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Hazard Assessment Document

for the

INTEC Headend Processing Plant CPP-640

Idaho National Engineering and Environmental Laboratory

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ACRONYMS

CCA	criticality control area
CFR	Code of Federal Regulations
D&D	decontamination and decommissioning
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
EDP	Electrolytic Dissolution Process
HAD	Hazard Assessment Document
HM	hot makeup
HPP	Headend Processing Plant
HVAC	heating, ventilating, and air conditioning
INTEC	Idaho Nuclear Technology and Engineering Center
INEEL	Idaho National Engineering and Environmental Laboratory
ISMS	Integrated Safety Management System
MAR	material at risk
MCP	management control procedure
MHC	mechanical handling cave
PEW	process equipment waste
PM	process makeup
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
TPQ	threshold planning quantity
TQ	threshold quantity
VCO	Voluntary Consent Order

1. INTRODUCTION

This Hazard Assessment Document (HAD) presents the results of the hazard analysis for the Headend Processing Plant (HPP), in Building Number CPP-640 at the Idaho Nuclear Technology and Engineering Center (INTEC), located at the Idaho National Engineering and Environmental Laboratory (INEEL).

The hazard assessment was performed in accordance with Title 10 Code of Federal Regulations (CFR) Part 830, Subpart B;[1] U.S. Department of Energy (DOE)-STD-1027-92,[2] DOE Idaho Operations Office (DOE-ID) Order 420.C;[3] and DOE-ID Order 420.D.[4] This hazard categorization is required to establish the type of safety analysis required for this facility.

2. FACILITY DESCRIPTION

The CPP-640 facility included the Space Nuclear Propulsion Program (Rover) fuel dissolution process and the Electrolytic Dissolution Process (EDP). The Rover facility provided a headend system for the reclaiming of uranium for both unirradiated and irradiated Rover fuels for the Atomic Energy Commission Rocket Program. The EDP was specifically used for the recovery of uranium from fuels with stainless-steel cladding. The aqueous solution from these processes was then sent to CPP-601 to extract the highly enriched uranium.

The Rover process consisted of two separate operations: (1) the dry side, involving fuel rod handling, burners, and ash handling, and (2) the wet side, involving aqueous dissolution of the ash. On the dry side, the graphite fuel rods were handled remotely and dropped into a fluidized bed burner to release the uranium from the graphite matrix. The resulting ash was then gravity-drained into a secondary burner to further reduce the carbon content. In a separate process cell, the wet side of the operation took this uranium-bearing ash and dissolved it in hydrofluoric and nitric acid.

The processing of Rover fuel ended June 1984, and the wet side was flushed. The majority of the fissile material in the dry side was finally packaged and transported for interim storage at CPP-603, on January 28, 1998. The only vessels remaining in the dry side of the Rover facility are Burner Vessels VES-100 and VES-104 and Vacuum Vessel VES-106. Vessel VES-106 contains only residual amounts of fissile material. Burner Vessels VES-100 and VES-104 have been filled with grout to immobilize the remaining residual fissile material and abandoned in place. The grout is made up of a mixture containing 22% Portland cement, 52% fly ash, and 26% water and two water-reducing additives totaling <0.1%. After the grouting was complete, the vessel openings were capped or plugged to minimize any possible degradation of the grout. Grouting of the Rover facility was completed on February 28, 1998. The facility was declared decontaminated and decommissioned in April of 1998, and is currently inactive.

1. All process equipment in the Rover process hot makeup (HM) area has been removed. All hazardous chemicals and accessible fissile materials have been removed from the facility. No storage of fissile material or chemicals is allowed in any of the areas of the HPP.

2. All vessels in the Cell 5 EDP and Rover Cell 2 have been flushed with HNO_3 and water. All hazardous chemicals and fissile material have been flushed from the system. Cells 1 and 2 are posted as high-radiation and high-contamination areas.

3. Rover Cells 3 and 4 have had all the process equipment removed, with the exception of VES-106 and burner vessels VES-100 and VES-104. Vessels VES-100 and VES-104 have been grouted in place. All hazardous chemicals and fissile material have been removed. Cells 3 and 4 are posted as high-contamination and high-radiation areas.

