A, Acceptable Knowledge Procedure for Remote-Handled Waste, of DOE/WIPP-02-3214, *Remote-Handled TRU Waste Characterization Program Implementation Plan* (WCPIP); NM4890139088-TSDF*, Waste Isolation Pilot Plant Hazardous Waste Facility Permit*, Attachments B-B6, *Waste Analysis Plan* (WIPP-WAP); and CCP-TP-005, *CCP Acceptable Knowledge Documentation* (References 1, 2, 3).

The CCP is tasked with certification of TRU waste for transportation to and disposal at the Waste Isolation Pilot Plant (WIPP). The CCP is responsible for reviewing, approving, and maintaining this report and supporting AK source documentation as CCP Quality Assurance (QA) records. The CCP maintains responsibility for all referenced documentation stored at the CCP Records Center, Carlsbad, New Mexico.

Waste stream ID-EBR-S5000 consists of five RSWF liners of RH TRU metal debris waste. The waste was generated from decommissioning EBR-I and transfer of the materials to the RSWF for interim waste storage was conducted from October 1965 to October 1966. EBR-I was the first Liquid Metal Fast Breeder Reactor (LMFBR) and was the predecessor of EBR-II. Following repackaging into 55-gallon drums, the waste will be characterized, certified, and loaded into WIPP canisters at INTEC.

This AK summary report includes information relating to the EBR-I, RSWF, and MFC histories, missions, configurations, equipment, process operations, and waste management practices, as well as relevant waste management practices at the INL for RH TRU waste management. This report also includes information regarding the physical form, radiological characteristics, and chemical contaminants of the waste, as well as prohibited items management.

This report, along with the referenced supporting documentation, provides a defensible and auditable record of AK for waste stream ID-EBR-S5000. The references and AK sources used to prepare this report are listed in sections 8.0 and 9.0 respectively. The AK sources are referenced within this report by an alphanumeric designator (i.e., C001, DR001, P001, and U001) corresponding to a unique CCP Source Document Tracking Number for this waste stream.

This report and supporting source documentation provide the mandatory waste program and waste stream-specific information required by Attachment B4 of the WIPP-WAP

(Reference 2). This report also compiles data relevant to applicable U.S. Environmental Protection Agency (EPA) requirements and presents the documentation necessary to satisfy each WCPIP data quality objective (DQO) and quality assurance objective (QAO) for RH TRU metal debris waste stream ID-EBR-S5000 (Reference 1).

2.0 WASTE STREAM IDENTIFICATION SUMMARY

Site Where TRU Waste Is Generated and Stored:

Generation Location:
INL Experimental Breeder Reactor-I
INL Materials and Fuels Complex Radioactive Scrap and Waste Facility

Storage Location:
MFC RSWF
INL Idaho Nuclear Technology and Engineering Center

EPA ID No. ID4890008952

TRU Waste Generating Facilities:

This waste was generated from EBR-I reactor decommissioning operations conducted at the Building EBR-601. The waste was transferred to and stored at the MFC RSWF pending transfer to INTEC. RH TRU waste repackaging and characterization operations are conducted at INTEC in Building CPP-659, the New Waste Calcining Facility (NWCF) or in building CPP-666, the Fluorinel Dissolution Process (FDP) and Fuel Storage Facility.

Facility Mission:

EBR-I, the world's first breeder reactor, was established to demonstrate the validity of the breeding principle, the operational feasibility of small, highly concentrated or fast neutron, liquid metal-cooled reactor cores, and was the predecessor of EBR-II. The reactor was built and operated by the Argonne National Laboratory; a national laboratory assigned the responsibilities for pioneering fast breeder reactor technologies for the United States (U.S.) Atomic Energy Commission (AEC), now the U.S. Department of Energy (DOE).

EBR-I first achieved criticality in August 1951, full power operation in December 1951, and was operated until December 1963. The reactor was retired in April 1964 for lack of further assignments and decommissioning activities started in 1964. Over its lifetime the reactor had operated with four separate and distinct loadings. Three of these were fueled with enriched uranium (U)-235, and the fourth and last with plutonium.

Among the most notable achievements of EBR-I were the following:

- First generation of electricity from uranium fission.
- Proof operating characteristics of fast reactors are similar to thermal systems.
- Proof a breeder reactor can produce more fuel than it consumes.
- First production of “super-pure” plutonium.
- Measurement of nuclear parameters needed for the design of more advanced liquid metal fast breeder reactor systems such as EBR-II and the Fast Flux Test Facility (FFTF).
- Demonstration of the simplicity of working with metal coolants.
- Evaluation of effects of alloying materials on the behavior of metallic fuels.
- Evaluation of effects of structural features on operational stability.
- First plutonium-fueled reactor loading.
- Proof that plutonium fueled breeder reactors have higher breeding ratio than uranium fueled reactors.

Following the successful operation of EBR-I, the MFC was established in 1958 at INL as ANL-W to lead the development of advanced, sustainable nuclear power systems. The original and continued mission of the MFC emphasizes technologies associated with nuclear fuel, including advanced methods for fuel reprocessing, improving fuel efficiency, testing fuel performance, technologies for characterizing nuclear material and restoring the environment, and technologies and processes requiring remote handling of nuclear fuel. MFC is the primary center in the United States for testing and demonstrating nuclear energy technology and experiments. This work centers on the LMFBR programs of the 1960s and 1970s, the Integral Fast Reactor (IFR) program of the 1980s, with continued operation to the present under the Advanced Fuel Cycle Initiative (AFCI) program, as well as the Generation IV Nuclear Reactor Program and Space Nuclear Program initiatives. These programs involved fuel preparation, fuel and experimental material irradiation, fuel reprocessing, non-destructive and destructive testing of irradiated fuels and materials, analytical laboratory support, and scrap and waste storage conducted in the Transient Reactor Test Facility (TREAT), EBR-II, Fuel Conditioning Facility (FCF), Hot Fuels Examination Facility (HFEF), the Laboratory and Operations (L&O) Building, and the RSWF.

Summary Category Group:	S5000 – Debris Waste
Waste Matrix Code Group:	Uncategorized Metals
Waste Matrix Code:	S5110
RH TRU Waste Content Code (RH TRUCON):	ID317 and ID325
Annual Transuranic Waste Inventory Report Identification Numbers (Reference 4):	AW-W029
EPA Hazardous Waste Numbers (HWNs):	None (non-mixed)
Layers of Confinement:	Maximum of one layer

Waste Stream Description:

Waste stream ID-EBR-S5000 consists of five RSWF liners generated from decommissioning the EBR-I reactor after 12 years of operation. The debris consists of the reactor outer blanket components composed of natural uranium (NU) and clad with stainless steel. The waste was generated from October 1965 to October 1966. The RSWF liners are not the final waste package and they will be repackaged into 55-gallon drums. Refer to section 5.0 for specific details about this waste stream.

Waste stream ID-EBR-S5000 consists predominantly of metal debris and contains the following materials:

Cellulosic materials, including blotter paper and rags. These cellulosic debris materials are composed of paper and cloth.

Plastic materials, including bags, sleeves, disks, and woven drum lifting bags. These plastic debris materials are composed of polyethylene, polypropylene, and polyvinyl chloride (PVC).

Rubber items, including gaskets. These rubber debris materials may be composed of neoprene.

Metal (ferrous) items, including waste cans, drums, and EBR-I outer blanket component cladding. Metal debris items are primarily composed of carbon steel, iron, and stainless steel.

Metal (nonferrous) items, including EBR-I outer blanket components including bricks, inner ring, safety plug, and control rods. These items are composed of uranium.

Although liquids may have been used in the outer blanket component disassembly operations, they are not likely. However, waste stream ID-EBR-S5000 may contain lesser amounts (less than 50 volume percent in any container) of homogeneous solids generated from absorption of prohibited liquids identified during repackaging operations. Any payload container consisting of more than 50 percent by volume homogeneous solids will be excluded from this waste stream.

The waste is primarily contaminated with NU and mixed activation and fission products. Based on generator reported radionuclides, the two predominant isotopes by mass are U-238 and U-235, while over 95 percent of the total activity in the waste stream is from Sr-90, Y-90, Cs-137, Ba-137m, Co-60, Fe-55, and Pu-239. A discussion relating to the radiological characterization of this stream is provided in section 5.4.3.

Based on historic waste characterization, certification, and management operations conducted by INL, and in compliance with the Resource Conservation and Recovery Act (RCRA), the containers in this waste stream are currently managed as non-hazardous waste. Review of AK resulted in the assignment of no EPA HWNs numbers to this waste stream. Refer to section 5.4.2 for the waste stream chemical content evaluation.

Based on the review of container documentation and documented waste management practices, prohibited items potentially present in the waste stream consist of sealed containers greater than 4-liters. Specific waste packaging information is not available. However, waste management practices included the use of “paint cans”, carbon steel paint cans stacked and welded together to form a nominally 6-foot-long, 11-inch internal diameter “paint” can with a gasketed and machine-crimped lid. Once loaded, the container was transferred to the RSWF and dropped into the RSWF liner, a 16-inch diameter by 148-inch carbon steel vessel. The liner was closed by welding a steel plate or concrete shield plug to the top. All of the containers in this waste stream will be characterized by visual examination (VE) to ensure no prohibited items are present. Waste packages containing prohibited items identified during characterization activities will be segregated, then dispositioned appropriately and/or repackaged to remove the items prior to certification and shipment. Refer to section 5.4.5 for a detailed prohibited item discussion.

Waste stream ID-EBR-S5000-RH is currently stored in RSWF liners. Detailed waste packaging information and container documentation is not available. The exact packaging configuration and primary waste container for each canister has not been identified. Some or all of the waste may be stored in a single containment configuration consisting of one or more “paint” cans. Once loaded, the container was transferred to the RSWF and dropped into an RSWF liner which contained approximately 6-inches of sand in the bottom. Gravel may have been added to the liner after placement of the waste to provide shielding from the gamma radiation associated with the stored radioactive material. The liner was closed by welding a steel plate (when gravel was used for shielding), or by welding a concrete shield plug to the top. One liner is equipped with a concrete plug. One of the RSWF liners (NN-03) is a unique size,

24-inches in diameter, to accommodate the EBR-I doughnut. In the early 1990s the original RSWF liners were excavated intact, inspected, and transferred to larger liners. The liners will be retrieved from the RSWF and transferred to INTEC for waste repackaging prior to shipment to WIPP. The waste from the liners will be placed into 30-gallon drums. A lid with a NucFil-certified carbon composite filter, but without a locking ring will be placed on each 30-gallon drum. The 30-gallon drum will be placed into a woven polyethylene lifting bag. The drum and lifting bag are then wrapped in a plastic sleeve as the drum is lifted out of the repackaging cell. The sleeve is closed around the drum and lifting bag using a wire tie, plastic tie, or bungee cord. A 4-mil thick polyethylene dust cover may be placed over the lower part of the drum as the drum is lifted from the repackaging cell encapsulating the lower sleeve, drum lifting bag, and 30-gallon drum. The wrapped 30-gallon drum is then lowered into a standard U.S. Department of Transportation (DOT) Type A 55-gallon steel drum. The plastic sleeve may be removed from the 30-gallon drum before placement, or the top breached following placement in the 55-gallon drum. Polyethylene disks may be placed in the 30-gallon or 55-gallon drums just prior to placing on the drum lids to facilitate pushing down plastic used for contamination control. The standard 55-gallon drum is constructed of 16-gauge materials and has a removable head with a drum head gasket. The 55-gallon drums will include a NucFil-certified carbon composite filter. The 55-gallon drum is loaded into the removable lid canister using a 55-gallon drum lifting bag. The drum lifting bag will remain in the canister with the drum. Up to three drums will be loaded into the removable lid canister. Refer to section 5.5 for detailed waste packaging discussion.

3.0 ACCEPTABLE KNOWLEDGE DATA AND INFORMATION

TRU waste destined for disposal at the WIPP must be characterized prior to shipment. Development of knowledge of the waste materials and processes that generate and control the waste is required to provide a clear and convincing argument about the characteristics of each waste stream. The AK characterization documented herein complies with the requirements of the WIPP-WAP (Reference 2) and the WCPIP (Reference 1) and was developed in accordance with CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan* (Reference 5). The WCPIP identifies waste characterization requirements and methods to satisfy requirements in:

- 40 Code of Federal Regulations (CFR) Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes* (Reference 6)

- 40 CFR Part 194, *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR 191 Disposal Regulations* (Reference 7)

- *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Certification Decision* (Reference 8)

- Public Law 102-579, *The Waste Isolation Pilot Plant Land Withdrawal Act* (LWA) (Reference 9)

This report presents information obtained from review of approximately 100 AK sources relating to the INL, EBR-I, MFC, RSWF, and INTEC history, process operations, and waste management practices. Examples of source documents include facility safety basis documentation, historical document archives, operational logbooks, sample logbooks, procedures for waste generation activities, interviews with cognizant MFC personnel, results of waste characterization programs, and site mission descriptions identifying defense and non-defense operations. The references and AK sources used to prepare this report are listed in sections 8.0 and 9.0 respectively. The AK sources referenced within this report by alphanumeric designations (i.e., C001, DR001, P001, and U001) correspond to the Source Document Tracking Number using the following convention:

- C – Correspondence (i.e., memoranda, letters, e-mail, interviews)
- DR – AK Discrepancy Reports
- P – Published Sources (i.e., reports, controlled procedures)
- U – Unpublished Data (i.e., databases, analytical data, draft reports)

4.0 PROGRAM INFORMATION

This section provides a description of the INL and MFC facilities associated with the generation and storage of waste stream ID-EBR-S5000. Included is a description of the locations of the associated INL and MFC facilities. In addition, a description of the facilities, a summary of the missions, a defense determination, and descriptions of MFC operations associated with the generation and storage of waste stream ID-EBR-S5000 are provided.

4.1 Facility Location, Description, Mission, and Defense Determination

4.1.1 Facility Locations

INL

The INL encompasses approximately 2,300 square kilometers on the Eastern Snake River Plain in Southeastern Idaho. Located approximately 34 miles west of Idaho Falls, Idaho, and formerly named the National Reactor Testing Station, the INL was established in 1949 as a site where the DOE could safely build, test, and operate various types of nuclear facilities. The INL has also served as a storage facility for TRU, low-level, and high-level waste since 1952. Strict security is maintained for all INL facilities in accordance with the INL's nuclear and defense missions. At present, the INL supports the engineering and operations efforts of DOE and other federal agencies in areas of nuclear safety research, reactor development, reactor operations and training, nuclear defense materials production, waste management technology development, and energy technology and conservation programs (References P042, P049, P051, P4081, P4090).

EBR-I

The EBR-I facility is located on the southwest portion of the INL site, approximately 18 miles east southeast of Arco, Idaho and approximately 12 miles northwest of Atomic City, Idaho. The reactor was confined entirely within a single ordinary steel, concrete, and brick building, Building EBR-601 (References P881, P4082).