The EDP was performed in Cell 5. Following the final processing campaign, the cell was washed down with in-cell spray nozzles. The vessels were flushed out several times using a multistep process of water, nitric acid, sodium hydroxide, Turco 4502, and Turco 4521. All of the Cell 5 process equipment remains in place. The cell is posted as a high-radiation area.

No additional operation or decontamination and decommissioning (D&D) work has been completed on the building since the Rover deactivation project was completed. Deactivation and Voluntary Consent Order (VCO) activities are currently being planned for this facility. The process of deactivation will place the facility in a safe and stable condition to minimize the potential for releases of radioactive and hazardous materials. The deactivation activities involve removal of hazardous and/or radioactive contaminated materials and equipment, draining residual liquids, isolating and/or rerouting process systems such as electrical, water, steam, plant air, vessel off-gas lines, heating, ventilating, and air conditioning (HVAC), and plant communication systems. Any necessary rerouting of rainwater and snow melt that could enter the facility will also be included.

2.1 HPP Structure

The HPP (CPP-640) is a five-level rectangular 20 × 27-m (66 × 89-ft) structure (see Figure 1). The HPP is located south of and adjacent to CPP-627, and west of and adjacent to CPP-601 (see Figure 2). The HPP, formerly designated as the Hot Pilot Plant, contains five shielded cells and a mechanical handling cave (MHC) for headend processes built to recover uranium from spent reactor fuel. Three of the cells and the MHC have viewing windows for remote operations. The other two cells are designed to accommodate tall equipment and are 9 m (30 ft) deep. Removable walls allow two or three individual cells (Cells 3, 4, and 5) to be combined into larger units. Cells 3 and 4 have been combined in this manner.

<u>Process Cells</u>. The five process cells and the MHC in the HPP are centrally located with operating and access areas around the sides.

<u>Cave</u>. The MHC is located above portions of Cells 2 and 3 in the process makeup (PM) area of the building. The cave has 1-m (3.5-ft)-thick walls and a 0.3-m (1-ft)-thick ceiling.

<u>Cell 1</u>. Cell 1 has a viewing window and is empty. The cell was primarily used as access to Cell 2. Cells 1 and 2 are separated by a 0.6-m (2-ft)-thick, high-density concrete wall. The cell is 3.0 × 4.9 m (10 × 16 ft).

<u>Cell 2</u>. This cell has three viewing windows. Entry to the cell is through Cell l or through a door in the west access corridor of the process floor level. The cell is 3.0 × 4.9 m (10 × 16 ft).