MFC

The MFC (formerly ANL-W) encompasses an area on the southeastern portion of the INL reservation about three miles north of U.S. Highway 20 and approximately 35 miles west of Idaho Falls, Idaho. The MFC includes several facilities for processing, examining, characterizing, and analyzing radioactive materials. The major facilities that comprise the MFC site and their operational status are listed as follows (References P001, P042, P049, P051, P145, U025):

- EBR-II (1961 – 1994)
- TREAT (1959 – presently in standby)

- Zero Power Physics Reactor (ZPPR) (1969 – presently in standby), originally named Zero Power Plutonium Reactor
- HFEF (1972 – present), originally named HFEF-North
- FCF (1964 – present), originally named Fuel Cycle Facility (FCF), then HFEF-South
- Fuel Manufacturing Facility (FMF) (1986 – currently operating)
- L&O Building (1962 – currently operating)
- RSWF (1965 – currently operating)

The RH TRU debris waste described in this report was generated in EBR-I and was transferred to and is stored in carbon steel liners at the MFC RSWF. The RSWF is a RCRA permitted interim radioactive and mixed waste storage facility, located one-half mile northeast of the MFC main site (References P001, P042, P049, P4072, P4084, U552, U4041).

The design of RSWF was approved by the AEC in 1964 and the facility was established for the interim storage of MFC generated radioactive material. Radioactive waste generated at MFC was normally disposed of at the Radioactive Waste Management Complex (RWMC). However, much of the waste generated by the FCF could not be shipped to the RWMC, because there was no approved over-the-road cask at that time. In addition, scrap fuel was generated containing recoverable quantities of fuel material (i.e., recoverable scrap) that required storage prior to reprocessing. Some of this material was later retrieved from the RSWF and reprocessed at MFC facilities or disposed at the RWMC. Site preparation was completed in February 1965. The first radioactive material was placed in the underground carbon steel RSWF storage liners in June 1965 (References P051, P4072, P4073).

INTEC

INTEC is located in the southwestern portion of the INL, three miles north of the Central Facilities Area. The RH TRU debris will be retrieved from the RSWF and stored in modified interim storage containers (ISCs) at INTEC. The RSWF liners will be repackaged into 55-gallon drums in the remote decontamination cell, NWCF Cell 308 in Building CPP-659 or in the FDP Cell in Building CPP-666. The drums will be stored in ISCs pending final characterization, certification, and transportation activities. The NWCF is located in the northeast quadrant and the FDP is located in the center of the INTEC facility. Certified drums will be packaged into canisters stored in Building CPP-659 (References C698, P089, P100, P101, P103).

Maps showing the location of the INL, EBR-I, MFC, RSWF, and INTEC facilities are provided in Attachment 1, Location of the INL and INL Facilities, and

Attachment 2, Materials and Fuels Complex Map. A map of the INTEC facilities is maintained in the AK record (References P077, P089, P100, P101, P102, P103).

4.1.2 EBR-I Description

The EBR-I reactor was confined entirely within a single ordinary steel, concrete, and brick building, Building EBR-601. In addition to the reactor and its associated controls, cooling and power generation systems, office, heating, utility, and maintenance provisions, the building housed facilities and equipment for handling, storage, and wash-down of nuclear fuel elements. Attachment 3, EBR-I Main Floor Plan, and Attachment 4, EBR-I Basement Plan, show the EBR-I Building layout and the locations of the reactor and associated facilities (References P881, P4082).

The reactor consisted of three principle regions, a core, a light inner blanket surrounding the core axially and radially, and a denser outer blanket, also known as the cup. The core and light radial blanket consisted of hexagonal fuel assemblies filled with fuel elements, cylindrical stainless steel or Zircaloy rods of small diameter filled with fuel slugs. Over its lifetime the reactor had operated with four separate and distinct loadings. The fuel material, depending on the loading, consisted of U-235 enriched uranium or plutonium, whereas the blanket material consisted of natural or depleted uranium. Upper and lower axial blankets consisted of natural or depleted uranium slugs above and below the fuel sections of the core rods. All core and light blanket components were contained within a double-walled tank system (Reference P881, P4090).

To permit the efficient removal of heat under high-power density conditions, and to maintain neutron moderation, a potassium-sodium eutectic (NaK) was used as a coolant. The coolant flowed under gravity from an elevated supply tank downward through the inner blanket, upward through the core, through a heat exchanger, and into a receiving tank in the basement. A pump returned the coolant to the gravity supply tank. Heat from the coolant was removed in two ways; one, through the generation of steam which was used to drive a conventional turbine generator, or two, through a fan-cooled load dissipator (References P777, P881, P4078, P4090).

Surrounding the inner tank assembly, the outer blanket or cup consisted of an assembly of stainless steel-clad keystone shaped bricks, inner ring, and safety plug, all of NU. The entire assembly was mounted on a pedestal which was raised or lowered relative to the core. An induced circulation of air through finned cooling holes in the bricks removed heat generated through fission and gamma absorption. Twelve uranium rods, which penetrated holes in the vertical columns of bricks served as control or safety rods. Controlled movement of the cup assembly and/or safety plug served as a major variation of reactivity. Upon receipt of a scram (emergency shutdown) signal, the pedestal and cup dropped away from the reactor tank (References P778, P838, P881, P954, P4090).

A cutaway view of the reactor as it existed during the Mark I and Mark II loadings is shown in Attachment 5, Cutaway View of EBR-I Marks I and II. A view of the reactor during the Mark III and IV loadings is shown in Attachment 6, Cutaway View of the Marks III and IV Tank and Cup Assemblies. Attachment 7, Outer Blanket, shows the cup assembly pulled away from the inner tank. Waste stream ID-EBR-S5000 consists of NU components from the outer blanket assembly (References P777, P778, P881, P954, P4078, P4084, U552).

Fuel and blanket rods were transferred to and from the reactor in a lead coffin handled by overhead crane. Upon removal from the reactor, the rods were lowered from the coffin through access holes in the ceiling of the wash room, washed, then transferred to the rod farm, consisting of pipe thimbles embedded in concrete, for storage (References P881).

Manipulations of the outer blanket were possible through the use of a remotely operated handling system. A special remotely controlled carriage lifted the entire cup and transferred it to adjacent cells, the blanket handling room (repair rooms), which were provided with remotely operating equipment designed to dismantle the cup into its components. All cup handling operations were carried out behind shielding windows (References P881, P4078, P4082).

4.1.3 EBR-I Mission

The origin of the breeding concept, nuclear-electric systems that would produce plutonium in quantities at least as large as the amount consumed, is traced to the war years when the United States, the United Kingdom, and Canada committed unprecedented resources to the development of nuclear weapons. After the war, the newly established Atomic Energy Commission, now the DOE, began developing peaceful uses of the atom. The large bodies of uranium ore found in the 1950s were unknown then, and since uranium was in very short supply, it was decided the first power reactor would attempt to prove the theory of fuel breeding. A government-financed system of National Laboratories was implemented during the late 1940s. Of these, Argonne National Laboratory was assigned the responsibilities for pioneering fast breeder reactor technologies (References P4081, P4090).

EBR-I was the world's first breeder reactor, and was designed and built to establish the validity of the breeding principle, to demonstrate the operational feasibility of small, highly concentrated or fast neutron, liquid metal-cooled reactor cores, and was the predecessor of EBR-II (References P777, P778, P881, P4078, P4082, P4084, P4090).

The reactor first achieved criticality in August 1951 and full power operation was reached in December 1951. On December 20, 1951, steam was fed to a turbine generator and for the first time nuclear heat was transformed into electrical energy. In early 1953, laboratory analysis showed that EBR-I had achieved the primary objective, it was creating or breeding one new atom of nuclear fuel for each atom it burned. Additional experiments were conducted and EBR-I was operated

until December 1963 and was retired in April 1964 for lack of further assignments. EBR-I decommissioning activities started in 1964. Over its lifetime the reactor had operated with four separate and distinct loadings. Three of these were fueled with enriched U-235, and the fourth and last with plutonium (References P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

Among the most notable achievements of EBR-I were the following (Reference P4090):

- First generation of electricity from uranium fission.
- Proof operating characteristics of fast reactors are similar to thermal systems.
- Proof a breeder reactor can produce more fuel than it consumes.
- First production of “super-pure” plutonium.
- Measurement of nuclear parameters needed for the design of more advanced liquid metal fast breeder reactor systems such as EBR-II and FFTF.
- Demonstration of the simplicity of working with metal coolants.
- Evaluation of effects of alloying materials on the behavior of metallic fuels.
- Evaluation of effects of structural features on operational stability.
- First plutonium-fueled reactor loading.
- Proof that plutonium fueled breeder reactors have higher breeding ratio than uranium fueled reactors.

Following the successful operation of EBR-I, the MFC was established in 1958 at INL as ANL-W to lead the development of advanced, sustainable nuclear power systems. The original and continued mission of the MFC emphasizes technologies associated with nuclear fuel, including advanced methods for fuel reprocessing, improving fuel efficiency, testing fuel performance, technologies for characterizing nuclear material and restoring the environment, and technologies and processes requiring remote handling of nuclear fuel. MFC is the primary center in the United States for testing and demonstrating nuclear energy technology and experiments. This work centers on the LMFBR programs of the 1960s and 1970s, the IFR program of the 1980s, with continued operation to the present under the AFCI program, as well as the Generation IV Nuclear Reactor Program and Space Nuclear Program initiatives. These programs involved fuel preparation, fuel and experimental material irradiation, fuel reprocessing, non-destructive and destructive testing of irradiated fuels and materials, analytical laboratory support, and scrap and waste storage conducted in

TREAT, EBR-II, FCF, HFEF, the L&O Building, and the RSWF (References C004, P036, P049, P055, P071, P4090).

4.1.4 Defense Waste Determination

The WIPP requires generator sites to use AK to determine that TRU waste streams to be disposed of at the WIPP meet the definition of TRU defense waste. TRU waste is eligible for disposal at the WIPP if it has been generated in whole or part by one of the atomic energy defense activities listed in Section 10101(3) of the *Nuclear Waste Policy Act of 1982* (NWPA) (Reference 10). Based on the review of AK, there is sufficient evidence to demonstrate that TRU wastes generated by EBR-I operations are contaminated with materials from atomic energy defense activities associated with naval reactors development, defense nuclear materials productions, defense nuclear waste and materials by-products management, and defense research and development activities (References C002, P001).

EBR-I was the world's first breeder reactor, designed and built to establish the validity of the breeding principle, to demonstrate the operational feasibility of small, highly concentrated or fast neutron, liquid metal-cooled reactor cores, and was the predecessor of EBR-II (References P777, P778, P881, P4078, P4082, P4084, P4090).

The objectives of the LMFBR program include testing of alloy fuel materials; demonstrating transmutation of a variety of actinide materials as reactor fuel; developing more efficient and environmentally sound fuels; and enhancing nuclear non-proliferation. Among the most notable achievements of EBR-I with defense applications were the following (Reference P001, P071, P4090):

- Proof operating characteristics of fast reactors are similar to thermal systems.
- Proof a breeder reactor can produce more fuel than it consumes.
- First production of "super-pure" plutonium.
- Measurement of nuclear parameters needed for the design of more advanced defense LMFBR systems such as EBR-II and FFTF.
- Proof that plutonium fueled breeder reactors have higher breeding ratio than uranium fueled reactors.

Following the successful operation of EBR-I, the MFC was established in 1958 at INL to lead the development of advanced, sustainable nuclear power systems. The original and continued mission of the MFC emphasizes technologies associated with nuclear fuel, including advanced methods for fuel reprocessing, improving fuel efficiency, testing fuel performance, technologies for characterizing nuclear material and restoring the environment, and technologies and processes requiring remote handling of nuclear fuel. MFC is the primary center in the United States for testing and demonstrating

nuclear energy technology and experiments. This work centers on the LMFBR programs of the 1960s and 1970s, the IFR program of the 1980s, with continued operation to the present under the AFCI program, as well as the Generation IV Nuclear Reactor Program and Space Nuclear Program initiatives. These programs involved fuel preparation, fuel and experimental material irradiation, fuel reprocessing, non-destructive and destructive testing of irradiated fuels and materials, analytical laboratory support, and scrap and waste storage conducted in TREAT, EBR-II, FCF, HFEF, the L&O Building, and the RSWF (References C004, P036, P049, P055, P071, P4090).

Waste stream ID-EBR-S5000 was generated from EBR-I decommissioning operations. The EBR-I reactor was the first operational LMFBR. This program is a defense program with applications relative to naval reactors development (maintaining available fuel supplies), defense nuclear materials productions (production of pure plutonium), defense nuclear waste and materials by-products management (produces fuel in greater ratio than feed material, reducing waste), and defense research and development activities (measurement of nuclear parameters for the design of more advanced reactor systems and fuel materials). Therefore, waste stream ID-EBR-S5000 is eligible for disposal at WIPP as a defense waste stream generated “in part” by the atomic energy defense activities described in this section (References P001, P071, P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

4.2 RH TRU Waste Management

The elements of RH TRU waste management discussed in this section include descriptions of the EBR-I facilities operations; and waste identification, segregation, and characterization, as well as organizational and administrative controls that are in place to ensure proper management of RH TRU waste at INTEC.

Uniform INL waste management requirements were not implemented before the 1970s. Although the different INL operational and support areas often had common waste management problems, the responsibility for solving the problems rested upon the area manager. While specific waste management requirements/practices for the EBR-I facility were not identified, based on the Argonne National Laboratory management of the reactor, it is assumed the actual practices were the same or similar to the waste management practices implemented at MFC (Reference P051).

The RSWF was established for the interim storage of MFC generated radioactive material. The first radioactive material was placed in the underground carbon steel RSWF storage liners in June 1965. Waste and scrap materials were transferred using a top loading, bottom dumping, vertical, shielded cylindrical waste handling coffin. The coffin provided shielding and was equipped with top and bottom shielding doors which were rolled out for loading and unloading. To transport the coffin, a special lowboy trailer was built. The trailer allowed the coffin to be positioned over the designated RSWF liner for dumping (Reference P982, P4072, P4073, P4075, U552, U4041).

From 1965 to 1978, radioactive material destined for storage at RSWF was placed in a single containment configuration. The typical container was constructed of carbon steel paint cans stacked and welded together to form a nominally 6-ft-long, 11-inch internal diameter “paint” can, with a gasketed and machine-crimped lid. Another container consisted of steel canisters, 8 in. OD × 5 ft long, with gasketed and threaded lids. Depending on criticality safety requirements at the time, some materials were contained in sealed steel pipes within the paint can containers. Once loaded, the container was transferred to RSWF and dropped (approximately 14 ft) into the liner, which contained approximately six inches of sand in the bottom. Gravel was then added to the liner to provide shielding from the gamma radiation associated with the stored radioactive material. The liner was closed by welding a steel plate to the top (when gravel was used for shielding) or by welding a concrete/metal shield plug to the top (Reference P4072).

Due to concerns about liner corrosion, an upgrade of the RSWF was initiated in 1989. Material relocation was determined based on the container configuration inside the liner. Liners with radioactive material in single containers (pre-1978) were removed in their entirety and relocated to cathodically protected 24-in. liners. The relocation effort was completed in 1997 and resulted in the current containment configurations (Reference P4072).

From 1960 through 1970, waste container documentation was usually hard copies of standardized waste disposal Form 110. These forms generally reported waste types sent to the SDA along with net activities per shipment from 1960 through 1970. Most Form 110 data have been input into an electronic database called “WasteOScope” (Reference P049).