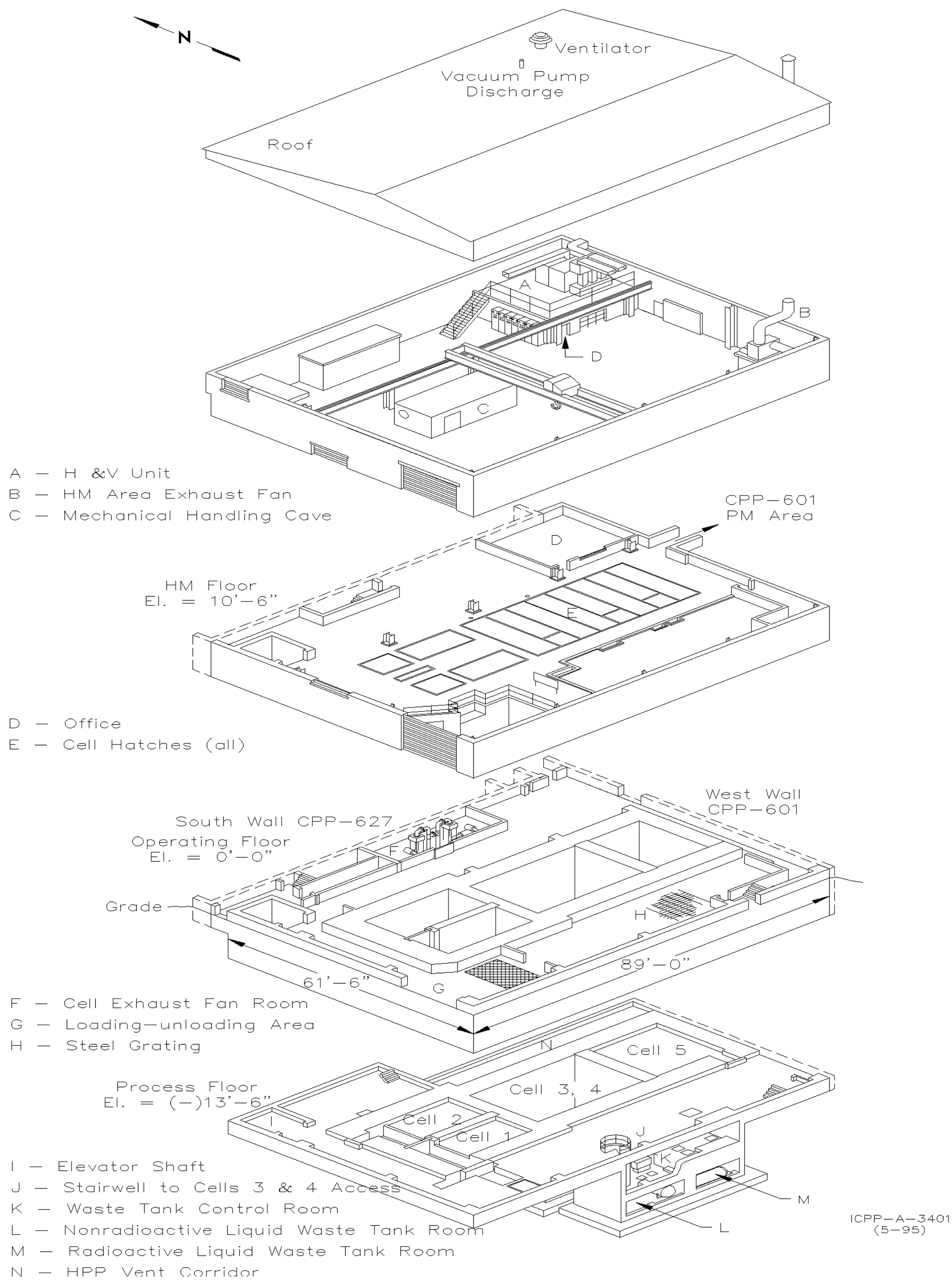

Figure 1. Isometric view of the HPP.

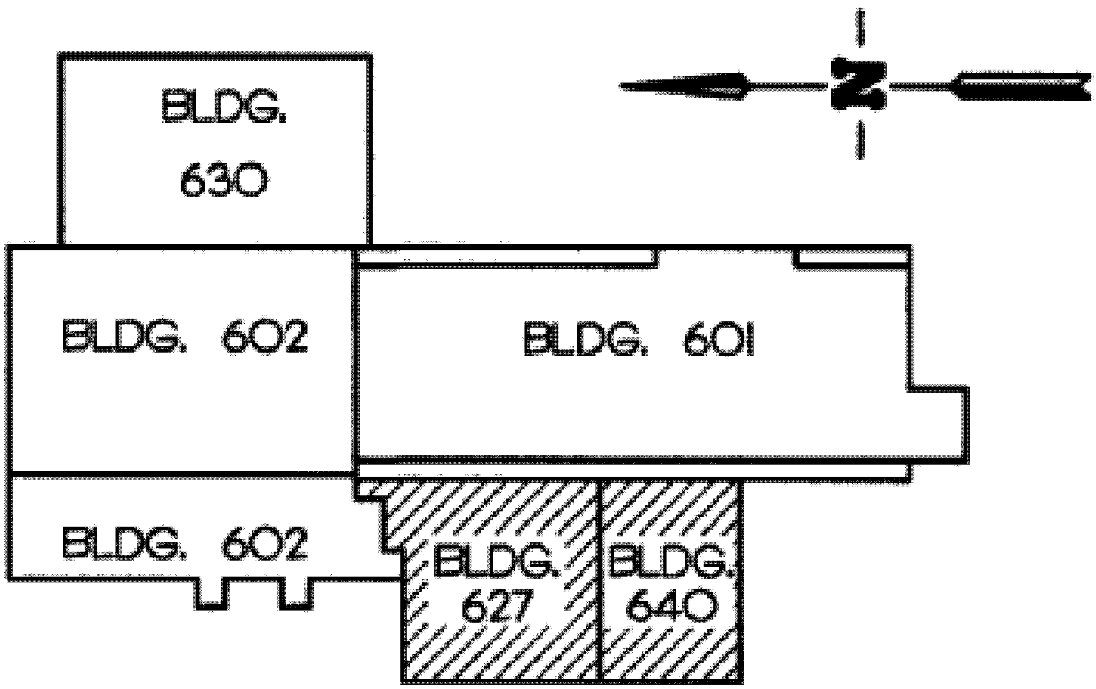

Figure 2. CPP-640 location.

Cells 3 and 4. Each cell is 3.5 × 5.2 × 9 m (11.5 × 17 × 30 ft). The cells were combined by removing the 1-m (3.5-ft)-thick wall between them. Access to the expanded cell is through the Cell 4 access hatches and an access hatch from Cell 3, or through an entry way (1.0 m [3.5 ft] high) covered by a sliding, shielded door at the bottom of each cell.

Cell 5. The cell is 3.5 × 5.2 × 9 m (11.5 × 17 × 30 ft) and contains the abandoned EDP equipment. The cell also contains a viewing window. The cell floors are constructed of reinforced concrete, lined with stainless steel, which extends up the walls to a height of 1.4 m (4.5 ft).

Hot Makeup Area. The HM area of the HPP was formerly used for mixing process chemicals, decontamination solutions, or other chemical solutions used in the HPP process cells. The operation panels (except for one) have also been removed. The remaining panel still has active instrumentation for the waste tank and sump level instrumentation that remain in service for Resource Conservation and Recovery Act (RCRA)-regulated compliance.

Floors. The concrete floors generally are 1 ft thick and placed monolithically, with floor loading specifications of 2,000 lb/ft^2 for the HM deck and unloading areas, and 200 lb/ft^2 for the other areas. A polyurethane floor finish covers the floors of the process, and access areas. The reinforced concrete walls, except for the cell walls, generally are 0.3 m (1 ft) thick. The interior walls enclosing stairways, offices, and elevator shafts are constructed of 20-cm (8-in.)-thick concrete. The floor of the chemical makeup area, which was located 6 m (20 ft) south of the HM area, is covered with stainless steel. The floor of the HM area is covered with epoxy paint. Asphalt tile covers the office floor, and the remainder of the floor is covered with a polyurethane floor finish.

Walls. CPP-640 shares common walls with CPP-601 and CPP-627. The building is a six-level structure extending from 10.1 m (33 ft) below grade to 10.4 m (34 ft) above grade at the top of the south wall with a rectangular floor plan that is 20 m × 27 m (66 ft × 89 ft). The reinforced exterior concrete walls extend to an elevation of 3.2 m (10.5 ft); above this, the walls are constructed of concrete masonry units. The floors are constructed of reinforced concrete, except for the south side of the operating floor, which consists of a metal deck plate.

Cell construction. Exterior process cell walls and ceilings are constructed of 1.3 m (53 in.) normal-density concrete. The wall between Cells 1 and 2 is constructed of 0.6-m (2-ft)-thick, high-density concrete. The other common cell walls are constructed of 1-m (3.5-ft)-thick ordinary, reinforced concrete. The five cells have ceiling hatches, each 1.4 m (4.5 ft), at the PM floor level, that provide access to the cells for equipment installation or removal.

Roof. The HPP has a 1:8-pitch ridge roof and is designed for a vertical live load of 30 lb/ft^2. The roof is constructed of corrugated asbestos roofing over structural steel trusses, which are supported by beams, columns, and walls.

Waste Tank Vaults and Control Room. Three liquid waste tanks are located in two shielded vaults that are accessible through hatches in the tops of the vaults. These waste tanks were noted as "HPP tanks" on some older drawings. The vault walls and floors are constructed of reinforced concrete.

Waste Tanks HW-100 and -101 are located in the radioactive waste tank vault, and waste tank HW-102 is located in the nonradioactive waste tank vault. Prior to 1985, these vessels collected radioactive and nonradioactive liquid material from the HPP drains. Pumps were then used to pump the tank contents directly to the westside waste holdup tanks (VES-WL-103, -104, and -105), which are located in CPP-641.