Waste Acceptance Criteria (WAC) have been implemented for the INL since the 1970s requiring some level of waste generator documentation and certification. These requirements have been modified to incorporate DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (WIPP-WAC), requirements as they have been developed for the disposal of TRU waste. TRU waste was defined as radioactive waste contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years in concentrations greater than 10 nanocuries per gram (nCi/g). The concentration threshold limit was increased to 100 nCi/g in the early 1980s. RH is defined as waste materials packaged so the dose rate at the surface of the waste package is 200 millirem per hour (mrem/hr) or greater and is acceptable at the WIPP if less than 1,000 rem per hour (rem/hr) (References C096, C214, P035, P037, P060, P063, P091, U552).

Since 1984, the INL has initiated formal policies for the management of radioactive mixed wastes. In May 1987, INL promulgated requirements that all RH TRU waste generators develop certification plans so waste may be direct-shipped to the WIPP (References C119, P091).

Waste program documentation developed by MFC includes the *ANL-West Remote-Handled Transuranic Waste Certification Plan*, W0001-0898-ES-00, July 1988. Prior to implementation of this plan, waste handling and packaging requirements were documented in the Argonne Health and Safety Manual. This document describes the implementation of the INL WAC including the development of waste stream information, including content code; waste description; generating process; physical, chemical, and radiological compositions; and waste packaging (References C129, C214, P060, P088).

4.2.1 Description of Waste Generating Processes

Waste stream ID-EBR-S5000 consists of outer blanket components generated from decommissioning of the EBR-I reactor. The disassembled components were transferred to the RSWF for interim waste storage, and will be retrieved and transferred to INTEC for waste repackaging (References U552, U4041).

Historical EBR-I Operations

Construction of EBR-I began in October 1949. Over its lifetime the reactor operated with four separate and distinct loadings. Three of these were fueled with enriched U-235, and the fourth and last with plutonium. The first loading, the Mark I, was fueled with cylindrical slugs of highly U-235 enriched unalloyed uranium metal in stainless steel, NaK bonded jackets. Criticality was first achieved in August 1951, and full power operation was reached in December 1951. On December 20, 1951, steam was fed to a turbine generator and for the first time nuclear heat was transformed into electrical energy. In early 1953, laboratory analysis showed that EBR-I had achieved its primary objective, it was creating or breeding one new atom of nuclear fuel for each atom it burned (References P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

With the exception of minor changes in fuel rod design, the second loading, Mark II, was essentially identical with the Mark I loading. The Mark II core was fueled with an enriched uranium and 2 percent zirconium alloy to study the effects of alloying on radiation resistance. This resulted in a significant increase in the integrity of the fuel. A final phase of the experimental program was devoted to the analysis of the reactor performance under various conditions of power and flow. Upon completion of these experiments, operation of the reactor was to be terminated, and the reactor placed in standby. However, one of a number of transient experiments conducted with the main coolant stopped, led inadvertently to a partial melting of the reactor core in November 1955. To prove there was nothing intrinsically unsafe in the operation of a fast reactor, the damaged core was replaced with a loading (Mark III) in late 1957. This core was specifically designed and sufficiently versatile to study in detail the feedbacks arising from the fuel, coolant, structure and rod deformation. As a result, those features responsible for the instability noted in the Mark I and Mark II loadings was eliminated by elementary changes in mechanical design. The Mark III core was fueled with the same enriched uranium and zirconium alloy. Upper and lower upper blanket slugs, and blanket fuel rods consisted of 98 percent NU and 2 percent zirconium alloy (References P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

Additional data beneficial to the design of future, more advanced plutonium-fueled reactors was the purpose of the Mark IV loading, consisting entirely of metallic plutonium-aluminum alloy. Other benefits consisted of those resulting from practical experience such as the actual handling of plutonium fuel and the routine day to day startup and shutdowns of the system. To provide upper and lower axial blankets in the core region, depleted uranium slugs were positioned in the stainless steel fuel rod jackets immediately above and below the fuel section. Blanket rods for the Mark IV core were composed of depleted uranium (References P777, P778, P881).

EBR-I was operated until December 1963 and was retired in April 1964 for lack of further assignments. LMFBR operations at INL were assumed by EBR-II in 1964, the new Argonne reactor at the MFC of the INL. EBR-I decommissioning activities started in 1964 and on August 26, 1966, the reactor was designated a Registered National Historic Monument (References P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

The outer blanket or cup utilizied for the Mark I, II, and III loadings consisted of the assembly of stainless steel-clad keystone shaped bricks, inner ring, safety plug, and control rods all of NU. The entire assembly was mounted on a pedestal which was raised or lowered relative to the core. For maintenance and repair of the cup, and the eventual reactor decommissioning, the entire cup assembly was lifted and transferred to one of the repair rooms adjacent to the reactor. In these rooms, cup assembly components were remotely dismantled, replaced, and reassembled as necessary (References P778, P838, P881, P954, P4078, P4082, P4090).

During the operating lifetime of the reactor, the stainless steel cladding of several blanket bricks failed under conditions of full power operation. An option developed for the Mark IV loading consisted of replacing the entire uranium blanket with a physically similar cup made of lead. However, both the original uranium cup and the massive lead “reflector” were used for Mark IV operations (References P777, P881).

The NU cup assembly was disassembled and the components transferred to the RSWF and placed into designated storage liners. In the early 1990s the RSWF liners were excavated intact, inspected, and transferred to larger liners. The original liners will be retrieved from the RSWF and transferred to INTEC for waste repackaging (References P982, P4072, P4073, P4075, U552, U4041).

Waste Repackaging and Prohibited Item Disposition

RH TRU waste repackaging and prohibited item disposition will be performed at INTEC in the NWCF Cell 308 in Building CPP-659 or in the FDP Cell in Building CPP-666. The process of opening, loading, or unloading containers is normally conducted within these cells. Normally, containers would first be characterized using real-time radiography (RTR) and/or VE in the RH TRU characterization area (306) to identify nonconforming items. However, the RSWF liners are not the final waste package and they will be repackaged into approved containers prior to shipment to WIPP. Once in the cell and

the liner has been opened, the following activities may be performed: 1) the waste will be visually inspected and sorted, 2) absorbent will be added directly to the waste if free liquid is present, 3) nonconforming items will be removed, and 4) the waste will be transferred to 30-gallon drums, each of which will then be placed in a 55-gallon drum (References C464, C698, P035, P089, P102, P115, P182).

4.2.2 Types and Quantities of TRU Waste Generated

Waste stream ID-EBR-S5000 consists of five RSWF liners, a total volume of approximately 2.5 cubic meters (m^3) of metal debris. The waste was generated from decommissioning the EBR-I reactor after 12 years of operation. The waste stream was packaged and transferred for storage in the RSWF from October 1965 to October 1966. The RSWF liners are not the final waste package and they will be repackaged into 30-gallon drums prior to shipment. Each 30-gallon drum will be packaged into a 55-gallon drum. The total estimated repackaged waste stream volume is 12 55-gallon drums, approximately 2.5 m^3. Waste transfer operations between the RSWF and INTEC are scheduled to begin in December 2010 and repackaging complete by September 2011 (References C464, C698, C4124, P089, P115, P182, P4072, U552, U4041).

Waste stream ID-EBR-S5000 meets the WIPP-WAP and the WCPIP waste stream definitions of “waste materials generated from a single process or from an activity that are similar in material, physical form, hazardous and constituents.” The container specific records have been reviewed for each container to verify the composition and origin of the waste stream inventory. Every container in waste stream ID-EBR-S5000 was generated from EBR-I decommissioning operations and contains metal debris consisting of components from the NU cup assembly. In addition, the waste will be repackaged into WIPP-approved containers at INTEC in the NWCF Cell 308 or the FDP Cell (References C464, C698, C4124, P089, P115, P182, P4072, P4084, U552, U4041).

5.0 WASTE STREAM INFORMATION

This section presents the waste stream information required by the WIPP-WAP and the WCPIP for waste stream ID-EBR-S5000 (References 1, 2). The area of generation, waste stream volume, period of generation, waste packaging, and the physical, chemical, and radiological characterization of the waste stream are described.

5.1 Area and Building of Generation

Waste stream ID-EBR-S5000 contains metal debris generated from decommissioning the EBR-I reactor. The reactor was located in Building EBR-601. Following disassembly of the outer blanket assembly, the components were transferred to the RSWF and placed into designated storage liners. It has been determined that every container included in waste stream ID-EBR-S5000 meets the WCPIP and WIPP-WAP waste stream definition of waste material generated from a single process or from an activity which is similar in material, physical form, hazardous, and radiological constituents (References C464, C698, C4124, P089, P115, P182, P881, P4072, P4082, P4084, U552, U4041).

5.2 Waste Stream Volume and Period of Generation

As shown in Table 1, Waste Stream ID-EBR-S5000 Containers and Volume, waste stream ID-EBR-S5000 currently consists of five RSWF liners (2.5 m^3) of metal debris. This waste was generated from October 1965 to October 1966. The RSWF liners are not the final waste package and each container will be repackaged prior to shipment to WIPP. As described in section 4.2.2, the total estimated repackaged volume is 12 55-gallon drums (2.5 m^3), listed as projected inventory in Table 1. Waste transfer operations between the RSWF and INTEC are scheduled to begin in December 2010 and repackaging complete by September 2011 (References C464, C698, C4124, P089, P115, P182, P4072, P4084, U552, U4041).

Table 1. Waste Stream ID-EBR-S5000 Containers and Volume

Current Inventory	Volume (m^3)	Projected Inventory	Volume (m^3)
5 RSWF liners	2.5	12 55-gallon drums	2.5

5.3 Waste Generating Activities

As described in section 4.2.1, waste stream ID-EBR-S5000 contains metal debris consisting of components from the EBR-I outer blanket or cup assembly. The cup assembly was disassembled and the components transferred to the RSWF and placed into designated storage liners. These components are all NU encased in stainless steel cladding and include the blanket bricks, inner ring, safety plug, and control rods. The 84 6.5-inch thick blanket bricks were arranged for use in 12 stacks of seven each as shown in Attachment 7, Outer Blanket. A drawing of an individual brick is provided in

Attachment 8, Blanket Brick Drawing. A system of recesses and extensions in the upper and lower surfaces, respectively, ensured stability in stacking. The inner ring, which is shown in Attachment 9, Inner Ring Drawing, fit inside the bottom layer of bricks. The circular opening in the center of the inner ring was closed by the safety plug, shown in Attachment 10, Safety Plug Drawing. Each blanket brick was penetrated by five 1-inch holes through which cooling air was forced. A single 2-inch hole in each brick served as a passage for a control rod. Eight of the 12 1.625-inch diameter by 26-inch long control rods penetrating the passages served as safeties and were positioned either “all in” or “all out.” The remaining four rods were capable of being positioned accurately and served as fine control. The control rods are shown in Attachment 11, Control Rod Drawing (References P778, P883, P881, P954, P4078, P4084, P4090, U552).

Detailed descriptions of the outer blanket maintenance, repair, and decommissioning operations are not available. However, these operations are assumed to be similar to fuel handling operations. Fuel and blanket rods were transferred to and from the reactor in a lead coffin handled by overhead crane. Upon removal from the reactor, the rods were rinsed in successive baths of alcohol, water, and acetone. They were then transferred to storage. Although the outer blanket assembly was first transferred to the repair rooms for maintenance and disassembly, it is assumed they may have been washed similar to the fuel components. However, this is not likely since the outer blanket components were air cooled and did not come into contact with the NaK coolant used in the reactor core (References P777, P778, P838, P881, P954, P4078, P4082, P4090).

As described in section 4.2.1, the RSWF liners will be repackaged in the NWCF Cell 308 or the FDP Cell at INTEC and characterized by VE. Prohibited liquids identified during repackaging operations will be absorbed using NoChar N965 (References C464, C698, C4124, P006, P035, P089, P102, P115, P182).

5.4 Types of Wastes Generated

This section describes the process inputs, Waste Matrix Code assignment, Waste Material Parameter (WMP) weight estimates, radionuclide contaminants, and RCRA hazardous waste determinations for metal waste stream ID-EBR-S5000. The waste stream is characterized based on knowledge of the materials, knowledge of the processes generating the waste, and physical descriptions of the waste.

5.4.1 Material Input Related to Physical Form

Waste stream ID-EBR-S5000 contains waste generated from decommissioning the EBR-I reactor as described in section 5.3. The metal debris waste consists of the reactor outer blanket components composed of NU and clad with stainless steel (References P778, P838, P881, P954, P4078, P4084, P4090, U552).

Waste stream ID-EBR-S5000 consists predominantly of metal debris and contains the following materials:

Cellulosic materials, including blotter paper and rags. These cellulosic debris materials are composed of paper and cloth (References P881, U552).

Plastic materials, including bags, sleeves, disks, and woven drum lifting bags. These plastic debris materials are composed of polyethylene, polypropylene, and PVC (References C464, P089, P182, U552).

Rubber items, including gaskets. These rubber debris materials may be composed of neoprene (References C464, P089, P182, P4072, P4073, U552).

Metal (ferrous) items, including waste cans, drums, and EBR-I outer blanket component cladding. Metal debris items are primarily composed of carbon steel, iron, and stainless steel (References C464, P089, P182, P778, P838, P881, P4072, P4073, P4090, U552).

Metal (nonferrous) items, including EBR-I outer blanket components including bricks, inner ring, safety plug, and control rods. These items are composed of uranium (References P778, P838, P881, P4090, U552).

Although liquids may have been used in the outer blanket component disassembly operations, they are not likely. However, waste stream ID-EBR-S5000 may contain lesser amounts (less than 50 volume percent in any container) of homogeneous solids generated from absorption of prohibited liquids identified during repackaging operations. Any payload container consisting of more than 50 percent by volume homogeneous solids will be excluded from this waste stream (References C464, C698, C4124, P006, P035, P089, P102, P115, P182, P881).

5.4.1.1 Waste Matrix Code

Based on the evaluation of the EBR-I outer blanket components and container documentation, the waste stream is comprised of greater than 80 percent metal debris. Therefore, Waste Matrix Code S5110, Metal Debris, is assigned to waste stream ID-EBR-S5000 (References P778, P838, P881, P4090, U552).

5.4.1.2 Waste Material Parameters

The WMPs for waste stream ID-EBR-S5000 were based on descriptions of the outer blanket components generated from decommissioning of the EBR-I reactor. This waste stream is greater than 50 percent by volume material that meets the criteria for metal debris.

The WMP weight percentages for this waste stream were estimated by reviewing the waste container logs for the RSWF liners packaged from October 1965 to October 1966, the descriptions of the EBR-I outer blanket components identified on the

container logs, and INTEC waste repackaging plans and procedures. The waste container logs provided weights for the waste materials packaged in each liner. Average, minimum, and maximum WMP weight percentages were calculated using this data. These calculations conclude that the relative waste weight percentages for organic waste materials and inorganic waste materials for waste stream ID-EBR-S5000 are 0 percent and 100 percent, respectively. This is due to the fact that only uranium components are identified in the waste container logs. In addition, organic debris, such as plastic or rubber, or organic matrix consisting of absorbed liquids generated during repackaging operations, are expected to all be less than one percent. The results of the assessment are presented in Table 2, Waste Stream ID-EBR-S5000 Waste Material Parameter Estimates (References C464, P089, P182, P778, P838, P881, P4072, P4073, P4090, U552).

The analysis of the data is documented in a memorandum (included with Attachment 6 of CCP-TP-005) as required by that procedure (Reference 3).

Table 2. Waste Stream ID-EBR-S5000 Waste Material Parameter Estimates

Waste Material Parameter	Average Weight Percent	Weight Percent Range
Iron-based Metals/Alloys	<1%	0% - 1%
Aluminum-based Metals/Alloys	0%	0% - 0%
Other Metal/Alloys	99.9%	0% - 100%
Other Inorganic Materials	0%	0% - 0%
Cellulosics	<1%	0% - <1%
Rubber	<1%	0% - <1%
Plastics (waste materials)	<1%	0% - <1%
Organic Matrix	<1%	0% - <1%
Inorganic Matrix	0%	0% - 0%
Total Inorganic Waste Avg.	**100%**	
Total Organic Waste Avg.	**0%**	

5.4.2 Chemical Content Identification – Hazardous Constituents

The following sections describe the characterization rationale for assignment of EPA HWNs to waste stream ID-EBR-S5000. Chemical content identification is based on the review of available AK related for the decommissioning of the EBR-I reactor, waste container documentation, and Material Safety Data Sheets (MSDS) obtained for commercial products identified or used to determine the presence of RCRA regulated constituents. This waste will be repackaged at INTEC and the material verified to be consistent with that described in this report. Based on historic waste characterization, certification, and management operations conducted by INL, and in compliance with the RCRA, the containers in this waste stream are currently managed as non-hazardous waste. Review of AK resulted in the assignment of no EPA HWNs numbers to this waste stream (References 11, P006, P089, P115, P777, P778, P838, P881, P954, P4078, P4082, P4090, U552).

5.4.2.1 F-Listed and Other Solvents

Based on review of AK relative to process inputs, waste stream ID-EBR-S5000 does not contain or is not mixed with F-listed hazardous wastes from nonspecific sources listed in 40 CFR 261.31, Identification and Listing of Hazardous Waste (Reference 11). F003-listed solvent acetone may have been used for cleaning in EBR-I decommissioning operations. Unspecified alcohol may have also been used for cleaning. It is assumed this alcohol is F003-listed solvent methanol based on the use of this constituent for the same purpose at other MFC reactor facilities. F003 constituents, including acetone and methanol, are listed solely because these solvents are ignitable in liquid form. The waste stream does not exhibit the characteristic of ignitability because it is not liquid; therefore, F003 is not assigned. No other F-listed hazardous constituents have been identified for this waste stream. Therefore no F-listed HWNs are assigned to waste stream ID-EBR-S5000 (References DR008, P006, P070, P777, P778, P838, P881, P954, P4078, P4079, P4082, P4090, U552).

5.4.2.2 Toxicity Characteristic Compounds

Based on review of AK relative to chemicals and materials used during the EBR-I decommissioning operations, waste stream ID-EBR-S5000 is not contaminated with toxicity characteristic compounds as defined in 40 CFR 261.24 (Reference 11). With the exception of lead (EPA HWN D008), none of the other toxicity characteristic metals were identified. Although lead was used as shielding in fuel and reactor component transfer coffins and casks, as described in sections 4.1 and 4.2, lead is not identified as present in the waste containers. The lead reflector, built to replace the NU outer blanket assembly for the Mark IV core experiments as described in section 5.3, is not identified as present in the container paperwork as it is not expected to have been packaged with the NU components. No toxicity characteristic organic hazardous constituents were identified for EBR-I decommission operations or present on reactor outer blanket components. Therefore no toxicity characteristic EPA HWNs are assigned to waste stream ID-EBR-S5000 (References P777, P778, P838, P881, P954, P4078, P4079, P4082, P4090).

5.4.2.3 Ignitables, Reactives, and Corrosives

<u>Ignitability</u>

The debris materials in this waste stream do not meet the definition of ignitability as defined in 40 CFR 261.21 (Reference 11). Ignitable liquids (e.g., acetone, alcohols) may have been used in outer blanket component handling activities; however, prohibited liquids were not identified in the container documentation. In addition, the waste is not or does not contain constituents capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical change. This material is not a compressed gas. In addition, waste liners containing prohibited items identified during repackaging activities will be segregated, then dispositioned appropriately and/or repackaged to remove the items prior to

certification and shipment. The materials in this waste stream are, therefore, not ignitable wastes (References P006, P089, P182, P881, U552).

Corrosivity

The debris materials in this waste stream do not meet the definition of corrosivity as defined in 40 CFR 261.22 (Reference 11). The materials are not liquid and liquids were not added to containers during packaging. In addition, waste liners containing prohibited items identified during repackaging activities will be segregated, then dispositioned appropriately and/or repackaged to remove the items prior to certification and shipment. The materials in this waste stream are, therefore, not corrosive wastes (References P006, P089, P182, P881, U552).

Reactivity

The debris materials in this waste stream do not meet the definition of reactivity as defined in 40 CFR 261.23 (Reference 11). The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not liquid and liquids were not added to containers during packaging. In addition, waste liners containing prohibited items identified during repackaging activities will be segregated, then dispositioned appropriately and/or repackaged to remove the items prior to certification and shipment. The materials in this waste stream are, therefore, not reactive wastes (References P006, P089, P182, P881, U552).

Based on MFC and INTEC waste management practices, the materials contained in waste stream ID-EBR-S5000 do not exhibit the characteristics of ignitability (D001), corrosivity (D002), or reactivity (D003) as defined in 40 CFR 261.21, 261.22, and 261.23, respectively (Reference 11). VE will also be used to verify the absence of prohibited materials.

5.4.2.4 P- and U-Listed Waste

Based on review of AK relative to chemicals and materials used during the decommissioning of EBR-I, waste stream ID-EBR-S5000 does not contain and is not mixed with a discarded commercial chemical product, an off-specification commercial chemical product, or a container residue or spill residue thereof as defined in 40 CFR 261.33 (Reference 11). P- and U-listed reagents, including beryllium (P015), and hydrofluoric acid (U134), were not identified as being used or present in the EBR-I reactor outer blanket components or decommissioning operations. No listed chemicals were identified in the container-specific documentation and no record of a significant spill of listed chemicals was located (e.g., incident report). Waste stream ID-EBR-S5000 is, therefore, not assigned a P- or U-listed HWN (References P777, P778, P838, P881, P954, P4078, P4079, P4082, P4090, U552).

As described above, beryllium was not identified as a constituent present in the EBR-I outer blanket components. Beryllium is therefore not expected to exceed one percent in any payload container (References P777, P778, P838, P881, P954, P4078, P4079, P4082, P4090, U552).

5.4.2.5 K-Listed Waste

The material in this is not a hazardous waste from any of the sources specified in 40 CFR 261.32 (Reference 11).

5.4.3 Radiological Characterization

As described in section 5.2, waste stream ID-EBR-S5000 consists of debris waste generated from decommissioning the EBR-I reactor. The waste materials include the EBR-I reactor control rods and cup assembly and includes blanket bricks, the inner ring or doughnut, doughnut inserts, the safety center plug or insert, and the control rods. These components are all NU encased in stainless steel cladding and were designed to provide the “fertile” material to capture neutrons from the reactor core for the breeding or production of plutonium. The nominal NU isotopic mass ratios are provided in Table 3, Isotopic Composition of Normal Uranium. With the exception of some of the blanket bricks, all of the components are believed to have been used for all four core loadings of the reactor (References P778, P838, P881, P954, P4078, P4082, P4084, P4090, U552).

Table 3. Isotopic Composition of Normal Uranium

Isotope	Mass Percent
U-234	0.0054 %
U-235	0.7204 %
U-238	99.2742 %

Based on estimated quantities of Pu-239 “grown” in the outer blanket components and the MFC waste management practices and categorization schemes, containers in this waste stream have surface dose rates exceeding 200 mrem/hr and contain more than 100 nCi/g of alpha-emitting TRU isotopes with half lives greater than 20 years. The waste is contaminated primarily with fissile materials and MFP. The approach implemented by CCP to fully characterize this waste stream is documented in CCP-AK-INL-601, *Central Characterization Project Remote-Handled Transuranic Radiological Characterization Technical Report for Remote-Handled Transuranic Debris Waste of the Experimental Breeder Reactor-I (EBR-I) at the Idaho National Laboratory (INL)* (References 12, P777, P778, P881, P4078, P4081, P4082, P4084, P4090, U552).

As described in section 4.2.1, the EBR-I reactor was operated with four separate and distinct loadings. Three of these were fueled with enriched uranium, and the fourth and last with plutonium. The Mark I core consisted of 217 fuel rods, each of which consisted

of a stainless steel tube containing two axially spaced highly enriched U-235 slugs. For the Mark II core, the unalloyed uranium metal was replaced by an alloy consisting of 98 weight percent uranium and 2 weight percent zirconium. The Mark III fuel material consisted of the same uranium-zirconium alloy with a U-235 enrichment of 93 percent. Fuel breeding in conjunction with the enriched uranium cores consisted of the conversion of U-235 to Pu-239 (References P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

The fuel material used in the Mark IV loading consisted of 98.6 weight percent plutonium, 1.2 weight percent aluminum, and 0.2 weight percent impurities, primarily iron, chromium, nickel, and copper. The fuel was fabricated from two batches of plutonium feed material with the following compositions in Table 4, Isotopic Composition of Feed Plutonium. The fuel portion of the rods consisted of four plutonium-aluminum alloy slugs. Fuel breeding in the outer blanklet in conjunction with the plutonium fueled core consisted of the fission of U-238 forming Pu-239 (References P777, P778, P881, P4078, P4081, P4082, P4084, P4090).

Table 4. Isotopic Composition of Feed Plutonium

Isotope	Weight Percent		
	Batch 1	Batch 2	Average
Pu-239	95.1 %	93.2 %	94.4 %
Pu-240	4.5 %	6.2 %	5.1 %
Pu-241	0.44 %	0.55 %	0.5 %
Pu-242	Trace	Trace	Trace

5.4.3.1 Historical Radiological Data Evaluation

The WCPIP requires that, as a minimum, the masses and activities of the following 10 WIPP-tracked radionuclides (if present) be reported (Reference 1):

Am-241	U-233
Pu-238	U-234
Pu-239	U-238
Pu-240	Sr-90
Pu-242	Cs-137

In addition to the above 10 radionuclides, other radionuclides are required to be reported that, in aggregate, constitute 95 percent of the total radiological hazard. For criticality purposes, U-235 is also included in the list of radionuclides to be reported.

The outer blanket components of the waste stream contain fission products and small amounts of inbred plutonium. The stainless-steel casing contributes activation products to the radiological composition. The container documentation provides total curies, total NU, and total plutonium, without distinguishing among individual isotopes. It is also

assumed that the quantity of plutonium listed is Pu-239. In an attempt to assign curies to individual isotopes for a more complete source term, the following methodology has been developed (Reference P4084, P4085, U552).

With limited data available for EBR-I, data gathered for EBR-II was supplemented with EBR-II–related waste data. A source term calculator for EBR-II has been developed for assigning curie amounts to isotopes. Usually these calculators are adequate for as-generated wastes. They contain larger percentages of short-lived isotopes that contribute significantly to dose consequences. As this material decays, the percentages of the total distribution changes as the longer-lived isotopes become the significant contributors. In an attempt to adjust the calculators used, the relative concentrations for the mixed activation and mixed fission products were estimated based on a decay time of two years and 180 days. This represents the dormant time between when reactor operations ceased (December 1963) and the time when these reactor components were placed into storage at RSWF (summer 1966). The relative distributions for mixed activation and fission products were then estimated for each RSWF liner (Reference P4084).

The information in Table 5, Summary of Radionuclides in Waste Stream ID-EBR-S5000, presents the distribution of the reported and calculated radionuclides for the current population of RSWF liners in the waste stream. The “Total Radionuclide Weight%” values are the reported gram values for each radionuclide over the entire waste stream divided by the total radiological mass reported in all containers in the waste stream. The same calculation produced the values for the “Total Radionuclide Curie%” using the sum of activity values for each radionuclide over the entire waste stream. The “Radionuclide Weight% Range for Individual Containers” and “Radionuclide Curie% Range for Individual Containers” illustrate the reported ranges of radionuclides in individual containers by identifying the maximum and minimum values for each radionuclide on a container-by-container basis over the entire waste stream. The minimum and maximum values include only those containers where the radionuclide was reported. As illustrated in Table 5, the radionuclide weight percent of individual radionuclides varies on a container-by-container basis (References P4084, U552).

Table 5. Summary of Radionuclides in Waste Stream ID-EBR-S5000

Radio-nuclide	Number of Containers with Reported Nuclide	Total Radionuclide Weight%[1,5, 6]	Radionuclide Weight% Range for Individual Drums[2,5]	Total Radionuclide Curie%[3,5,6]	Radionuclide Curie% Range for Individual Drums[4,5]	Expected in Waste Stream
WIPP Required Radionuclides						
Am-241	Not Reported	NA	NA	NA	NA	No
Pu-238	Not Reported	NA	NA	NA	NA	No
Pu-239	5	Trace	Trace - 0.01%	**3.29%**	0.22% - 36.80%	Yes
Pu-240	Not Reported	NA	NA	NA	NA	No
Pu-242	Not Reported	NA	NA	NA	NA	No
U-233	1	Trace	0.00% - Trace	0.14%	0.00% - 4.67%	Yes
U-234	4	Trace	0.00% - 0.01%	0.38%	0.00% - 4.69%	Yes
U-238	5	**99.27%**	99.27% - 99.27%	0.52%	0.03% - 4.67%	Yes
Sr-90	5	Trace	Trace - Trace	**18.38%**	10.76% - 19.16%	Yes
Cs-137	5	Trace	Trace - Trace	**16.64%**	9.74% - 17.34%	Yes
Additional Radionuclides						
Ba-137m	5	Trace	Trace - Trace	**15.74%**	9.22% - 16.40%	Yes
C-14	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Ce-141	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Ce-144	5	Trace	Trace - Trace	0.49%	Trace - 0.52%	Yes
Co-58	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Co-60	5	Trace	Trace - Trace	**14.62%**	8.56% - 15.24%	Yes
Cr-51	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Cs-134	5	Trace	Trace - Trace	0.26%	0.15% - 0.27%	Yes
Eu-154	5	Trace	Trace - Trace	0.06%	0.03% - 0.06%	Yes
Eu-155	5	Trace	Trace - Trace	1.03%	0.60% - 1.07%	Yes
Fe--55	5	Trace	Trace - Trace	**8.33%**	4.88% - 8.69%	Yes
Fe-59	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Mn-54	5	Trace	Trace - Trace	0.96%	0.56% - 1.00%	Yes
Mo-93	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Nb-93m	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Nb-94	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Nb-95	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Ni-59	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Ni-63	5	Trace	Trace - Trace	0.14%	0.08% - 0.14%	Yes
Pr-144	5	Trace	Trace - Trace	0.50%	0.29% - 0.52%	Yes
Pr-144m	5	Trace	Trace - Trace	0.01%	Trace - 0.01%	Yes
Rh-106	5	Trace	Trace - Trace	0.04%	0.03% - 2.85%	Yes
Ru-106	5	Trace	Trace - Trace	0.04%	0.02% - 0.04%	Yes
Sb-124	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes

Table 5. Summary of Radionuclides in Waste Stream ID-EBR-S5000 (Continued)

Radio-nuclide	Number of Containers with Reported Nuclide	Total Radionuclide Weight%[1,5, 6]	Radionuclide Weight% Range for Individual Drums[2,5]	Total Radionuclide Curie%[3,5,6]	Radionuclide Curie% Range for Individual Drums[4,5]	Expected in Waste Stream
Sb-125	5	Trace	Trace - Trace	0.04%	0.02% - 0.04%	Yes
Tc-99	5	Trace	Trace - Trace	Trace	Trace - Trace	Yes
Te-125m	5	Trace	Trace - Trace	0.01%	0.01% - 0.01%	Yes
U-235	5	0.72%	0.72% - 0.72%	0.02%	Trace - 0.22%	Yes
Y-90	5	Trace	Trace - Trace	**18.38%**	10.76% - 19.16%	Yes

1. This listing indicates the total weight percent of each radionuclide over the entire waste stream.
2. This listing is the weight percent range of each radionuclide on a container-by-container basis.
3. This listing indicates the total activity (curie) percent of each radionuclide over the entire waste stream.
4. This listing is the curie percent range of each radionuclide on a container-by-container basis.
5. "Trace" indicates <0.01 weight or activity (curie) percent for that radionuclide.
6. Bold type indicates isotopes which contribute to 95% or greater total %Ci or total Wt%.