In 1985, Tanks HW-100 and -101 were emptied and taken out of service. The tanks are connected to the CPP-601 vessel off-gas system, so the tanks are most likely dry. However, the drain lines to these two tanks have not been isolated; therefore, the tanks could still physically receive material. These tanks could also receive material from the in-vault sump. Instrument readings confirm that Tanks HW-100 and -101 are empty and are not receiving liquids. However, since level-detection instruments are approximately 2 in. from the bottom of the tanks, there could be as much as 50 L (13 gal) of heel remaining in these tanks. If any inadvertent liquid heel accumulates in HW-100 or -101, the contents can be jetted to HW-102, via the System Jets HW-500 and HW-503, respectively. Tanks HW-100, -101, and –102 are part of an interim status unit.

In 1985, Tank HW-102 was decontaminated. Currently, it is in service to receive nonhazardous material from leaks in the building roof and from the building heating system or similar condensate that is collected in the floor drains. The tank could also receive material from the in-vault sump. As necessary, Waste Tank HW-102 is discharged to the CPP-601 process equipment waste (PEW) collection system using the system pump.

The waste tank control room is located on top of the waste tank vaults on the second level below ground. The waste tank control room provides controls for waste tank operation and access to tank vaults and Cell 3/4.

3. MATERIAL INVENTORY

The status of the HPP has been reviewed. These areas have been cleaned of all hazardous chemicals. Based on analytical results from flushing activities, Cells 2 and 5 have been removed from criticality control area (CCA) status.[5] The fissile material in the Rover portions of the facility are listed in Table 1.[6] These quantities of fissile material are not considered accessible, because the fixed material has been immobilized in grout in the vessels. All areas have both fixed and loose radiological contamination. The cells are posted as high-radiation and high-contamination areas.

The facility contains approximately 41 ton of lead. The lead may be in the form of shot, sheeting, wool, or bricks as needed to shield equipment and provide protection for workers. There is no limit on the amount of solid lead greater than 100 microns (0.004 in.) in diameter listed in 40 CFR 302.4; therefore, lead in these forms is not considered releasable.[7]

Table 1. Estimated remaining quantities of U-235 (g).

Vessel/Area	Loose U-235	Fixed U-235	Total U-235
MHC Surfaces	1	NA	1
Cell 3/4 Surfaces*	5	NA	5
VES-100	NA	924	924
VES-104	NA	318	318
VES-106	20	NA	20
Sample Blister	1	NA	1
Total	27	1,242	1,269

* Includes material on the surface of the cell and the internal/external surfaces of all remaining equipment within the cell.

4. HAZARD ASSESSMENT

The pertinent hazard to facility hazard assessment at the HPP is radioactive contamination and the resultant radiation fields. In accordance with the 1997 Uniform Building Code, CPP-640 is classified as a Group F-1 occupancy. The total quantity of hazardous materials is maintained below the requirements for a Group H (hazardous) occupancy.[8] There are no biological, explosive, or live-fire range hazards associated with this facility.

All facility operations have been shut down. The Cell 5 and Rover Cell 2 wet side equipment have been flushed out, and most of the Rover dry side vessels have been removed. All chemicals, accessible fissile material, and any other loose materials have been removed from the facility. The only quantities of hazardous chemicals and nonradiological materials that remain are small quantities that may be trapped in isolated portions of the wet side equipment and solid lead used for shielding.[9]

There is some fissile material that has been immobilized in grout in system vessels that makes it unavailable for a criticality and vessel VES-106 is estimated to contain 20 g of loose U-235.[10]

4.1 Radiological Materials

Cell 5 is locked and posted as a high-radiation area. During the last EDP processing campaign, a leak developed in the dissolver and unknown amounts of material spilled onto the cell floor. After the final process run in 1981, Cell 5 and the EDP vessels were flushed out several times, using a multistep process of water, nitric acid, sodium hydroxide, Turco 4502, and Turco 4521. In 1995, additional RCRA-regulated flushes and sampling were performed on the Cell 5 equipment using nitric acid and water. A survey and inspection of Cell 5 was conducted on June 18, 2003.[11] The results of the survey are consistent with the radiation levels expected from old spills associated with the leaks that caused the process to be shut down in 1981. The readings in the range of 2 to 3 R/h around portions of the dissolver vessel are consistent with other dissolution equipment in other INTEC facilities after extensive decontamination. Based on the results of this survey, an analysis was performed to determine a possible source term for the recorded radiation readings. The model used a log normal average radiation exposure rate of 700 mR/h at