Based on generator reported radionuclides, the two predominant isotopes for the waste stream are U-238 and U-235, while over 95 percent of the total activity in the waste stream is from Sr-90, Y-90, Cs-137, Ba-137m, Co-60, Fe-55, and Pu-239 (References C4115, P4084, U552).

5.4.4 Polychlorinated Biphenyls (PCBs)

No sources of polychlorinated biphenyls (PCBs) were identified as inputs into waste stream ID-EBR-S5000. PCB items, such as light ballasts, are not identified in the RH TRU debris waste (References P4079, U552).

5.4.5 Prohibited Items

Based on the review of container documentation and documented waste management practices, prohibited items potentially present in the waste stream consist of sealed containers greater than 4-liters. Specific waste packaging information is not available. However, waste management practices included the use of "paint cans", carbon steel paint cans stacked and welded together to form a nominally 6-ft-long, 11-inch internal diameter "paint" can with a gasketed and machine-crimped lid. Once loaded, the container was transferred to the RSWF and dropped into the RSWF liner, a 16-inch diameter by 148-inch carbon steel vessel. The liner was closed by welding a steel plate or concrete shield plug to the top (References P982, P4072, P4073, P4075, U552).

All of the containers in this waste stream will be characterized by VE to ensure no prohibited items are present. Waste packages containing prohibited items identified during characterization activities will be segregated, then dispositioned appropriately and/or repackaged to remove the items prior to certification and shipment (References P089, P115, P182).

The WIPP LWA (Reference 9) prohibits the disposal of spent nuclear fuel and high-level waste as defined by the NWPA (Reference 10) at the WIPP. According to the NWPA,

spent nuclear fuel is "fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing." DOE M 435.1-1, *DOE Radioactive Waste Management Manual* (Reference 16), expands on this definition to clarify that "Test specimens of fissionable material irradiated for research and development only, and not production of power or plutonium, may be classified as waste, and managed in accordance with the requirements of this Order when it is technically infeasible, cost prohibitive, or would increase worker exposure to separate the remaining test specimens from other contaminated material." High-level waste is defined by the NWPA as "the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation." Waste stream ID-EBR-S5000 consists of metal debris generated from decommissioning of the EBR-I reactor. This RH waste stream consists of the reactor outer blanket material components and does not contain fuel material. In addition, this waste stream was not generated from reprocessing of constituent elements from reactor fuel. Therefore, the waste is not a spent nuclear fuel, not high-level waste, nor a waste historically managed as high-level waste, and is eligible for disposal at the WIPP as RH TRU waste (References P778, P883, P881, P954, P4078, P4084, P4090, U552).

5.5 Waste Packaging

As described in section 4.2.1, waste stream ID-EBR-S5000-RH consists of debris waste generated from decommissioning the EBR-I reactor. The materials were removed from the reactor and placed into designated 16-inch or 24-inch (one container) storage liners at the RSWF. Detailed waste packaging information and container documentation is not available. The exact packaging configuration and primary waste container for each canister has not been identified. Prior to 1978, waste material was placed in a single containment configuration consisting of "paint" cans. These containers were typically constructed of carbon steel paint cans stacked and welded together to form a nominally 6-ft-long, 11-inch internal diameter "paint" can with a gasketed and machine-crimped lid. Once loaded, the container was transferred to the RSWF and dropped into the RSWF liner, a 16-inch diameter by 148-inch carbon steel vessel, which contained approximately 6-inches of sand in the bottom. The waste in three of the canisters (DD-45, FF-43, and FF-45) may be packaged in multiple "paint cans" since the waste was transferred to each of these RWSF liners in several shipments. It is also possible the waste was placed directly into the RWSF liners and does not include internal packaging. Gravel may have been added to the liner after placement of the waste to provide shielding from the gamma radiation associated with the stored radioactive material. The liner was closed by welding a steel plate to the top (when gravel was used for shielding) or by welding a concrete shield plug to the top. The waste container logs for four of the canisters indicate a fill type of "other" and "no fill" is handwritten on the records. The record for one liner (FF-46) indicates it is equipped with a concrete plug. One of the RSWF liners (NN-03) is a unique size, 24-inches in diameter by

69.5-inches long, to accommodate the EBR-I doughnut. In the early 1990s the 16-inch RSWF liners were subsequently excavated intact, inspected, and transferred to 24-inch liners. The custom 24-inch liner was retrieved and transferred to a 30-inch liner. The 16-inch and one 24-inch liner will be retrieved from the RSWF and transferred to INTEC for waste repackaging (References P982, P4072, P4073, P4075, U552).

RSWF liners will be repackaged prior to shipment to WIPP. The waste from the liners will be placed into 30-gallon drums. A lid with a NucFil-certified carbon composite filter, but without a locking ring will be placed on each 30-gallon drum. The 30-gallon drum will be placed into a woven polyethylene lifting bag. The drum and lifting bag are then wrapped in a plastic sleeve as the drum is lifted out of the repackaging cell. The sleeve is closed around the drum and lifting bag using a wire tie, plastic tie, or bungee cord. A 4-mil thick polyethylene dust cover may be placed over the lower part of the drum as the drum is lifted from the repackaging cell encapsulating the lower sleeve, drum lifting bag, and 30-gallon drum. The wrapped 30-gallon drum is then lowered into a standard DOT Type A 55-gallon steel drum. The plastic sleeve may be removed from the 30-gallon drum before placement, or the top breached following placement in the 55-gallon drum. Polyethylene disks may be placed in the 30-gallon or 55-gallon drums just prior to placing on the drum lids to facilitate pushing down plastic used for contamination control. The standard 55-gallon drum is constructed of 16-gauge materials and has a removable head with a drum head gasket. The 55-gallon drums will include a NucFil-certified carbon composite filter. The 55-gallon drum is loaded into the removable lid canister using a 55-gallon drum lifting bag. The drum lifting bag will remain in the canister with the drum. Up to three drums will be loaded into the removable lid canister (References C464, C633, P035, P089, P115, P182).

6.0 QUALIFICATION OF AK INFORMATION

Document CCP-AK-INL-602, *Central Characterization Project RH TRU Waste Certification Plan for 40 CFR 194 Compliance and Confirmation Test Plans for INL Waste Stream: ID-EBR-S5000* (Reference 13), describes how each DQO and QAO will be met along with the rationale for selection of the AK qualification methods used. The description of the confirmatory testing process, the percentage of containers that will be subjected to the process, a discussion of why the process is considered representative of the waste stream, and quantitative acceptance criteria are to be determined and will be presented in CCP-AK-INL-602 (Reference 13).

Table 6, Waste Stream ID-EBR-S5000 DQO Determination Summary, lists the DQOs to be addressed using AK associated with waste stream ID-EBR-S5000 relating to the defense waste, radiological, and physical waste stream determinations.

Table 6. Waste Stream ID-EBR-S5000 DQO Determination Summary

DQO Determinations	Summary of AK	AK Sources
Defense Waste	As described in the defense waste justification in section 4.1.4, there is sufficient evidence to demonstrate that TRU wastes generated by EBR-I decommissioning operations are contaminated with materials from atomic energy defense activities associated with naval reactor development, defense nuclear materials productions, defense nuclear waste and materials by-products management, and defense research and development activities. **Qualification Method**: Not Applicable	C002, C003, C004, C028, C127, C214, P001, P036, P049, P055, P071, ,P777, P778, P881, P4078, P4081, P4082, P4084, P4090, U552
TRU Waste	Evaluation of generator reported radionuclides demonstrates that this is a TRU waste stream. Based on generator reported radiological data, the estimated average TRU alpha concentration exceeds 100 nCi/g. **Qualification Method**: Method described in CCP-AK-INL-602.	P777, P778, P881, P4078, P4081, P4082, P4084, P4090, U552, and CCP-AK-INL-581
RH Waste	Generator reported surface dose rates for the RSWF liners indicate the surface dose rates exceed 200 mrem/hr. **Qualification Method**: Method described in CCP-AK-INL-602.	P777, P778, P881, P4078, P4081, P4082, P4084, P4090, U552, and CCP-AK-INL-581
Activity	This DQO is specific to payload containers and will not be assessed until the final payload configuration has been established.	To Be Determined (TBD)
WIPP 10 Required Radionuclides	The relative activity of the WIPP 10 required radionuclides for this waste stream is documented in CCP-AK-INL-601, *Central Characterization Project Remote-Handled Transuranic Radiological Characterization Technical Report for Remote-Handled Transuranic Debris Waste of the Experimental Breeder Reactor-I (EBR-I) at the Idaho National Laboratory (INL).* **Qualification Method**: Method described in CCP-AK-INL-602, *Central Characterization Project RH TRU Waste Certification Plan for 40 CFR 194 Compliance and Confirmation Test Plans for INL Waste Stream: ID-EBR-S5000.*	P4084, P4085, U552, and CCP-AK-INL-601

Table 6. Waste Stream ID-EBR-S5000 DQO Determination Summary, Continued

DQO Determinations	Summary of AK	AK Sources
Physical Form	As described in section 5.4.1, waste stream ID-EBR-S5000 consists primarily of metal debris meeting the WCPIP definition for Summary Category Group S5000. Section 5.4.1.2 identifies the WMPs, including the estimated amount of each in the waste stream. **Qualification Method**: 100 percent VE or RTR as described in CCP-AK-INL-602.	C464, C698, C4124, P006, P035, P089, P102, P115, P182, P778, P838, P881, P954, P4072, P4073, P4078, P4084, P4090, U552
Residual Liquids	As described in section 5.4.5, residual liquids are prohibited during the packaging of waste stream ID-EBR-S5000. **Qualification Method**: 100 percent VE or RTR as described in CCP-AK-INL-602.	P089, P115, P182, P982, P4072, P4073, P4075, U552

The methods used to qualify the AK information associated with waste stream ID-EBR-S5000 are TBD pending development of CCP-AK-INL-601 and CCP-AK-INL-602 (References 12, 13).

7.0 CONTAINER SPECIFIC INFORMATION

In accordance with the procedure CCP-TP-005 (Reference 3), a CCP Waste Containers List (Attachment 8 of the procedure) is completed and maintained as a quality record for waste tracking purposes. Information tracked includes container identification number, waste stream number, and the closure date for each container.

Container specific information for each drum in waste stream ID-EBR-S5000 will be maintained in the most current Container Tracking Spreadsheet. The Container Tracking Spreadsheet, at a minimum, will identify the waste stream, container identification number, summary category group, vent date, and closure date for each drum, based on AK and the most current information from AK characterization activities, as applicable.

8.0 REFERENCES

1. DOE/WIPP-02-3214, *Remote-Handled TRU Waste Characterization Program Implementation Plan*, Carlsbad, New Mexico, U.S. DOE Carlsbad

2. NM4890139088-TSDF, *Waste Isolation Pilot Plant Hazardous Waste Facility Permit*, Attachments B-B6, *Waste Analysis Plan*, New Mexico Environment Department, Santa Fe, New Mexico

3. CCP-TP-005, *CCP Acceptable Knowledge Documentation*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

4. DOE/TRU-10-3425, *Annual Transuranic Waste Inventory Report – 2010*, Carlsbad, New Mexico, U.S. DOE Carlsbad

5. CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

6. 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*, Washington, D.C., U.S. EPA, December 20, 1993

7. 40 CFR Part 194, *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations*, Washington, D.C., U.S. EPA, February 9, 1996

8. *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Certification Decision*, Washington, D.C., U.S. EPA, May 18, 1998

9. Public Law 102-579, *The Waste Isolation Pilot Plant Land Withdrawal Act*, October 30, 1992, as amended by Public Law 104-201, September 23, 1996

10. 42 U.S.C. 10101, *Nuclear Waste Policy Act of 1982*, U.S. Congress

11. 40 CFR Part 261, *Identification and Listing of Hazardous Waste*, U.S. EPA

12. CCP-AK-INL-601, *Central Characterization Project Remote-Handled Transuranic Radiological Characterization Technical Report For Remote-Handled Transuranic Debris Waste of the Experimental Breeder Reactor-I (EBR-I) At The Idaho National Laboratory (INL)* Carlsbad, New Mexico, Washington TRU Solutions, LLC.

13. CCP-AK-INL-602, *Central Characterization Project RH TRU Waste Certification Plan for 40 CFR 194 Compliance and Confirmation Test Plans for INL Waste Stream: ID-HFEF-S5400-RH*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

9.0 AK SOURCE DOCUMENTS

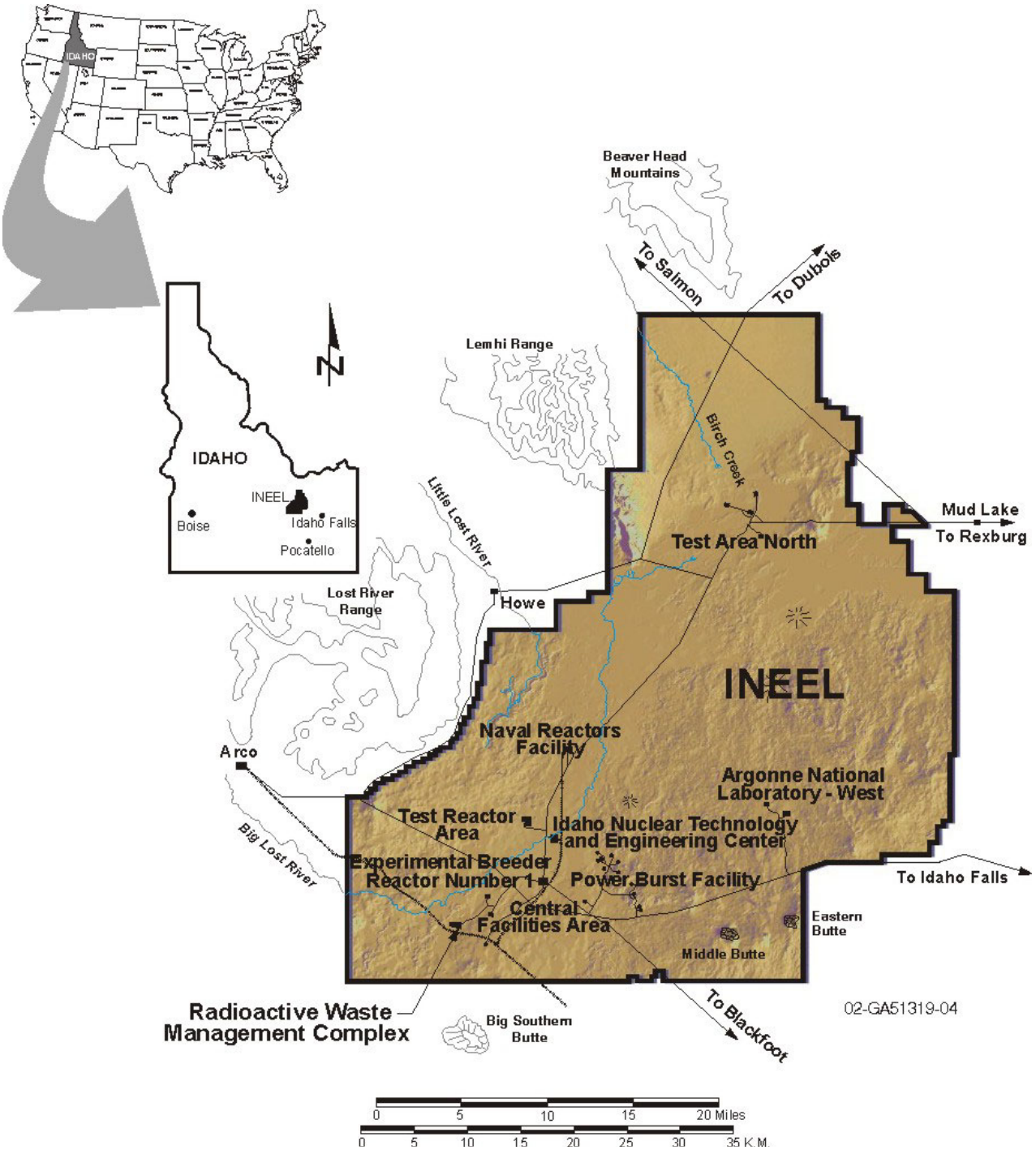
Source Document Tracking Number	Title	Document Number	Author	Date
C002	Interview of Pam Crane, Analytical Laboratory, re: Analytical Laboratory Mission and Objectives	NA	Scott Smith	08/31/2005
C004	Interview of Steve Hayes, Materials and Fuel Complex Project Manager, Advanced Fuel Cycle Initiative, re: Advanced Fuel Cycle Initiative Program Related to Casting Laboratory Operations	NA	Scott Smith	08/22/2005
C005	Interview of Jennifer Tournage, former Waste Specialist, Nancy Stewart, Waste Specialist, and Roy Grant, Waste Specialist, re: MFC Analytical and Casting Laboratories Waste Management and Waste Characterization	NA	Scott Smith	09/01/2005
C014	Intra-Laboratory Memorandum To W.P. Keeney, "Procurement of Uranium Feedstock for FMF Production"	NA	L.C. Walters and D.B. Tracy, ANL	09/15/1989
C021	United States Government Memorandum to Distribution, re: Receipt of Contact-Handled (CH) and Remote-Handled (RH) Transuranic (TRU) Waste at the INEL	NA	J.P. Hamric	05/19/1987
C096	Letter to Distribution re: Changes to Internal Technical Report PR-W-78-014, Rev2	KPL-86-82	K.P. Lange	10/14/1982
C119	Department of Energy, Idaho Operations Office Order, re: Hazardous and Radioactive Mixed Waste Management	ID 5480.2	Operational Safety Division	01/03/1984
C129	Argonne National Laboratory Intra-Laboratory Memo to Distribution, re: TRU Waste Profile Sheets	ANL-W-SSS-(LCW)-88-118	L.C. Witbeck	01/06/1988
C214	MFC Interview	NA	Scott Smith and Carrie Johnson	04/14/2008
C633	Email to Mike Papp, re: 90-Mil Liner Use	N/A	Tom Clements	7/14/2009
C464	HFEF Repackaging Operations Email	NA	Tom Clements	03/03/2009
C698	Email to Tom Clements, re: Operation of CPP-666	N/A	Gerald Streier	07/28/2009
C4124	Evaluation of Volume, Period Generation, and Estimated Repackaging Volume for Waste Stream ID-EBR-S5000	NA	Scott Smith	11/05/2010
DR008	Solvent Use in EBR-I Operations	NA	Scott Smith	11/12/2010
P001	The Defense Programs Origin of Transuranic Waste at Argonne National Laboratory - West	ANL-NT-192	H. F. McFarlane	11/2001
P006	Packet of MSDS	NA	Various	Various
P035	Idaho National Engineering and Environmental Laboratory Waste Acceptance Criteria	DOE/ID-10381, Rev. 19	U.S. DOE Idaho Operations Office	04/2004
P036	Pollution Prevention/Waste Minimization Plan	NA, Rev. 10	A. M. Collins	01/2004
P037	Nuclear Fuel Cycle Division, Idaho Operations Office: INEL Transuranic Waste Acceptance Criteria	DOE/ID-10074, Rev. 5	R. M. Brown and J. D. Wells	07/1993

Source Document Tracking Number	Title	Document Number	Author	Date
P042	Analytical Laboratory Safety Analysis Report	W0660-0055-KH, Rev. 4	Idaho National Laboratory	04/06/2006
P049	Estimated radiological Inventory Sent from Argonne National Laboratory-West to the Subsurface Disposal Area from 1952 through 1993	INEEL/EXT-02-01385, Rev. 0	Michael L. Carboneau, James A. Vail	04/2004
P051	A Survey of NRTS Waste Management Practices, Volume II	ICP-1042-II	Allied Chemical Corporation, Idaho Chemical Programs, Operations Office, National Reactor Testing Station	09/1971
P055	Argonne-West Criticality Hazards Control Statement	ID-CHCS-A11, Rev. 7	W.P. Keeney	05/07/1984
P060	ANL-West Remote-Handled Transuranic Waste Certification Plan	W0001-0898-ES-00, Rev. 0	R.J. Teunis	07/05/1988
P063	ANL-West Remote-Handled Transuranic Waste Certification Plan	W0001-0898-ES-01, Rev. 1	Michael E. Vaughn	08/02/1991
P070	Waste Preparation Procedure for Analytical Laboratory Waste Disposal	W0660-0035-OP, Rev. 0	J.R. Krsul	08/19/1991
P071	Plant Description, Administration and General Policy	GET/PD	NA	08/1985
P077	ANL-W RCRA Part B Permit Application, General Information	W0001-0920-ES-04	NA	09/1994
P088	TRU-RH Waste Handling Plan for Waste Management Operations	AW-AL-WM-001	William R. Sovereign	03/30/1988
P089	AK Summary Documentation AK TRU Packaging	RPT-456, DRAFT, Rev. 0	Idaho Cleanup Project	10/2007, 11/2007
P091	INEL Transuranic Waste Acceptance Criteria	IDO-10074, Rev. 1-4	Fuel Processing and Waste Operations Division	04/1980 02/1984 03/1986 07/1987
P100	Engineering Design File, CPP-1617 Fire Area Evaluation	EDF-4684	Nancy Makey	04/26/2004
P101	Technical Procedure, CPP-1617 Waste Handling and Operations	TPR-7318	Radioactive Waste Management Complex at INTEC	02/01/2007
P102	Estimated Radiological Inventory Sent from the Idaho Nuclear Technology and Engineering Center to the Subsurface Disposal Area from 1952 through 1993	ICP/EXT-03-00967 (R0), INEEL-EXT-05-00967 (R1)	James A. Vail, Michael L. Carboneau, Glen R. Longhurst	03/2004, 12/2005
P103	Safety Analysis Report for the INTEC Waste Management Facility (IWMF)	SAR-103 Addendum A	Idaho Cleanup Project	12/20/2006
P115	Decontamination Cell Operations in CPP-659	TPR-7298, Rev 7 and Rev. 11	Idaho Cleanup Project	06/04/2008, 06/03/2009
P145	EBR-II Reactor Review	NA	NE Reactor Review Team	05/23/1980

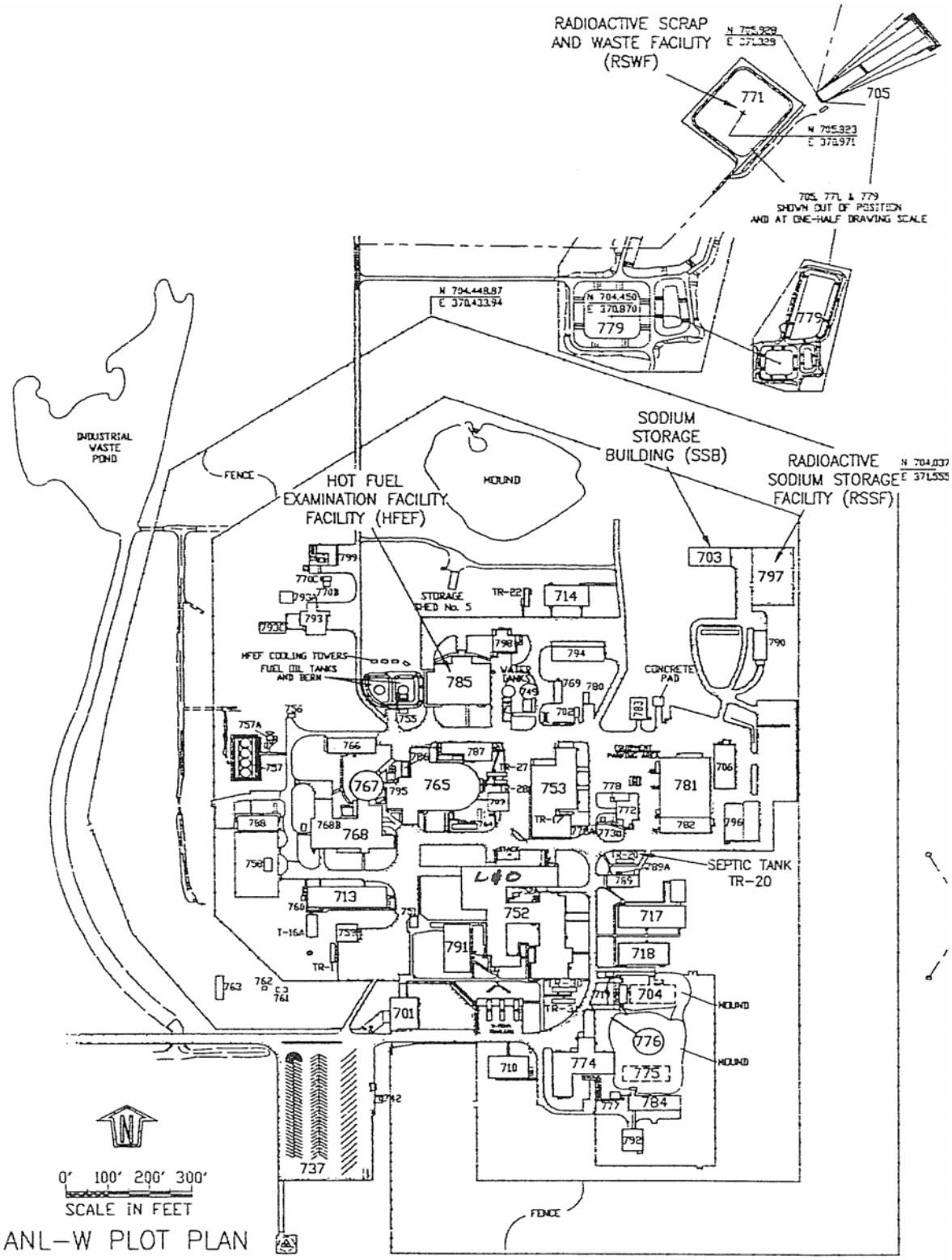
Source Document Tracking Number	Title	Document Number	Author	Date
P182	Packing Configurations for Repacked TRA and ANL-E RH-TRU Waste	EDF-8860	Greg Hulet	08/18/2008
P777	Terminal Report for the Mark IV (Plutonium) Loading in EBR-I	ANL-6865	R.R. Smith, C.B. Doe, R.O. Haroldsen, F.D. McGinnis, M. Novick	04/1965
P778	The Breeding Ratio of Plutonium Loading in EBR-I	ANL-6789, NA	R.R. Smith, R.O. Haroldsen, R.E. Home, R.G. Matlock	02/1964
P838	Casting of Blanket Bricks, Ring, Plug, and Control Rods for the Experimental Breeder Reactor (CP-4)	ANL-5009	Robert E. Macherey	Not Dated
P867	Radioactive Scrap and Waste Facility Operating Instructions, Material Acceptance for Storage	RSWF-OI-003, Rev. 0, 0a	R. Bryan, T. Zahn	10/25/2002, 08/11/2003
P881	Safety Analysis Report, EBR-I Mark-IV	ANL-6411	R. O. Haroldsen, F. D. McGinnis, M. Novick, R. R. Smith, and F. W. Thalgott	02/1963
P952	Experimental Breeder Reactor Project, Report for Period December 1, 1948 thru February 28, 1949	ANL-4274	H.V Lichtenberger	04/12/1949
P953	Experimental Breeder Reactor Project, Report for Period March 1, 1949 thru January 31, 1950	ANL-4420	H.V Lichtenberger	03/13/1950
P954	Experimental Breeder Reactor Project, Report for Period February 1, 1950 thru March 31, 1951	ANL-4554	H.V Lichtenberger	04/01/1951
P982	Radioactive Scrap and Waste Facility Procedure for Free-Air Transfer of Loaded 16" Liners to Empty 24" Liners	W7710-0293-ES, Rev. 3	Argonne National Laboratory - West	11/11/1991
P4072	System Design Description, Radioactive Scrap and Waste Facility Storage Liner System	SDD-225, Rev. 0	Idaho National Laboratory	06/16/2008
P4073	Presentation - Radioactive Waste Management at the EBR-II Site, Argonne National Laboratory	NA, NA	Donald C. Hamson	04/17-18/1969
P4074	Radioactive Scrap and Waste Facility Operating Instructions, Storage Operations	RSWF-OI-1, Rev. 0b	R. Lee, T. Zahn	05/14/2002
P4075	Radioactive Scrap and Waste Facility Operating Instructions, Retrieval of Material from 16-in. Liners	RSWF-OI-002, Rev. 1	R. Lee, T. Zahn	11/04/2002
P4076	Radioactive Scrap and Waste Facility Operating Instructions, Administrative Requirements/Process for Material Transfers	RSWF-OI-004, Rev. 0a	R. Bryan, V. Sandifer	01/06/2003
P4078	EBR-I, Mark-III - Design Report	ANL-5836, NA	R. E. Rice, R. N. Curran, F. D. McGinnis, M. Novick, F. W. Thalgott	P4078
P4079	Hazards Assessment Document for the Experimental Breeder Reactor - I (EBR-I) Facility	HAD-205, Rev. 0	Idaho National Engineering and Environmental Laboratory	P4079
P4080	An Overview of the Argonne National Laboratory Fast Critical Experiments, 1963-1990	ANL-NT-175, NA	L. G. LeSage	P4080
P4081	The Birth of Nuclear-Generated Electricity	NA	NA	P4081