1 m. The resultant source term was compared against the threshold quantities in DOE-STD-1027-92. The results of the comparison shows that the radiological material at risk (MAR) remaining in Cell 5 is below the Hazard Category 3 thresholds, the sum or the ratios result was 0.18. The primary contributors to this value are shown in Table 2. The calculations to determine the source term and hazard category determination are contained within Engineering Design File (EDF)-2551.[12] The radioactive material inventory in the HPP is contained in contamination on facility walls, floors, and equipment, or held up in the vessels.

Table 2. Hazard Category 3 sum of ratios major contributors

Radionuclide	Inferred Curies (Ci)	Hazard Category 3 Ratio
Cs-137	8.9E+00	1.5E-02
Pu-239	5.9E-02	1.1E-01
Sr-90	8.0E+00	5.0E-02

The Cell 2 wet system vessels were flushed twice with borated water and then drained. Heelout was performed, using nitric and a final flushing with water. Final RCRA-regulated flushes were conducted in 1996, using nitric acid and water. Records indicate Cell 2 has a general body field of <50 mR/h, but no recent survey has been performed.[9] This radiation level is more than a factor of 10 less than the 700 mR/h used in EDF-2551 for the Cell 5 source term; therefore, this cell would not be expected to contain radiological materials in excess of the Hazard Category 3 thresholds either, and should not impact the overall hazard categorization of the facility.

Based on the results of the flushing activities in Cells 2 and 5, the results of the EDF to determine the MAR in Cell 5, and the past deactivation activities that were performed on the Rover equipment and cells (which includes Cell 2), the remaining radiological materials do not exceed the Hazard Category 3 thresholds in the CPP-640 facility

4.2 Hazardous Material Inventory

There are no hazardous materials that pose a hazard. Approximately 41 ton of solid lead remain in the facility. There is no limit on the amount of solid lead greater than 100 microns (0.004 in.) in diameter listed in 40 CFR 302.4.[7] There may be residual quantities of chemicals contained in isolated spots in the piping systems. These quantities are qualitatively estimated to be too low for consideration because of the extensive flushing of the systems that has been done.[9] There are no other inventories of hazardous materials or chemicals within the HPP facility. Based on inspections and past flushing activities, the inventories of materials are qualitatively estimated to be less then the threshold quantity (TQ) levels from 29 CFR 1910.119, or the threshold planning quantities (TPQs) from 40 CFR 355.[13,14]

4.3 Criticality

All possible fissile material has been removed from Burner Vessels VES-100 and VES-104 and vacuum vessel VES-106. Table 1 lists the final quantities of U-235 remaining in the Rover facility.[6] The remaining loose quantities of fissile material in the burner vessels could not be removed without disassembling the vessels. Due to significant industrial and radiation safety concerns, disassembly was not feasible. The burner vessels have been filled with grout as an immobilizing agent and left in place for final disposition. The grout effectively immobilizes the remaining fissile material in the vessel, eliminating any possibility of a criticality in the Rover facility.[10]

The values in Table 1 are based on large area smears of the cells, samples of material taken from the cans of burned uranium-bearing material, samples from the vessel interiors, and estimates of the amounts remaining in the vessels.[6] As a safety factor, the burner vessel U-235 values have been increased by 50% to allow for error.

The burner vessels are constructed of Hastelloy. Hastelloy is a strong, corrosion-resistant nickel-based alloy that provides protection for the grout. Therefore, once filled with grout, the vessels became monoliths encased in Hastelloy. The inner solidified grout should last indefinitely, unless acted upon by outside forces, such as weathering or physical impacts. The capped or plugged and grouted burner vessels will remain in place in Cell 3/4 inside the HPP, and are therefore, protected from environmental conditions and physical impacts.