Source Document Tracking Number	Title	Document Number	Author	Date
P4082	Decontamination and Decommissioning of the EBR-I Complex, Final Report	ANCR-1242, NA	E.W. Kendall, D.K. Wang	P4082
P4083	The EBR-I Meltdown - Physical and Metallurgical Changes in the Core	ANL-5731, NA	J. H. Kittel. M. Novick, R. F. Buchanan	P4083
P4084	Engineering Calculations and Analysis Report: Source term calculations for the re-evaluation of EBR-I components currently stored at RSWF	ECAR-1105, Rev. 0	Michel Hall	07/09/2010
P4085	Determination of the Conversion Ratio of the Experimental Breeder Reactor by Radiochemical Methods	ANL-5095, NA	Milton Levenson	12/23/1953
P4090	EBR-II, Sixteen Years of Operation	ANL-001	Argonne National Laboratory-West	05/1980
U001	Various Sections of the ANL-W Waste Handling Manual, Waste Management Information Bulletins	WMIB-8 through WMIB-	Various	Various
U025	DRAFT Facility Waste Descriptions Argonne – West	NA	NA	12/14/1973
U552	Compilation of MFC Liner Documents	Various	Various	Various
U4041	EBR-II High Level Waste Facility Storage Logsheets for Storage Holes QQ-36, QQ-09, PP-15, OO-26, OO-10, NN-28, NN-03, FF-46, FF-43, FF-45, FF-32, DD-45, DD-51	NA	NA	Prior to 1990

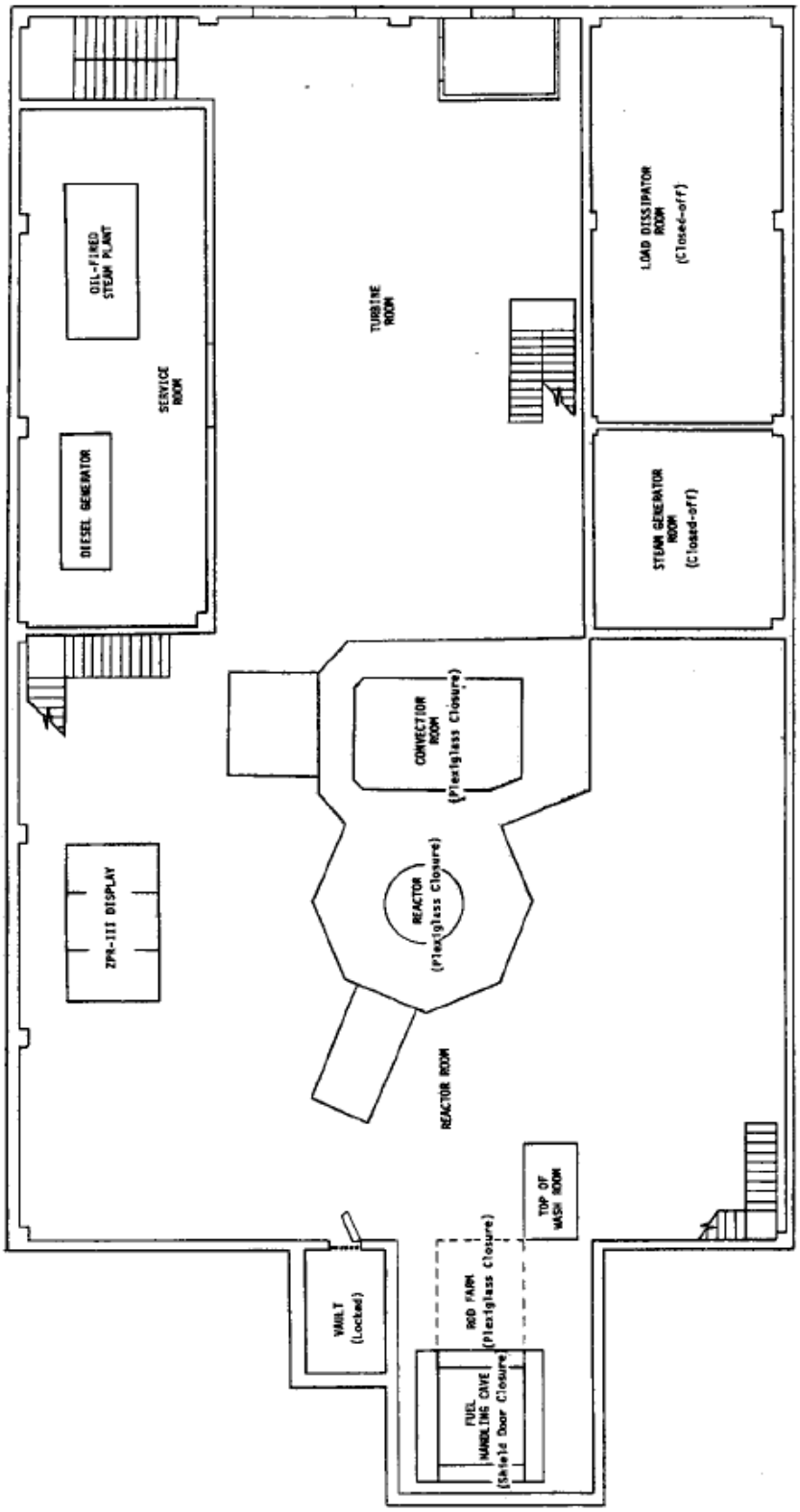
Attachment 1 – Location of the INL and INL Facilities



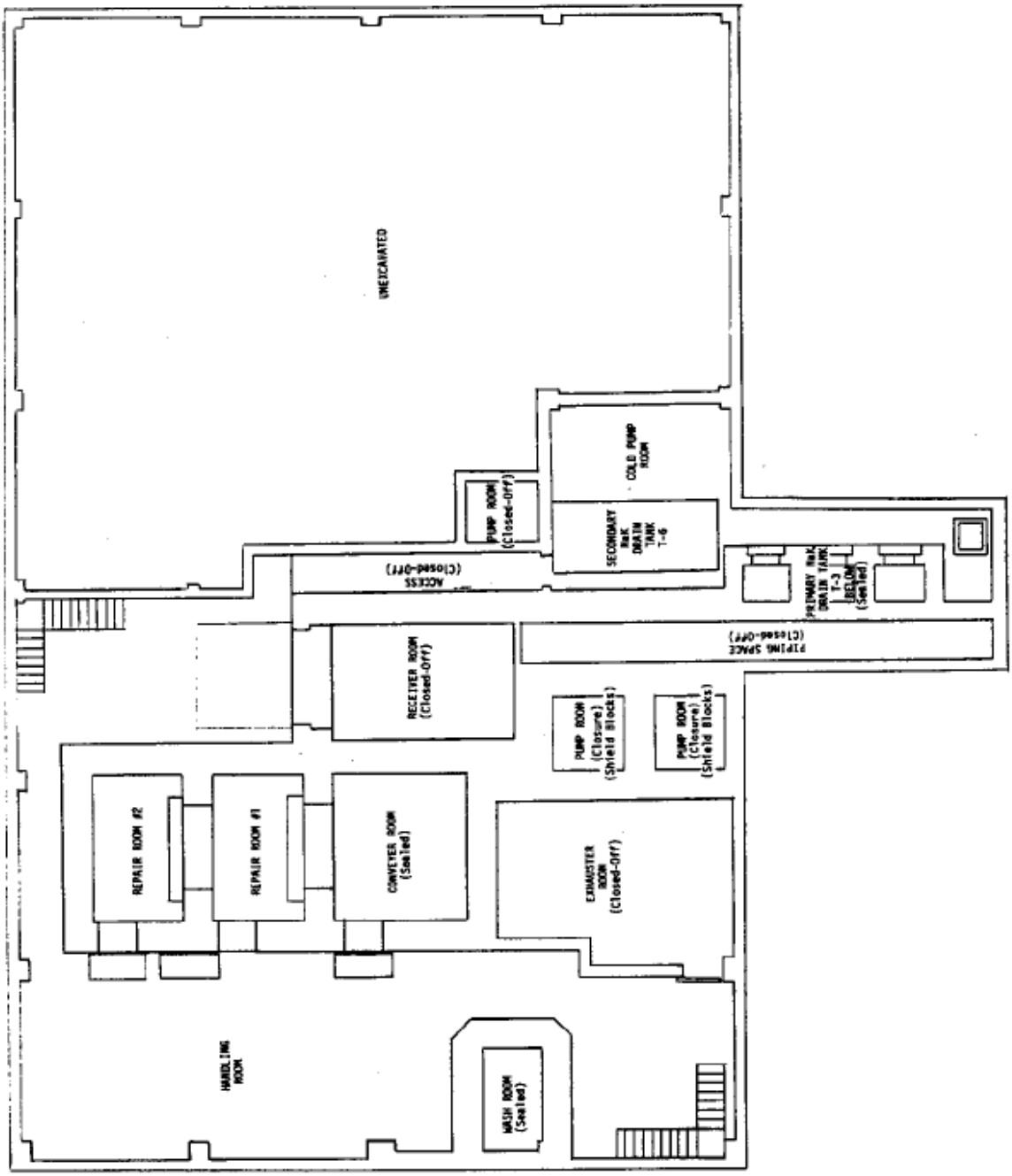
Attachment 2 – Materials and Fuels Complex Map



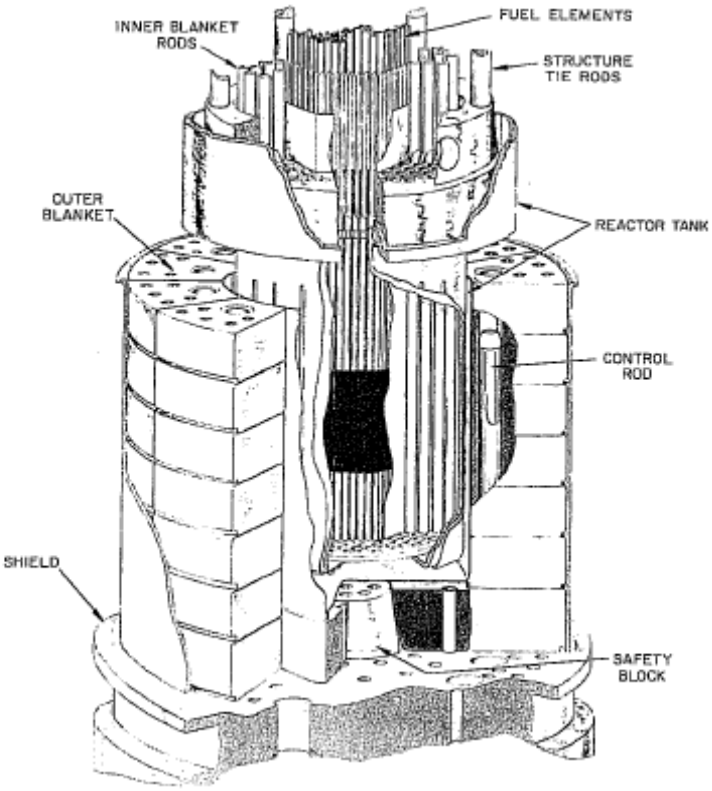
Attachment 3 – EBR-I Main Floor Plan



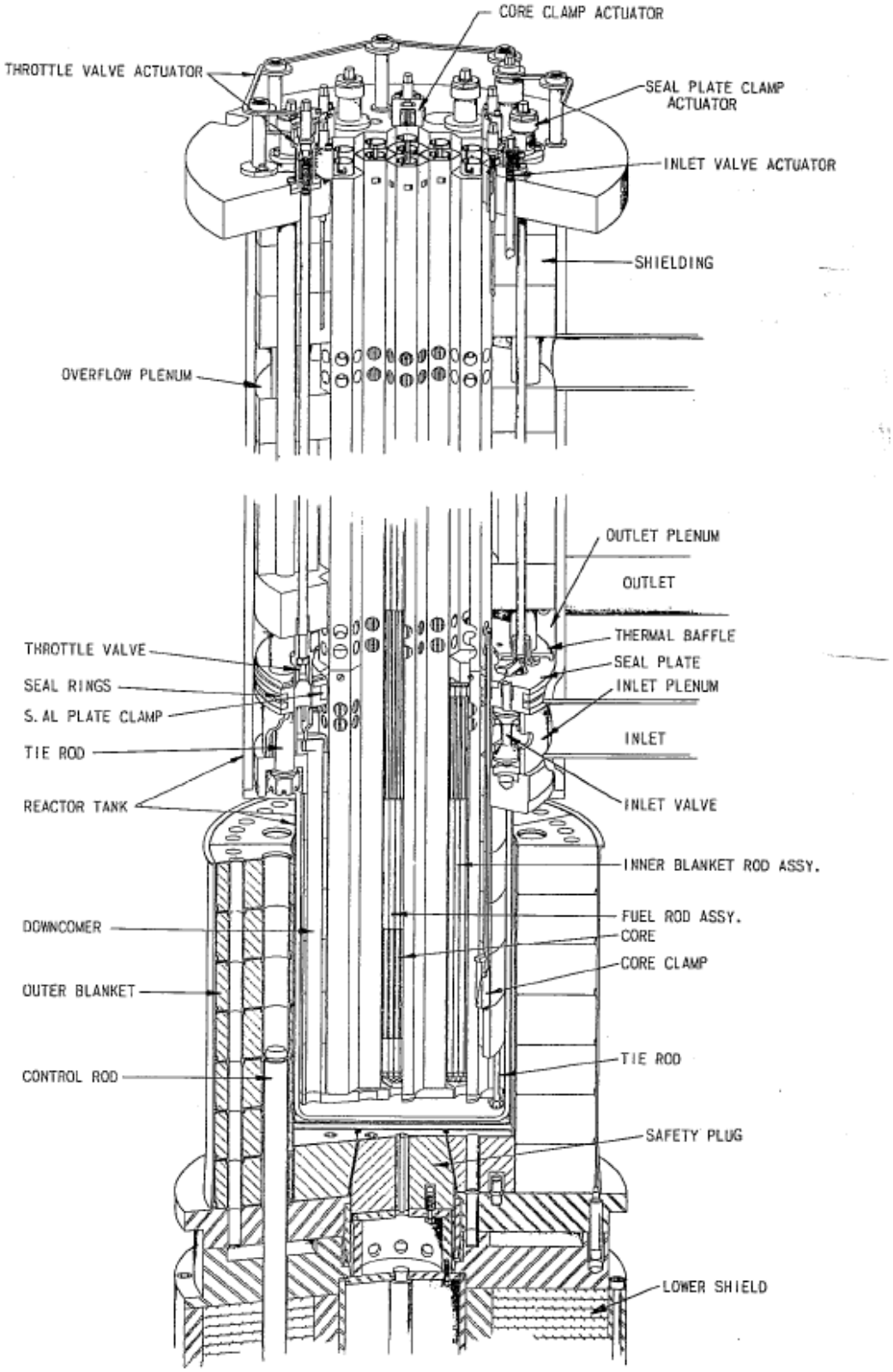
Attachment 4 – EBR-I Basement Plan



Attachment 5 – Cutaway View of EBR-I Marks I and II

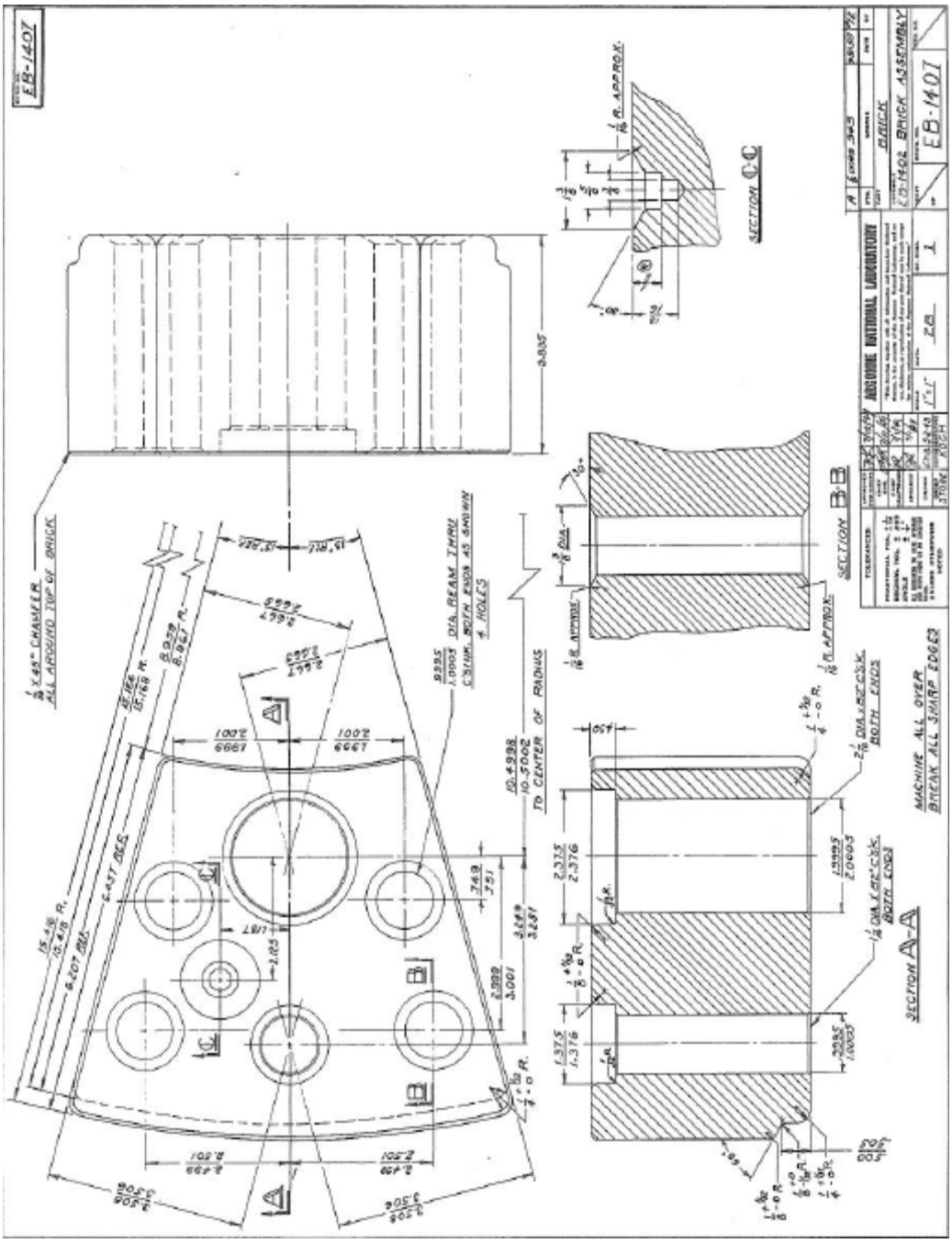


Attachment 6 – Cutaway View of the Marks III and IV Tank and Cup Assemblies

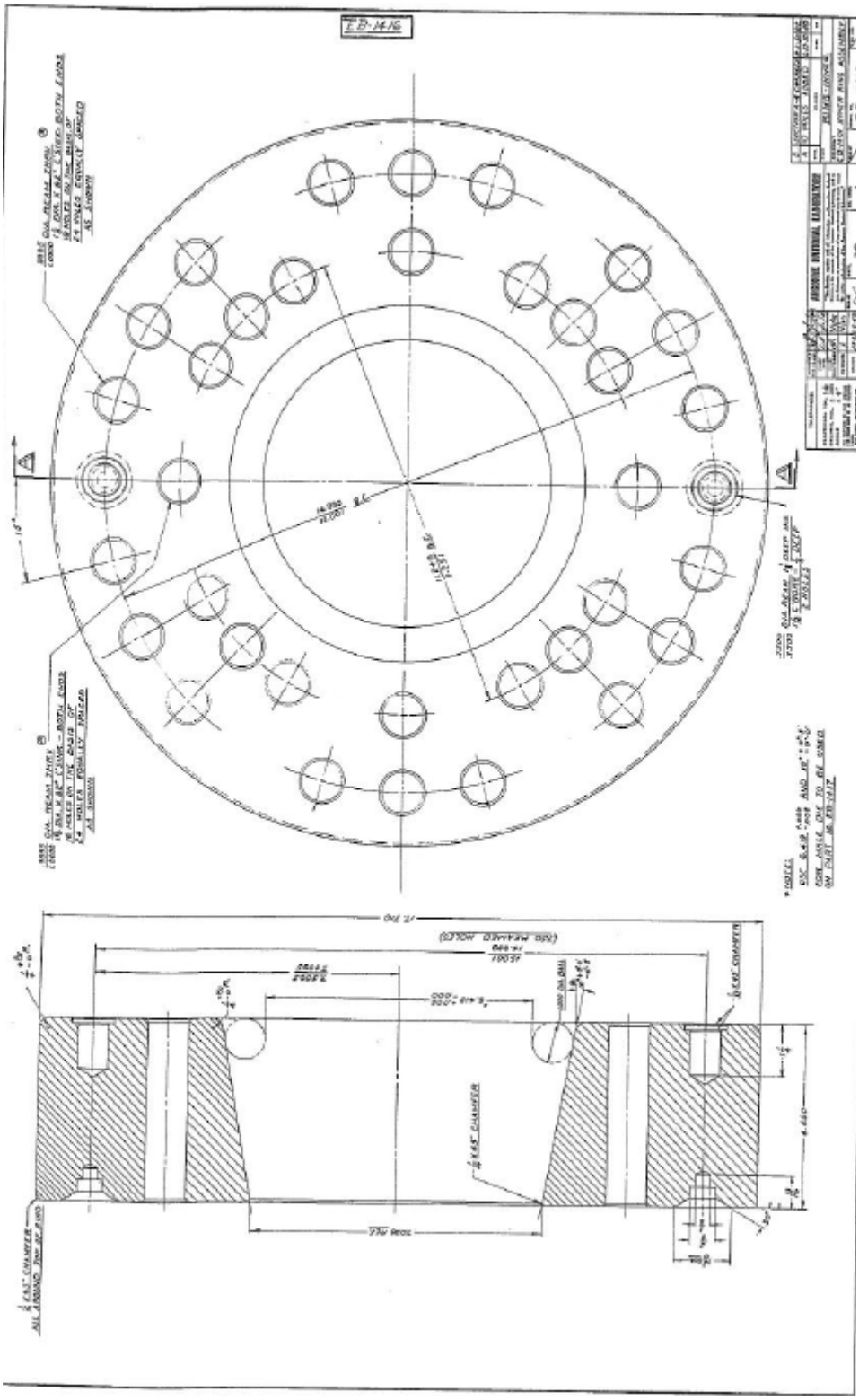


Attachment 7 – Outer Blanket

Attachment 8 – Blanket Brick Drawing



Attachment 9 – Inner Ring Drawing



Attachment 10 – Safety Plug Drawing

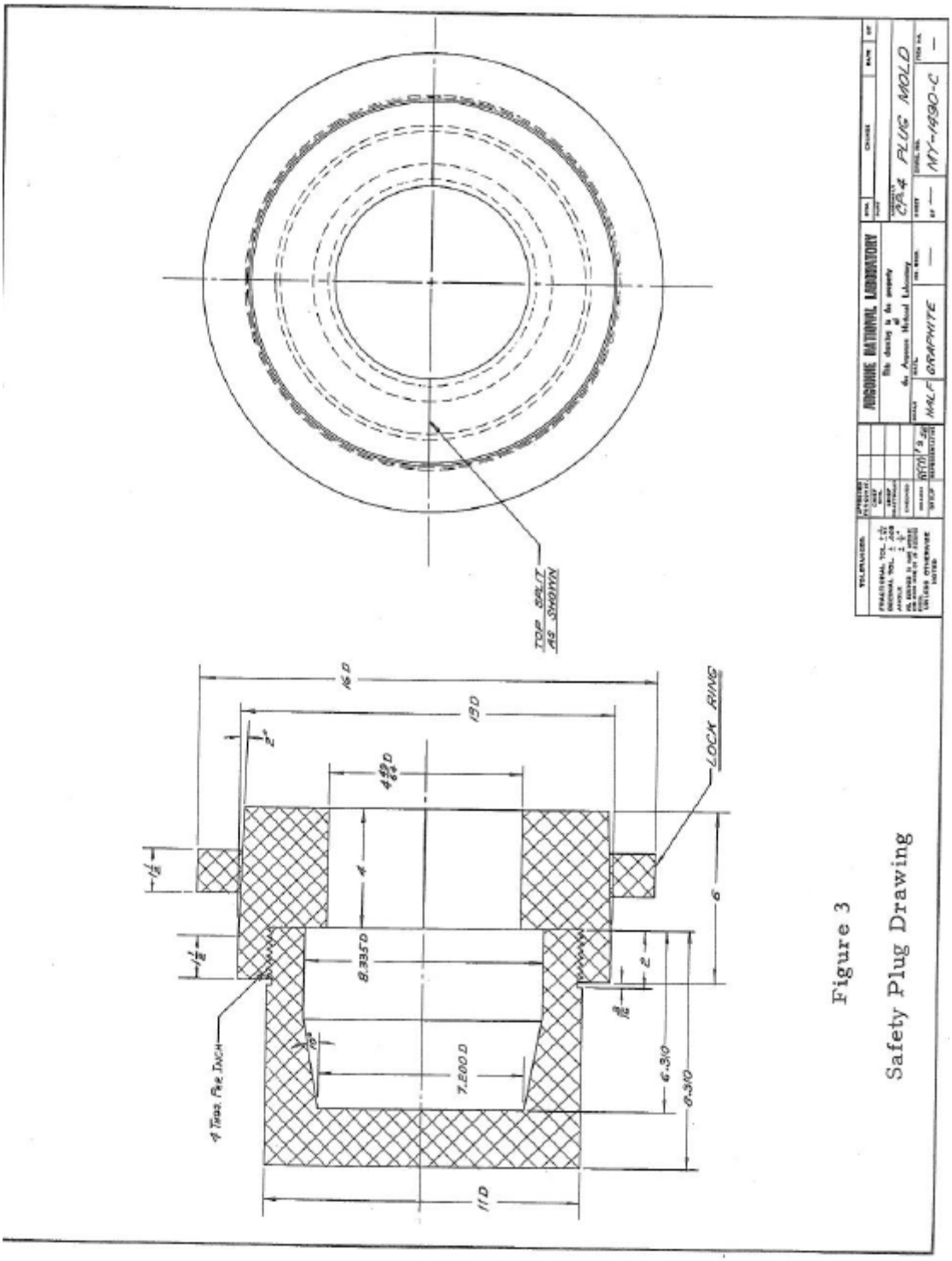


Figure 3

Safety Plug Drawing

Attachment 11 – Control Rod Drawing

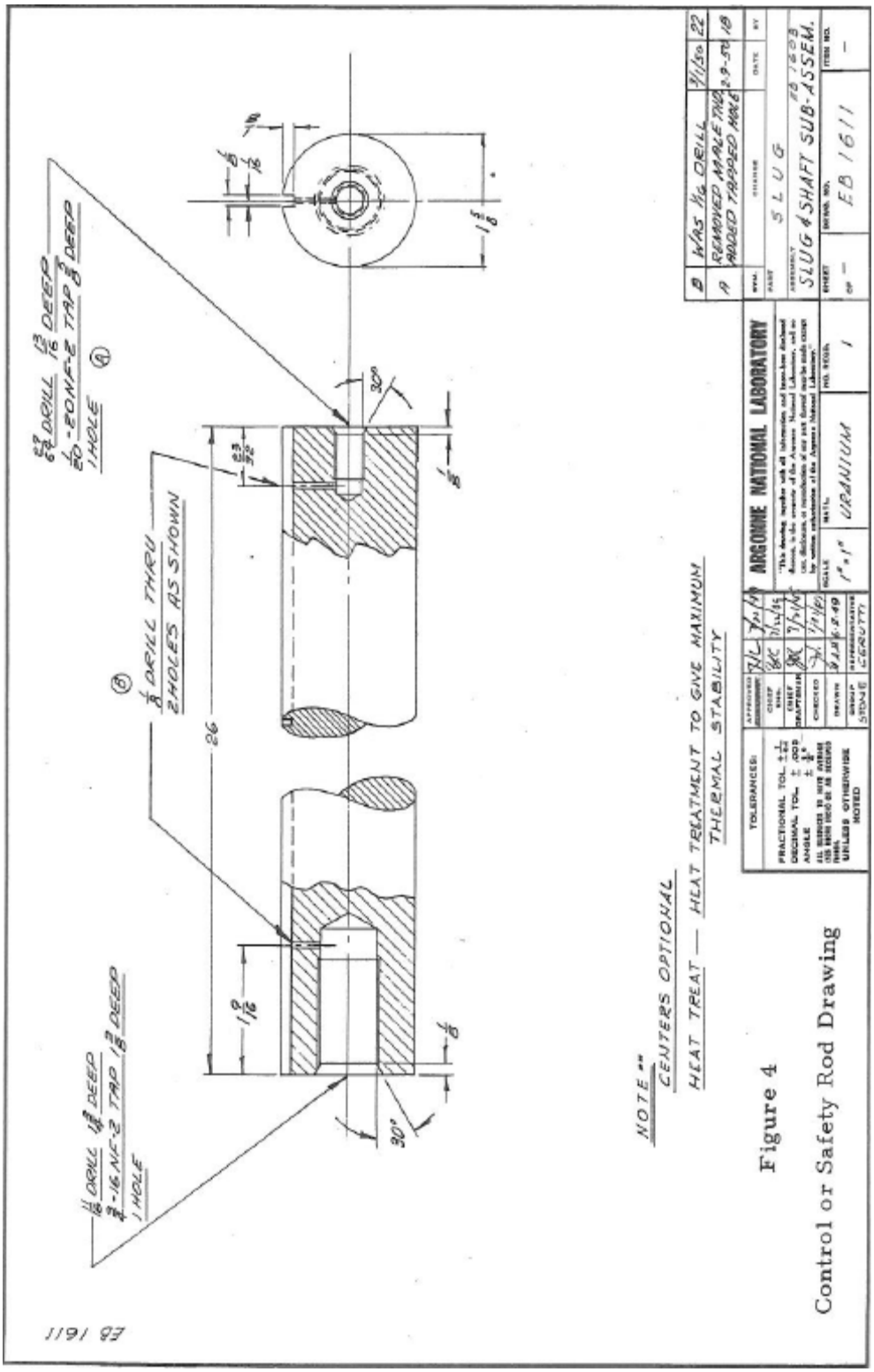


Figure 4

Control or Safety Rod Drawing