Based upon the inferred source term developed in EDF-2551, Table 3 lists the potential fissile material quantities in Cell 5.

Table 3. Cell 5 source term fissile material

Radionuclide	Curies (Ci)	Specific Activity (Ci/g)	Mass (g)
U-233	1.50E-09	2.07E+01	7.23E-11
U-235	2.30E-07	2.13E-06	1.08E-01
Pu-239	5.90E-02	6.13E-02	9.62E-01
Pu-241	5.90E-05	1.14E+02	5.19E-07

The Cell 2 and Cell 5 equipment have been flushed out with water, acid, and other decontamination chemicals and have been removed from CCA status.[5] All accessible fissile material has been removed from the facility. No storage of fissile material is allowed in any of the HPP areas. The subcritical mass limit for U-235 is 760 g (1.67 lb) (k_{eff} = 0.98).[15] Since there is insufficient loose fissile material available to collect together for a criticality, as shown in Table 1, no criticality hazard exists in the HPP facility.[16]

4.4 Direct Radiation Exposure

The radiation levels in the Rover portion of the facility (Cells 1-4 and the MHC) all have general radiation levels of <50 mrem/h.[9] Cell 5, which contains the EDP equipment, has a sump in one corner measuring approximately 20 R/h 0.6 m (2 ft) above the floor. The highest radiation in the remainder of Cell 5 is 3 R/h.[11] The Radiation Protection Program controls this hazard and there is no reasonable mechanism for failure of these controls that would result in a significant dose to workers and these radiation levels would not be expected to challenge the 100 rem in one hour whole body or the 500 rem in one hour to extremities criteria.[4]

4.5 Other NRASA Criteria

There are no x-ray equipment, toxic materials, explosive materials, lasers, kinetic energy, pressure, high temperature, or biohazards present in the facility. There are no hazards posed by electrical energy and flammable materials beyond those allowed in national codes and standards.

5. CONCLUSION

The HPP is categorized as less than a Hazard Category 3 nuclear facility because the radiological MAR of Cells 2 and 5 as discussed in Section 4.1, is less than the DOE-STD-1027-92 thresholds, and there is no longer a criticality hazard, as discussed in Section 4.3. Furthermore, the facility does not contain hazardous materials in excess of the TQs of 29 CFR 1910.119 or the TPQs from 40 CFR 355, as discussed in Section 4.2. The facility does not have direct radiation exposures that would exceed the thresholds of DOE Order 420.D, as discussed in Section 4.4. Approximately 41 ton of solid lead remains in the facility. There are no x-ray equipment, toxic materials, explosive materials, lasers, kinetic energy, pressure, high temperature, or biohazards present in the facility. There are no hazards posed by electrical energy and flammable materials beyond those allowed in national codes and standards. Therefore, the facility is classified as a NRASA facility.

Therefore, since the facility does not contain any unique unmitigated hazards that present a potential impact on worker safety, no additional safety analysis is required beyond what is presented in this document and any activities conducted for deactivation can be safely controlled using sitewide hazard and work control programs and the sitewide programs listed below.

The INEEL environmental management, radiation protection, emergency preparedness, safety and industrial hygiene, and quality assurance (QA) programs for the continuous safe operation of all facilities apply to the operation and conduct of operations for the CPP-640 facility. The Integrated Safety Management System (ISMS) provides for identification and analysis of hazards, development and implementation of hazard controls, and performing the work safely with feedback and continuous improvement. The ISMS is implemented by STD-101, "Integrated Work Control Process,"[17] and company procedures such as Management Control Procedure (MCP)-3562, "Hazard Identification Analysis and Control of Operational Activities."[18]

6. REFERENCES

1. 10 CFR 830, Subpart B, "Safety Basis Requirements," *Code of Federal Regulations*, Office of the Federal Register, January 1, 2001.

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11. Form 441.45, "Radiological Survey Report," RWP# 31003058-01, Log 3, 1035 hours, CPP-640 Cell 5, June 18, 2003.

12. EDF-2551, "Head End Processing Plant (CPP-640) Cell 5 Radionuclide Inventory Inference and Hazard Categorization," December 18, 2003.

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17. STD-101, "Integrated Work Control Process," Rev. 5, July 28, 2003.

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